JIMAR Joint Institute for Marine and Atmospheric Research

JIMAR

Annual Report for Fiscal Year 2016

For Cooperative Agreements NA11NMF4320128 and NA15NMF4320128

Mark A. Merrifield, PhD
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SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

Annual Report for Fiscal Year 2016

Performance Period July 1, 2015–June 30, 2016

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Introduction

Mark Merrifield, Director

The Joint Institute for Marine and Atmospheric Research (JIMAR) manages the Cooperative Institute for the Pacific Islands Region, one of 16 NOAA cooperative institutes nationwide. JIMAR's mission is to conduct 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 numbers NA11NMF4320128 and NA15NMF4320128. 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;
- sponsor interactions through the support of visiting scientists and post-doctoral scholars;
- promote the transition of research outcomes to operational products and services that benefit the Pacific Islands Region.

JIMAR is located at the University of Hawaii, a research-intensive land-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 substantially 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.

The principal NOAA Line Office for JIMAR is the National Marine Fisheries Service (NMFS), and JIMAR collaborates closely with the Pacific Island Fisheries Science Center (PIFSC) at the Inouye Regional Center (IRC). 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 ~25 JIMAR projects ranging from 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 also interacts with the NOAA NWS, NESDIS, and 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. JIMAR programs active in these areas include the University of Hawaii Sea Level Center (UHSLC), the Pacific ENSO Applications Climate (PEAC) Center, and the Pacific Island Ocean Observing System (PacIOOS).

JIMAR research covers eight themes, all aligned with the NOAA strategic plan and the University's Indo-Pacific mission. The themes are: (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.

The year 2015-16 was an especially active period for JIMAR researchers, with a focus on impacts in the Pacific Islands region of the largest El Niño event in nearly 20 years. Strong westerly wind bursts in early 2014 led to forecasts of an El Niño that ultimately failed to materialize. This set the stage, however, for the strong event that peaked in late 2016 with significant changes in tropical typhoon activity, shifts in precipitation patterns, and the flip in the zonal seesaw pattern resulting in anomalously high water levels in the east Pacific and low levels in the west. JIMAR's Pacific ENSO Applications Climate (PEAC) Center issued advanced warnings and practical information that helped with mitigation efforts throughout the Pacific Island region. The sea level variations during the El Niño event were forecast in a new multimodel seasonal product developed by Matthew Widlansky of the International Pacific Research Center and others, which is now available through JIMAR's University of Hawaii Sea Level Center (UHSLC). JIMAR also provided partial funding for Dr. Widlansky to continue his

studies of the meridional changes in El Niño sea level, with field observations in American Samoa to document low water levels and their impact on coral reefs.

JIMAR supported a team led by Samantha Stevenson to continue NSF-sponsored field observations in the Line Islands to capture dynamical processes affecting temperature, salinity, isotopic variability, and local circulation throughout all phases of an El Niño event. The information will provide dynamical constraints which will yield new insights into coral-based reconstructions of ENSO. In addition, researchers at the UHSLC contributed to a new study documenting the sea level response to the recent El Niño and an accompanying shift in the state of the Pacific Decadal Oscillation. JIMAR researchers will continue to study the 2015-16 El Niño event for years to come.

JIMAR's collaboration with the NOAA Pacific Islands Fisheries Science Center (PIFSC) drives the primary research and educational activities within the Institute. Here are a few 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.

- The identification of regions of essential habitat is key for environmental planning to mitigate the potential impacts of anthropogenic activities on marine mammal populations. A satellite tagging study led by JIMAR's Melanie Abecassis examined relationships between whale habitat and the environment. The study emphasized the importance to whale foraging of midwater micronekton, which likely represents an energy and nutrient transfer link between nearshore and oceanic ecosystems which is essential to supporting insular cetacean populations.
- Tools that reduce bycatch mortality have long been a central focus of the Institute. JIMAR Senior Fisheries Economics Specialist Hing Ling Chan and PIFSC Economist Minling Pan recently examined spillover effects resulting from U.S. fishing regulations instituted to protect sea turtles. When one fishery is required to curtail fishing activity to reduce incidental fishing mortality on sea turtle populations, the activity of other, unregulated fleets may change in ways that adversely affect the very species intended for protection. An empirical model was developed to estimate these "spillover effects" on sea turtle bycatch in the North and Central Pacific Ocean.
- To ensure continued seafood harvests for global societies, understanding relationships in oceanic food webs is critical, especially at a time where the ocean is experiencing both large-scale environmental changes and continued fishing pressure. JIMAR's Anela Choy, Mariska Weijerman and others developed an ecosystem model of the central North Pacific food web designed to examine which mid-trophic groups are important to moving energy up to tunas, billfishes, and sharks. The study revealed a complex pelagic food web where small crustaceans and medium and larger squids were most efficient at transferring energy from the bottom of the food web up to commercially important fish species.
- Innovative sampling strategies are needed to assess fish abundance and length frequency distributions. Using baited stereo-video surveys of bottomfish in the Main Hawaiian Islands, JIMAR's William Misa with PIFSC and UH-Manoa researchers showed how optimization of sampling soak time allow for better survey efficiency and improved cost–benefits through potential improved field sampling, reduction in video-processing time, and ability to detect differences in relative abundance and lengths.
- JIMAR researchers are concerned with the sustainable management of coastal fish populations in Hawaii waters and elsewhere. A study by JIMAR scientist Marc Nadon, along with researchers from PIFSC and the Rosenstiel School Marine and Atmospheric Science presents the first large-scale single-species assessment of reef fishes in the Main Hawaii Islands. They used average fish length values obtained from both diver surveys and commercial catch reports to calculate current exploitation rates and stock status. The study demonstrates the robustness of the length-based data-poor modeling approach.
- Conserving living marine resources is important to the people of the Pacific Islands. JIMAR Marine Turtle Research Specialist Denise Parker and others examined the movement of five satellite tagged adult female green turtles (*Chelonia mydas*) from their nesting beach at the Republic of the Marshall Islands to various parts of the North and South Pacific through multiple Exclusive Economic Zones. This study highlights the international connectivity of green turtles, and their findings can be used to exchange information and enhance regional conservation efforts between nations that share these endangered and culturally important turtle resources.
- The impact of climate change on ocean acidification and coral reefs is a fundamental concern. JIMAR's Bernardo Vargas-Angel, Chip Young, and collaborators determined a comprehensive baseline of carbonate accretion rates primarily by crustose coralline algae (CCA) on Calcification Accretion Unit CAU plates deployed across reef systems in American Samoa and the Pacific Remote Islands. The study highlights the role played by CCA as a reef calcifier and offers a unique perspective to contextualize our understanding of the

potential effects of ocean acidification with different scenarios of future ocean chemistry.

JIMAR devotes a significant portion of its annual budget to educational opportunities for K-12 students through to postgraduate research training. To engage the next generation of marine scientists, JIMAR researchers working in the NOAA Pacific Islands Fisheries Science Center (PIFSC) and the NOAA Pacific Islands Regional Office (PIRO) regularly participate in the annual "Fisheries Science Camp" held in the Inouye Regional Center (IRC) on Ford Island, Oahu. This free, five-day camp is designed for 8th grade students from economically underserved communities and consists of several science modules, a field trip to Waikiki Aquarium, and a beach cleanup. Each segment of the camp includes hands-on experiences for the young campers in fisheries research areas such as marine debris, fish sampling techniques, stock assessment, marine food webs, plankton, marine animal behavior, and fishing and fisheries data. In addition, local teachers are engaged to develop kit lessons based on the science modules, including lesson plans to reach Hawaiian students throughout the school year.

Undergraduate research supported by JIMAR during the past year included: translations of Hawaiian language newspapers during the monarchy period which enhance understanding of hurricane events and their impacts on the island region prior to the advent of instrumented environmental monitoring; collection of tree ring samples from high elevation forests in Hawaii to examine climate reconstructions; and participation in research cruises to a marine ecosystem in a high latitude environment that is potentially exposed to dramatic climate shifts. JIMAR-sponsored graduate research assistantships allowed for the pursuit of studies focused on: coastal inundation events and flooding along Pacific Island shorelines; changes in wind wave climatologies across the Pacific Island region and possible impacts on beach morphology; the influence of ocean processes on nutrient upwelling to coral reef communities; and ENSO influences on draught conditions in the Pacific Island region. After an extensive international search, Dr. Jonathan Whitney was nominated this year as the JIMAR Postdoctoral Fellow. He will collaborate with UH-Manoa, JIMAR, and PIFSC researchers on a variety of projects aimed at understanding how biological and physical processes impact marine ecosystems and fish recruitment.

Other educational events supported during the reporting period are the 41st Albert L. Tester Symposium (April 6-8, 2016, University of Hawaii at Manoa) and the PIFSC Young Scientist Opportunity (PYSO) 2016 summer intern program. The PYSO is a collaborative program between PIFSC and JIMAR that offers qualified participants professional scientific research experience and training under the mentorship of selected researchers of the PIFSC.

JIMAR provides administrative support for the Pacific Islands Ocean Observing System (PacIOOS) program, which empowers ocean users and stakeholders in the Pacific Islands by providing accurate and reliable coastal and ocean information, tools, and services that are easy to access and use. During the reporting period, PacIOOS served information and data to over 200,000 unique users, totaling 1.28 million web page views on the pacioos.org website, and over 500 GB of data transferred to users outside of UH during FY 2016. Operational wave and ocean modeling products, as well as wave run-up forecasts were expanded or refined to better serve the Marshall Islands and Hawai'i. PacIOOS continues to maintain over 30 deployed buoys, sensors and other instruments throughout the U.S. Pacific Islands, including a new high frequency radio station in Kapolei, which provides real-time surface current information as far as 120 km from shore. More than 1,600 individual datasets (both PacIOOS and partner data) are available to the public through PacIOOS' data visualization platform 'Voyager' at http://pacioos.org/voyager.

A one-day meeting of the JIMAR Council of Fellows was held on April 29, 2016 at the Imin Conference Center, UH Manoa Campus. The meeting purpose was to develop the role and responsibilities of the Council in the overall governance of JIMAR and to define what ways the Council with its extensive range of expertise and experience can best be utilized to ensure JIMAR continues to conduct high-quality scientific research and engage in productive collaboration between UH, NOAA and other research entities. Another priority of the meeting was to identify other research and educational opportunities that will enhance JIMAR's program goals and priorities.

Finally, JIMAR's Visiting Scientist Program promotes an invigorating scientific exchange between local researchers and leading scholars from around the world. JIMAR was fortunate to host experts in global sea-level rise, fisheries sciences, ocean mixing, climate dynamics, state-of-the-art numerical ocean modeling, and climate policy. The Visiting Scientist Program also provided support for JIMAR researchers to attend meetings and workshops in support of our research theme areas. Notably, JIMAR was able to provide travel support to Global Environmental Science student and C-MORE Scholar Jennifer Wong-Ala to attend the 2015 ICES Annual Science Conference in Copenhagen, Denmark, where she was awarded the Best Oral Presentation Award by an Early Career Scientist.

It has been a busy and productive year for JIMAR. The project descriptions that follow in the next section will provide a glimpse of the vital role 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. And a new video produced by the school's outreach office presents more information about the JIMAR program. The video can be found at https://www.youtube.com/watch?v=SpjpH5MCgMk.

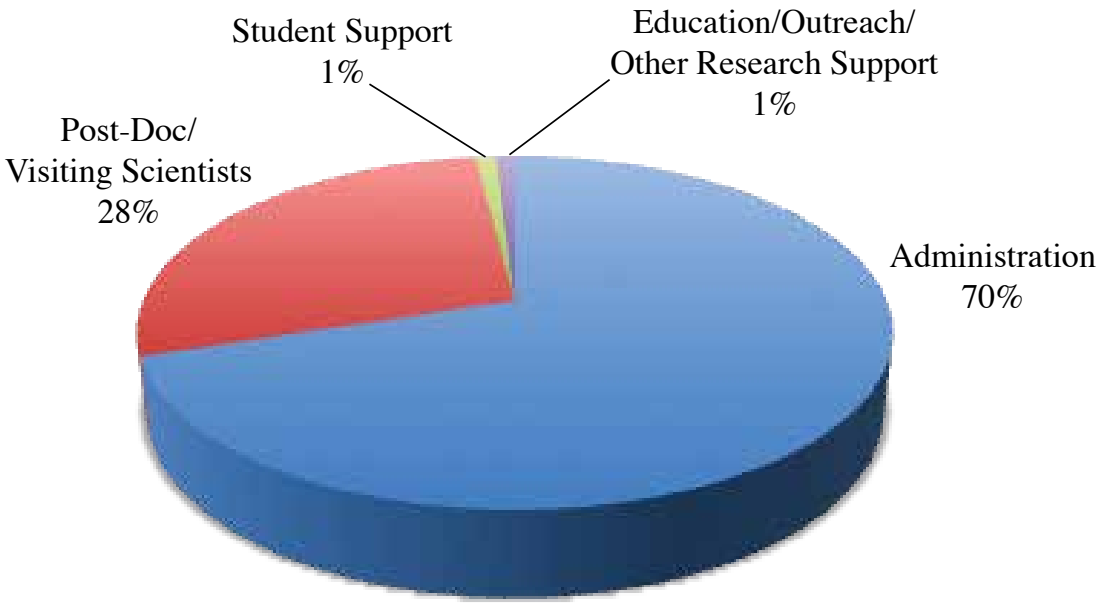
The Director of JIMAR is a regular member of the University of Hawaii faculty and is appointed through joint decisions by leaders of the University and NOAA Research. The Director reports to an Executive Board composed of University and NOAA officials. The Director manages day-to-day operations through the administrative staff (fully-supported by the Cooperative Agreement and returned indirect cost funds), Program Managers and faculty PI/Directors. A Council of Fellows advises the Director on research priorities, major expenditures and visiting scientists.

JIMAR Council of Fellows from NOAA are Dr. Christofer Boggs (PIFSC), Dr. Russell Brainard (PIFSC), Dr. Edward DiMartini (PIFSC), Mr. Justin Hospital (PIFSC), Dr. Gregory Johnson (PMEL), Dr. William Kessler (PMEL), Dr. John Marra (PRCS), Dr. Michael McPhaden (PMEL), Dr. Dennis Moore (PMEL), Dr. Frank Parrish (PIFSC), Dr. Jeffrey Polovina (PIFSC), Dr. Christopher Sabine (PMEL), Dr. Michael Seki (PIFSC), and Mr. Raymond Tanabe (NWS).

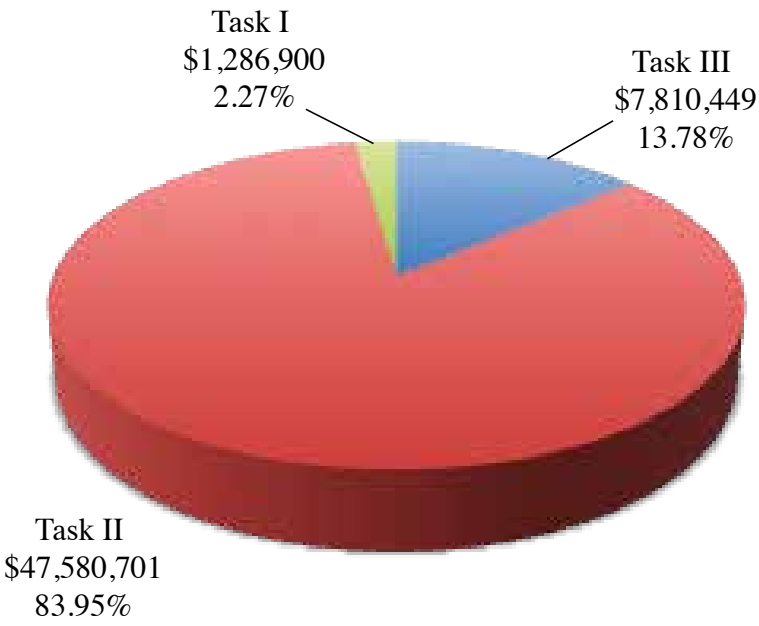
JIMAR Council of Fellows from the University of Hawaii are Dr. Gary Barnes, Dr. Steven Businger, Dr. Jeffrey Drazen, Dr. Eric Firing, Dr. Erik Franklin, Dr. Kim Holland, Dr. Roger Lukas, Dr. Douglas Luther, Dr. Margaret McManus, Dr. Anna Neuheimer, Dr. James Potemra, Dr. Brian Powell, Dr. Robert Toonen, and Dr. Bin Wang.

Task I is the base program of JIMAR. It provides research support for the visiting scientist and postdoctoral programs, and the administrative support for the Institute. The University of Hawaii contributes to this task by bearing all indirect costs, and by paying the salary of the Director. Funding percentages by activity are exhibited in the following chart.

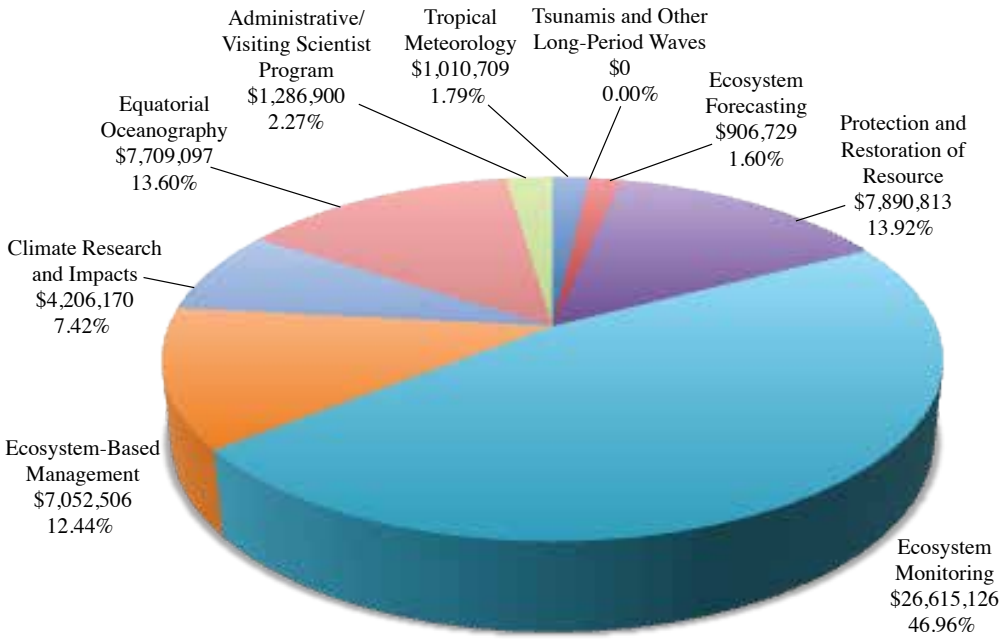
Distribution of JIMAR's Task I NOAA Funding by Activity



Distribution of NOAA Funding by Task (FY 2012-2016)



Distribution of NOAA Funding by Theme (FY 2012-2016)



Accomplishments for Fiscal Year 2016

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.

ADMB Open Source Project

P.I: John R. Sibert

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

NOAA Sponsor: Michael P. Seki

Budget Amount: $165,000

NOAA Goal(s):

- Resilient Coastal Communities and Economies
- NOAA Enterprise-wide Capabilities: Science and Technology Enterprise; Engagement Enterprise; Organization and Administration Enterprise

Purpose of the Project

The general purpose of the ADMB Open Source Project is to maintain and improve the ADModel 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 2016

During FY 2016, work continued on a number of ADMB Project priorities. Minor release of the software, with improvements and fixes to the documentation, installation procedure, and source code, was delivered in December 2015 (ADMB 11.5). The ADMB Project will start supporting Template Model Builder (TMB) developed by Kasper Kristensen of the Technical University of Denmark. Both ADMB and TMB software are similar in what they do but use very different approaches for computing automatic differentiation. By collaborating with each other, both software projects will benefit from each other in improving testing, design and developing new features.

Other project tasks accomplished during FY 2016 related to improvements in project infrastructure. Notably, the ADMB Project migrated many of its core services to GitHub, a widely used web-based server for hosting open source projects. Moving to GitHub enabled the project to either replace or improve, several services used by the ADMB Project, including the following: 1) moving the main ADMB website from NCEAS to a commercial hosting site; 2) moving content from content management system Plone to WordPress; and 3) improving and streamlining the main ADMB website on WordPress.

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.

A Biogeographic Assessment of Reef Fishes, Fisheries, and Benthic Assemblages in Hawaii

PI: Alan Friedlander

NOAA Office (of the primary technical contact): Biogeography Branch, Center for Coastal Monitoring and Assessment

NOAA Sponsor: Matt Kendall

Budget Amount: $56,098

Purpose of the Project

Working with NOAA's Biogeography Program, the purpose of this project is to conduct a biogeographic assessment of reef fish and benthic assemblages in the Main Hawaiian Islands (MHI) to support Bureau of Ocean and Energy Management (BOEM) efforts to manage renewable energy activities in Hawaii. The objectives for the assessment include: 1) characterizing the distribution of reef fishes and benthic assemblages found within the Main Hawaiian Islands; 2) identifying spatial and temporal data gaps; and 3) supporting marine spatial planning in the MHI. The assessment will help to define the biogeographic distribution of fishes across the MHI with the intended goal of developing a biogeographic framework to examine natural and anthropogenic factors that influence the patterns of reef fish distributions and benthic assemblages across one of the most unique and isolated marine ecosystems on earth. This assessment will also help support ecosystem-based management and marine spatial planning of the MHI by multiple federal agencies.

Progress during FY 2016

A total of seven tasks were outlined for the entire two-year study. Tasks 1 and 2 were completed in FY 2015 and the remaining tasks were accomplished in FY 2016. The third task was to synthesize GIS data to create complete data layers that span the study area, and the fourth task was to conduct spatial analyses to identify biogeographic patterns and ecologically important regions. Project staff produced spatial predictive maps for several variables in the study region (MHI), including summary information and metadata (task 5). A draft report of the project findings was completed (task 6) and is in preparation for publication.

Bio-Sampling

PI: Mark A. Merrifield [JIMAR Project Lead: Brett Taylor]

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

NOAA Sponsor: Michael P. Seki, Robert Humphreys

Budget Amount: $217,400

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project conducts primary research on marine species that represent major food and cultural resources to the Pacific Islands Region. The projects aims to provide scientific data to those charged with the management of marine resources as mandated by legislation (e.g., Reauthorized Magnuson Stevens Act). The primary objectives of the NOAA Life History Program (LHP) and the JIMAR Biosampling project is to conduct fundamental biological and ecological research on harvested marine species, provide new or improved estimates of life history parameters (length-at-age growth curves, size at maturity, spawning seasonality, length-weight relations) and improve and support the biological data needs of ongoing and future stock assessments of fishery resources in Hawaii and the Pacific Island Territories.

Progress during FY 2016

The project exceeded the intended objectives for FY 2016. The quantity of necessary laboratory work was a bottleneck in the beginning of the project period, but JIMAR Biosampling staff managed to section and interpret 7,000 otolith samples and 1,800 histologically-prepped gonad slides of specimens for research. JIMAR staff also conducted research onboard a 47-day NOAA research cruise through the Samoan Archipelago, during which they (with the LHP) sampled over 500 coral reef fishes and 1,000 deepwater bottomfishes for life history research. A new and vastly improved life history data base was developed to collate and manage the various data holdings of the Territorial Biosampling and LHP data bases. Biosampling staff also collaborated with international agencies (Western Australia Department of Fisheries and Secretariat of the Pacific Community) to advance biological research of deepwater eteline snapper species. Finally, staff conducted four site visits to U.S. Pacific Island Territories and lead workshops in Guam and Saipan to train Biosampling staff and collaborators on effective otolith sectioning techniques.

Figure 1. JIMAR Biosampling and NOAA Life History Program staff poses with participants from the American Samoa Community College during a science outreach event shortly before departing on the SE 16-01 Samoan Archipelago Research Cruise.

Figure 2. JIMAR Biosampling scientist Brett Taylor demonstrates otolith processing techniques during a workshop at the University of Guam in February 2016. Workshop participants included representatives from the University of Guam, NOAA, JIMAR, Guam Fishermen's Cooperative, Western Pacific Regional Fishery Management Council and Guam Division of Aquatic and Wildlife Resources.

The work efforts listed above resulted in several research outputs as well as media attention. A draft manuscript was completed which documents the median length at female maturity for the Hawaiian opakapaka (*Pristipomoides filamentosus*). Five other research papers were accepted for publication during FY 2016 covering topics of speciation, life history traits and ecology of coral reef fishes and deepwater snappers and groupers. Three other manuscripts are currently submitted and under review. Also, a NOAA report was published internally which details the efforts and strategy of the Commercial Fisheries Biosampling Programs in each of the U.S. Pacific Island Territories, and an oral presentation was delivered at the 13th International Coral Reef Symposium highlighting the largest study of life history variation ever conducted on coral reef fishes. Finally, the NOAA research cruise to the Samoan Archipelago received notable media attention both in American Samoa and Independent Samoa (Western) news agencies.

Ecosystem Modeling

P.I.: Mark A. Merrifield [JIMAR Project Lead: Melanie Abecassis]

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

NOAA Sponsor: Michael P. Seki, Jeffrey J. Polovina

Budget Amount: $62,500

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The purpose of this JIMAR project is to update a population dynamics model for swordfish to investigate potential strategies for reducing loggerhead turtle takes in the Hawaii-based shallow longline fishery by modeling swordfish habitats with the SEAPODYM model using revised fishing data. The project will also examine changes in the oceanography and ecology of the North Pacific Transition Zone (TZCF), and continue processing acoustic data from previous cruises and laboratory analysis of lancetfish stomachs provided by the Longline Observers Program.

Progress during FY 2016

Two journal publications summarizing previous work for this project were finalized and published. One paper, published in *PLOS ONE*, characterized the relationships between the density of short-finned pilot whales and Blainville's beaked whales in the West Hawai'i region and the biomass of micronekton and environmental variables. The second paper, published in *Marine Ecology Progress Series*, described how changes in the various micronekton functional groups impact apex predator production using the Ecopath with Ecosim ecosystem model, and highlights the importance of different energy pathways from lower trophic level animals up to commercially harvested apex predators.

Acoustic data from a NOAA research cruise in the North Pacific TZCF region were cleaned, processed and analyzed for micronekton biomass to provide a better understanding of the forage biomass in that area.

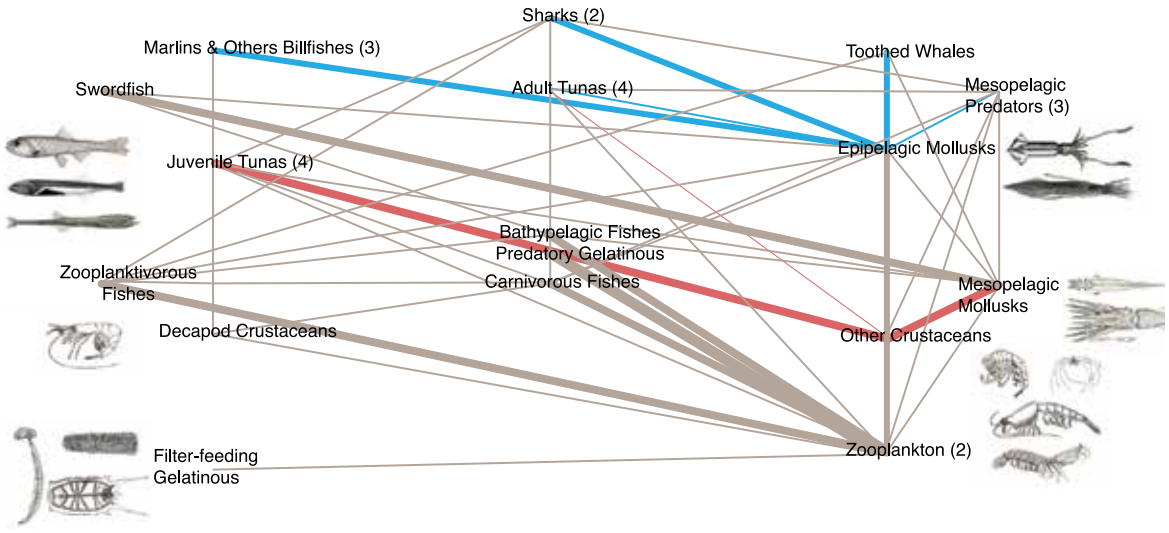


Figure 1. Simplified food web diagram showing the energy flow through key micronekton and top predator functional groups. Diet proportions 5% or greater (from the balanced diet matrix) are shown between groups, where the thickness of the lines is scaled to parameterized diet proportions. Numbers next to group names indicate the number of pooled functional groups within that group, and diet fractions are averaged for included groups. Lines highlight the energy pathways of 'other crustaceans' (red) and 'epipelagic mollusks' (blue) through the food web (From Choy et al, 2016).

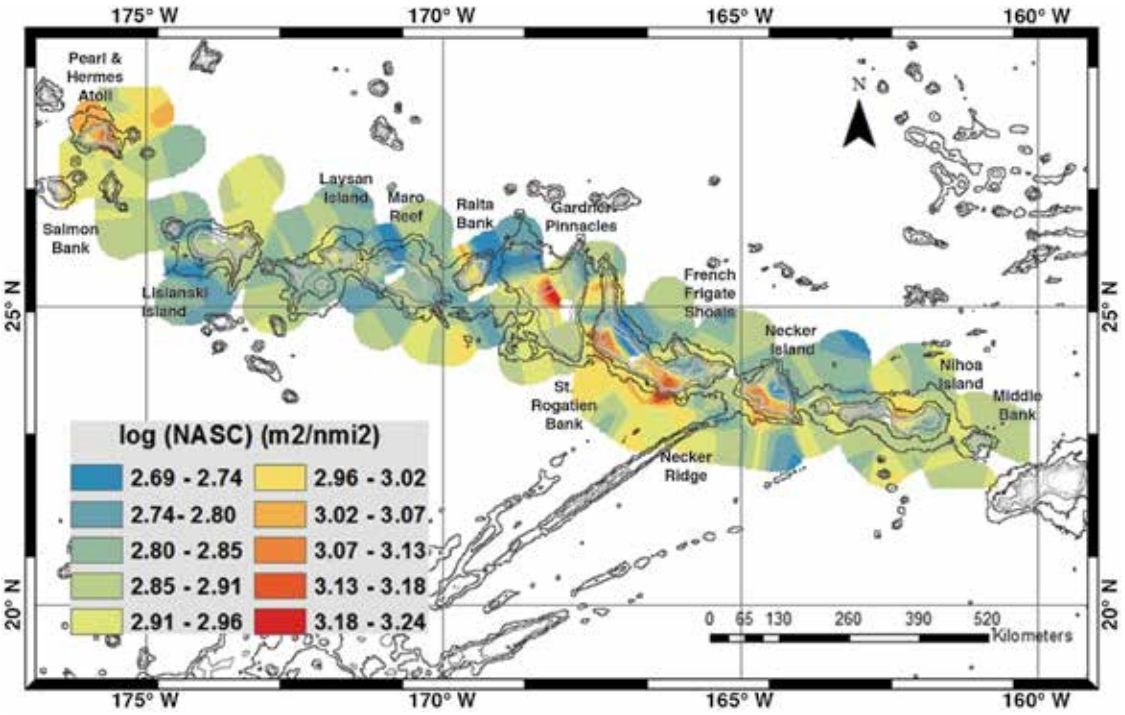


Figure 2. Acoustic biomass of micronekton (organisms between 2 and 20 cm) in the Northwestern Hawaiian Islands.

JIMAR staff worked with the PIFSC Science Operations Division (SOD) to update the acoustics inventory and equipment, performed small boat acoustics work, ordered equipment and helped design the sampling plan for small boat acoustics work and an upcoming NOAA research cruise.

Finally, a JIMAR student assistant documented the contents of about 200 lancetfish stomachs provided by the NOAA Longline Observers Program and is analyzing the diet data findings to better understand the spatial and temporal distribution of inorganic debris found in the stomachs. This will then be compared to a dispersal model to improve the understanding of debris accumulation in the central North Pacific.

Ecosystems Observations Research Program

P.I.: Mark A. Merrifield [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

Budget Amount: $1,195,500

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project 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: environmental data management, aquaculture system support, bottomfish population assessments, outreach and education, benthic habitat mapping, deepwater surveys in the Line Islands, and GIS mapping tools development for the Mariana Islands area. These subprojects are reported here.

Enhanced Environmental Data Management to Support Fisheries Research. This project continuously supports 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, administration, and management, data application development, and Geographic Information System (GIS) support to scientists and resource managers at the Pacific Islands Fisheries Science Center (PIFSC) to facilitate quality research and resource management.

Aquaculture Systems Management. This 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 close coordination with federal and University partners to develop, modify, and maintain the captive care facility for research, culture, and rehabilitation for marine species.

Coordinated Main Hawaiian Islands Bottomfish Population Assessments. A coordinated fishery research program for bottomfish species was implemented in the Pacific Islands Region (PIR) by NOAA's Pacific Islands Fisheries Science Center (PIFSC) to provide size-structured abundance estimates of bottomfish assemblages, to better understand bottomfish ecology and habitat, and to monitor bottomfish populations through non-extractive sampling techniques. Active acoustics, stationary camera systems, and mobile platforms are used to gather pertinent bottomfish information needed for improved stock assessments and ecological surveys. JIMAR staff in the Science Operations Division (SOD), Survey and Sampling Technologies Program (SSTP) provide technical and analytical support in current bottomfish research projects through field work, gear calibration and maintenance, video annotation, and data analysis to assess the feasibility of conducting cooperative bottomfish fishery-independent surveys in the PIR using current PIFSC sampling technologies.

Pacific Islands Region Fisheries Science Outreach and Education. The objectives of the Pacific Islands Region Outreach and Education effort are to plan, develop and implement an effective outreach and education program in partnership between JIMAR and the NOAA Pacific Islands Fisheries Science Center (PIFSC). JIMAR staff serves as resource, advisor and point of contact for outreach and education activities for JIMAR, PIFSC, and PIRO staff across all divisions and programs. This project directly supports the JIMAR aim of achieving a sustainable balance between the forces of coastal development and the goals of conservation/preservation through scientific and public outreach and education. Project staff produces printed and digital materials about the scientific research conducted by JIMAR and other scientists and technicians at PIFSC. The staff also participates in local and regional outreach activities, and coordinates science camps and other educational activities on behalf of JIMAR and PIFSC. This work is conducted under the Outreach and Education Program to help educate and promote JIMAR's and NOAA's missions and highlights the work undertaken to support those goals.

Main Hawaiian Islands (MHI) Bottomfish Benthic Habitat Mapping. The multibeam backscatter data necessary to resolve substrate composition for the MHI domain were collected, but with such a variety of sensors operating at a range of different frequencies, similar numeric values from disparate areas do not signify similar levels of substrate hardness. The lack of readily available backscatter synthesis products across the MHI survey domain is an impediment to the development of a properly stratified operational fishery-independent survey for MHI bottomfish. Thus, the prime objective of this project was to create a synthesized benthic habitat substrate characterization (hard or soft bottom) with 20-meter resolution from existing backscatter data in the main Hawaiian Islands extending from a depth range of at least 75 to 400 m. During post-award meetings, it was decided to produce a five-meter synthesis instead and to also generate a five-meter multibeam bathymetric synthesis for the same depth range, both to a depth of 500 m and as shallow as possible. It was realized that in some areas the available data would not support the requested resolution, depth range, or complete coverage.

Analysis of Deepwater Surveys in the U.S. Line Islands. Jarvis Island, Palmyra Atoll, and Kingman Reef comprise the Line Islands, which are part of the Pacific Remote Islands Marine National Monument established in 2009. In 2014 the offshore boundaries of the Monument area were increased to the limit of the U.S. Exclusive Economic Zone and NOAA is researching existing data about the marine biota and habitats of these islands. In July 2005, PIFSC staff collaborated with researchers from the University of Hawaii's Undersea Research Laboratory (HURL) to utilize the Pisces IV and Pisces V submersible platforms to survey the fauna and habitats between around the Line Islands, with efforts concentrated at depths of 350-750 m. The surveys were the first ever accomplished at these unique habitats below depths attainable by standard or mixed-gas SCUBA diving and provide the first detailed information about the biota and habitats of the slopes of these islands below 200 m. Data from the submersible surveys were recorded as video with concurrent audio by two observers and pilot, and include CTD and sonar readings.

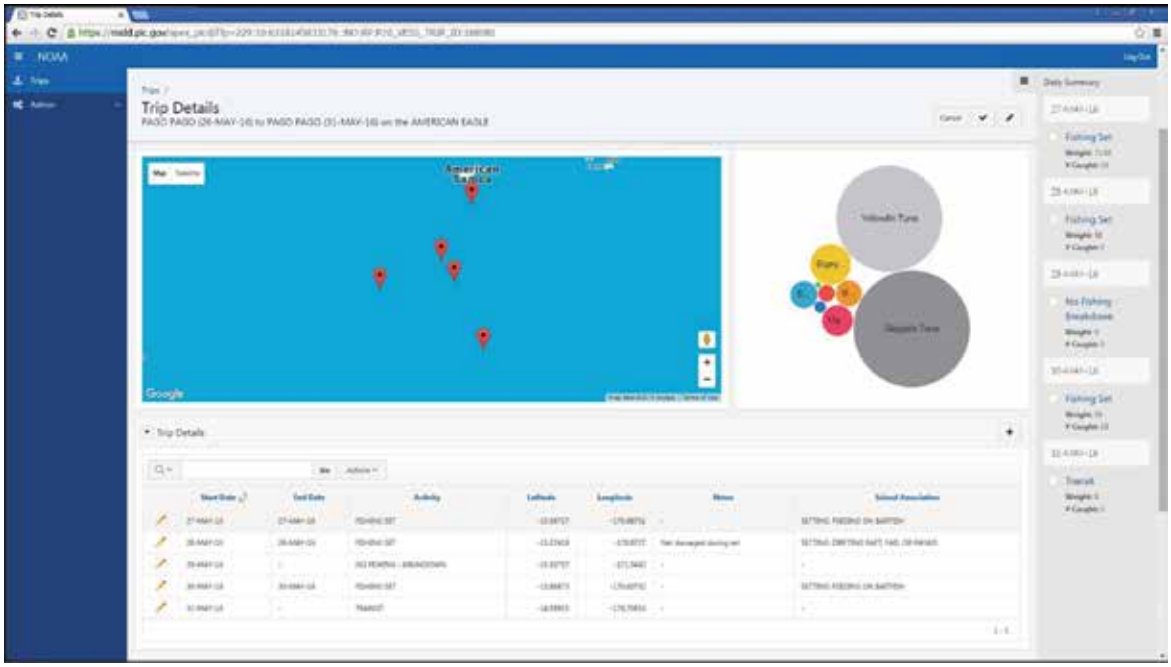
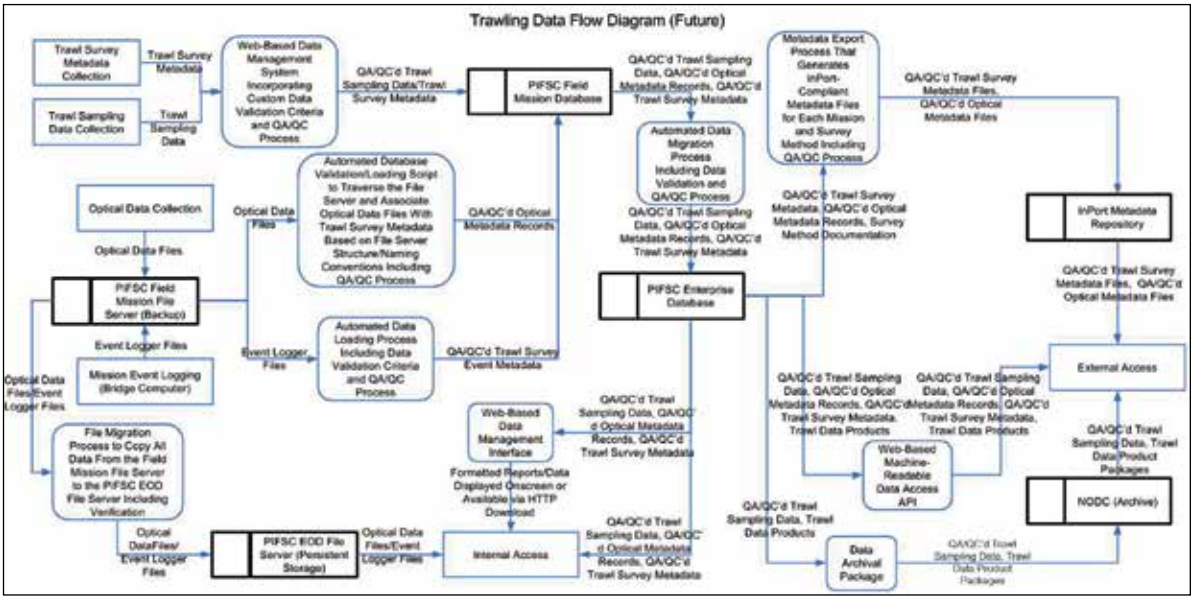


Figure 1. APEX training scientific data management application working example developed based on an actual SPTT data stream that integrates the instructor's best practices.

Figure. 2. Example of a "future state" data flow diagram for trawl surveys developed for the EOP DMIP to document the different at-sea data streams.



Data from the survey transects were developed using the HURL Video Annotation and Reference System (VARS) and includes substrate attributes, coral species identifications and abundances, and sponge species identifications and abundances. Identification and sizes of other invertebrates and fishes still need to be developed, which is the intention of this project. Subsequent data from the surveys and annotations will be archived and made available for management activities related to the Monument.

Figure. 3. Monk seals in a tank at the Inouye Research Center (IRC) seawater facility on Ford Island. These seals are in transit to return back to the Northwestern Hawaiian Islands (NWHI). They are originally from the NWHI but were taken to be raised for several months at the Ke Kai Ola facility on the Big Island to increase their chance for survival. (NMFS stranding permit #18786).

Figure. 4. Modular Optical Underwater Survey System (MOUSS) testing in a tank at the IRC seawater facility.

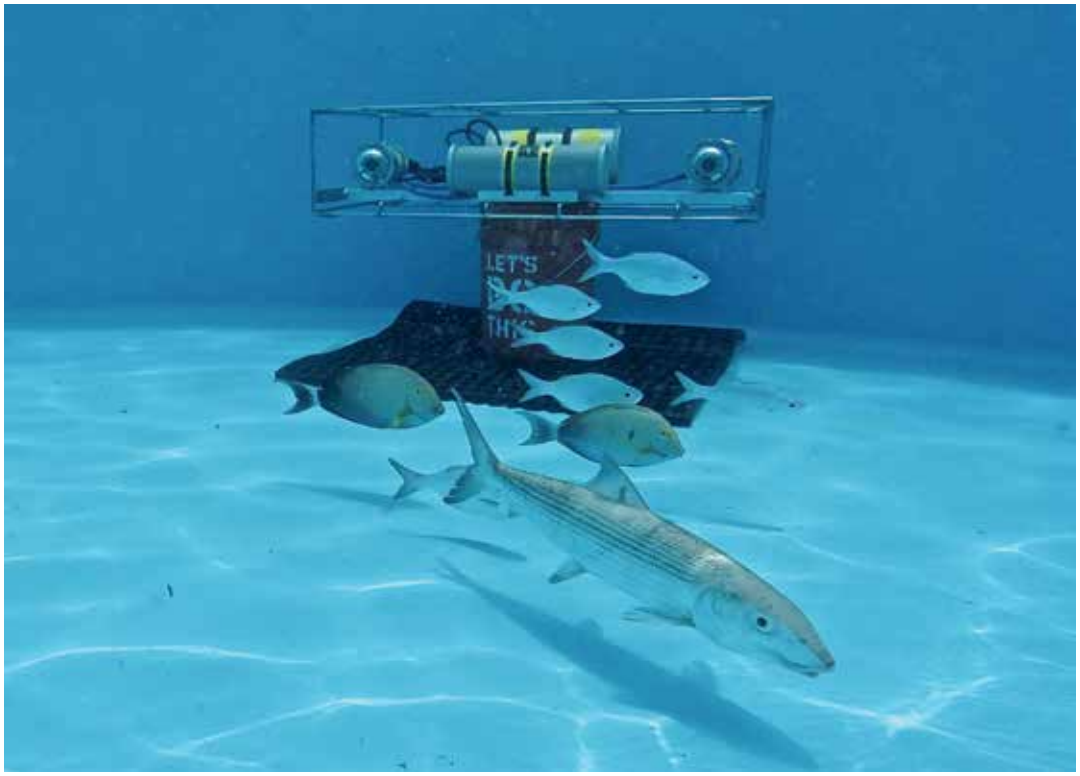


Figure. 5. Modular Optical Underwater Survey System (MOUSS) being deployed off of a 19' small boat platform on the NOAA project HA-16-01.

GIS Mapping Tools for the Marianas Trench Marine National Monument Waters. The purpose of this project is to continue developing web-based mapping tools and services to improve access to PIFSC data collected in and around Marine National Monuments. The first phase of this project utilized a subset of PIFSC data from the Mariana Archipelago to establish a framework that includes the appropriate technologies and workflows allowing for future growth of the project. The long-term goal for these tools is to serve as a repository and data dissemination portal for PIFSC geospatial data collected throughout the Pacific region. Primary objectives for FY 2016 included finalizing development of publicly accessible mapping applications and data distribution services for the Mariana Trench Marine National Monument and begin work to expand the tool to include new capabilities and additional PIFSC data and regions throughout the Pacific.

Progress during FY 2016

Enhanced Environmental Data Management to Support Fisheries Research. Led by Jesse Abdul, the Enhanced Environmental Data Management to Support Fisheries Research project successfully fulfilled the objective of transitioning data management responsibilities from SWFSC to PIFSC for all current data. The project made an extensive effort to define data requirements and develop the migration process but the historical data was not provided to PIFSC in the defined format for all SPTT data streams. The JIMAR project met the April 30, 2016 Regional Fishery Management Organization (RFMO) reporting deadline by developing tools/processes to import, quality control, and access the SPTT data.

The project also developed a flexible data validation module for the SPTT project that can potentially be further developed into a centralized tool to provide all PIFSC divisions a standardized method to perform data quality control (QC) on scientific data. Another module developed specifically for the SPTT project can potentially be further developed to parse and load data provided in Extensible Markup Language (XML) and JavaScript Object Notation (JSON) formats into relational database structures.

The project also worked to develop standard operating procedures (SOP) for Oracle's Application Express (APEX) application development, documentation, and application migration that integrate best practices for use throughout PIFSC. This is important because the Science Center is in the process of moving existing applications from the deprecated Oracle Forms and Report to APEX, which is a viable and recommended alternative platform.

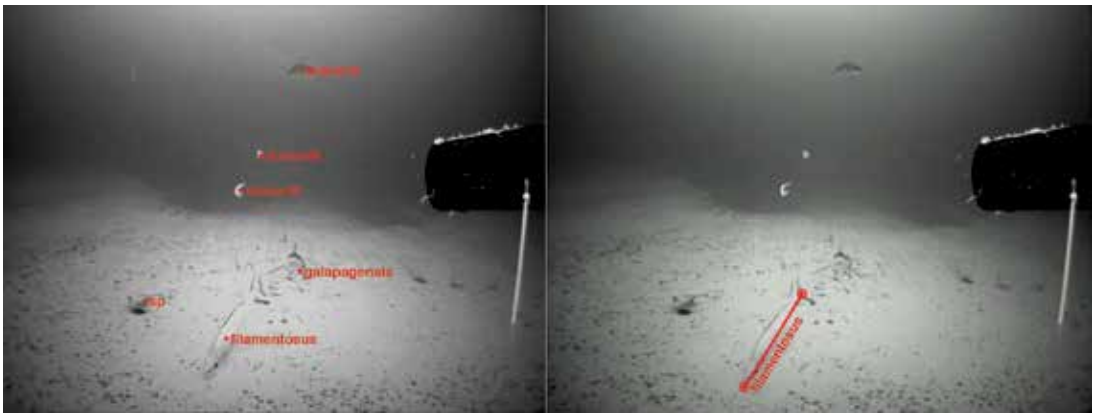
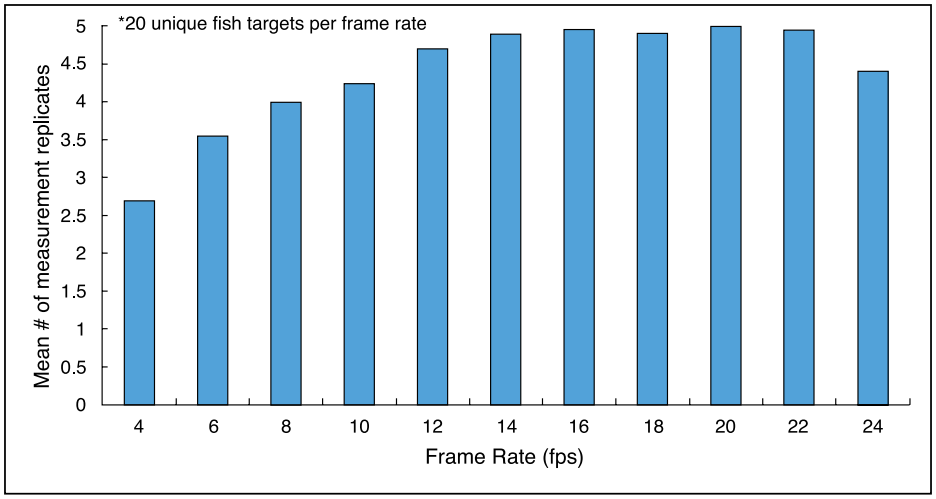


Figure. 6. Opakapaka being identified, measured, and quantified using Modular Optical Underwater Survey System (MOUSS) videos and EventMeasure annotation software.

Figure. 7. Results for MOUSS optimal frame rate tests showing 10 to 14 frames per second as the optimal range.



The project utilized a private contractor to conduct two APEX trainings for participants across PIFSC divisions. Project staff worked extensively with the contractor to develop a directed training agenda specifically for importing, managing, and disseminating scientific data using examples from within PIFSC. To facilitate PIFSC JIMAR staff in utilizing their new APEX training skills, the project developed instructional documentation on how to deploy and configure the different working example application modules provided during the APEX training. The documentation also provides stand-alone training modules that can be used by PIFSC staff interested in learning APEX application development but unable to attend the trainings. Communication and collaboration through the APEX training sessions created new workspaces for PIFSC employees to work collaboratively on new projects. Additionally, the project provided documentation on using the Git collaborative revision control system for staff to facilitate group development of code and data products.

The project provided support for the PIFSC geospatial community by developing and maintaining ArcGIS map services, maintaining the PIFSC enterprise geo-database, developing multiple spatial data products, conducting spatial analysis, and maintaining the JIRA and APEX centralized services.

Due to several unsuccessful recruitments to fill the Data Applications Developer position, as well as extensive involvement in the Fisheries Research and Monitoring Division (FRMD)'s South Pacific Tuna Treaty (SPTT), the project was unable to conduct an assessment for every division's data stream, data management workflows, infrastructure, and internal capacity. However, project staff was successful in completing a data assessment for the Ecosystem Sciences Division's Ecosystems and Oceanography Program (ESD, EOP) at-sea data streams. Data flow diagrams and accompanying documentation were developed for the current and future states of each

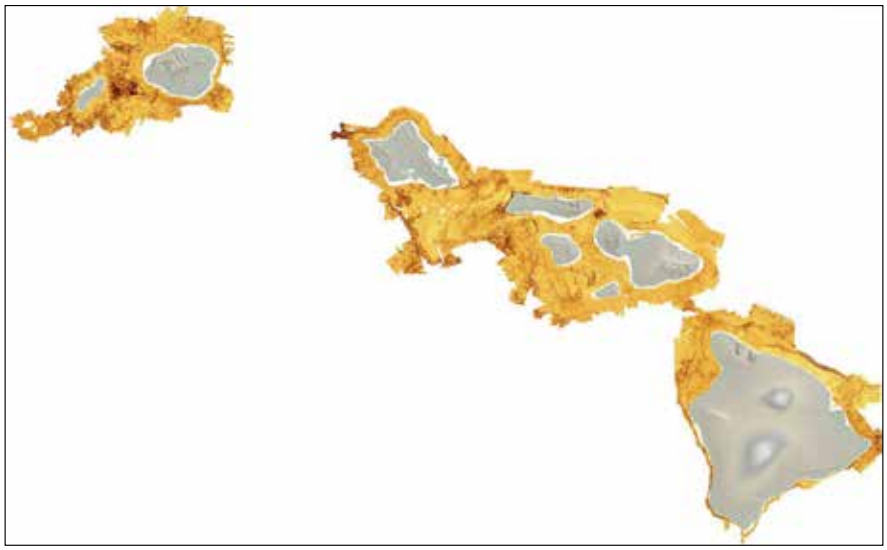


Figure. 8. Five-meter resolution multibeam backscatter synthesis for the Main Hawaiian Islands with island topography in gray shades. Brown color indicates harder seafloor, while yellow/gold indicates softer seafloor.

data stream for EOP based on the results from this assessment; these materials will be compiled into a National Marine Fisheries Service (NMFS) Data Management Improvement Plan (DMIP).

Aquaculture Systems Management. During the project year, JIMAR staff (led by Aaron Moriwake) continued to maintain a weekly exercise program and monthly equipment maintenance schedule to ensure system readiness for incoming animals in the four distinct units (monk seal, turtle, fish, and multi-purpose). Other accomplishments during this fiscal year included: 1) training in system operations for turtle, monk seal and SWS staff; 2) maintaining a data log (date of repair, maintenance, replacement, etc.) for the various equipment; 3) sewing and installing shade covers for three turtle tanks; 4) conducting monthly safety assessment for the SWS facility; 5) coordinating daily maintenance activities; 6) organizing chemicals and updating safety data sheets for the SWS yard; and 7) identifying, logging and troubleshooting maintenance issues. Project staff repaired a leaking back flow preventer, installed new ballast and liquid crystal displays for Ultraviolet sterilizer monitors, replaced UPS in control panels, installed a new ultrasonic level transmitter, and successfully repaired leaking tank bottom using fiberglass materials.

During this period, JIMAR staff provided facility support for thirteen monk seals, twelve turtles, five underwater video camera calibrations, and an acoustic underwater testing for the monk seal project. When animals were housed at the SWS facility, JIMAR staff provided 24/7 emergency support through email/text alarm alerts, remote access control of cameras, and the Supervisory Control and Data Acquisition (SCADA) system.

Coordinated Main Hawaiian Islands Bottomfish Population Assessments. During FY 2016, JIMAR staff (led by William Misa) in the SOD-SSTP worked towards the operationalization of the Modular Optical Underwater Survey System (MOUSS) to meet the objective of operational readiness of PIFSC advanced technology assets for use in coordinated bottomfish surveys. To operationalize the MOUSS, cross-comparisons with the previous Bottom Camera Bait Station (BotCam) were made while field operating procedures and logistics needs to allow for MOUSS deployments off a NOAA 19-foot safe boat had to be determined prior to MOUSS cruise HA-16-01. JIMAR SOD-SSTP staff accomplished the following: 1) outfitted NOAA safe boats with a battery box-pot hauler assembly (Figure 5) that could successfully deploy and retrieve MOUSS using the small boat davit; 2) developed MOUSS standard operating procedures (SOP) on small boats and a MOUSS-BotCam tandem system field SOP on NOAA ships; 3) conducted training for MOUSS use, and 4) conceptualized new video analysis protocols specific to HA-16-01 data deliverables. After successfully completing 175 MOUSS small boat deployments and 33 MOUSS-BotCam tandem system ship deployments during HA-16-01, MOUSS and BotCam data generated from the cruise and previous in-tank tests were used in a comparative report looking into differences in image quality, light sensitivity, measurement accuracy, and file size.

Using videos collected during HA-16-01 and corresponding bottomfish count data, JIMAR SOD-SSTP staff provided the Automated Image Analysis Strategic Initiative (AIASI) and OceanEyes crowd sourcing project

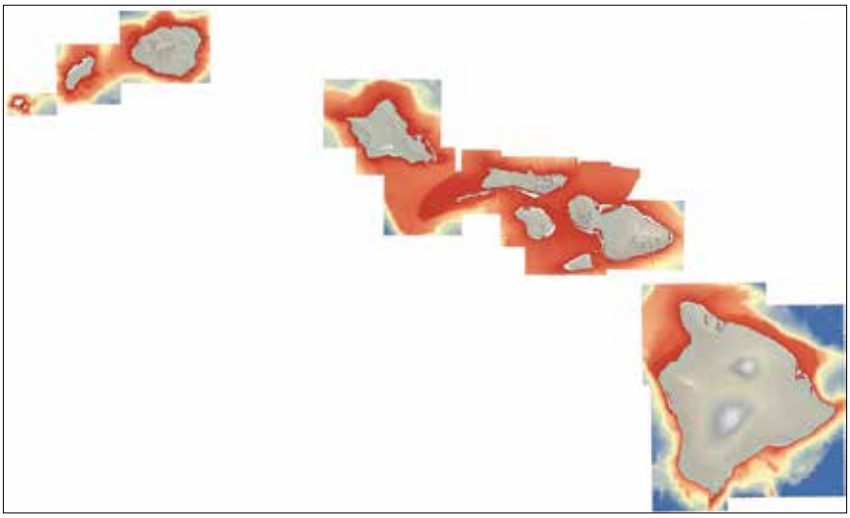


Figure. 9. Five-meter resolution multibeam bathymetric synthesis for the Main Hawaiian Islands with island topography in gray shades. Cooler colors (i.e., blue) indicate deep water, while hotter colors (i.e., red) indicate shallow depths.

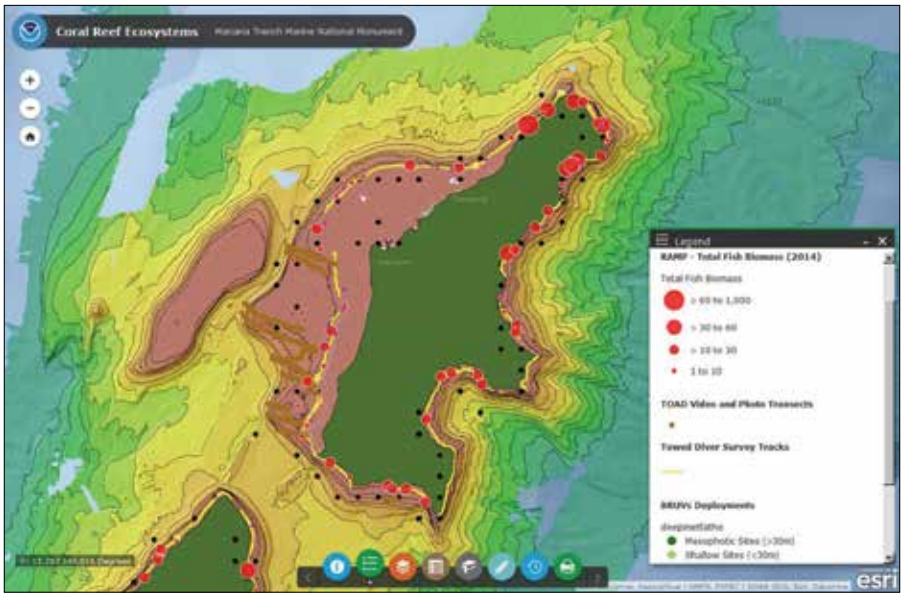


Figure. 10. The above image is a screenshot of the Coral Reef Ecosystems web map for the Mariana Archipelago, and is displaying the locations of various PIFSC scientific data collection operations, such as RAMP fish monitoring sites, towed diver survey tracks, Baited Remote Underwater Video system deployments, and CTD casts around the island of Saipan in the Commonwealth of the Northern Mariana Islands.

with imagery and fish data required for developing automated processing algorithms and methods as part of the required deliverables for the coordinated bottomfish population assessments project. Bottomfish length data from HA-16-01 MOUSS deployments was also used in a MOUSS optimal frame rate analysis. Determining an ideal frame rate for MOUSS operations maximizes the ability to generate fish metrics while keeping the data storage requirement on the systems to a minimum. Other efforts to fine-tune MOUSS functionality and field operations/logistics are currently being undertaken with the goal of full MOUSS operationalization in FY 2017.

Further development of the Autonomous Underwater Vehicle (AUV) and Remotely Operated Vehicle (ROV) in bottomfish surveys could not be undertaken in FY 2016 due to a lack of resources and intensified focus on the MOUSS technology. However, JIMAR SSTP staff supported Simrad EK60 acoustic operations with troubleshooting

and rewiring of calibration equipment, technical support, and modeling of weather and ocean conditions to identify ideal locations to conduct calibration operations around Oahu. Collaboration between EOP and SSTP led to the successful calibration of the 38, 70, and 120 kHz transducers on a one point anchor system and successfully replicated it conducting drift calibrations; both of which had never been accomplished before. In addition to Simrad EK 60 acoustic operation support, JIMAR SSTP analysis team staff annotated all of the mesophotic 2014 Baited Remote Underwater Video Stations (BRUVS) Guam drops for the Coral Reef Ecosystem Program (CREP).

Pacific Islands Region Fisheries Science Outreach and Education. Led by Amy Vandehey, the most significant educational activity carried out with EORP support is the annual NOAA Fisheries Science Camp held at the NOAA Inouye Regional Center (IRC). The camp is also supported by the JIMAR Pacific Islands Region Outreach and Education project. The camp is targeted to eighth graders from public and charter schools, with an emphasis on reaching under-represented students. The four-day camp for 45 students consists of nine science modules conducted over three days and culminates with a team challenge, evaluation and award ceremony on the fourth day. The team challenge requires the campers to utilize what they learned while rotating through the science modules to develop a research plan. The 2016 Fisheries Science Camp will be conducted July 18-22 and will be reported in a subsequent JIMAR Annual Report.

The selection of science modules includes the following:

- Marine Debris Removal—Hands-on activity with GPS and computers that informs campers about marine debris and how it relates to Hawaii.
- Fishery-Independent Sampling Techniques and Stock Assessment—Students learn various fishery independent sampling techniques and basic population modeling principles.
- Marine Food Webs—Introduces campers to marine food webs and basic ecological concepts that structure energy flow and animal interactions.
- Amazing World of Marine Plankton—Educates students on marine plankton including collection methods, types, importance, and environmental threats.
- Hawaiian Monk Seal Crittercam: A Seal-Eyed View—Campers learn about and test hypotheses using different techniques and technologies to understand the diet and feeding behavior of Hawaiian monk seals.
- Fishing Gear and Casting Lesson—Hands-on activity where campers learn and practice casting a rod and reel; go "fishing"; log catch data; and learn about the importance of fishing and fisheries-dependent data.

Docents from the Waikiki Aquarium and science teachers are recruited to serve as team leaders (one per group of 5 students). A training day is held for the team leaders the week before camp to familiarize them with the science modules, activities, and camp schedule, as well as their important role as mentor to the students.

Camp costs are covered by JIMAR's Pacific Islands Region Outreach and Education project and JIMAR's Ecosystems Observations and Research Program (EORP), including items such as daily lunch and t-shirts for the participating children, lab equipment, supplies, and printing costs. Camper applications are organized and processed through a dedicated online registration website and e-mail account.

The science camp is managed and staffed by NOAA Fisheries and JIMAR PIRO communications team employees. Each year there are between 30-40 NOAA Fisheries and JIMAR scientists and staff from PIRO and PIFSC working together to conduct activities in the IRC building and labs, providing the students with unique hands-on experiences. They also expose campers to the diversity of backgrounds and career fields represented at NOAA Fisheries.

Main Hawaiian Islands Bottomfish Benthic Habitat Mapping. Led by John Smith, all data products and analysis were delivered. These include the Main Hawaiian Islands acoustic backscatter imagery, bathymetry, and benthic substrate composition syntheses. The latter is the threshold-based hard/soft categorization based on the acoustic backscatter data. Metadata in the form of a detailed data processing log sheet were also delivered. The NOAA and UH Web Designer and Developer/Data Manager who handled datasets of this type for the project in the past was notified of its availability for posting on the SOEST/University of Hawaii Mapping Research Group (HMRG) website, to accompany the pre-existing 60-m MHI regional backscatter and 50-m bathymetric syntheses. The project will also offer it to the SOEST/Pacific Islands Ocean Observing System (PacIOOS) group for posting on their website.

The final technical report describing the processed data and integrated benthic habitat mapping of the MHI is in progress although delayed because funding expired during product development and other funded projects had to be attended to. In addition, a five-meter bathymetric synthesis was developed and delivered, which was beyond the scope of the original proposal. The generation of this data product, deemed important to meet the objectives, also delayed completion of the overall project. A manuscript describing the methods and stratification analyses of

the MHI demersal survey domain has not yet been accomplished because the first half will fall out of the technical report described above, and the second portion must be developed with the NOAA/PIFSC personnel and their contractors once the stratified analyses is complete.

Additionally, JIMAR staff supported numerous requests to use benthic data products over the last year. These included a doctoral student at the UH/HIMB using it for modeling mesophotic hard coral distribution across the main Hawaiian Islands and the State of Hawaii DLNR/DAR to assemble a geodatabase for bottomfish management use.

Analysis of Deepwater Surveys in the U.S. Line Islands. Led by Virginia Moriwake, the project annotated video from six submersible dives and one ROV dive (still in progress) in the Line Islands using the VARS software. Taxonomic identifications, estimates of abundance, and size estimates when possible, were obtained for non-coral invertebrates and fishes. These new records are combined with existing coral and sponge records from the same dives. Substrate types, estimates of rugosity and slope, and video overlay information (time of day and depth information) were subsequently associated with all records. CTD (depth, temperature, salinity, and oxygen levels) and tracking (latitude and longitude) datasets were then merged and formatted in preparation for concatenating the data with the VARS records via custom scripts. A partial extraction of the finished dataset was provided to PIFSC staff for review of the format for the final product.

GIS Mapping Tools for the Marianas Trench Marine National Monument Waters. During FY 2016 the project team (led by Bryan Dieter) successfully launched a series of web-based mapping applications and data distribution services highlighting various PIFSC research objectives in the Mariana Archipelago, including fisheries research, cetacean surveys, coral reef monitoring, benthic habitat mapping and PIFSC research cruises. In collaboration with data owners throughout the Science Center, these data are being distributed as RESTful map and feature services utilizing the ArcGIS Server managed by the PIFSC Information Technology Services program. The web-based mapping applications are hosted on ArcGIS Online and can be accessed via the PIFSC website.

In addition to launching the application for the Mariana Archipelago region, the project team began working to expand the tool to include data from other PIFSC data collection regions. Ongoing work is currently focused on developing data distribution services for data collected by the Coral Reef Ecosystem Program and the Protected Species Division throughout the Pacific Region, including the Hawaiian Archipelago, Pacific Remote Island Areas and American Samoa.

Fisheries Monitoring and Support

P.I.: Mark A. Merrifield [JIMAR Project Lead: Walter Machado]

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

NOAA Sponsor: Michael P. Seki, Keith Bigelow

Budget Amount: $300,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project works to provide PIFSC with timely and accurate Fishery Management Plan (FMP) 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 Hawaii's pelagic longline fleet, which is currently and increasingly subject to international management at the 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 2016

The JIMAR Fisheries Specialist continues to provide timely high level support to fishery monitoring activities by providing high quality fisheries data to NMFS, PIFSC, and other JIMAR projects. The daily burden of

quality control and processing logbook data has increased due to fast-tracking procedures, which were implemented to monitor Hawaii's bigeye tuna (BET) landings. This information is used in forecasting landings to predict possible closure dates of the Hawaii longline BET fishery if the Western and Central Pacific Fisheries Commission (WCPFC) and Inter-American Tropical Tuna Commission (IATTC) annual quota is predicted to be reached. The fast track monitoring was expanded to include striped marlin due to stock concerns. JIMAR staff has been cross training during the year to cover the multiple facets of fast track duties during vacations, travel, and or absences of any designated staff. The additional monitoring requirement increases the daily workload and are compiled weekly or as necessary as the quota gets taken. Additional quality control procedures and cross checks of relevant data bases have been implemented as needed to continually improve the results and timeliness of the product. As an example, a matching program comparing the longline logbook tuna counts to sales records at the United Fishing Agency auction was developed and is now used to improve the quality of the data. The general Hawaii longline fleet-wide quarterly reports are completed 45 days after the end of the quarter. The logbook scanning and archiving project is ongoing and will now be including the American Samoa longline logbooks.

Figure 1. Emeline Kalahiki checking on longline vessels offloading.

Figure 2. Nathan Chan training Capt. Wayne Carr to use an electronic logbook.

A photo database of Hawaii's pelagic longline fishing fleet has been continually updated throughout the year and is used to document the fleet on an ongoing basis.

The PIFSC longline electronic reporting initiative funded by the Western Pacific Regional Fishery Management Council (WPRFMC) is in progress. The electronic reporting system, which uses handheld tablets to record logbook information, is at the step of testing and certification by PIFSC and JIMAR staff. During this process additional duties for JIMAR staff in terms of distribution of tablets, tablet reporting application training of captains and new internal procedures to deal with the transition to collecting and editing the electronic forms are adding to the workload.

JIMAR project staff Mia Iwane and Walter Machado assisted with Barbless Circle Hook Project (BCHP) outreach on April 9-10, 2016 at the Hawaii Ocean Expo, providing expertise and raising public awareness during the event. The project outreach message explains the advantages and benefits while encouraging the fishing community to try using the barbless circle hooks. JIMAR project staff Mia Iwane and Emeline Kalahiki regularly help prepare for these events that occur throughout the year across the Hawaiian archipelago.

Investigation of Ecological Constraints for Bumphead Parrotfish

P.I.: Mark A. Merrifield [JIMAR Project Lead: Meagan Sundberg]

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

NOAA Sponsor: Michael P. Seki, Robert Humphreys

Budget Amount: $57,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The principal activity under this JIMAR project was to conduct an abundance survey of juvenile bumphead parrotfish (*Bolbometopon muricatum*) in the interior lagoon at Wake Island. Some geographical locations are devoid of young *B. muricatum*, yet these same areas maintain large numbers of adult fish; this anomaly had yet to be investigated at Wake Island. Among the U.S. jurisdictions where bumphead parrotfish are found, Wake Island represents the highest density of adults in U.S. waters. The survey results were intended to confirm or reject bumphead parrotfish presence in the lagoon, provide a better understanding of the dynamics of settlement and recruitment of this species, and provide a quantitative description of their nursery habitat.

Progress during FY 2016

A four-member team conducted a 12-day survey of the lagoon at Wake Island in June of 2013. No juvenile bumphead parrotfish were found during the snorkel surveys of the lagoon and only 5 adult bumphead parrotfish were spotted. This lack of survey data has presented substantial obstacles to identify and characterize the ideal juvenile bumphead parrotfish habitat. The scarcity of adults was expected considering they usually frequent deeper water, however the lack of juveniles was surprising. Because of its remoteness, it was hypothesized Wake Island was primarily self-seeding. It is however, too premature to conclude juvenile bumphead parrotfish are completely devoid from the lagoon and surrounding waters since much of the lagoon habitat and all of Wilkes Island has yet to be explored.

As was previously reported in last year's report, project activity has been suspended in order to re-assess priorities on development of findings and potential alternative avenues for exploration.

Kona Integrated Ecosystem Assessment

P.I.: Mark A. Merrifield [JIMAR Project Lead: Melanie Abecassis]

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

NOAA Sponsor: Michael P. Seki, Jeffrey Polovina

Budget Amount: $205,850

NOAA Goal(s)

- Healthy Oceans

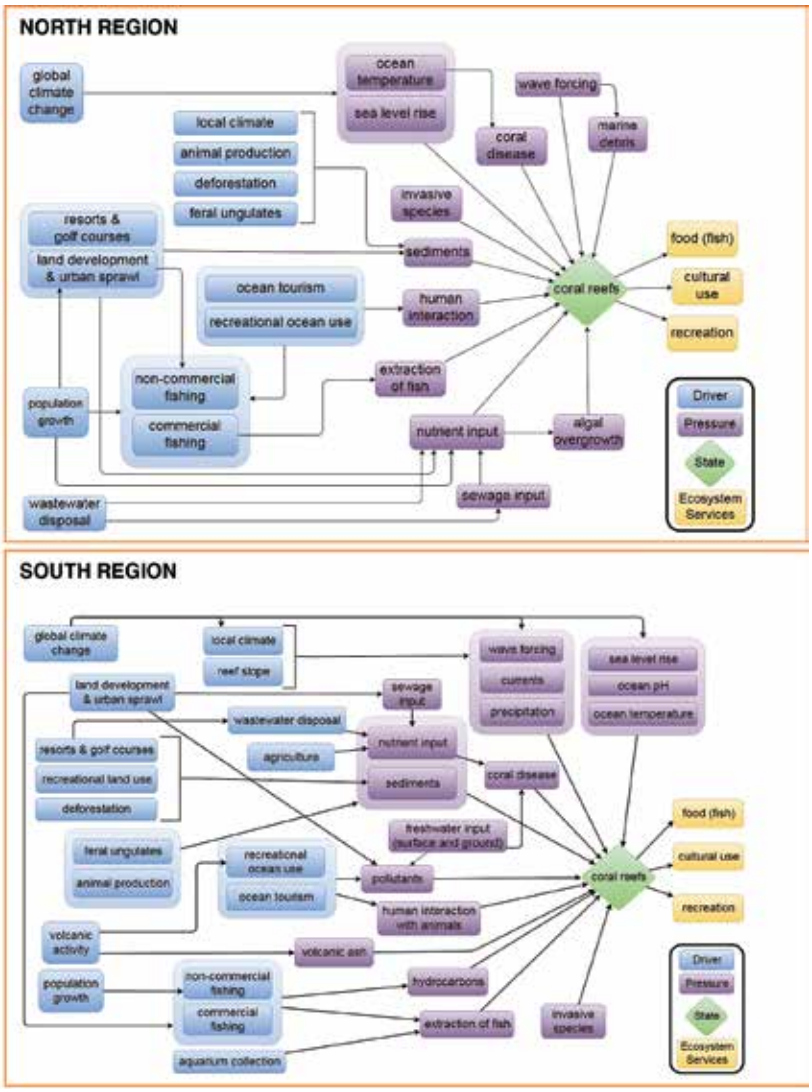
Purpose of the Project

This JIMAR project is focused on conducting research that directly supports management-relevant goals and objectives in West Hawai'i. During the reporting period JIMAR researchers developed a series of tools that provide insight into current and possible future changes to ecosystem state. A Conceptual Ecosystems Model (CEM) for the region was developed to clarify interactions between land and coastal habitats, identify all possibilities available to accomplish management objectives, and illuminate the trade-offs that are associated with each possibility. This work supported the development of 30 ecosystem indicators to help track the trends

and status in marine ecosystem state in the region. Finally, a dynamic simulation module (Ecosim) was added to a previously developed Ecopath model to provide the capability of simulating the influence of variations in environmental and human-related pressures and conduct a formal management strategy evaluation process of West Hawai'i's marine ecosystem.

Progress during FY 2016

During a series of JIMAR facilitated workshops, community members, scientists, and resource managers met to develop a consensus of the primary pressures and drivers of coral reef ecosystem state in West Hawaii. Information collected during these workshops was compiled to develop the first Conceptual Ecosystem Models of the region (Fig. 1). Conceptual Ecosystem Models (CEMs)—a method of diagramming social-ecological system components and relationships—illustrate the best understanding of system dynamics, key processes, connections between ecosystem components, and highlight social influence and values. Importantly, CEMs merge existing scientific and community knowledge and collect information and observations from scientists and managers, as well as from community members, an especially useful information source when data are scarce for any part of the system, a common occurrence for West Hawai'i.



Coral reef Conceptual Ecosystem Models for the North (top) and South (bottom) regions of West Hawai'i (Ingram et al., in prep). Arrows indicate connections between the drivers (blue boxes) and pressures (purple boxes) of coral reef ecosystem state. Yellow boxes represent ecosystem services derived from coral reefs.

With the outputs of the CEMs and current scientific understanding of sub-tropical marine ecosystems, a series of ecosystem indicators were compiled to help track the status and trends in West Hawai'i's marine ecosystem. Indicators are specific and well-defined measurable variables proven to reflect the status of some component of the ecosystem and provide a practical means to judge changes in ecosystem attributes related to the achievement of management objectives. Ecosystem indicators derived for West Hawai'i spanned a wide range of ecosystem components, from climatic and oceanographic drivers of ecosystem change, to the states of biological and human communities and associated activities. Indicators, along with CEMs, were compiled into a comprehensive, interdisciplinary report (Gove et al., 2016) that serves to elucidate linkages across the different components of West Hawai'i's marine ecosystem, and provide important context as resource managers move towards ecosystem-based management of this highly productive and biologically diverse marine ecosystem.

In order to evaluate ecosystem-based management strategies and tradeoffs, JIMAR researchers focused on building an ecosystem model with simulating capabilities (Ecopath with Ecosim). The model is specifically for

the coral reef ecosystem of Puako, Hawai'i, and will examine the suite of ecosystem indicators highlighted in the Ecosystem Trends and Status Report (Gove et al., 2016) for West Hawai'i and outputs from the CEM work. The modeling work will enable JIMAR scientists to investigate ecosystem responses to variations in the environment (e.g., ocean temperature) and to important human stressors such as fishing pressure. This work is intended to support the management strategy evaluation process for the West Hawai'i Integrated Ecosystem Assessment program.

Main Hawaiian Islands Deep 7 Bottomfish Fast Track Project

P.I.: Mark A. Merrifield [JIMAR Project Lead: Kimberlee Harding]

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

NOAA Sponsor: Michael P. Seki, Kimberly Lowe

Budget Amount: $360,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This project is an ongoing JIMAR effort that began in September 2007. The primary objective is to improve data collection accuracy, timely reporting, and data 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 system was implemented by NOAA Fisheries in the State of Hawaii to manage sustainable harvest of the Deep 7 bottomfish species caught near 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*),

Figure 1. JIMAR Deep 7 Bottomfish Data Supervisor, Kimberlee Harding, participating on a panel discussion with representatives from NOAA/PIFSC, Stock Assessment Division, Fishery Analyst from WPRFMC, and a professional Bottomfish fisher at the Western Pacific Regional Fishery Management Council's Fishers Forum: Main Hawaiian Island Bottomfish History, Research and Management.

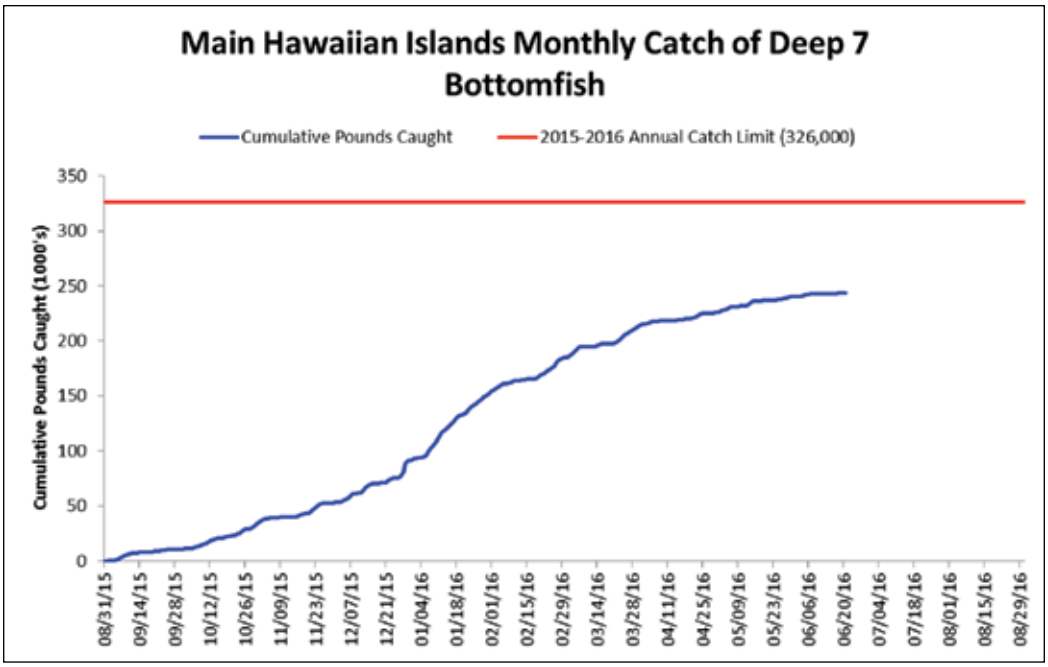


Figure 2. Chart of the accumulation rate for the ACL during the current 2015-2016 MHI Deep 7 bottomfish fishing year of 243,544lbs; 74.7% of the ACL.

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-Division of Aquatic Resources (DLNR-DAR) 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-DAR 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).

Progress during FY 2016

JIMAR staff continue to successfully fast-track the processing of the Main Hawaiian Islands commercial catch and dealer data, including the Deep 7 bottomfish fishery that is managed by a federal ACL, with the 2015-2016 fishing year at 326,000 pounds with a 44% risk of overfishing for the following species: onaga (*Etelis coruscans*); ehu (*Etelis carbunculus*); opakapaka (*Pristipomoides filamentosus*); kalekale (*Pristipomoides sieboldii*); gindai (*Pristipomoides zonatus*); lehi (*Aphareus rutilans*); and hapu'upu'u (*Hyporthodus quernus*).

The project hired a new DLNR-DAR Data Supervisor, Kimberlee Harding, during the reporting year, and she oversees the fast tracking of bottomfish fishing data and the Main Hawaiian Island commercial fisheries. She runs daily error reports and creates weekly data summaries that are sent to fishery managers, scientists, and bottomfish fishers. She also transfers both fisheries and dealer data to WPacFIN on a daily basis. Eric Yokomori, JIMAR Database Assistant and Brian Akizuki, JIMAR Data Monitoring Associate, enter fishing report data using the Online Fishing Reporting System (OFRS), and Siu "Nikky" Yuen, JIMAR Database Assistant, runs discrepancy reports between dealer sales and fisher's catch data. After the report data are error checked and reports analyzed for discrepancies project staff will contact the fisher or dealer by phone, email, or letter to clarify any discrepancies to ensure accurate and timely processed data.

Implementation of the new interactive DLNR-DAR website that includes access to the Online Fishing Reporting System (OFRS), where fishers enter their data on a per-trip basis, was launched on June 27, 2016. This new system will increase near real-time monitoring for all commercial fisheries. The website will provide access

to commercial marine license services and bottomfish vessel identification registration, and give all fishers the ability to file their trip reports online, including for fisheries beyond the MHI Deep 7, which previously did not have online reporting capabilities. JIMAR staff provide support, outreach and education to fishers and marine dealers on how to navigate the new website.

Ocean Remote Sensing

P.I.: Mark A. Merrifield [JIMAR Project Lead: Melanie Abecassis]

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

NOAA Sponsor: Michael P. Seki, Jeffrey J. Polovina

Budget Amount: $146,500

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This project provides satellite remotely-sensed oceanographic data expertise to the NOAA OceanWatch-Central Pacific node (OWCP). This node is a website and data base that supplies near-real time, remotely sensed oceanographic and environmental data for the entire Pacific-based communities, including resource managers, researchers, educators and the general public. The satellite-derived products include ocean surface temperature, ocean color, ocean surface topography, ocean surface wind fields, environmental indicators (Empirical Orthogonal Functions), and high-resolution (1.1 km) thermal infrared High Resolution Picture Transmission (HRPT) imagery from the NOAA AVHRR (Advanced Very High Resolution Radiometer) satellites. The HRPT data is collected daily by the AVHRR receiving station located in Ewa Beach, Oahu (Hawaii).

Progress during FY 2016

In addition to maintaining all databases and servers and servicing data to OWCP users, this project continued its collaboration with the NOAA Climate Service, Pacific Islands Region, and the NOAA Pacific Climate Information System (PacIS), in order to provide customized remote sensing data and quarterly analyses, as well as with the Pacific Islands Ocean Observing System (PacIOOS). OWCP data is regularly integrated into the PacIS dashboard and the PacIOOS Voyager.

During the reporting year, JIMAR staff implemented a new data processing architecture to improve data processing efficiency and reduce data storage requirements; this work to make systematic improvements is ongoing. Twenty of 32 data streams were transitioned to the new architecture. This project also completed the ingestion and data processing of the Aqua Modis ocean color data that was reprocessed and transitioned to a new data format by NASA in June 2015.

JIMAR staff began redesigning the OWCP website to make it fully responsive, ensure greater user-friendliness and ability to broadcast any changes to known users for feedback. This redesign includes the implementation of a new data platform (Environmental Research Division Data Access Platform, ERDDAP) developed by the NOAA's SouthWest Fisheries Science Center. ERDDAP is comprised of a web application with an interface for users to download or plot the data, and a RESTful web service that allows direct data access from any computer program.

The project inputted metadata information into the NMFS InPort data management system to ensure that all OWCP data streams are fully compliant with NOAA Public Access to Research Results (PARR) requirements. Project staff provided climate indicators to the regional fisheries management council to include in their Stock Assessment and Fishery Evaluation (SAFE) reports and to the West Hawaii Integrated Ecosystem Assessment Program (IEA). Project staff also attended the CoastWatch Meeting in January 2016 to present updates on OWCP activities and gave a presentation of the OWCP program at the PIFSC Ecosystem Sciences External Review.

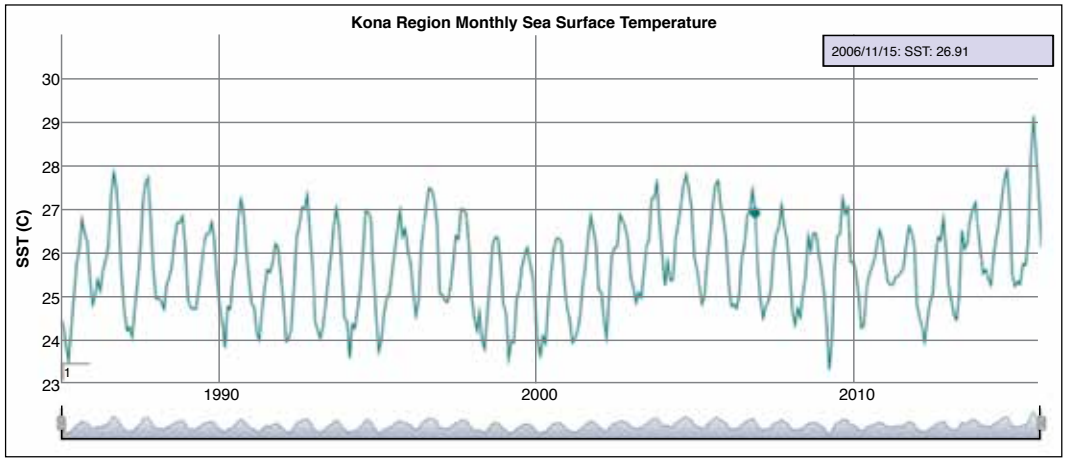


Figure 1. Interactive time-series graphic (dygraph) developed for the West Hawaii IEA program to include on their website, showing mean monthly SST in the West Hawaii Region.

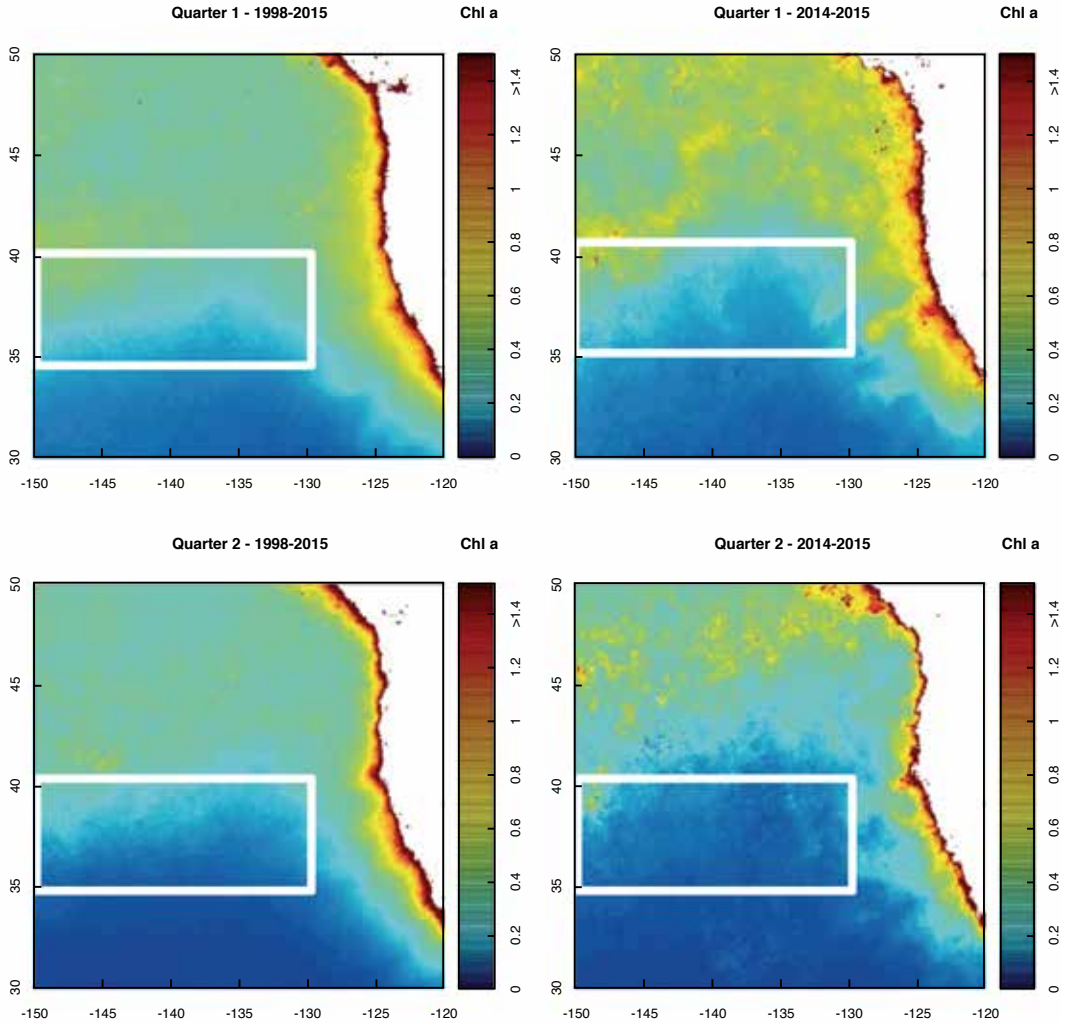


Figure 2. Mean chlorophyll a concentration in 2014-2015 compared to 1998-2015 during quarters 1 and 2, using SeaWIFS and Aqua Modis data, to investigate recent ecosystem changes in the North Pacific.

Pacific Islands Territorial Science Initiative

P.I.: Mark A. Merrifield [JIMAR Project Lead: Toby Matthews]

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

NOAA Sponsor: Michael P. Seki, Kimberly Lowe

Budget Amount: $125,000

NOAA Goal(s)

- Healthy Oceans
- Resilient Coastal Communities and Economies

Purpose of the Project

The overarching objective of this JIMAR 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 CNMI. Lack of data collection and quality control in the U.S. Pacific 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 NMFS in these islands have all contributed to inadequate data collection programs. Thus, there is a need to improve the data volume from the territories and for better quality control of those data to conduct accurate stock assessments, especially the monitoring and validation of commercial and recreational landings. The data collected is managed by the Western Pacific Fisheries Information Network (WPacFIN), which operates a centralized database supporting fisheries monitoring across the Pacific Islands Region. The Territorial Science Initiative (TSI) project collaborates with several other JIMAR projects and 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.

Figure 1. William Jasper, Territorial Fisheries Associate on Guam under the TSI project, interviewing a returning boat crew for the DAWR offshore creel survey.

Progress during FY 2016

Toby Matthews, Territorial Fisheries Data Specialist, produced several creel data analysis programs to allow creel managers to independently obtain information on appropriate numbers of sampling days to schedule and interviews to collect in order to achieve specific levels of precision in the derived total catch estimates. Matthews also created programs to automate the survey scheduling process, allowing a lengthy randomization procedure that previously took many hours each month to be completed in a matter of minutes. Each program has a user-friendly interface and staff was trained to operate the programs in-person during visits to each territory. In addition to these general analysis tools, Matthews performed specific analyses for creel managers as questions arose. Finally, Matthews produced detailed documentation of the expansion algorithms used to compute total catch from the collected creel data, making the cryptic details available to creel managers and other staff that are not experienced in programming. These accomplishments have satisfied the objectives established for the period with the exception of species identification training, which needed to be pushed back due to delays in arranging local help with the training workshops.

William Jasper, Territorial Fisheries Associate on Guam, became fully trained in the DAWR creel survey methodology and has been contributing surveys to the offshore creel program. Jasper produced a thorough documentation of the DAWR creel survey to act as a reference book and training material for new staff. Finally,

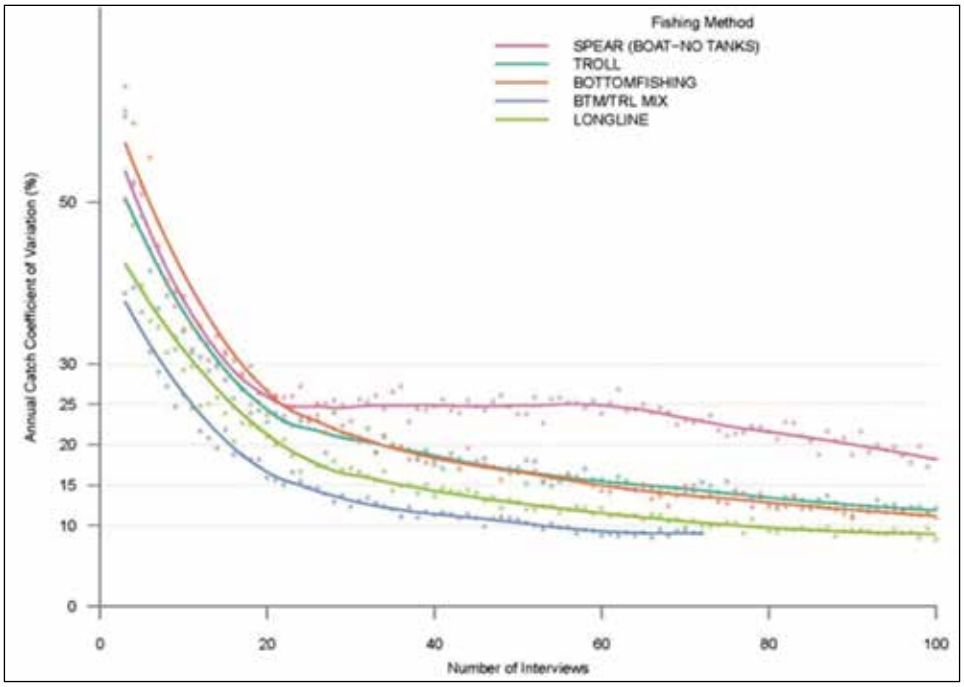


Figure. 2. Graphical output from a creel data analysis program written by Toby Matthews, Territorial Fisheries Data Specialist under the TSI project. This specific graph can be used by the boat-based creel survey manager at DMWR to determine necessary numbers of interviews for each fishing method in order to achieve specific levels of precision in the derived catch estimates.

Jasper has taken the lead in conducting quality control of creel survey data sheets. Jasper processed a multi-month backlog of data sheets, and now verified data is generally entered within a week after it is collected. These accomplishments have satisfied the objectives established for the period.

Pacific Tuna Fishery Data Management

P.I.: Mark A. Merrifield [JIMAR Project Lead: Jesse Abdul]

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

NOAA Sponsor: Evan Howell

Budget Amount: $185,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The objective of this JIMAR 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 highly valuable to tuna stock assessors and tuna fisheries monitors but is currently housed in an outdated and relatively inaccessible database system. Project staff will develop updated tools to enable access to the data and will also develop a system for sustained data management. The project will coordinate with several NOAA National Marine Fisheries Service (NMFS) offices towards developing the data management system and will also collaborate with several Pacific Islands Fisheries Science Center (PIFSC) research projects and the Pacific Islands Regional Office (PIRO) for subsequent access and analyses functions and to coordinate monitoring and reporting requirements.

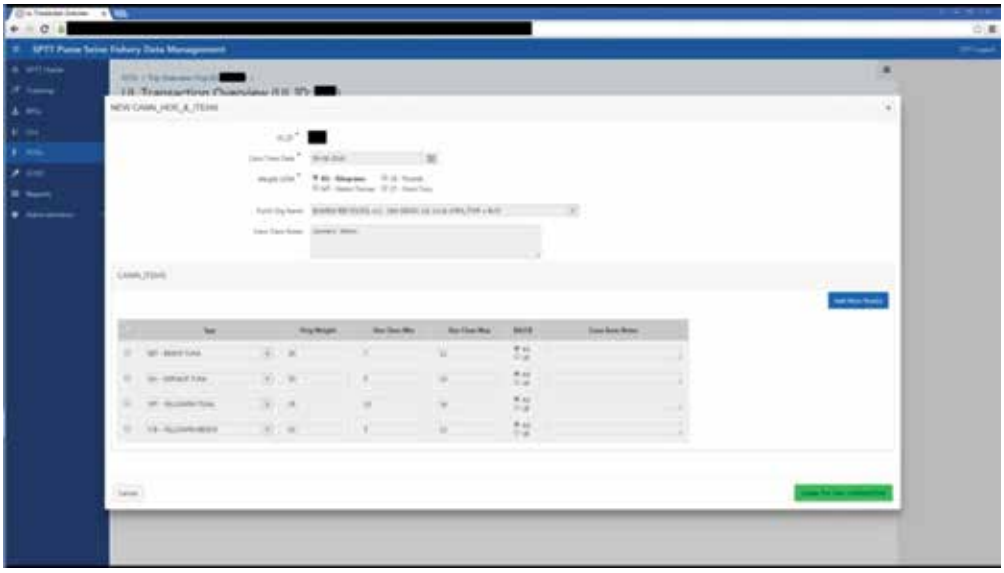


Figure 1. Screenshot of FOT APEX data management application used to enter 2014–2015 fishing trip data.

Progress during FY 2016

Implement interim procedures for increasing data accessibility. The project developed numerous documented Oracle Views to provide formatted production SPTT data directly via Oracle without requiring the recipient to understand the underlying data model. The project facilitated project members' direct access to the data by granting access to these Oracle Views for specific team members to allow the exporting of data in conventional data formats and importing data into analysis programs like R.

Test procedures for loading new SPTT data and integrating with existing data. Due to time constraints and technical capacity, the project decided to leverage an existing Smart portable document format (PDF) form, eTunaLog, to electronically enter all regional purse-seine logsheet (RPL) data provided in paper forms. In addition some vessels already used the smart PDF form to report their RPL data electronically. Project staff developed an extensible markup language (XML) Import Module as an application framework implemented to parse the exported Smart PDF RPL data and load it into the PIFSC SPTT relational database.

The project developed separate Oracle Application Express (APEX) data management applications to allow the unloading and transshipment logsheets (UL) and final out turn receipts (FOT) data streams to be managed directly in the PIFSC SPTT database.

The project developed a flexible Data Validation Module as an application framework to evaluate specific data quality control (QC) criteria defined for the RPL data stream. The Data Validation Module automates the process of evaluating each fishing trip's data in the RPL data stream and populates the SPTT database with records representing the various data validation issues based on the defined QC criteria. An Oracle View was developed to export a single report that contains each data validation issue instance that allows a Data Specialist to easily identify the data issue and provides information about how to resolve it. For the RPL data stream 172 distinct validation criteria were implemented to date. The flexible framework can be further developed to allow data QC to be conducted on all SPTT data streams.

JIMAR worked with the Southwest Fisheries Science Center (SWFSC) to migrate the historical SPTT data from the SWFSC database to the PIFSC database while accounting for differences between data models. This historical data migration process was not completed but project staff made an extensive effort to define the data requirements and develop the migration process based on the preliminary data provided by SWFSC. The historical data was not provided to PIFSC in the defined format for all SPTT data streams. The data model to accommodate this data has already been developed by PIFSC, and the historical data is ready to ingest when the data are provided by SWFSC in the defined format. PIFSC completed all items within its control for the historical data migration project, and once the historical data are migrated into the PIFSC SPTT database, the Data Validation Module will be used to perform QC on all migrated data.

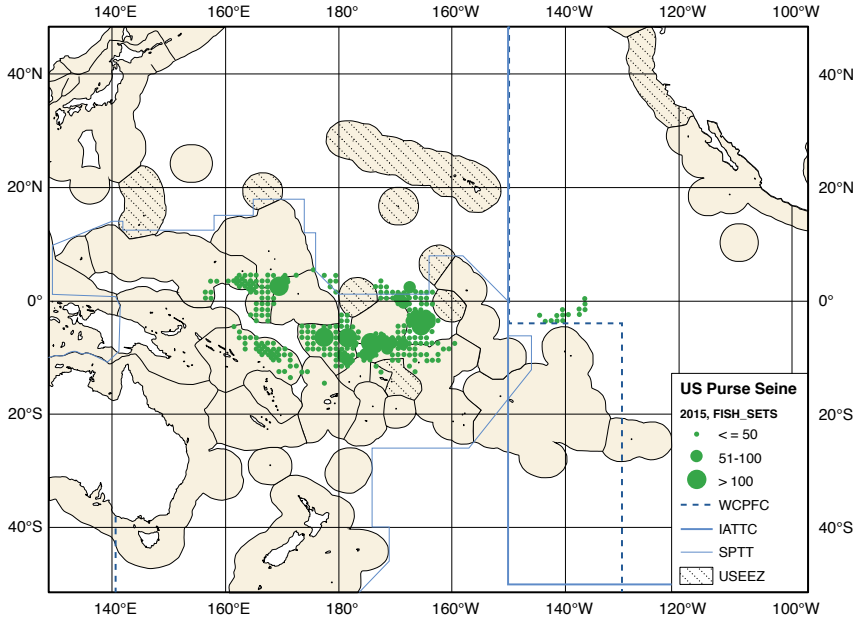


Figure. 2. Distribution plot of SPTT purse-seine effort by RFMO zones with graduated symbols of fishing set counts.

Evaluate methods of Electronic Reporting (ER) from the vessels to reduce the lag in data integration. The eTunaLog Smart PDF was already being used to electronically report RPL data by a small percentage of fishing vessels so it was decided that the project would use the existing Smart PDF to manually enter all non-electronically reported RPL data. The XML import module can quickly load and validate a given smart PDF form as soon as it is received. There were various limitations with the eTunaLog including weak data validation and being incapable of reporting certain types of data like net sharing events. It was determined that the eTunaLog is not a viable electronic reporting mechanism moving forward but it was instrumental in achieving the short-term Regional Fishery Management Organization (RFMO) reporting goal of April 30, 2016.

The project researched the integrated Fisheries Information Management System (iFIMS) electronic reporting system to determine the level of effort necessary to implement an RPL data import process. Project staff traveled to meet with Secretariat of the Pacific Community (SPC, New Caledonia) technical staff to discuss data management best practices in place in both organizations. During these meetings SPC's existing iFIMS import process was also reviewed and discussed. SPC discussed multiple problems with the North Atlantic Format (NAF) for data exported by iFIMS and recommended that JIMAR staff work with iFIMS to define a more flexible JavaScript Object Notation (JSON) data format for the exported data. This topic will be explored further in the following project year.

Access data from at-sea observer monitoring to investigate the existence of hot-spot areas of shark bycatch. This objective was not addressed due to lack of a data sharing agreement with the Forum Fisheries Agency. Discussion on data access will continue in the next year.

Modernize the data input and data reporting stages. The project performed data entry into the PIFSC SPTT database for all RPL, UL, and FOT data streams for fishing trips that departed in 2014–2015 using the APEX data management applications, eTunaLog Smart PDF, and XML Import Module. During FY 2016 the decision was made to prioritize the data quality of the RPL data and use this data stream as the sole source of PIFSC data for the RFMO reports this year instead of attempting to report using the RPL, UL, and FOT data streams.

At the conclusion of the data QC process on the RPL data stream the data was "frozen" using a repeatable process developed by JIMAR to create a copy of the 2014-2015 RPL data used to generate the RFMO reports for the April 30, 2016 deadline. This copy of the RPL data can be used to reproduce the results of the April 30, 2016 reports at any given time in the future. Project staff were responsible for ensuring that all 2014-2015 RPL data were validated, annotated, and frozen in preparation for the April 30 deadline and this was completed on March 24, 2016. Once the data were frozen it was used by non-JIMAR staff to develop the RFMO reports using Oracle Views provided by JIMAR.

Scientific Advice and Coordination for NOAA Office of Exploration and Research's 2015-2016 "CAPSTONE" Operations in the Pacific

P.I.: Christopher Kelley

NOAA Office (of the primary technical contact): Office of Ocean Exploration and Research

NOAA Sponsor: Jeremy Potter

Budget Amount: $228,234

NOAA Goal(s)

- Healthy Oceans
- NOAA Enterprise-wide Capabilities: Science and Technology Enterprise; Engagement Enterprise; Organization and Administration Enterprise

Purpose of the Project

Science expertise will be acquired through the services of a science advisor supported by NOAA Office of Exploration and Research (OER). The advisor will provide advice and expertise during three phases of the *Okeanos Explorer* Campaign to Address Pacific Monument Science, Technology, and Ocean NEeds (EX CAPSTONE) missions. The first phase is project planning whereby the advisor will: 1) work with OER personnel and key NOAA constituents to determine priority geographic areas and science themes for EX operations in out-years; and 2) engage the NOAA and external science and management communities to refine primary science objectives and targets for current year operations. The second phase will be the execution of annual field programs involving multidisciplinary expeditions that integrate science, education, and outreach objectives. The third phase will be the post cruise deliverables that will include high-quality data and information products generated to inform science and management needs soon after cruise completion. The advisor will essentially be the CAPSTONE Senior Scientist serving as a critical OER representative to NOAA and external partners in the U.S. Pacific Islands.

Progress during FY 2016

The project continued the work under this proposal from July 1, 2015 to February 15, 2016. As detailed in the proposal's "description of work" section, the PI has responsibilities related to 1) out-year planning; 2) expedition planning; 3) expedition execution; and 4) post expedition deliverables. The four EX 2015 expeditions took place between July 10 and September 30, 2015. Therefore, this report period began with item 3. The project PI was one of the two onboard scientists for the first 2 ROV cruises to the Papahānaumokuākea Marine National Monument (PMNM) and the Main Hawaiian Islands (MHI) including the Geologist seamounts. The PI also operated the UH Exploration Command Center (ECC) for the third and last ROV cruise to Johnston Atoll in September. Between September 2015 and February 2016, the PI was occupied with responsibilities related to items 1, 2, and 4. Similar to last year, science priorities and plans were developed for the 2016 EX operations in PMNM and the Western Pacific, and the project assisted OER staff in the identification of the core and auxiliary science teams in collaboration with external partners, and the science community. Three of the 2016 cruises were in the

Figure 1. Left: A high-density community of deep-sea corals and sponges encountered at 2078 m on the crest of Pioneer Bank Ridge during ROV dive 7. Right: A high-density community of deep-sea corals encountered at 2110 m on a seamount east of Pearl and Hermes Atoll during ROV dive 13.

Figure 2. Example images from the new OER Deepwater Benthic Animal Guide.

Marianas, and as a result, the CAPSTONE priorities were expanded to include hadal biology and geology, active hydrothermal vents, island arc volcanism, and fisheries habitats. These were presented to OER staff, NOAA and external partners, and interested members of the science community via numerous teleconferences, webinars, and in-person presentations.

Regarding item 4, all of the biological and geological samples obtained during the cruises were subsequently shipped out to the Smithsonian and Oregon State University Geological repository, respectively. Arrangements were made for the MBARI software engineer to come to UH to provide upgrades and improvements to the video annotation software VARS that is used to extract records from the ROV video. The project PI processed all of the environmental and tracking data from the 37 ROV dives completed in the 2015 season so they could be merged with the records. He also selected over 1,700 animal images taken from the ROV dives for the creation of an online Animal Guide as part of a different grant through JIMAR. Finally, the PI drafted a 2015 expedition report on all of the cruises that is currently awaiting the final edits. This report is large and took longer than expected, having originally been scheduled for completion by the end of December. However, it will be finalized shortly and is the only task that experienced slippage during the report period.

Seasonal Fluctuations in Pacific Island Marine Debris Deposition

P.I.: Mark A. Merrifield

NOAA Office (of the primary technical contact): National Ocean Service, Marine Debris Program

NOAA Sponsor: Peter Murphy

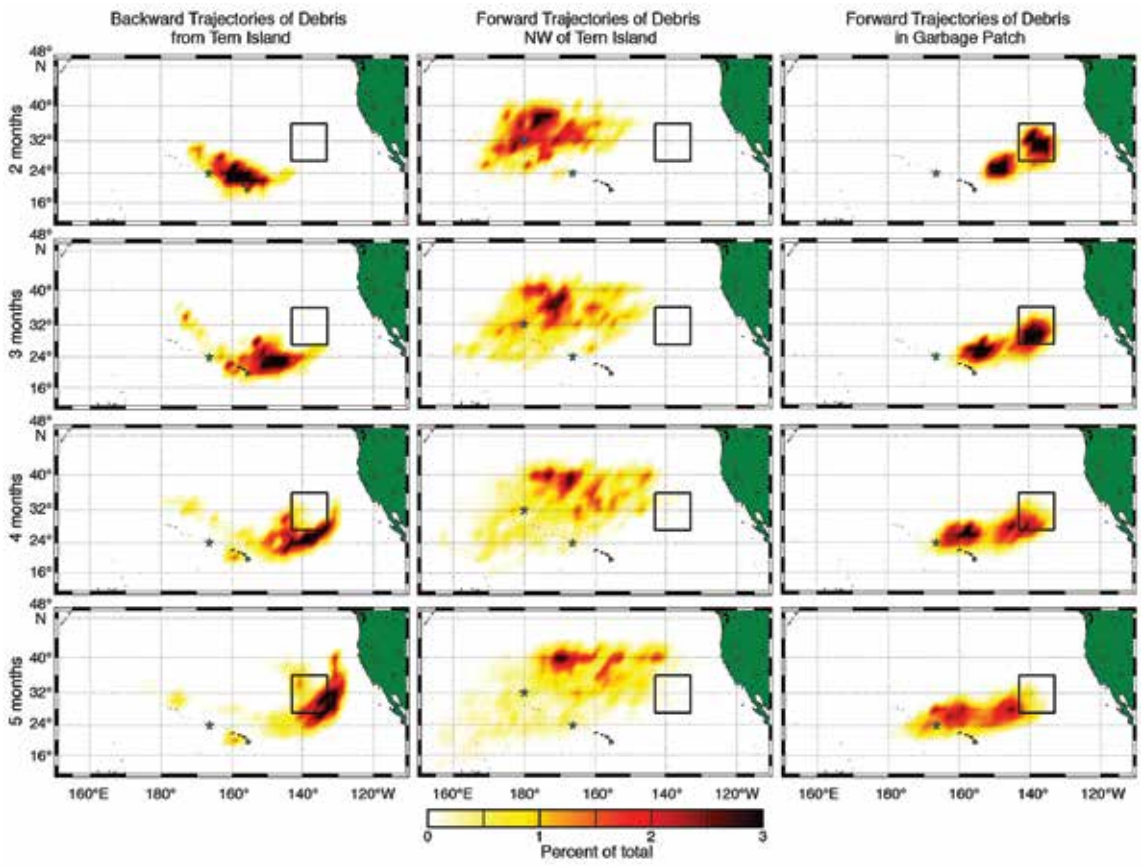
Budget Amount: $32,999

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The Hawaiian Archipelago extends from the Big Island of Hawaii 1,500 miles northwest to Kure Atoll. The entire island chain is subject to marine debris deposition and accumulation. Areas of high debris concentration in the vicinity of Hawaii include the accumulation zone in the eastern Pacific between Hawaii and California as well



First column: GNOME simulation of debris released from Tern Island and integrated backward through time. The box represents the approximate position of the Eastern Pacific Garbage Patch and the star indicates the location of Tern Island. Second column: GNOME simulation of debris released from 32_N, 180_W (denoted by a star) and integrated forward through time. Third column: GNOME simulation of debris released from the garbage patch and integrated forward through time.

as the North Pacific Subtropical Convergence Zone (STCZ) to the north of the islands. Both zones experience seasonal and interannual variations that may impact wind and current-driven drift patterns ultimately affecting the Hawaiian Islands.

The availability of a long, relatively high temporal resolution (bi-weekly sampling) dataset of debris collection at Tern Island in French Frigate Shoals and potential supporting debris data from other sites provide an excellent opportunity to determine whether temporal variability in debris collection can be linked to environmental forcing. Correlation analyses were performed on available environmental data from the region with the aim of establishing predictive linkages between wind, wave, current and sea level patterns and debris deposition at Tern Island.

Progress during FY 2016

A twenty-two year record of marine debris collected on Tern Island was used to characterize the temporal variability of debris deposition at a coral atoll in the Northwestern Hawaiian Islands. Debris deposition tends to be episodic, without a significant relationship to local forcing processes associated with winds, sea level, waves, and proximity to the Subtropical Convergence Zone. The General NOAA Operational Modeling Environment (GNOME) was used to estimate likely debris pathways for Tern Island. The majority of modeled arrivals came from the northeast following prevailing trade winds and surface currents, with trajectories indicating the importance of the convergence zone, or garbage patch, in the North Pacific High region. Although debris deposition does not generally exhibit a significant seasonal cycle, some debris types contain considerable 3 cycle/yr variability that is coherent with wind and surface pressure over a broad region north of Tern.

Ship-Based GPS Sensing of Precipitable Water

P.I.: Steven Businger

NOAA Office (of the primary technical contact): Joint Polar Satellite Systems

NOAA Sponsor: Mitch Goldberg

Budget Amount: $21,188

NOAA Goal(s)

- Weather-Ready Nation

Purpose of the Project

The project proposes to equip the NOAA ship *Ron Brown* with a geodetic GPS (Global Positioning System) and meteorological sensor package. With this equipment project researchers will be able to observe moisture fluxes streaming across the ship from the sub-tropics to the mid-latitudes while determining the operating and processing strategies that generate the most robust and accurate solutions.

Progress during FY 2016

Project researchers successfully acquired high rate GPS data during the entire CalWater 2015 field campaign, along with meteorological observations. Vanessa Almanza, a recent M.S. graduate of the UHM Department of Atmospheric Sciences, made significant progress processing and analyzing the data sets to generate accurate estimates of precipitable water during the cruise including its passage underneath atmospheric rivers. This effort is a particularly challenging one due to the extremely long distances between the ship and the nearest reference GPS sites. As a consequence the project has not yet generated an entirely satisfactory time-series. In order to corroborate current results and provide an alternate, independent solution, new processing software package was acquired. This new software package has demonstrated its ability to perform analysis of these kinds of data sets and work is underway to configure this package and generate the new solutions.

Sustaining Healthy Coastal Ecosystems

P.I.: Mark A. Merrifield [JIMAR Project Leads: Annette DesRochers, Adel Heenan, Troy Kanemura, James Morioka, Tom Oliver, Bernardo Vargas-Angel, and Supin Wongbusarakum]

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

NOAA Sponsor: Michael P. Seki, Russell Brainard

Budget Amount: $3,098,000

NOAA Goal(s)

- Healthy Oceans
- Resilient Coastal Communities and Economies

Purpose of the Project

The JIMAR Sustaining Healthy Coastal Ecosystems project mission provides sound science to enable informed and effective implementation of ecosystem-based management and conservation strategies for coral reef ecosystems of the US-affiliated Pacific Islands, the Coral Triangle and Southeast Asian regions. To accomplish this mission, project scientists lead and participate in a multi-partner, integrated, interdisciplinary program of ecosystem assessment and long-term monitoring, benthic habitat mapping, and applied research on the coral reef ecosystems of 40 primary islands and atolls in the Hawaiian Archipelago, the Mariana Archipelago (Guam and the Commonwealth of the Northern Mariana Islands), American Samoa, and the Pacific Remote Island Areas. Using an Ecosystem Approach to Fisheries Management (EAFM), the project also helps develop capacity and provides scientific expertise and technical partnerships to governments and key partners in these regions to inform and

support the implementation of effective management of the coral reef ecosystems and sustainable fishery management in the Coral Triangle and Southeast Asia regions. This work supports NOAA and other agencies in meeting mandates of the Coral Reef Conservation Act of 2000 and various executive orders issued to ensure conservation and protection of the nation's coral reef ecosystems. JIMAR project staff comprises the operational and research endeavor of the PIFSC Coral Reef Ecosystem Program (CREP) in the Ecosystems Sciences Division (ESD) of the Pacific Islands Fisheries Science Center (PIFSC).

Progress during FY 2016

Coral Reef Fish Research. The Coral Reef Fish Research team (led by Adel Heenan) met its established objectives for FY 2016.

Accomplishments for data collection include the following: 1) successfully executed diver dependent reef fish monitoring survey cruise in American Samoa and contributed to the auxiliary bleaching cruise in Jarvis. This included deploying a Baited Remote Underwater Video System (BRUVS) in cooperation with Curtin University and the Global FinPrint Project; 2) continued diver survey efforts in the Kahekili Herbivore Fisheries Management Area for the NOAA Coral Reef Conservation Program (CRCP); 3) collected diver dependent fish data in West Maui as part of a NOAA priority watershed management project (CRCP); 4) led fish diver survey training and acted as the fish monitoring lead on the Monument's Northwest Hawaiian Islands cruise (Papahānaumokuākea Marine National Monument); and 5) led field training and deployments of stereo video camera systems on Modular Optical Underwater Survey Systems (MOUSS) during an Advanced Technologies bottom fish research cruise in the Maui-Nui region.

Accomplishments for data handling include the following: 1) continued to provide analytical support to the Hawaii Division of Aquatic Resources; and 2) responded to requests for CREP Pacific Reef Assessment and Monitoring Program (RAMP) fish data including ~50 data requests to the Hawaii Division of Aquatic Resources, ~50 requests for the CREP reef fish survey data, and 6 requests for BRUVS survey data.

The team produced the following technical reports, briefs, and data reports: 1) routine standard monitoring reports; 2) a monitoring brief for the American Samoan reef fish survey project and the reef fish annual data report, this year incorporating tow data for the first time; 3) a revised version of reef fish stationary point count survey method standard operating procedures; 4) co-authored standard operating procedures for the deployment and retrieval of the MOUSS; 5) launched the online reef fish monitoring training package. Eight of the 11 people trained in the CREP fish survey method went on to collect data during this year's monitoring efforts; 6) submitted a report to the CRCP on integrating

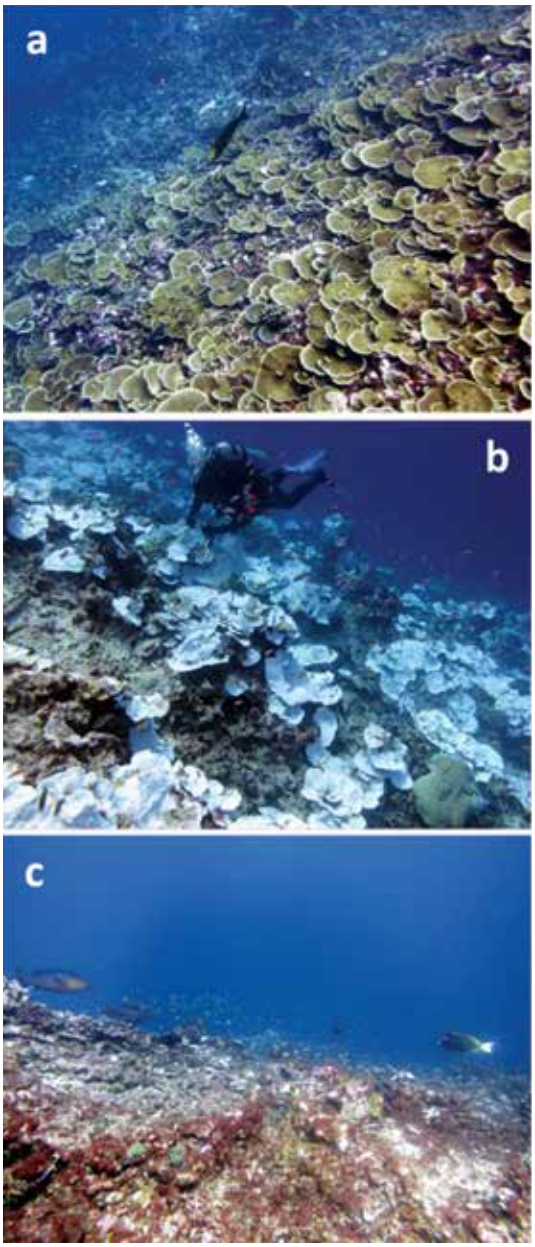


Figure 1. Seascapes of the steep-sloping forereef communities at Jarvis Island illustrating the coral reef assemblages before, during, and after the catastrophic 2015–2016 El Niño Sea Warming Event. a) Normal appearance of the coral assemblages prior to the onset of the El Niño conditions (April, 2015; photo credit: NOAA/Paula Ayotte). b) Widespread coral bleaching (loss of the symbiotic algae making corals look white) during the peak sea warming event (November 2015; photo credit Anne Cohen Lab WHOI). c) Catastrophic mortality of the benthic assemblage (now covered with algae) at the end of the sea warming event resulting in >95% coral loss (May 2016; photo credit NOAA/ Bernardo Vargas-Ángel).

Figure 2. The 2015 Marine Debris team poses with 14,606 kg of marine debris they removed from the shorelines of Midway Atoll National Wildlife Refuge.

socio-ecological monitoring data; and 7) produced quarterly reports on CREP activities for the Western Pacific Regional Fishery Management Council.

Papers and manuscripts produced by the team include the following: 1) a paper published in the *Journal of Applied Ecology* on ecosystem monitoring for ecosystem management; 2) submitted a publication to *Marine Policy* summarizing an expert panel review of science and technology to promote sustainable fisheries in Southeast Asia and the Coral Triangle; 3) submitted a publication to Proceedings of the Royal Society Biological Sciences on natural bounds on herbivorous coral reef fishes; 4) submitted a paper to PLoS One reporting on a comparison of re-breather versus open circuit SCUBA estimates using the stationary point count method; 5) submitted a paper to PLoS One reporting on the effects of the 5-year herbivorous fish management area in Maui; and 6) a completed manuscript on long term monitoring of reef fishes at Honaunau is currently with co-author for review and comment.

Benthic Research. In a continuation of the decade-long monitoring of coral reef ecosystem health in the U.S. Pacific Islands, the Benthic Research team (led by Bernardo Vargas-Angel) made preparations for the sixth Pacific RAMP research cruise in the main Hawaiian Islands (MHI) and the tenth cruise in the Northwestern Hawaiian Islands (NWHI) onboard the NOAA Ship *Hi'ialakai*. For the MHI the team will study the reef systems at Kaua'i, Ni'ihau, Maui, Lāna'i, Molokai, Kaho'olawe, O'ahu, and the island of Hawai'i. In the NWHI the team will study the reef systems at French Frigate Shoals, Lisianski, Neva Shoals, Pearl and Hermes Atoll, and Kure Atoll. JIMAR scientists will examine the reefs around these islands to document any ecological changes since the prior expeditions in 2013, with special emphasis on the effects of the 2015 and 2016 coral bleaching episode.

The team conducted dedicated benthic Rapid Ecological Assessment (REA) surveys for coral community structure, demographics, diversity, and coral condition, and completed the installation of permanent, replicate, long-term monitoring transects in the Kahana, Honokahua, and Honolua watersheds (West Maui), on July 22–31, 2015. These surveys were part of a larger project lead by JIMAR and NOAA/PIFSC/CREP scientists in partnership with State of Hawai'i Division of Aquatic Resources (DAR), the U.S. Geological Survey (USGS), the West Maui Ridge-2-Reef Initiative, and the U.S. Coral Reef Taskforce (USCRTF) Watershed Initiative. The aim of this collaborative project is to provide a baseline assessment for benthic structure and coral demographics to evaluate the effectiveness of watershed restorative management practices intended to reduce land-based sources of pollution (LBSP) threats, namely siltation and sedimentation stress, across West Maui Priority Watersheds.

Figure 3. The 2016 Marine Debris team poses with two small boats full of derelict fishing nets removed from the shorelines of Midway Atoll National Wildlife Refuge.

JIMAR scientists conducted additional surveys in areas of special management interest around the Island of Tutuila, American Samoa. Surveys for benthic community structure, coral demographics, diversity, and colony condition were conducted from October 23-November 15, 2015, at 54 sites in Faga'alu Bay, Vatia Bay, and the Fagamalo no-Take Marine Protected Area (MPA). These surveys were part of three projects supported by NOAA's Coral Reef Conservation Program (CRCP) to establish comprehensive baselines for benthic composition and coral demographics in three management priority areas in American Samoa; i.e., Faga'alu Bay: USCRTF priority site; Vatia Bay: Territorial and CRCP priority watershed; and the Fagamalo: Village No-take MPA. The coral reefs at Vatia and Faga'alu bays are severely affected by high levels of terrigenous runoff, nutrients, and sedimentation, resulting from prolonged, deficient land use practices within the boundaries of the respective watersheds. By conducting these surveys JIMAR coral scientists are providing critical information to local and federal managers to evaluate the effectiveness of ridge-to-reef management practices aimed at reducing land-based sources of pollution in Faga'alu Bay. These projects were developed in partnership with the American Samoa Department of Marine and Wildlife Resources (DMWR).

Finally JIMAR benthic scientists were also involved in a field mission in American Samoa and the U.S. Line Islands from May 1-31, 2016 to document the aftermath of the 2015–2016 El Niño Warming Event. A total of 46 benthic surveys were completed: 16 at Rose Atoll and 30 at Jarvis Island. Preliminary findings documented the catastrophic coral die off at Jarvis Island resulting from the prolonged and anomalously high water temperatures experienced between October 2015 and April 2016 (Figure 1).

JIMAR scientists were also involved in two analytical projects aimed at developing habitat use outputs and linking to environmental drivers to improve the population assessment of Caribbean and Pacific Endangered Species Act (ESA) listed corals.

In addition, the Benthic Research Team completed all established milestones for FY 2016, including the following: 1) successful transition and implementation of CoralNet as the main tool to fulfill CREP's benthic image analysis needs; 2) completed analysis of benthic imagery collected at benthic and fish survey REA sites, Calcium Accretion Units (CAU) sites, and Climate Stations for the 2015 American Samoa Reef Assessment and Monitoring Program (ASRAMP) research cruise (~ 34,000 images); 3) completed lab processing of 328 CAU units from the recent 2015 ASRAMP research cruise, 24 CAU units from the Philippines 2015, and 34 CAU units from Timor-Leste 2014; 4) completed and submitted metadata records for the benthic structure and

coral demographic surveys off the Kahana-Ka'opala, Honokahua, Honokeana, and Honolua drainages on West Maui, and Vatia, Faga'alu, and Fagamalo no-take Marine Protected Areas in American Samoa; 5) fulfilled 19 benthic cover and coral demographics data requests; 6) successfully held the Species Identification of ESA-listed Indo-Pacific corals workshop; 7) successfully prepared and delivered oral presentations for the Ecosystems Sciences Division external review and the 13th International Coral Reef Symposium; 8) completed and updated the Standard Operating Procedure manual for benthic image analysis implementing CoralNet (stratified random and towed-diver imagery); and 9) continued coral demographic and species identification training for the NOAA-PIFSC –CREP staff and partner divers.

Ocean and Climate Change Research. The Ocean and Climate Change (OCC) team (led by Tom Oliver) measures environmental drivers and responses of coral reef ecosystems, with particular attention to the impacts of warming and ocean acidification. In so doing, the JIMAR Team supports scientific research and information relevant to stakeholders, managers, and scientific communities to better understand changes in coral reef ecosystem health associated with climate change, land-based sources of pollution, over-fishing, and other reef ecosystem stressors.

In FY 2016, the OCC Team continued implementation of NOAA's National Coral Reef Monitoring Plan-climate (NCRMP-climate) efforts involving a standard suite of oceanographic and ecological information throughout each of NOAA's jurisdictions in the Pacific. The purpose of the NCRPM-climate is to assess coral reef ecosystem health and quantify spatial and temporal variability related to a changing climate including the impacts of global warming and ocean acidification through the deployment of in-situ instrumentation and collection of discrete water and biological samples. The OCC team's involvement within the NCRMP-climate effort is to: 1) investigate nearshore water column thermal structure at four depths down to 25m deploying Seabird-56 Subsurface Temperature Recorders (STR); 2) quantify calcification rates of crustose coralline algae using calcification accretion units (CAUs) and coral communities (*Porites spp*. using coral cores); 3) assess rates of bioerosion using bioerosion monitoring units (BMUs); 4) evaluate the carbonate system through discrete water sampling and conductivity, temperature, density (CTD) hydrocasts; and 5) investigate cryptic invertebrate biodiversity through the Autonomous Reef Monitoring Structures (ARMS) project. These instruments and chemical and biological samples are standardized between the NOAA offices conducting research and monitoring in the Pacific and Atlantic regions, providing results that can be compared between basins.

This reporting period (July 1, 2015-June 30, 2016) did not span any scheduled RAMP cruises, as ASRAMP 2015 ended May 3, 2015 and HARAMP 2016 will begin July 12, 2016. However, the OCC team participated in two cruises to assess the impacts of the 2014-2015 coral bleaching events across both the Main Hawaiian Islands (MHI) in November 2015, and Jarvis Island in June 2016. In the MHI the team surveyed 76 km of impacted reef in thirty-eight bleaching tows following a modified benthic tow protocol. In Jarvis team members recovered and redeployed five STRs, collected fifteen water samples for carbonate system analysis, and deployed the project's diurnal suite, thereby collecting forty-eight more water samples. During the FY 2016 period the team continued analysis of bleaching surveys, STR, ARMS, CAU, and carbonate system data. Project findings were presented at three international meetings: the Oceans in a High CO2 World Conference, and the Global Ocean Acidification Network Meeting, both in Hobart, Tasmania in May 2016, and the International Coral Reef Symposium in Honolulu HI, June 2016. Three manuscripts on this work are in preparation, scheduled for submission in fall/winter 2016. Further, the OCC team is in the process of conducting a climate resilience assessment for the U.S. Affiliated Pacific Islands, which will be completed in FY 2017.

Marine Debris Response and Operations. The JIMAR Marine Debris Response and Operations team (led by James Morioka) met all established objectives for FY 2016. The Team provided planning, logistical, and operational support for the Insular MHI Reef Fish Survey (HA-15-03), Fall Insular Bottom Fish Survey (HA-16-01), American Samoa Insular Reef Fish Survey (SE-16-02), NWHI Monk Seal Field Camp Deployment (HA-16-03) and Hawaiian Islands RAMP (HA-16-06).

From August 11-September 8, 2015, JIMAR's nine-member team of divers and specialists successfully completed a 29-day operation (MP-15-15) conducting in-water and shoreline marine debris survey and removal operations at Midway Atoll National Wildlife Refuge in the Papahānaumokuākea Marine National Monument. The primary objective of this year's effort was to continue studying and monitoring marine debris accumulation both in-water and along the shorelines. Secondary objectives included the annual NOAA Marine Debris Program standing stock surveys, and the establishment of a micro-plastic (<5mm) surface-water trawl study and a meso-plastic (5mm-2.5cm) shoreline study. During 23 operational days, the team surveyed 2.87 km^2 of shorelines and shallow coral reef environments, resulting in the removal of 14,606 kg of derelict fishing gear and plastics.

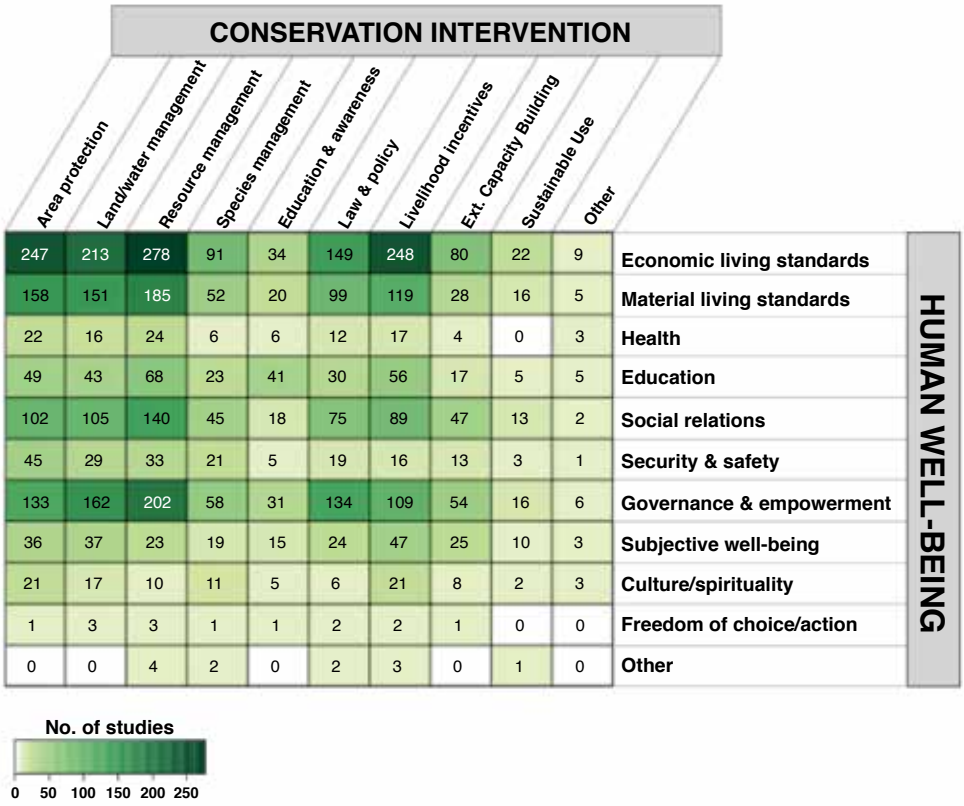


Figure 4. A figure in Environmental Evidence *paper showing a systematic map of linkages between nature conservation and human well-being illustrated as a structural matrix of the distribution and frequency of occurrences of evidence. Darker-shaded cells indicate higher occurrence of evidence with lower occurrence indicated by lighter cells.*

Additionally, marine debris staff submitted a PIFSC internal report titled, "Marine debris removal and assessment at Midway Atoll 2015" for publication. This report summarized the team's 2015 marine debris survey and removal effort at Midway Atoll National Wildlife Refuge in the Papahānaumokuākea Marine National Monument.

From April 12-May 13, 2016, JIMAR's ten member team of specialists successfully completed a 32-day two-part operation conducting shoreline marine debris survey and removal operations at various islands and atolls within the Northwestern Hawaiian Islands in the Papahānaumokuākea Marine National Monument. The first part was a 15-day land-based marine debris survey and removal operation (MP-16-10) at Midway Atoll National Wildlife Refuge. The second part was a collaborative 17-day ship-based marine debris survey and removal operation (HA-16-03) aboard the NOAA ship *Hi'ialakai* with the Protected Species Division (PSD) Hawaiian Monk Seal Research Program (HMSRP) at Kure Atoll, Pearl and Hermes Atoll, Lisianski Island, and French Frigate Shoals. The primary objective of this year's effort was to survey and remove derelict fishing nets and potential lethal entanglement hazards from islands and habitats where protected species (Hawaiian monk seals, green sea turtles, and sea birds) were at most risk. Secondary objectives included marine debris accumulation monitoring along Midway Atoll's shorelines and establishing NOAA Marine Debris Program (MDP) standing stock surveys at all HMSRP Field Camp Stations. In 23-operational days, the team surveyed 0.152 km^2 of shorelines for plastics, and 23.95 km of shorelines for derelict fishing gear and entanglement hazards, resulting in the removal of 10,965 kg of marine debris.

International Capacity Building. Social science activities and research by the International Capacity Building Team (led by Supin Wongbusarakum) are conducted under the National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP) projects, Strengthening Sustainable Socioeconomic Monitoring of Reef-dependent Communities in Micronesia (Guam, the Commonwealth of Northern Marianas CNMI) and Hawai'i, and the NOAA Pacific Islands Regional Office (PIRO)'s Pacific Island Managed and Protected Area Community (PIMPAC) Project. Activities are also in partnership and collaboration with the Pacific Islands Fisheries Science Center (PIFSC) Socioeconomic Program; NOAA's National Ocean Service; University

of Hawai‘i Social Science Research Institute (UH SSRI); the Science for Nature and People Program (SNAPP) at the National Center for Ecological Analysis and Synthesis (NCEAS), University of California, Santa Barbara; and country partners. All the projects strive for establishing and strengthening social science application to enhance ecosystems management that takes into consideration human well-being and balancing it with ecological health through good governance. Accomplishments during FY 2016 include the following.

- Developed and conducted a socioeconomic monitoring capacity development needs survey among the team members of the core Micronesia socioeconomic monitoring (SEM) team with representatives from CNMI, Guam, Yap, Chuuk, Pohnpei, Kosrae, Marshalls Islands, and Palau and participants from Guam. The survey data were analyzed and a report of the results was submitted to NOAA CRCP. The survey results were used to guide content and material development for subsequent socioeconomic monitoring training.
- Led a socioeconomic monitoring training with the core Micronesia SEM team. Report submitted to PIRO Pacific Island Managed and Protected Area Community (PIMPAC).
- Advised and provided technical support to Micronesia Islands Nature Alliance and Conservation Society of Pohnpei on a PIMPAC-supported socioeconomic assessment in Takaieu, Pohnpei.
- Together with the NOAA Field Office staff in Guam, developed and submitted a household survey questionnaire, and key informant interview and focus group guiding documents to the NOAA Office of Management and Budget for an approval on a study with human subjects. These data collecting instruments were approved, finalized and are currently being used to collect data from the Merizo community members in the NOAA Habitat Blueprint site Manell-Geus and from key local stakeholder groups who are dependent on the reef resources and/or impacted by sedimentation and its causes including increasing floods and human-induced fires.
- Guided and provided technical support in developing socioeconomic monitoring draft plans for the NOAA Habitat Blueprint site Manell-Geus in Guam, Laolao Bay in CNMI.
- Advised the Community-Based Subsistence Fishing Area Program (CBFSA) of the Hawai‘i DAR on developing a socioeconomic baseline study on Ha‘ena and other potential CBFSA sites.
- Developed and submitted to NOAA CRCP a conceptual framework for integrated monitoring that takes into consideration both bio-physical and socioeconomic research.
- Served as the socioeconomic monitoring team lead and participated in the Micronesia Challenge (MC) Scorecard meeting.
- Gave a presentation titled, “Applying Social Science to understand the well-being of reef-dependent communities in Micronesia,” at the 13th International Coral Reef Symposium.
- Served as a member in the SNAPP working group and participated in a workshop at NCEAS to develop two manuscripts. The first, “Sustainability: Map the evidence,” was published in *Nature* and the second, “What are the effects of nature conservation on human well-being? A systematic map of empirical evidence,” in *Environmental Evidence*.
- Published three papers related to community-based climate vulnerability assessment and climate adaptation in *Coastal Management*. The titles of the papers are: “Community-based climate vulnerability and adaptation tools: A review of tools and their applications,” “Enhancing community-based planning for coastal and island communities in a changing climate: The Local Early Action Planning (LEAP) Tool,” and “Using expert knowledge to develop a vulnerability and adaptation framework and methodology for application in tropical island communities”.
- Published a paper titled, “Conservation organizations need to consider adaptive capacity: why local input matters,” in *Conservation Letters*.
- Developed questions to update the report “CNMI as a Fishing Community” by the PIFSC Socioeconomic Program.

Ecospatial Information Research. For FY 2016 the Ecospatial Information Research Team (led by Annette DesRochers) completed a number of milestones for on-going projects including the following.

A series of benthic habitat map layers were completed for Tutuila, American Samoa and provided to the CREP Fish Team as part of an on-going joint project to identify map layers that are the best predictors of reef fish distribution. Preliminary findings from this analysis were documented in the draft report, “A preliminary analysis examining linkages between reef fish assemblages and benthic habitat characteristics in Tutuila, American Samoa” and posted online, along with the source data used for carrying out the analysis described in the report.

New benthic habitat mapping data products to support PIRO on the critical habitat designation for the Pacific coral species listed under the ESA were completed as part of an on-going project, including depth contours

Figure 5. Participants of a socioeconomic monitoring training with the core Micronesia SEM team members and representatives from Guam natural resource management agencies.

(10-50m) for PIRO's priority islands (28) in the Pacific Islands Region, and new hard/soft substrate maps for the islands Guam, Saipan and Tutuila. Project findings were highlighted at the 13th International Coral Reef Symposium (ICRS) in a poster titled, "Mapping to Support Management of Endangered Species Act Listed Corals in the U.S. Pacific Islands Region".

Updated benthic habitat maps were completed as part of an on-going project for the West Maui and West Hawaii CRCP/Hawaii DAR priority sites and the West Hawaii Habitat Blueprint Focus Area (HFA) including geomorphological layers (slope, rugosity, bathymetric position index structures and zones, and hard/soft substrates), and final products were delivered to partners. To produce the maps, processing and classification of the existing partner datasets and newly collected imagery in 2015 was completed, and a deep-water benthic classification method was developed. The West Hawaii map has been incorporated in the Pacific Islands Ocean Observing System (PacIOOS) online mapper tool, and a Story Map of the project has been developed for the HFA website.

A grid of high-resolution bathymetry data, products, and metadata were completed for the West Hawaii priority site (known as Pelekane) on the Big Island of Hawaii and for a ship grounding site on Oahu.

The data, metadata, and associated products for these completed milestones were made available on the project's Pacific Islands Benthic Habitat Mapping website. Metadata documenting the products, data, and analyses were developed in the NMFS InPort system and posted on the Coral Reef Information System (CoRIS) website.

The team also provided support to a number of new projects led by other teams in FY 2016, including the following.

As a partner in the new joint project with the Office of Coastal Management to support geospatial capacity building in the Hawaii State DAR, the project team participated in a 3-day Geographic Information System (GIS) training to learn about DAR's current GIS needs and challenges and to present the project's geospatial capabilities and projects.

In support of a new project to enhance management of Pacific ESA-listed corals with improved utility of existing data and automated image analysis using CoralNet, the project team began quality control of the spatial data from the towed-diver surveys conducted during the 2014 Marianas Archipelago Reef Assessment and Monitoring Program (MARAMP) and 2015 ASRAMP cruises. The project team also completed calibration tests

in preparation for ground-truthing the performance of the CoralNet computer vision algorithms to do image analysis.

In support of a new project to link spatial patterns of *Isopora* with environmental drivers in American Samoa, a new method was developed to integrate the benthic habitat information to the sampling units for further analyses, and for another project, a new process to integrate satellite/model-based oceanographic parameters into new GIS grids for the Pacific Islands was developed.

In support of a new project to develop a monitoring report and overview booklet for the Pacific Remote Islands Marine National Monument, the team provided overall project coordination and helped supervise a team of master's students from the University of California at Santa Barbara, Bren School of Environmental Science and Management in conjunction with the other team leads.

A number of mapping-related milestones for international projects were completed or in-progress in FY 2016 by team members. These milestones include the following.

As part of the Moorea Long Term Ecological Research joint project with UH SOEST, multibeam data collected around Moorea in 2014 were processed, grids for priority sites were developed, new data were integrated with existing data from the Kilo Moana, and map products were created.

As part of the USAID partnership with NOAA to provide assistance in satellite mapping of coral reefs and nearshore ecosystems for Timor-Leste the team completed the following: 1) developed a method for deriving benthic habitat information from WorldView-2 (WV2) satellite imagery; 2) pseudobathymetry and benthic habitat data were derived from the WV2 satellite imagery for the nearshore areas around Timor-Leste and team members produced seamless base maps and final products; 3) conducted a hands on GIS workshop for the Ministry of Agriculture and Fisheries GIS staff in Timor-Leste and presented a draft spatial data framework for the Timor-Leste data; and 4) developed a draft of the final report for the project. Findings from the WV2 satellite mapping component of the project were highlighted at the 13th ICRS in a poster titled, WorldView-2 Satellite Mapping of the Nearshore Ecosystems Around Timor-Leste: Goals, Challenges and Accomplishments.

The team worked on two web-based GIS mapping tool projects. The first, in collaboration with the PIFSC and supported by the Pacific Marine National Monument, is a project to develop web-maps for the Monument areas. The second is a Marine Debris Story Map highlighting the 2016 debris mission in the Northwestern Hawaiian Islands while underway. The Story Map received over 5,000 views in just a few short months.

Additionally, the team participated in or supported several other Program initiatives, including the Marine Debris, Bleaching, Reef Fish, and RAMP missions. As part of the PIFSC External Review on Ecosystem Sciences, the team made presentations to the review panel on the Benthic Habitat Mapping initiatives, and contributed to two other presentations on PIFSC Data Management and Endangered Species Act (ESA) listed corals.

Data Management. In FY 2016, the Data Management team (led by Troy Kanemura) continued to support the CREP research efforts and activities. The team's contributions were largely focused on addressing several stages in the data life cycle.

To improve planning for data management the team continued to utilize a resource allocation plan for communication, project planning, and prioritization of data management resources, and participated on the PIFSC PARR (Public Access to Research Results) implementation team to achieve compliance for the program.

To support data collection the team accomplished the following.

- Provided personnel to serve as cruise data manager for the SE-16-02 (American Samoa and Jarvis Island Reef Fish Surveys) and HA-15-03 (Main Hawaiian Island Reef Fish Surveys) cruises. The team also provided data management support for several field missions: HA-15-05 (Northwestern Hawaiian Islands Reef Assessment and Monitoring Program), MP-15-07 (Autonomous Reef Monitoring Structures), MP-15-12 (West Maui Benthic Surveys), MP-15-14 (Main Hawaiian Islands Reef Fish Survey Extension), MP-16-02 (American Samoa Coral Benthic Surveys), and HA-16-02 (Main Hawaiian Islands Coral Bleaching Surveys).
- Expanded the cruise data manager training program to broaden the pool of cruise data manager candidates and standardize cruise data management operations.
- Continued to provide data management support for the benthic image analysis efforts in Coral Point Count (CPCe) and the transition to CoralNet.
- Provided data management support for the marine debris mission, including data management support for deploying the missions, fulfilling data requests, and minor updates to the Oracle Application Express (APEX) data management application.
- Continued working on the data management project for American Samoa's Department of Marine and Wildlife Resources (DMWR), specifically, developing a data management interface to meet the needs of the American

Samoa Coral Reef Monitoring Program (ASCRMP) and the American Samoa Integrated Coral Reef Monitoring Program (ICRMP).

The Data Management team was also involved in numerous post-collection data processing activities. For all of the aforementioned missions that took place in FY 2016, the data was processed, quality controlled, and migrated to the CREP enterprise database. For missions supported by the Coral Reef Conservation Program (CRCP), the data collections under the National Coral Reef Monitoring Plan (NCRMP) were submitted to the program's data manager.

To support data documentation the team accomplished the following: 1) properly documented all in-scope data collections (as defined by NMFS PARR Implementation Plan) in InPort; 2) archived several data collections with the NOAA National Centers for Environmental Information (NCEI); 3) implemented a workflow to track the metadata and archival activities for each data collection; and 4) provided one metadata coordinator to serve as the point-of-contact for CoRIS and InPort to support documentation of the Project's data collections.

To increase data access and dissemination the team completed the following: 1) responded to numerous internal and external requests for data (tracking the end-to-end workflow for those data requests); 2) continued to increase access to the Oracle database within the division using Oracle Structured Query Language (SQL) Developer, Open Database Connectivity (ODBC), and Java Database Connectivity (JDBC); and 3) trained a database programming assistant and program volunteer to document data collections InPort and archive the data with NCEI.

On top of all these activities, the data management team continued to be significantly involved in the consolidation, storage, backup, and security aspects of the division's data holdings and managed to support outreach and educational efforts during the SE-16-02 American Samoa Reef Fish Survey cruise.

Western Pacific Fisheries Information Network (WPacFIN)

P.I.: Mark A. Merrifield [JIMAR Project Lead: Karen Brousseau]

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

NOAA Sponsor: Michael P. Seki, Kimberly Lowe

Budget Amount: $350,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The objective of this project is to ensure that the best available fisheries monitoring data can be provided by the NOAA Pacific Islands Fisheries Science Center's (PIFSC), Western Pacific Fisheries Information Network (WPacFIN), for research and sustainable management of fisheries in the Pacific Islands Region. This objective is met through computer programming, database and software development, design and management, and other information technology support to fisheries agencies participating in the WPacFIN. JIMAR and PIFSC federal staff work cooperatively with island agencies, contractors, fishermen and fish dealers to create data systems that implement quality control measures and synthesize fishery-dependent monitoring data for the island areas of Guam, the Commonwealth of the Northern Mariana Islands (CNMI), Hawaii, and American Samoa. This technical support enables PIFSC and WPacFIN agency partners to produce timely reports and summaries of the best available fisheries data from each island area.

Progress during FY 2016

JIMAR staff continued work with the federal contractor, Tukuh Technologies LLC, to develop the new WPacFIN website. With an updated "look and feel", the dynamic website supports user-driven queries designed to fulfill many of the frequently-asked nonconfidential data requests, including queries by individual species or group and annual summaries of estimated and reported landings for each island area. It provides better links to publications, metadata, and information from NOAA and partner agencies, and provides automated updates to two annual NMFS publications, *Fisheries of the United States (FUS)* and *Fisheries Statistics of the Western Pacific (FSWP*)

Figure 1. JIMAR and DAWR staff at the 2016 Guam Lunar Festival, which highlights traditional fishing and conservation practices of the Chamorro people. These practices are integral parts of the ecosystem-based approach to Pacific Pelagic Fishery Ecosystem Plans for the Western Pacific. From left to right, Celestino Aguon (DAWR Chief), Renee Franquez (DAWR Creel Survey Technician), and Anna Regis (JIMAR-DAWR Fisheries Database Assistant).

Figure 2. JIMAR and Division of Fish and Wildlife (DFW) staff in CNMI discuss the shore-based and boat-based creel survey data processing systems. From left to right, Steven Rasa (DFW Data Technician), David Benavente (DFW Shore-based Data Program Supervisor), Kelly Masuda (JIMAR WPacFIN Computer Specialist), and John Palacios (DFW Data Technician).

and two annual management-driven reports (Council Management Unit Species and Allowable Catch Limits). A demonstration of the new website was presented to PIFSC in November 2015 and to partner agencies, including the Western Pacific Regional Fishery Management Council in April 2016. It is currently undergoing a security review through NOAA and PIFSC Information Technology Services prior to going live.

The project completed the requirements and design for the next phase of the website with the following primary objectives: 1) enable user queries to serve available gear-level catch, effort and catch-per-unit-effort (CPUE) data for all island areas; 2) expand annual data queries to provide monthly and quarterly summaries; and 3) enable a few additional species group queries (e.g., based on salinity, habitat, and distances traveled from shore). JIMAR staff continued converting database processing applications from the legacy Visual FoxPro (VFP) systems to MySQL and C#. This year the project focused on the new Guam system as a prototype for all other island agency systems. The imaging module and the Pelagic Plan Team reporting module for Guam are well underway and the FSWP was completely generated in MySQL and C#. Some delays occurred during conversion of all database applications to MySQL and C#, but the conversion remains a high priority.

This year a new Public Access to Research Results (PARR) Implementation Plan from NOAA headquarters changed metadata requirements. In compliance with PARR mandates for metadata and data accessibility, the project met all requirements for WPacFIN datasets, posted online to the NMFS Metadata Catalog, InPort. This first milestone was completed before the December 31, 2015 deadline. Project staff completed documentation for VFP metadata Administrative Reports for American Samoa, Guam, and CNMI (in review prior to submission to the Fisheries Research and Monitoring Division Editorial Review). VFP metadata documentation for Hawaii is still in progress. The project continues to support the Hawaii Division of Aquatic Resources (DAR) so that data reported via the online reporting system developed by the Hawaii Information Consortium (HIC) can be used by DAR's MySQL database server. HIC is the State of Hawaii's online database contractor; progress has been gradual, as much of the work is dependent on contractor activity. WPacFIN met all annual and semi-annual reporting deadlines for FY 2015-2016, including those for PIFSC reports to Regional Fishery Management Organizations (RFMOs), the *Fisheries of the United States* (FUS, April 20th), and the *Fisheries Statistics of the Western Pacific* (FSWP, August 29th). The FSWP document was completed for calendar year 2013, and the FUS was completed for 2014 and 2015.

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.

Economics of Fisheries Initiative

P.I.: Mark A. Merrifield [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

Budget Amount: $173,000

NOAA Goal(s)

- Resilient Coastal Communities and Economies

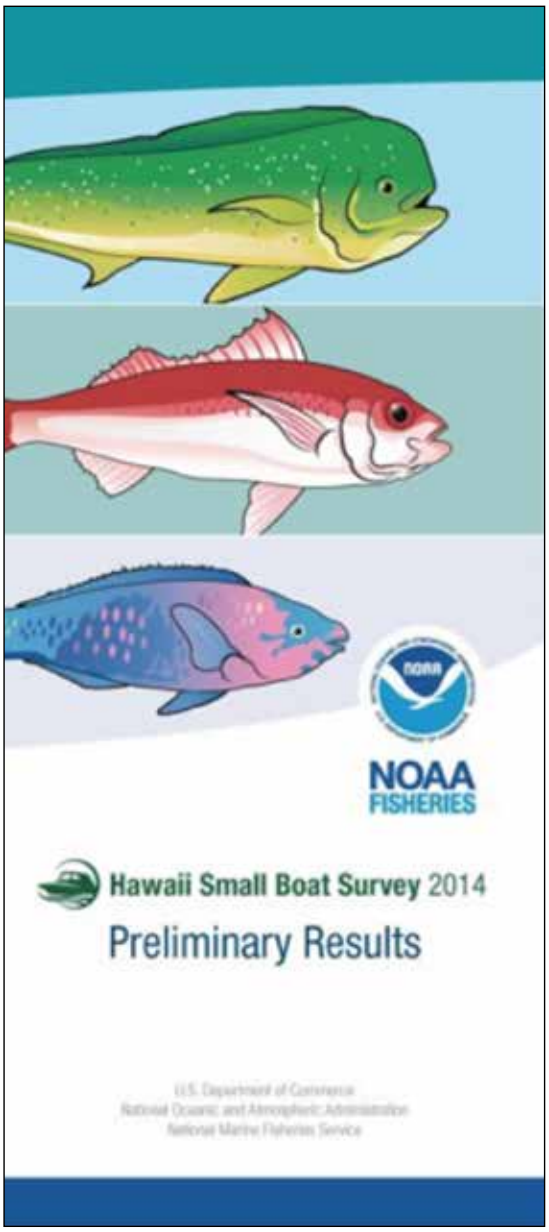
Purpose of the Project

The purpose of this project is to conduct economic assessment of commercial and recreational fisheries and of the seafood market in the Pacific Islands Region.

Progress during FY 2016

The project has been successful in continuing data collection and monitoring activities in the Guam and Commonwealth of Northern Mariana Islands (CNMI) small-boat fisheries and with database management of the Hawaii longline fishery and American Samoa longline fishery.

Project activities accomplished during FY 2016 include: 1) for the cost-earnings study of the Hawaii small boat fishery, a brochure summarizing the preliminary results was published and distributed to small boat fishermen who participated in the survey. Results were also summarized in the May 2016 PIFSC Report to the Western Pacific Regional Fishery Management Council. A draft NOAA technical report of this study is under development; 2) for the Hawaii longline fleet dynamic modeling research, a positive mathematical programming model was completed; it accurately simulated individual vessel's effort and revenue over the period of 2002 to 2013. Research results were presented at various venues; 3) for the cost-earnings study of the American Samoa small boat fishery, data were entered and a database was created; and 4) for the cost-earnings study of the Hawaii bottomfish fishery, field work, data entry, and data analysis were completed.



Cover of the brochure that summarized the key preliminary findings of Hawaii small boat survey.

Human Dimensions of Fishing and Marine Ecosystems in the Western Pacific

P.I.: Mark A. Merrifield [JIMAR Project Lead: HingLing Chan]

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

NOAA Sponsor: Michael P. Seki, Justin Hospital

Budget Amount: $173,288

NOAA Goal(s)

- Resilient Coastal Communities and Economies

Purpose of the Project

The need for information on the human dimensions of marine ecosystems is becoming increasingly important in the Pacific Islands region. Uses include but are not limited to: a) assessment of the social, cultural, and economic impacts of fishery management measures on individuals, households, and communities; b) identification of possible management alternatives and accompanying social, cultural, and economic objectives; and c) identification of local perspectives regarding the status of marine ecosystems, and sources of human impacts to such ecosystems over time. JIMAR researchers collect valuable sociocultural information to examine the impacts of these emerging management concerns. Researchers assist PIFSC in coordinating with local populations and collecting relevant information to describe the sociocultural considerations to managers as they develop management priorities and plans.

Figure 1. Tanapag Harbor Fishing dock on the island of Saipan, CNMI.

Progress during FY 2016

During this reporting period, activities accomplished by the project include the following.

For the fishing community profile update for CNMI, initial scoping updates with stakeholders were completed and fieldwork was conducted with fish markets owners, fishers, and Division of Fish and Wildlife staff members in Saipan in June 2016. A diverse set of secondary data sources to support the fishing community profile update are currently under construction. This project is approximately six months behind schedule due to staffing limitations and changes.

To refine the social indicators of vulnerability and resilience in fishing communities for Hawaii, fisheries data and American

Figure 2. Roadside fish vendor in Garapan village on the island of Saipan, CNMI.

Community Survey data through 2014 at the Census County Subdivision geographic scale were updated. Additional indicators of inundation risk from sea level rise were developed including measures of potential economic loss attributed to various future sea level rise scenarios.

For rights based management alternatives for the Hawaii longline fishery, a brochure supporting the project was developed and translated into Vietnamese and Korean languages and distributed during semi-structured interviews with the Hawaii longline fishermen between September and December 2015. In addition, brochures in various languages, a blog post, and a video were posted on PIFSC's blog. A manuscript on the effects of the 2015 regulatory closure is in preparation for internal review and will be submitted to *Marine Policy*.

International Ecosystem Approach to Fisheries Management Project

P.I.: Mark A. Merrifield [JIMAR Project Lead: Supin Wongbusarakum]

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

NOAA Sponsor: Michael P. Seki, Russell Brainard

Budget Amount: $424,900

NOAA Goal(s)

- Healthy Oceans
- Resilient Coastal Communities and Economies

Purpose of the Project

The International Ecosystem Approach to Fisheries Management (IEAFM) Project is a multi-disciplinary research and capacity development endeavor to inform and support the implementation of effective management of the coral reef systems and sustainable fishery management in the Coral Triangle and Southeast Asia regions, and is complementary to the JIMAR Sustaining Healthy Coastal Ecosystems project. Using an Ecosystem Approach to Fisheries Management (EAFM), the project provides scientific expertise and technical partnerships to governments and key partners. This work support efforts to adopt an ecosystem-based approach throughout NOAA's broad ocean and coastal stewardship, science, and service programs. The goal of ecosystem-based management is to maintain ecosystems in a healthy, productive and resilient condition so they can provide the services humans want and need.

Progress during FY 2016

In FY 2016, the International Team in the PIFSC Coral Reef Ecosystem Program (CREP) continued building capacity and providing technical support related to implementing effective coral reef ecosystems and sustainable fisheries management among governmental and other key partners in the Coral Triangle (CT) and Southeast Asia regions. Key accomplishments of each of the missions are listed below.

Philippines. Accomplishments by the team for this region include the following.

- Developed educational and outreach materials, including informational Autonomous Reef Monitoring Structures (ARMS) posters and postcards featuring species collected from ARMS activities in the Verde Island Passage. The Philippines Department of Environment and Natural Resources Biodiversity

Figure 1. Hands-on-ARMS outreach event in Mabini, Philippines, May 2016.

Management Bureau (DENR-BMB) used these materials during the Month of the Ocean in May to create a greater awareness and understanding of the importance of biodiversity in Philippines waters.

- Participated in the ARMS outreach event and education program for the Month of Ocean hosted by the DENR-BMB in Mabini, Batangas.
- Developed a method for selecting the most appropriate climate projection models for the Philippines from the suite of 40+ Intergovernmental Panel on Climate Change (IPCC) Coupled Model Intercomparison Project (CMIP) Phase 5 models based on historical datasets.
- Completed a draft manuscript titled, "Climate-induced vulnerability of fisheries in the Coral Triangle: Skipjack tuna thermal spawning habitats". This manuscript applied the method noted above to relate sea surface temperature with projected skipjack spawning habitats and is in review for submission to the *Journal of Fisheries Oceanography*. Results of the analyses were presented at the 13th International Coral Reef Symposium. Projected changes in tuna spawning habitats are likely to have important consequences for local and regional fisheries management in the CT region.
- Extracted nightly fishing light locations and intensities from the Visible Infrared Imaging Radiometer Suite (VIIRS) Suomi National Polar-orbiting Partnership instrument via satellite imagery between May 2012 and December 2015 to infer spatial distribution of small pelagic fishes. A related field validation was conducted in Quezon province.

Figure 2. E-EAFM trainers team in Cebu, Philippines, April 2016.

Figure 3. NOAA booth at U.S. Embassy Outreach Event, "Amérika iha Timor Leste: Parseria ba Prosperidade", in Dili, Timor Leste, October 2015.

- Conducted training with Bureau of Fisheries and Aquatic Resources (BFAR) staff in Quezon City on the use of R statistical software for analyzing and visualizing fisheries data.
- Modified the standard E-EAFM curricula and conducted training in collaboration with BFAR and Ecosystems Improved for Sustainable Fisheries Project (ECOFISH) for BFAR Provincial Fisheries Management Officers. A Fisheries Office Order to mainstream EAFM was drafted and went into effect Philippines-wide following the training event.
- Started coordinating a peer-to-peer exchange "Bridging Science for Ecosystem-based Fisheries Management and Conservation Peer Exchange" between the Philippine Government and NOAA. The objective is to foster scientific and management exchange and relationships between the U.S. and Philippine Government marine practitioners/scientists.

Timor-Leste. Accomplishments by the team for this region include the following.

- Successfully sequenced sixty-six samples extracted from the ARMS fractions using next-generation sequencing on the Illumina platform producing over one billion reads.
- Quality controlled and analyzed temperature data downloaded from fourteen temperature loggers.

- Completed lab processing of the samples from thirty-four calcification accretion units (CAUs) to determine the total accreted calcium carbonate. Calcification rates were calculated and analyzed.
- Continued DNA meta-barcoding and bioinformatics analysis of the ARMS samples.
- Completed benthic habitat data processing and clean-ups, standardizing data names and creating metadata records for each dataset.
- Finalized bathymetric data layers for the northeast shore of Timor Leste and delivered to the Government of Timor a set of WorldView2 satellite images for bathymetric mapping and benthic habitat characterization. Deliverables include naming conventions, translating data and creating metadata. Bathymetric maps will aid in answering questions related to the geographic distribution and biodiversity of near-shore coral reef habitats and will support science-based management and the designation of marine protected areas (MPAs) or key biodiversity areas (KBAs).

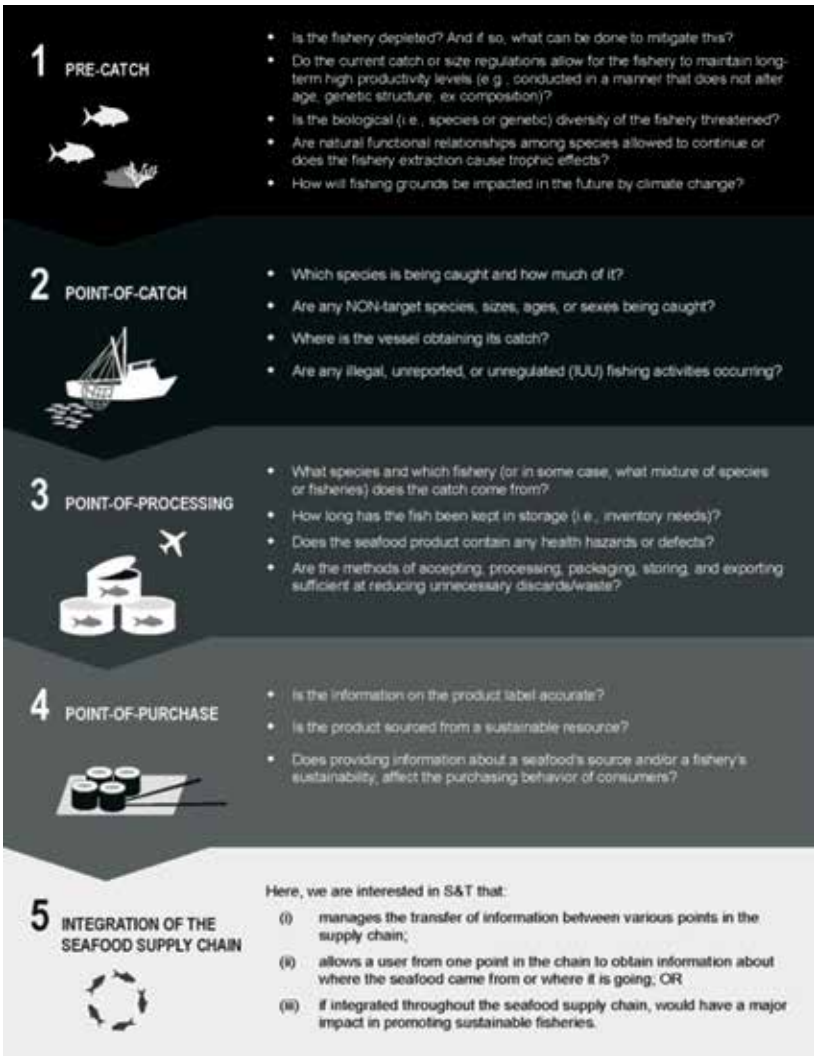


Figure 4. Figure in a manuscript titled "The mobilization of science and technology fisheries innovations towards an ecosystem approach to fisheries management in the Coral Triangle and Southeast Asia". (Figure developed by A. Dillon).

- Conducted a Geospatial Information System (GIS) data workshop in Dili with participants from the Directorate National Fisheries and Aquaculture, Directorate National for Resource Management and Inspection, and the Directorate National for Research. The workshop provided an overview on how NOAA manages coral reef data and how to link science to fisheries management support in Timor-Leste. Through a series of instructional and hands-on GIS exercises, participants learned how to create maps of coral reef baseline data collected by NOAA and partners from 2012 to 2014, and to utilize the satellite-derived base maps. The data and map layers produced will be useful for longer-term capacity building and coastal resource and fisheries management decision making in Timor-Leste.
- Developed a template for the final report for the Timor-Leste project and drafted several sections. Reviewed, edited, and integrated data, figures, and content for each of the program components (satellite mapping, reef ecosystem assessments, climate change threat assessments, and spatial data framework) into the final report template sections, including Survey Effort & Methods, Results & Discussion, Spatial Data Framework, Appendices, and References. Reviewed requirements and developed a work plan for a NOAA editorial review of the final report.

Indonesia. Accomplishments by the team for this region include the following.

- Participated and provided technical expertise in a workshop with Indonesia Ministry of Fisheries and Marine Affairs, the United States Agency for International Development (USAID), the EAFM National Working Group

of Indonesia, and other key country partners toward developing Regional Fisheries Management Commissions (based on the U.S. Regional Fishery Management Councils and other successful structures) as a governance framework to support their efforts in EAFM. The Fisheries Management Commission was finalized and is being piloted in a fisheries management area of the Arafura Sea.

- Participated in the second workshop of the Intergovernmental Oceanographic Commission (IOC) Western Pacific Subregion (WESTPAC) program on "Research and Monitoring of the Ecological Impacts of Ocean Acidification on Coral Reef Ecosystems", in Phuket, Thailand. During this workshop Indonesia was joined by partners from Thailand, Philippines, Malaysia, China, Vietnam, and Bangladesh. The workshop participants developed chemical, physical, and biological parameters and standardized methods for monitoring the ecological impacts of ocean acidification at twenty-two sites across the Western Pacific and Indian Ocean region. Indonesia is a potential site for instrument deployment and monitoring.

Regional Development Mission of Asia—RDMA. Accomplishments by the project for this region include the following.

- Completed a workshop report titled "Sulu-Sulawesi Seascape: Ecosystem Approach to Fisheries Management Implementation Planning Meeting." The report forwards a draft EAFM plan to address identified trans-boundary issues of the region and was published on the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) website.
- Submitted to the journal *Marine Policy* a peer-reviewed manuscript titled "The mobilization of science and technology fisheries innovations towards an ecosystem approach to fisheries management in the Coral Triangle and Southeast Asia".
- Organized a Training of Trainers (ToT) workshop and collaborated with instructors from IMA International, a UK-based training and consultancy for international development firm. The workshop focused in part on the Essential EAFM curriculum to improve trainers' skillsets, familiarize trainers with select E-EAFM activities, and share both lessons learned and best practices.
- Co-developed tools for EAFM for Leaders, Executives and Decision-makers (LEAD) and participated in related tool planning and writing workshop meetings in Phuket and Bangkok, respectively. The LEAD toolkit is designed to assist EAFM champions and facilitators in acquainting leaders with EAFM, encouraging leadership engagement in an EAFM, and helping leaders empower their people to implement an EAFM. The draft products were submitted as the JIMAR International capacity building team's annual milestone to the PIFSC.
- Organized and chaired a symposium session titled "Ecosystem Based Management of Coral Reef Fisheries" at the 13th International Coral Reef Symposium. At this conference, a poster was also presented on Ecosystem Approach to Fisheries Management for Leaders, Executives and Decision Makers (LEAD).
- Worked with a group of social scientists at The Nature Conservancy and finished a draft manuscript titled "Incorporating monitoring, and evaluating human well-being in conservation programs".

Pacific Islands Region Observer Program Initiative

P.I.: Mark A. Merrifield [JIMAR Project Lead: Jeffrey Hare]

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

NOAA Sponsor: Michael Tosatto, John Kelly

Budget Amount: $233,341

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The NOAA Pacific Islands Regional Observer Program (PIROP) is required by a fishery management plan (FMP) developed by the Western Pacific Regional Fishery Management Council (WPRFMC). This FMP was approved by the National Marine Fisheries Service (NMFS) with the authority of the Magnuson-Stevens Fishery Conservation and Management Act, the Endangered Species Act, and the Marine Mammal Protection Act. The

observer program provides high quality data on protected species interactions (sea turtles, marine mammals, and seabirds), catch composition, fishing effort, and selected fisheries research projects from commercial longline vessels based in Hawaii and American Samoa. The data are collected at sea by fisheries observers, and it is the responsibility of the JIMAR PIROP debriefers to train and debrief those observers. The focus is on maintaining the overall quality and integrity of the fisheries-dependent data. Debriefers also perform other duties, as needed, including editing data, assisting with daily operational needs, developing program protocols and procedures, filling enforcement-related documents, editing management-related documents, and other tasks.

Progress during FY 2016

Over the reporting period, JIMAR program staff debriefed many observed fishing trips, and completed data editing processes on many other trip reports. Program staff led instruction sessions and developed training modules for observer training classes and safety refresher training classes. An Institutional Animal Care and Use Committee (IACUC) protocol, which enables the handling of live animals as a part of emergency at-sea readiness, was renewed. The program staff presented briefings at several meetings with WPRFMC Scientific Advisory Committee and other groups. Program staff continued to work with stakeholders on the development and implementation of an electronic reporting system.

Pacific Islands Region Outreach and Education Program

P.I.: Mark A. Merrifield [JIMAR Project Lead: Amy Vendehey]

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

NOAA Sponsor: Michael Tosatto, Michelle Mansker

Budget Amount: $374,000

NOAA Goal(s)

- Healthy Oceans
- Resilient Coastal Communities and Economies

Purpose of the Project

The objectives of this project are to plan, develop, and implement effective communications, outreach and education programs as a partnership between the Joint Institute of Marine and Atmospheric Research (JIMAR) and the NOAA Fisheries Pacific Islands Region (PIR)—including both the Pacific Islands Regional Office (PIRO) and the Pacific Islands Fisheries Science Center (PIFSC). To carry out the project, the JIMAR employees make up a Communications Team that serves as a resource, advisor, and point of contact for outreach and education activities for JIMAR and NOAA Fisheries PIR staff of both offices. This project directly supports the JIMAR theme of achieving a sustainable balance between the forces of coastal development, conservation and preservation goals by performing outreach and education.

Progress during FY 2016

During the past year, the program produced communications, outreach and education materials which JIMAR and/or NOAA Fisheries PIR staff displayed or distributed directly to the public, partners or stakeholders at community events and other venues. The program supports all divisions and programs within both PIRO and PIFSC creating a consistent outward facing message and image. Participation in outreach and education events informs and engages the public and stakeholders concerning PIRO and PIFSC efforts to manage, conserve and recover the marine resources under its jurisdiction. The materials provide information to the public, partners, collaborators and stakeholders that communicate NOAA's mission to the public and other audiences in easy to understand language and a visually appealing format.

Web and Social Media. The Web is a fundamental part of every region, science center, and program's communications strategy. Through the web, the program conveys and amplifies NOAA Fisheries' core mission stories, letting the public, stakeholders, and partners know how the agencies are working for them to protect and

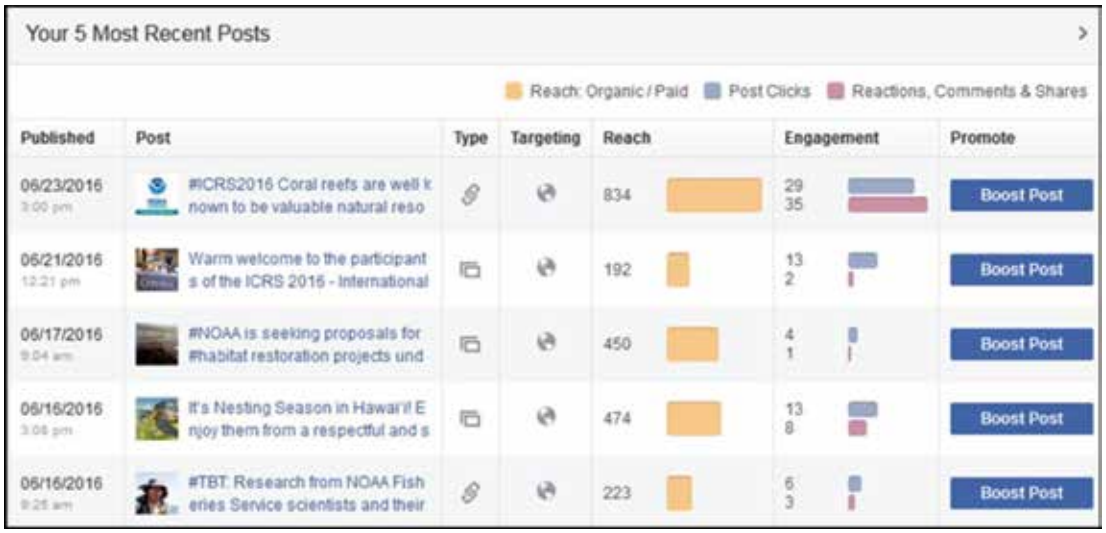
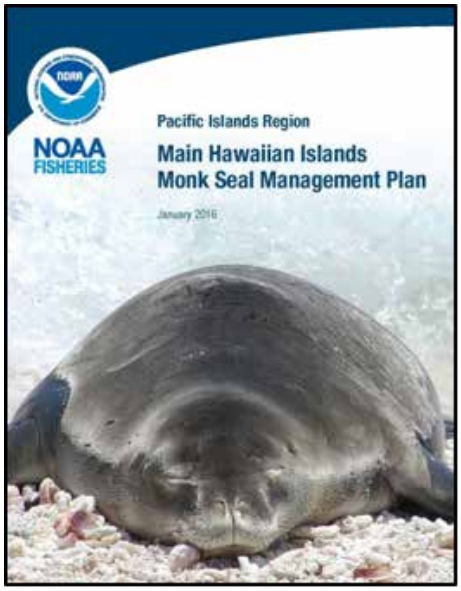


Figure 1. Recent PIRO Facebook posts.

manage the nation's living marine resources and the ecosystems these resources need to thrive. It is JIMAR's obligation to use the agency's websites and social media channels to present timely information and data to the public.

NOAA Fisheries Web Transformation Effort 2015-2018. NOAA Fisheries is working on a major web modernization effort for the agency in the form of a Fisheries Web Strategy. PIRO participated in the upfront planning to develop a web design that will be suitable for all. The main goals of the web transformation are to: 1) enhance usability for NOAA customers and target audiences; and 2) improve efficiency and web management.

PIRO and PIFSC Social Media. PIRO launched NOAA-approved Twitter and Facebook accounts in January 2015. As of June 2016, there are 1,244 Facebook followers and 343 Twitter followers. PIFSC launched NOAA-approved Twitter and WordPress.com blog accounts in October 2013. There are currently 589 Twitter followers which get an average of 10-15,000 viewed hits per day on the PIFSC blog with 65 subscribed followers (25 WordPress.com followers and 40 email-only followers).



Hawaiian Monk Seal Management Plan. One of the more large-scale print projects that this JIMAR project has undertaken is the Hawaiian Monk Seal Management Plan (cover shown at right) along with its supplemental document entitled Planning Approach and Background Materials for the Hawaiian Monk Seal Management Plan. The purpose of this project was to design a communication outlet that addressed the full scope of monk seal management needs in the main Hawaiian Islands. The document was initially authored by the PIRO Protected Resources Division (PRD) and forwarded to the Outreach and Education Program for formatting. Formatting involved editing and proofreading of text, diagram and table development, implementation of photos and other graphic elements, and the creation of a culturally sensitive page layout. Once the layouts were approved by PRD and the Directorate, the program was responsible for managing the print procurement process. This involved coordinating with the Government Printing Office and the PIRO budget department to have enough copies printed for national distribution.

NOAA Fisheries Science Camp. A very influential educational activity carried out by the JIMAR Communications Team is the annual NOAA Fisheries Science Camp held at the NOAA Inouye Regional Center (IRC). This activity is also supported by the JIMAR project Ecosystems Observations and Research Program (EORP). The 2016 camp will be held July 19-22 in the IRC and will be reported in a subsequent JIMAR Annual Report. Target audience for the camp is eighth graders from public and charter

schools, with an emphasis on reaching under-represented students. The four-day camp for 45 students consists of nine science modules conducted over three days and culminates with a team challenge, evaluation and award ceremony on the final day. For more information, see the related report in the JIMAR Ecosystems Observations and Research Program (EORP).

Camp costs are covered by JIMAR's Pacific Islands Region Outreach and Education project and JIMAR's Ecosystems Observations and Research Program (EORP), including items such as daily lunch and t-shirts for the participating children, lab equipment, supplies, and printing costs. Camper applications are organized and processed through a dedicated online registration website and e-mail account.

A direct extension of the camp was the development of seven science modules kits with lessons for the classroom based on some of the modules presented at the NOAA Fisheries Science Camp. A workshop to introduce the kits was held at Kailua Middle School in April 2016, and several were field tested by the science teachers there. The initial feedback was very positive, and the project plans to widely advertise the kits to teachers in the fall.

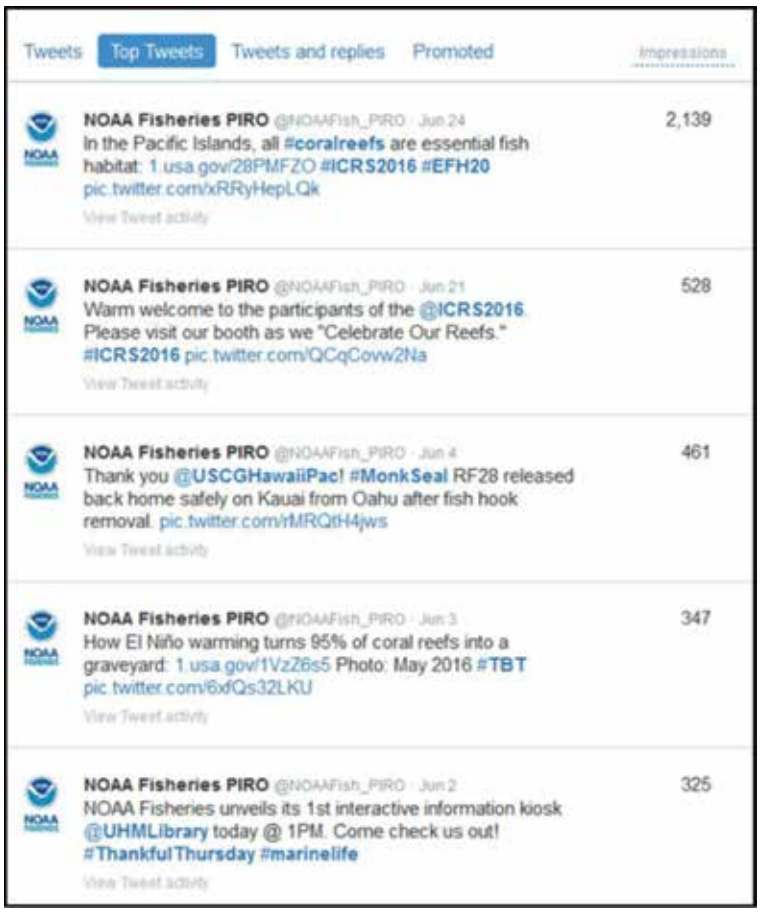


Figure 2. Sample of recent PIRO tweets.

Outreach Events. The events in which the program participated ranged from an elementary class size to over 3,000 at the Hawaii Ocean Expo. JIMAR Communications Team staff coordinated and implemented participation as well as designed and produced displays and informational materials for outreach events and activities throughout the year.

During FY 2016, the program worked with PIFSC and PIRO scientists to develop a suite of materials called Cetaceans in Your Neighborhood (CIYN). This year the project partnered with the Waikiki Aquarium to present CIYN activities and information at their popular annual celebration or "birthday" event. The materials were designed to engage people of all ages and raise their understanding and awareness of dolphins and whales in general, and protected species in Hawaiian waters. Elements of this outreach were incorporated into activities and displays at other events such as the North Shore Ocean Fest, organized by the North Shore Education Coalition.

In April 2016, the Education and Outreach coordinator traveled to Saipan, Commonwealth of the Northern Mariana Islands (CNMI) and Guam to disseminate information and materials about the activities of the NOAA Ship *Okeanos Explorer*. From April to July, the ship is investigating targeted deep-water environments in and around CNMI and the Marianas Trench Marine National Monument, which is co-managed by NOAA Fisheries and other agencies. The coordinator reached ~300 students on Saipan, and ~150 people on Guam through an Educational Expo, high school classroom visit and Earth Day event. Highlights and photos from this trip are posted on the comprehensive NOAA Office of Exploration website.

Other events staffed or supported during FY 2016 include the following.

- Kahala Mall Keiki Day
- Aliamanu Middle School Hiki No filming
- UH SOEST Open House
- Snow Day at Kapolei Commons

Figures 3 (above) and 4 (below). PIFSC blog stats for 2015 and 2016.

- Science at Sea-Teacher at Sea, NOAA intern presentation, and high school outreach
- Hawaii Island middle school visit
- CIYN at the Waikiki Aquarium
- Career fairs and topic presentations for various elementary, middle and high schools
- Hawaii State Science & Engineering Fair
- Hawaii Ocean Expo
- Day events on Oahu, Molokai and the Island of Hawaii
- NOAA Ship *Okeanos Explorer* outreach events on Saipan and Guam
- North Shore Ocean Fest at Turtle Bay Resort—A World Ocean's Day Celebration
- International Coral Reef Symposium, and associated community events
- NOAA Fisheries Science Camp

Outreach and educational printed materials and displays produced by project staff during FY 2016 include the following.

- Careers in Marine Science (college) brochure (revisions)
- Careers in Marine Science (middle school) brochure (revisions)
- NOAA Fisheries Science Camp Teacher and Student Notebooks (revisions)

- Regulatory Fact Sheets—various
- Turtle Stranding magnets (revisions)
- Folding information card for reporting Hawaiian monk seals, marine mammals, and sea turtles
- Hawaiian Monk Seal and Sea Turtle Beach Signs
- Fishing Around Sea Turtles Decals (revisions)
- Hawksbill Sea Turtle Brochure
- NOAA Fisheries "Species in the Spotlight" bookmark series
- 2016 IUCN World Conservation Congress—development of flyer for PRD discussion
- PIRO Sustainable and International Fisheries Division Compliance Guides—various
- Purse Seine Discard Logbooks and Forms (reprint)
- PIFSC Western Pacific Regional Fishery Management Council report covers
- 2014 Seabird Annual Report
- 2016-2020 PIRO Strategic Plan Report
- Main Hawaiian Islands Monk Seal Management Plan and Background Materials
- 2015 Federal Programs Annual Report
- Fishing Around Sea Turtles Advertisement, Hawaii Fishing News
- Banners, posters and displays for Cetaceans in Your Neighborhood, Hawaii Ocean Expo, North Shore Ocean Fest, Honolulu Hale, *Okeanos Explorer* Marianas Trench Expedition, Science at Sea, IRC Brown Bag and Lecture Series events
- Digital signage at Honolulu Service Center (Pier 38)—includes notices, announcements and events on Federal Register Notices, proposed and final rules, sea surface temperature maps, and important contact information
- Prize Wheel (Q&A)—cetacean educational activity materials
- PIRO Core Values—development of identifier and posters
- PIRO Wall of Fame—development of staff award posters
- PIRO Conflict Resolution Guide—development of interpersonal communication handout and conflict resolution guide flowchart
- PIRO Workflow Graphics—development of internal infographics
- PIRO website management/web updates, e.g., Federal Register Notices, proposed and final rules, page content edits and updates, new web pages, etc.
- Large format printing and laminating services for PIRO/PIFSC staff
- PowerPoint presentation and videos for career days
- Various videos and video clips for presentations and media availability events

Pacific Islands Region Sustainable Fisheries Initiative

P.I.: Mark A. Merrifield [JIMAR Project Lead: Jeffrey Hare]

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

NOAA Sponsor: Michael Tosatto, Robert Harman

Budget Amount: $171,683

NOAA Goal(s)

- Healthy Oceans
- Resilient Coastal Communities and Economies

Purpose of the Project

The project has two components: 1) to collect, compile and analyze social science data supporting regional federal fisheries policy-making per the Fishery Conservation and Management Act (FCMA), the National Environmental Policy Act (NEPA), and other federal statutes (social science), and 2) to further communication with stakeholders in the Region—including fishermen, the general public, non-government organizations and government agencies via outreach. In addition, JIMAR staff assists the Pacific Islands Regional Office (PIRO) Sustainable Fisheries Division (SFD) staff with various NOAA fisheries initiatives in the Region, as appropriate.

Progress during FY 2016

During the project year, work was exclusively directed to outreach and education efforts in collaboration with the JIMAR Pacific Islands Region Outreach and Education Program on various projects of interest to the Sustainable Fisheries Initiative (SFI) effort. This included: 1) the design of a variety of graphic materials such as fact sheets, posters, announcements, flyers, etc. to educate the public on PIRO and its various programs; 2) preparing materials for outreach events including the NOAA Fisheries Science Camp, and 3) assisting PIRO staff in developing presentations for conventions and meetings. The project also produced informative materials for publications that serve the fishing community, such as *Hawaii Fishing News* and *Lawaia*.

Stock Assessment Research Program

P.I.: Mark A. Merrifield [JIMAR Project Lead: Marc Nadon]

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

NOAA Sponsor: Michael P. Seki, Annie Yau

Budget Amount: $500,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

PIFSC and JIMAR staff conducts collaborative assessments of pelagic fish stocks in the Pacific Ocean together with scientists from Japan, Taiwan, Canada, Korea, China, Mexico, the Inter-American Tropical Tuna Commission (I-ATTC), and the Secretariat of the Pacific Community (SPC). The assessments are conducted under the auspices of the International Scientific Committee for Tuna and Tuna-like species in the North Pacific Ocean (ISC). Priority is given to marlins, swordfish, and oceanic sharks species (blue, oceanic whitetip, silky, mako and thresher sharks) in the North Pacific Ocean. Researchers on this project also investigate bottomfish, coral reef fishes, and crustaceans in the Pacific Islands Region (PIR). The primary objective of these investigations is to provide quantitative information that meets defined standards of scientific rigor and satisfies management requirements for sustainable exploitation of these resources.

Progress during FY 2016

For the insular assessment work, JIMAR researchers: 1) published a paper on Hawaii reef fish stock assessments (*PLoS ONE* journal) and a paper on estimating life history parameters for data-poor stocks (*Canadian Journal of Fisheries and Aquatic Sciences*); 2) conducted a successful Center for Independent Experts (CIE) review of the

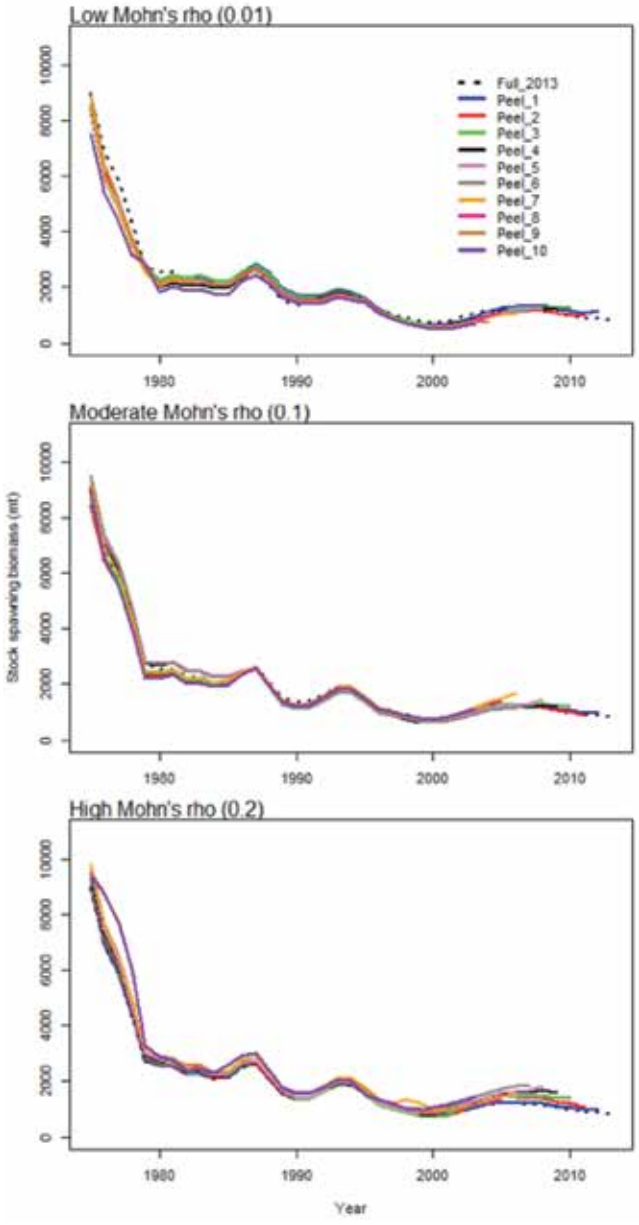


Figure 1. Retrospective patterns from the Western and Central Pacific blue marlin stock assessment.

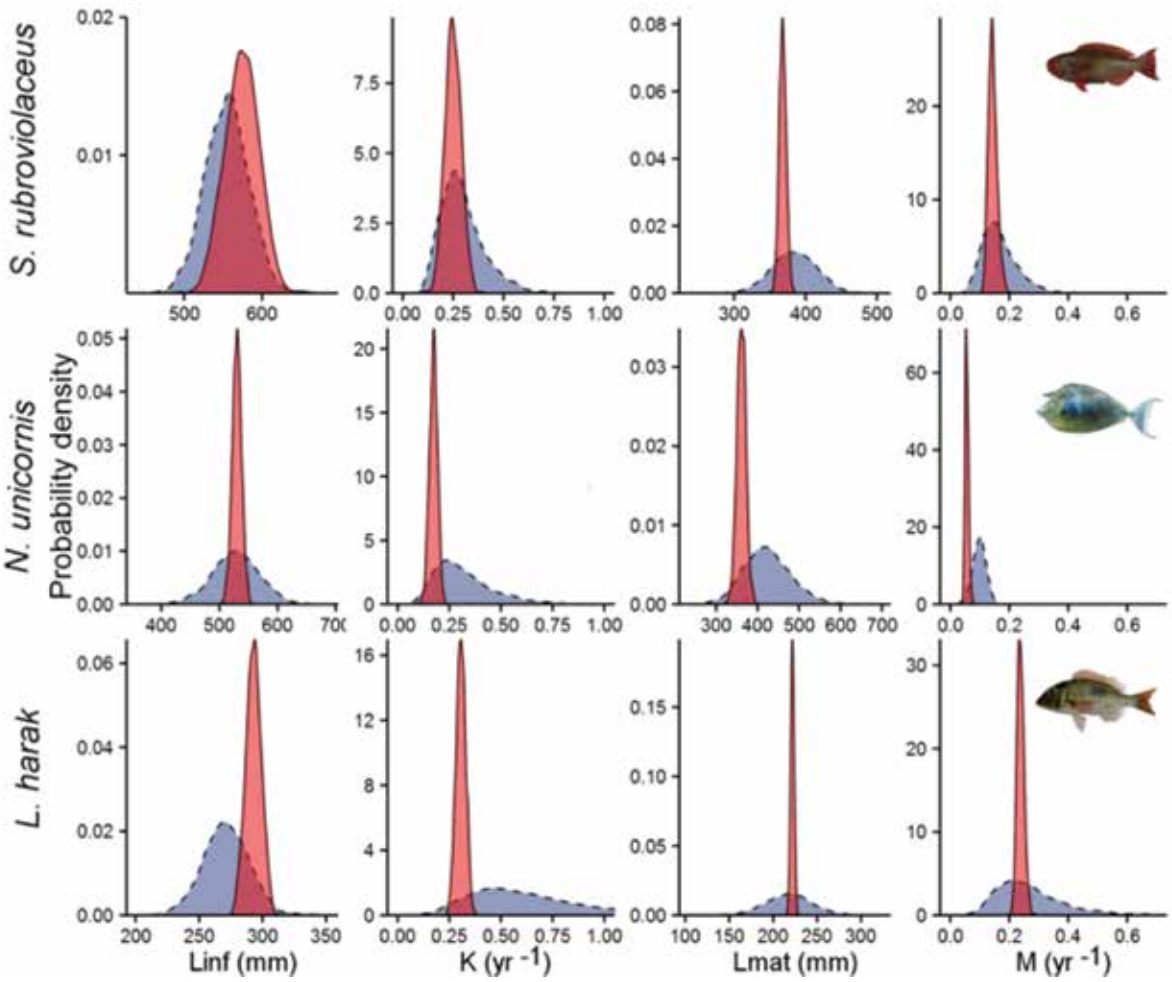


Figure 2. Probability distributions of life history parameters from the data-rich (red areas; solid lines) and data-poor (blue areas; dashed lines) approaches, for 3 selected fish species.

general approach used to conduct reef fish assessment at PIFSC; and 3) started work on reef fish assessments for the Guam area. Fishery-independent diver surveys of reef fish populations were also conducted during research cruises in Hawaii and American Samoa. An additional achievement is the completion of a draft tech memo to present preliminary overfishing limits for Hawaii reef fish stocks.

For the pelagic assessment work, JIMAR researchers participated in a suite of international scientific workshops and symposia. Of significance were the workshops of the ISC Shark Working Group and ISC Billfish Working Group and presentations at the Center for the Advancement of Population Assessment Methodology (CAPAM) workshop. The outcome from these workshops and the associated work included: 1) data preparation for blue marlin, which includes data from the Pacific, including Hawaii; 2) completion of a stock assessment for blue marlin; and 3) the completion of standardized catch rates for this species. JIMAR staff led most of these efforts and collaborated closely with federal staff on others. Furthermore, a paper on using fishery indicators for pelagic sharks was submitted for publication. An additional achievement is the publication of a paper on diagnostic tools for integrated assessments. Research on improving stock-recruitment relationships for sharks was postponed due to a change in prioritization of this project within the ISC Shark Working Group.

Fourteen publications were completed by JIMAR staff in the 2015-2016 performance reporting period. Nine of these publications are articles in refereed scientific journals covering biological research for billfish and shark catch rate, reef fish work, and advanced stock assessment methods. Other publications include four ISC Billfish Working Group working papers and one draft NOAA technical memo.

Western Pacific Fisheries Economic Integration

P.I.: Mark A. Merrifield [JIMAR Project Lead: HingLing Chan]

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

NOAA Sponsor: Michael P. Seki, Justin Hospital

Budget Amount: $92,000

NOAA Goal(s)

- Resilient Coastal Communities and Economies

Purpose of the Project

The JIMAR project focuses on processing and analyzing pertinent socioeconomic data to enable efficient and replicable analyses of area-based fishery management measures affecting fishing fleets active in the Western, Central and Eastern Pacific Ocean.

Progress during FY 2016

During FY 2016, for integration of Hawaii fisheries data and description of fishery dynamics, JIMAR staff compiled a number of fisheries catch and economic summaries at various geographic scales to support a community snapshot web tool currently under development. This tool includes State of Hawaii fisheries data through 2015 coupled with Census demographic data and is designed to be updated annually to allow users' timely access to the economic and social contribution of fisheries, gears, and species groups to communities across the State of Hawaii. In addition, data from the Hawaii small boat survey were merged with the Hawaii fisher report and dealer data to generate an integrated data set and draft report for data summary is under development.

For the rights based management alternatives for the Hawaii-based longline fishery, JIMAR staff assisted with field work through semi-structured interviews with stakeholders across the fishery to better understand the perspectives of the Hawaii-based longline fleet. Project staff also assisted in outreach materials including brochures, video, and blog post on PIFSC's blog.

For Hawaii-based longline vessel monitoring systems (VMS) data processing and integration, this project is behind schedule due to staffing changes. The project expects to address this area of work in the near term.

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

P.I.: Mark A. Merrifield [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

Budget Amount: $347,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The JIMAR Cetacean Research Program (CRP) 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 thirty-four 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 2016

During August-September 2015 the CRP conducted surveys off the southernmost islands of the Mariana Archipelago. These surveys are part of an ongoing effort within the Marianas that began in 2010. The primary goals are to collect photographs and biopsy samples, and deploy satellite tags on a variety of cetacean species to assess population structure, movements, and spatial use. With JIMAR participation, the program surveyed a total of 2,179 km of trackline, during which there were 28 encounters with cetacean groups. Species identity was confirmed during 26 of the encounters. The seven identified species included Blainville's beaked whales (*Mesoplodon densirostris*), bottlenose dolphin (*Tursiops truncatus*), Bryde's whales (*Balaenoptera edeni*), false killer whales (*Pseudorca crassidens*), pantropical spotted dolphins (*Stenella attenuata*), pygmy killer whales (*Feresa attenuata*), and spinner dolphins

Figure 1. Satellite tagging of a sperm whale off Saipan (credit: Adam Ü; NMFS permit 15240).

(*Stenella longirostris*). The project collected more than 8,000 photos, 20 biopsy samples, and deployed one location-dive satellite tag.

During March 2016, the CRP conducted small boat surveys off Saipan in the CNMI to look for humpback whales (*Megaptera novaeangliae*) as part of an ongoing project initiated the previous year. The purpose of the project is to assess population structure and spatial use of the humpbacks occurring within the Marianas and to determine how they are connected to western North Pacific humpback whale population. During nine survey days on the water, the CRP researchers encountered five mom/calf pairs and collected biopsy samples from all five mothers. In addition, the project collected fluke photographs of one mother, which was matched to an individual that had been photographed off Saipan in February 2007 during a shipboard survey of the Marianas. The presence of mothers with small calves suggests that the waters off Saipan and likely adjacent areas may be a breeding area for humpback whales. In addition, the sighting of one female off Saipan in 2007 and 2016 (with a calf) demonstrates wintering site fidelity for some individuals.

Figure 2. Pantropical spotted dolphin with a remora on its back photographed off Guam (credit: Adam Ü; NMFS permit 15240).

The CRP returned to the Marianas in May-June 2016 to continue the data collection effort for determining population structure, movements, and spatial use of cetaceans. During 24 days, a total of 2,090 km of trackline were surveyed. The project encountered 44 cetacean groups of which 42 were identified to species, including bottlenose dolphins, dwarf sperm whales (*Kogia sima*), pantropical spotted dolphins, rough-toothed dolphins (*Steno bredanensis*), short-finned pilot whales (*Globicephala macrorhynchus*), sperm whales (*Physeter macrocephalus*), and spinner dolphins. In addition, the project encountered two groups of unidentified Mesoplodont beaked whales. Approximately 11,000 photos, 42 biopsy samples were collected, and nine satellite tags were deployed.

Acoustic monitoring of the longline fishery for interactions with false killer whales continued over the past year through voluntary trips across many vessels of the longline fleet. Twelve trips were completed to date by voluntary participation from longline captains, using the PIRO Observer Program as a platform. Results from these trips were presented on a poster at the 21st Biennial Conference for the Biology of Marine Mammals in December 2015.

The CRP uses HARPs (High-frequency Recording Packages) to monitor for the year-round occurrence of cetaceans. During the 2016 fiscal year, the program recovered six HARPs and deployed six HARPs off Hawaii Island, Pearl and Hermes Reef, Wake Atoll, Saipan, and Tinian.

Fishing Impacts on Non-target Species

P.I.: Mark A. Merrifield [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

Budget Amount: $50,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project seeks to improve the understanding of impacts of commercial purse seine and longline tuna fishing on non-target species, with an emphasis on oceanic sharks. The project effort concentrates 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 or Indian Oceans. The research includes post-release survival studies to identify and develop best handling methods in recreational, purse seine and longline fisheries for improved post-release survival rates and ensuring crew safety. The deployment and analysis of electronic tags generates robust post-release survival estimates, which improve the rigor of stock assessments and aid in the development of best handling practices for fisheries impacting shark populations.

Melanie Hutchinson training fisheries observers to tag sharks over the rail of a longline vessel using mock satellite tags at pier 38.

Progress during FY 2016

This project began on April 1, 2016 and is still in progress. To date, 35 satellite tags were deployed on four different shark species (blue shark n =18, bigeye thresher n= 14, oceanic whitetip n = 2, silky n = 2) during commercial fishing operations and 18 more tags are currently at sea with observers. The project trained sixteen NMFS observers, provided them with tags and placed them on 34 different longline vessels that are participating in the project during commercial tuna trips. The project also conducted three tagging trips to Kona targeting bigeye thresher sharks. Data garnered from these tag deployments are returning valuable information regarding post release survival rates, best handling practices and habitat use. Currently the project is ahead of expected timeline and tagging schedules.

Hawaiian Monk Seal Northwestern Hawaiian Islands Research Seasonal Support

P.I.: Mark A. Merrifield [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, Charles Littnan

Budget Amount: $190,000

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 Research Seasonal Support project conducts population assessment, health and disease, survival enhancement, foraging, behavioral research, vocalization studies, as well as standard enhancement activities on Hawaiian monk seals. Research and enhancement activities are conducted primarily in the Northwestern Hawaiian Islands (NWHI) to augment year-round program activities in the main Hawaiian Islands (MHI). Field staff and volunteers are deployed on a seasonal basis at up to six main breeding sites and opportunistically at Mokumanamana, Nihoa, and Niihau. Field research activities include visual and photographic monitoring, tagging, pelage bleach marking, health screening, conducting necropsies, specimen collection, and foraging studies, as well as translocation, and other recovery actions. These recovery actions may include hazing

or removal of aggressive male seals, shark predation mitigation and deterrence, entrapment surveys, behavioral modification, vaccination research, disentangling, abscess treatment, marine debris removal, inter- and intra-atoll translocation, evaluation and capture of seals for rehabilitation, and the feeding and soft release of rehabilitated seals. Field staff also provided assistance to other programs and agencies including establishing and maintaining debris plots, conducting insect, plant, and duck surveys, and collecting information on turtle nesting.

Progress during FY 2016

Activities undertaken by the JIMAR HMSRP during the reporting period, which encompasses the majority of the 2015 field season (May 18, 2015 to September 30, 2015) and beginning of the 2016 field season, involved deploying 10 JIMAR staff and 4 volunteers in 2015 to establish field research camps at French Frigate Shoals (FFS), Laysan, Lisianski, Pearl and Hermes Reef, and Kure Atoll. Discontinuous field surveys were also conducted at Midway Atoll. Field staff at all established field sites except Kure Atoll were evacuated in August 2015 due to hurricane threats. With the exception of Lisianski where there was only a brief stopover, evacuated camps were re-established short term at all sites at the end of the field season during the pick-up cruise on the NOAA Ship *Oscar Elton Sette*. Training for the 2016 field season began on March 14, 2016 and included boat training, data collection techniques, Wilderness First Aid, animal handling and abscess treatment, and specimen collection and necropsy techniques. Field personnel participated in securing and packing food stores and quarantine clothing, testing boats, communication systems, and other equipment, and loading all supplies and equipment on the NOAA RV *Hi'ialakai*. A total of ten field staff and four volunteers departed on April 17, 2016 and established camps at all sites established in 2015. Field surveys were also conducted discontinuously at Midway Atoll. Staff and volunteers for the 2016 field season remained deployed through the end of the reporting period.

Figure 1. Releasing rehabilitated seal into temporary holding pen on Laysan Island, 2016. Research photographed under Marine Mammal Permit Research #16632; photographed by Brenda Becker.

Figure 2. Field camp at Pearl and Hermes Reef on Southeast Island, 2015. Photographed under Marine Mammal Permit Research #16632; photographed by Megan Hess.

Project activities during both field seasons included: 1) collecting survey and life history data and specimens; 2) tagging and marking seals for long-term identification; 3) documenting and mitigating mortality caused by males exhibiting aggressive behaviors towards other seals; and 4) shark predation monitoring and mitigation to prevent monk seal pup mortality, including fishing for predatory Galapagos sharks in nearshore areas of pupping sites at FFS.

Field staff also participated in translocation activities and performed numerous interventions to improve the survival chances of individual seals. These included: 1) disentanglements and marine debris/plastics/trash removal to mitigate threats to seals and other wildlife; 2) translocations to reduce shark predation at French Frigate Shoals; and 3) other actions including reuniting mothers separated from nursing pups. Translocation activities were conducted within FFS to mitigate shark predation. Two pups were brought to The Marine Mammal Center (TMMC) captive care facility, Ke Kai Ola, in Kona in May 2015 and were returned to the wild at the end of the 2015 field season. Six pups and a yearling seal were brought in for rehabilitation at the end of the 2015 field season and were returned back into the wild during the 2016 field season deployment cruise. A behavior study and vaccination drill was conducted in 2015 and a vocalization study on monk seals began early in the 2016 field season.

Hawaiian Monk Seal Research Program

P.I.: Mark A. Merrifield [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, Charles Littnan

Budget Amount: $780,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The JIMAR Hawaiian Monk Seal Research Program (HMSRP) conducts research on the Hawaiian monk seal (*Neomonachus schauinslandi*, HMS), the most endangered marine mammal occurring entirely within U.S. jurisdiction. There are approximately 1,300 individuals remaining, the majority of which occur at the six most studied sites in the Northwestern Hawaiian Islands (NWHI) where abundance is declining at approximately 2.8% per year (from 2005 to 2014). However, apparent stability or population growth at remaining sites (Mokumanamana, Nihoa, and the main Hawaiian Islands) substantially influences overall trends. The program conducts studies 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.

Figure 1. Weaned pup at Kalaupapa, Molokai. Research photographed under Marine Mammal Permit Research #16632; photographed by Mark Sullivan.

Progress during FY 2016

Accomplishments during the report period included population monitoring and assessment, survival enhancement, foraging ecology characterization, health and disease evaluation, and behavioral research.

Figure 2. JIMAR staff member prepares to vaccinate a seal on Rabbit Island, Oahu. Research photographed under Marine Mammal Permit Research #16632; photographed by Michelle Barbieri.

JIMAR staff played a crucial role in the establishment of seasonal field camps in the Northwestern Hawaiian Islands for the 2015 and 2016 field seasons. JIMAR staff reviewed and revised protocols, trained field personnel in data and specimen collection techniques, participated in research cruises, and provided logistical support to remotely deployed field staff. JIMAR staff served as Chief Scientist on research cruises, served as a visual observer during Unmanned Aerial Surveys, and deployed at field camps at FFS for both field seasons. Staff also played a key role in the coordination of an emergency evacuation of JIMAR field staff at four of five field camps deployed in the NWHI during the 2015 field season due to hurricane threats. JIMAR assisted with rehabilitation and transport of two pups brought in for rehabilitation in May 2015 and released at the end of the 2015 field season, and with six pups and a yearling seal that were brought in for rehabilitation at the end of the 2015 field season and were returned back into the wild during the 2016 field season deployment cruise. The seals were housed in captivity between field seasons at The Marine Mammal Center (TMMC) Ke Kai Ola monk seal hospital in Kona, and JIMAR staff assisted with veterinary exams and care and trained TMMC volunteers in animal restraint techniques. Project staff collected survey and life history data and specimens in the main Hawaiian Islands (MHI), including conducting two collaborative monk seal surveys of Niihau. Project staff also trained Niihau personnel to conduct future monk seal surveys on their own.

In December 2015, JIMAR staff presented research findings at the 21st Biennial Conference for the Society for Marine Mammalogy and a staff member presented at the NOAA Protected Species Division external review. Additional accomplishments by the program include: 1) ensuring JIMAR data resources were compliant with the NOAA Plan for Increasing Public Access to Research Results (PARR) requirements; 2) creation of an interface that allows a link from the specimen database into the population assessment database so there are now links in both directions providing greater efficiency and improved ability to analyze data; and 3) response and coordination of monk seal stranding responses in the MHI. JIMAR staff participated in oil spill response training and a risk assessment workshop. The project also participated in a vaccination drill, began vaccinating wild seals against morbillivirus, and trained federal and state partners in vaccination protocols. Two staff fulfilled NOAA requirements for operation of Unmanned Aircraft Systems (UAS) and attended platform-specific training in San Diego in March 2016 to learn to pilot hexacopters. This platform will be used in the future by HMSRP to conduct monk seal surveys and health assessment studies. A JIMAR staff member traveled to the Minnesota Zoo to train zoo staff members on Hawaiian monk seal capture techniques and to assist with veterinary exams on captive monk seals housed there.

Responses included the capture and hook removal for seals on Kauai and Oahu and the capture and assessment of stranded seals on Oahu. Staff also participated in necropsies and rehabilitation efforts, including veterinary care and husbandry of debilitated seals. The foraging ecology program deployed telemetry equipment opportunistically (e.g., instruments applied to stranded animals) to document individual HMS movements. Health and disease research included collecting biomedical samples for disease surveys in the MHI in conjunction with telemetry deployments and from stranded animals and sample analysis at various laboratories. JIMAR personnel continued collaboration with outside researchers to assess risks posed by Toxoplasma gondii to monk seals. The program also continued an ongoing reorganization project to better manage specimens and conducted ongoing maintenance of a live animal care life support system.

Pacific Islands Deep Sea Coral and Sponge Initiative

P.I.: Mark A. Merrifield [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, Frank Parrish

Budget Amount: $390,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project encompasses NOAA's Deep-Sea Coral Research and Technology Program (DSCRTP) priorities to advance knowledge of deep-sea corals and sponges in the U.S. Pacific Islands in order to improve the management of these important resources.

The objectives of the project are to: 1) compile and synthesize existing data from deep sea coral and sponge observations in the U.S. Pacific Islands; 2) compile and create an interpretive geological substrate map for the U.S. Pacific Islands, along with an updated bathymetry and backscatter syntheses from mapping data; 3) identify and map areas of high abundance and diversity of deep-sea corals and sponges in the Main Hawaiian Islands (MHI), in the Northwestern Hawaiian Islands (NWHI), the Papahānaumokuākea Marine National Monument (PMNM), Pacific Remote Islands Marine National Monument, Marianas Trench Marine National Monument, the Marianas archipelago, and American Samoa; 4) examine the benthic and oceanographic conditions that promote development of deep-sea coral and sponge ecosystems; 5) synthesize data on temperature, currents, pH, etc., from deployed instruments in known precious coral beds and use analysis of collected precious coral skeletons as a record of environmental change; and 6) coordinate and process data from multibeam surveys of American Samoa, PRIMNM, Marianas Archipelago, and Hawaiian Archipelago in depths shallower than 500 m.

The project has two operational components; one with the Ecospatial Information Team in the Coral Reef Ecosystem Program (CREP) at PIFSC, and one affiliated with Hawaii Undersea Research Laboratory (HURL) in the Department of Oceanography at the University of Hawaii at Manoa.

Progress during FY 2016

Accomplishments from the bathymetric mapping component of the project, conducted by JIMAR staff in CREP/PIFSC include the following.

Multibeam Data Processing Setup. A permanent networking solution for processing multibeam data in-house was established for the program. Project team members were provided access and were able to test the setup. With the new networked server, project team members have access to the requisite software and the local multibeam data archive.

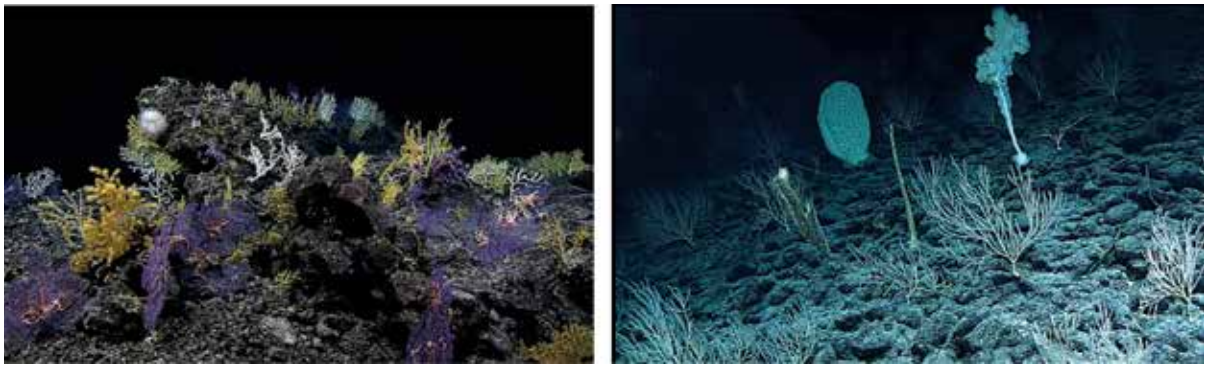


Figure 1. Two examples of high-density communities of deep-sea corals and sponges encountered during the cruises.

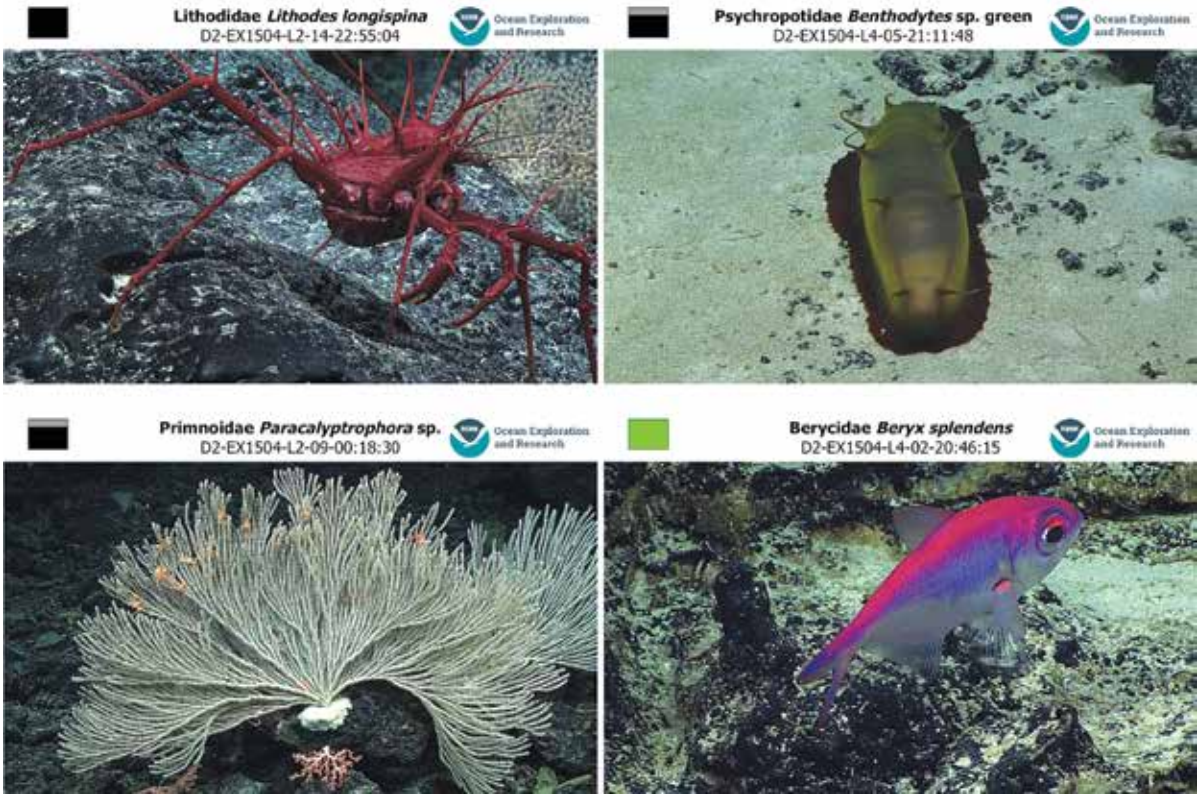


Figure 2. Example images from the new OER Deepwater Benthic Animal Guide.

Process New Multibeam Data. New multibeam data were collected by the NOAA Ship *Hi'ialakai* in American Samoa and the Pacific Remote Islands Marine National Monument (PRIMNM) during the CREP American Samoa Reef Assessment and Monitoring Program mission in 2015 (ASRAMP), and in the Papahānaumokuākea Marine National Monument (PMNM) during the Biogeography mission in 2016. The mission in 2015 was the first multibeam data collection since 2008. While the project team prepared the Hi'ialakai for mapping in advance of the mission, there were numerous challenges that impacted data quality. Evaluation of the data revealed accuracy issues leading to the conclusion that a full calibration of the ship's multibeam systems is required before the data can be processed.

Hi'ialakai Support for Multibeam Mapping. The project team provided support to the ship in preparation for the PMNM and Hawaiian Archipelago Reef Assessment and Monitoring Program (HARAMP) missions, including: 1) troubleshooting components of the multibeam systems that weren't properly functioning; 2) providing ship-based training to the Survey Technician, Engineer Technician, and project team members; 3) coordinating vendors and arranging land-based support; 4) providing content for the mission instructions and permits; and 5) developing a long-term multibeam mapping plan for the ship and the project.

Accomplishments by the UH team to identify animals in previously acquired video include the following.

- To begin the task of extracting and identifying animals records from the 37 Remotely Operated Vehicle (ROV) dives conducted off the NOAA Ship *Okeanos Explorer* in 2015 as well as from older submersible dive video, the team created a 1,700 image deep water animal identification guide from selected still images taken during the dives. This guide, prepared with taxonomic assistance from experts around the world, is now posted on the OER website. The guide took two months to complete and served two purposes: 1) to train project staff in the identification of deep water animals; and 2) to provide an image reference for use during video annotation. During this phase, the team also processed the tracking and conductivity, temperature, and density (CTD) data collected during the 37 ROV dives and created a single excel file for each dive in a format that could be easily imported into ArcGIS for visualization of dive tracks and environmental data.
- Once these preparatory steps were completed, the team initiated data extraction from the ROV dives using the Video Annotation and Reference System (VARS) software created by the Monterey Bay Aquarium Research

Latitude	Longitude	Depth (m)	Temp (°C)	Oxygen (mg/l)	Salinity	Date (GMT)
25.08216233	-172.4893637	1955.889	1.9096	2.9794	34.6276	20150807T222321Z
25.08216233	-172.4893637	1955.8	1.9091	2.961	34.6262	20150807T222322Z
25.08216233	-172.4893637	1955.69	1.9093	3.0122	34.627	20150807T222323Z
25.08216233	-172.4893637	1955.685	1.909	2.9562	34.6261	20150807T222324Z
25.08216233	-172.4893637	1955.645	1.9094	2.9426	34.6276	20150807T222325Z
25.08216233	-172.4893637	1955.486	1.9098	2.9681	34.6264	20150807T222326Z
25.08216233	-172.4893637	1955.424	1.9118	2.9648	34.6279	20150807T222327Z
25.08214852	-172.4893541	1955.328	1.9107	3.0035	34.6266	20150807T222328Z
25.08213483	-172.4893447	1955.372	1.9129	2.9596	34.6272	20150807T222329Z
25.08213483	-172.4893447	1955.227	1.9154	2.9549	34.6256	20150807T222330Z
25.08213483	-172.4893447	1955.06	1.9088	2.9582	34.6271	20150807T222331Z
25.08213483	-172.4893447	1955.062	1.9081	2.9669	34.626	20150807T222332Z
25.08213483	-172.4893447	1955.022	1.9082	2.9411	34.6275	20150807T222333Z
25.08213483	-172.4893447	1955.065	1.9087	2.9966	34.6267	20150807T222334Z
25.08213483	-172.4893447	1955.011	1.9112	2.9625	34.626	20150807T222335Z
25.08213483	-172.4893447	1954.97	1.9094	3.0164	34.627	20150807T222336Z
25.08213483	-172.4893447	1954.958	1.9087	2.9831	34.6273	20150807T222337Z
25.08213483	-172.4893447	1954.855	1.9087	2.969	34.6273	20150807T222338Z
25.08213483	-172.4893447	1954.87	1.9088	2.9514	34.6267	20150807T222339Z

Figure 3. Excerpt from a merged CTD/tracking data file.

Institute and custom installed on three workstations. So far, eleven of the 37 dives were annotated for corals, sponges, commensals on these animals, and fishes. The protocol involved using VARS to create records of animals captured on the dive video. The annotation process also involved the extraction of substrate and habitat data, identification certainties, and information on commensal organisms found on corals and sponges. Once each dive was completely annotated, custom scripts were run in VARS to merge the tracking and CTD data to each of the annotations based on time codes. Queries were then run to extract the records from the VARS database and import them into Excel. These records were then formatted for inclusion into the DSCRTP national database, and subjected to a final quality control protocol before being submitted.

- Regarding the additional tasks, 16,000 additional coral and sponge records from submersible dives conducted by the HURL are being prepared for submission to DSCRTP. These records have been extracted from the HURL database and are currently undergoing the quality control. In addition, substrate information is being added to 35,000 records of corals that were already submitted to DSCRTP several years ago without that information. Once this is completed, these records will be re-submitted.
- An onboard and post-cruise specimen collection and processing protocol was developed and used during the 2015 ROV dives. Biological samples numbered 118 and included commensal organisms found on corals and sponges. Most of the specimens were subsampled for DNA analysis as part of the Ocean Genomic Legacy (OGL) project, which provided the onboard processing kit used in the ship lab. These DNA aliquots were shipped to Northeastern University where the OGL project is headquartered. Once the specimens were removed from the ship and transferred to the laboratory at UH, selected coral and sponge specimens were split in order to provide a piece to the Bishop Museum. The main portion of each biological sample was then shipped to the Smithsonian for acquisition into their collections. All rock samples were shipped to the geological repository at Oregon State University.

Protected Resources Environmental Compliance Initiative (PRECI)

P.I.: Mark A. Merrifield [JIMAR Project Lead: Karen Frutchey]

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

NOAA Sponsor: Michael Tosatto, Sarah Malloy

Budget Amount: $305,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project works to develop and implement strategies to further recover marine species protected under the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA), including conduct of Section 7 consultations under the ESA. The project assists in the analysis and procedural requirements to manage federal fisheries in compliance with the ESA and the MMPA, and develops and delivers outreach and education campaigns for the public concerning protected resources issues.

Progress during FY 2016

Work on this project has been exclusively directed to outreach and education efforts in collaboration with the JIMAR Pacific Islands Region Outreach and Education Program and the NOAA Pacific Islands Regional Office Communications Outreach and Education Group. JIMAR staff participated in several workshops and other activities to promote marine turtle conservation and engaging with the public to support the Hawaii Monk Seal Research Program's conservation efforts. Efforts also focused on development of outreach printed materials and educational efforts directed at Hawaii's school children.

Sea Turtle Bycatch and Mitigation Research

P.I.: Mark A. Merrifield [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

Budget Amount: $124,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

Marine turtle bycatch in fisheries has resulted in population declines, ecosystem impacts, and economic loss. In response, multiple strategies to reduce turtle bycatch have been developed for pelagic longline fisheries. In contrast, few bycatch reduction strategies exist for gillnet fisheries. Identifying strategies to increase selectivity in gillnet fisheries and reduce marine turtle bycatch is a global fisheries management priority. Furthermore, small-scale fisheries (SSF) supply more than half of global fish catch, yet many SSF are data-limited. The majority of the global fishing fleet consists of small vessels that do not record any catch data, much less carry onboard observers to document catch. SSF can lack catch data for a variety of reasons, including inconsistent recording methods, lack of personnel, lack of continuity in observer programs, and prohibitive costs. This JIMAR project works to improve the overall selectivity of fishing gear, develop bycatch mitigation strategies for bycatch species, and gain a better understanding of catch records in global SSF to help inform fisheries management decisions. The objectives of this year's project were two-fold: 1) to test the effects of acoustic deterrent devices (ADD) on green sea turtle catch rates in gillnet fisheries; and 2) test the effectiveness of relatively low-cost electronic

monitoring (EM) systems on small vessels in a small-scale fishery.

Ocean Discovery Institute students preparing electronic monitoring cameras.

Progress during FY 2016

This year's field research occurred during July 2015. During this time a small study examining the use of ADDs tuned to produce low frequency sound that falls within the hearing range of sea turtles was conducted. ADDs have been used to effectively reduce bycatch of some cetacean species in net fisheries, however, use of a sound deterrent had not been evaluated for reducing incidental capture of sea turtles until this project's pilot study of this strategy in 2013. During 17 trials, 17 turtles were caught in total, 13 in control nets and 4 in experimental nets. Sea turtle catch per unit effort (CPUE) in control versus experimental nets were reduced by 65% but were not significant due to low capture rates (Wilcoxon signed-ranks test, n=17, p=0.2).

Concurrently, the project also initiated the EM study. The objective of this study was to test the effectiveness of relatively low-cost EM on small vessels in a small-scale fishery. Specifically, the study's goal was to determine the similarity of data collected by a single-camera EM system to a traditional onboard observer. Catch data collected by onboard observers when compared to the data collected through the EM system were found to be similar. No significant differences were found in both retained and discarded fish using both observing techniques (Wilcoxon signed-ranks test, n=29, p=0.44 for retained catch and p = 0.77 for discarded species). Project researchers also discovered that it was 34% faster to collect data by scoring EM videos than it was for an onboard observer to record data on the boat. Furthermore, onboard observer time does not include travel time to and from the fishing site, which can take up to an hour. This increase in efficiency could be important in small-scale fishing fleets that employ hundreds of fishing vessels.

Turtle Research Program (TRP)

P.I.: Mark A. Merrifield [JIMAR Project Lead: Devon Francke]

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

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

Budget Amount: $304,930

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The Turtle Research Program or TRP (also known as Marine Turtle Biology and Assessment Program or MTBAP) includes nine discrete elements: 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 with focus on sea turtle fibropapilloma (FP) tumor disease; 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 training in the collection of sea turtle data aboard commercial longline fishing vessels.

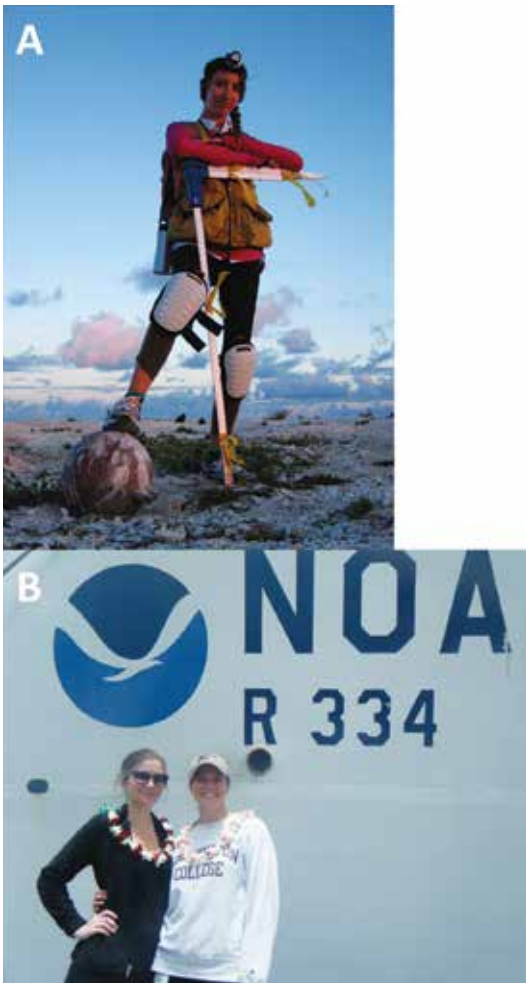


Figure 1a. JIMAR MTBAP staff member Emma Gosliner performing an evening green turtle nesting survey on East Island, French Frigate Shoals (FFS) in the Northwestern Hawaiian Islands (NWHI) during the summer of 2015 (photo credit Louise Giuseffi)

Figure 1b. JIMAR MTBAP staff members Olivia Hughes (R) and Kerry Lyons (L) board the NOAA ship Hi'ialakai on April 17, 2016 to journey up to the FFS to begin performing nightly green turtle nesting surveys for the 2016 season.

Progress during FY 2016

JIMAR MTBAP researchers successfully completed many research activities during the reporting period and continued to make significant scientific contributions towards MTBAP goals and objectives. JIMAR MTBAP staff accomplishments are as follows.

- Managed a Pacific-wide satellite-tracking database, prepared maps, analyzed satellite-tracking data, and provided data for publication in peer-reviewed journals. Data was managed and maps were produced for 30 turtles from four projects throughout the Pacific during FY 2016.
- Assisted NOAA's Pacific Islands Fisheries Science Center (PIFSC) staff and the general public in the rescue, rehabilitation, and release of 55 stranded sea turtles during the reporting year. Thirteen of these turtles required extended rehabilitation in the Life Support System (LSS) tanks at the Daniel K. Inouye Regional Center (IRC). Four turtles suffered fishing line entanglement, three of which JIMAR staff assisted in the surgical amputation of a front flipper. All four were eventually released. Another turtle suffered from a fishhook deeply embedded in its front flipper, also requiring flipper amputation surgery before being released. Another turtle suffered from fibropapillomatosis (FP), underwent surgery to remove large tumors attached to its flippers and jaws, and was subsequently released. Three other turtles suffered from a boat impact, one of which required screws and bone plates to be surgically attached to its carapace; all three were eventually released. Two turtles suffering from excessive buoyancy were both eventually euthanized—one was an olive ridley sea turtle that suffered from hyperinflated lungs and pneumonia, the other was a green turtle that ingested fishing hooks and line causing an impaction in its intestines. The last two turtles suffered from originally unknown causes; the first had an intestinal impaction, which eventually passed, and the turtle was released, and the second was found to have brain lesions and was therefore euthanized. Daily care of these 13 turtles involved feeding, cleaning tanks, administering medications, assisting the veterinarian and conducting external visual exams.
- Worked with PIFSC staff in conducting 155 necropsies on stranded marine turtles during FY 2016. Salvaged carcasses were examined externally and a gross necropsy was performed to ascertain a cause of stranding. Biological samples such as skin for genetic analysis, food items for diet analysis, and tumor tissue for disease studies were collected and managed by JIMAR MTBAP stranding associates.
- Assisted PIFSC MTBAP, United States Geological Survey (USGS), and National Institute of Standards and Technology (NIST) staff with the necropsies of 23 bycaught sea turtles from the Hawaiian and American Samoan longline fisheries. These included necropsies of 18 olive ridleys, three loggerheads, and two green turtles.

Figure 2. JIMAR participated in hosting 50 Malama Na Honu volunteers at the IRC. JIMAR Project Lead Devon Francke (9th from the right) gave a presentation on green turtle stranding trends in Hawaii to the group, who monitor basking turtles at Laniakea Beach on the north shore of Oahu.

Figure 3a. JIMAR MTBAP staff members releasing stranded and recently rehabilitated green turtles at Ke'ehi Lagoon Beach Park, Oahu. Olivia Hughes releases a turtle on September 21, 2015 that had previously stranded on August 30, 2015 at Chun's Reef in Haleiwa, Oahu in a weakened condition.

Figure 3b. Devon Francke releases a turtle on January 29, 2016 that had stranded previously the same day with a fishing hook in its mouth.

- Conducted a longline observer training session on August 28, 2015 in collaboration with PIFSC researchers. JIMAR staff led the presentation and co-led the hands-on training with MTBAP staff, demonstrating the proper techniques for tagging turtles, taking measurements, and collecting a skin biopsy for genetic analysis.
- Participated and helped coordinate field captures of juvenile, sub-adult, and adult green turtles in November 2015 at Haleiwa Ali'i Beach Park, Oahu and in April 2016 at Hanauma Bay, Oahu. At Haleiwa Ali'i Beach Park, basking turtles were captured by hand, and juvenile turtles were captured by hand/snorkel at Hanauma Bay. All turtles were tagged, measured, weighed, and examined to monitor residency, health, and growth rates.
- Temporary-hire JIMAR MTBAP Biological Research Associate (May-August 2015) Emma Gosliner led a 53 day field camp at East Island, French Frigate Shoals (FFS), a major nesting site for Hawaiian green turtles. This was the 42nd year of nesting data collection at this site, and 43rd consecutive year of sea turtle nesting surveys performed in the Northwestern Hawaiian Islands (NWHI). A total of 492 nesters were encountered and comprehensively cataloged during the monitoring period. Upon safe return to Honolulu, Ms. Gosliner completed the post-season analysis of information collected during the 2015 nesting season, including: 1) thorough proofing of the data; 2) finalizing the yearly findings report; 3) updating the Standard Operating Procedures manual; 4) downloading and archiving photos; 5) downloading

Global Positioning System (GPS) and temperature logger data; and 6) creating maps and graphs from the data. Currently, temporary-hire JIMAR MTBAP Biological Research Associate Kerry Lyons and JIMAR MTBAP Olivia Hughes are deployed to the FFS performing the 44th year of data collection.

- The project continues to make progress entering, updating, and validating records within the Oracle Turtle Data Processing System (OTDPS). During FY 2016, JIMAR created 3,299 records and validated 4,375 records within the "Stranding," "Nearshore," and "Nesting" databases of OTDPS.
- To meet NOAA's Public Access to Research Results (PARR) compliance requirements, JIMAR staff compiled and prepared 879 individual files for satellite tracked sea turtles in addition to all monthly Argos raw data from 1992 to the present.
- Throughout the year, JIMAR staff assisted MTBAP, United States Fish and Wildlife Service (USFWS), and National Institute of Standards and Technology (NIST) in necropsying the remains of six green and hawksbill sea turtle nests that were excavated throughout the Main Hawaiian Islands (MHI). Biological samples were collected to determine genetics, energetics, and pollutants.
- JIMAR assisted in various preparations for the PIFSC Protected Species Division (PSD) External Program Review in July 2015. This included assisting with creation of presentations and coordinating the travel arrangements and logistics of two members of the External Review panel. During the review, JIMAR staff helped to answer any of the panel's questions.
- From August 4-6, 2015, JIMAR staff attended the 23rd Annual Hawaii Conservation Conference, in Hilo, Hawaii and gave a presentation on updated stranding trends of Hawaiian sea turtles. The talk was attended by over 100 researchers, scientists, conservation managers, and members of the public.
- JIMAR project staff was trained to operate, maintain, and clean the sea turtle rehabilitation tanks at the IRC for the month of December 2015. During this time project staff successfully set up the LSS system to house a stranded turtle.
- On January 28, 2016, JIMAR project staff gave presentations to the Fishing Around Sea Turtles steering committee (including members from PIFSC, PIRO, USFWS, DLNR, WPRFMC, and OLE) regarding updated overall stranding trends in Hawaii and the spatiotemporal variability of those strandings. This information will help the committee make decisions regarding outreach to fishermen around the state to minimize negative interactions with sea turtles.
- Assisted in the preparations of a major PSD laboratory audit in February 2016. All supplies and gear in all lab and storage spaces at the IRC were inventoried, and a system was established to improve inventorying and tracking the locations of research supplies.
- Created one poster and gave two oral presentations at the 36th Annual Symposium on Sea Turtle Biology and Conservation, held from February 29 through March 4, 2016 in Lima, Peru.
- Project staff participated in the PIFSC Young Scientist Opportunity (PYSO) Committee. They assisted with the selection of candidates and developing projects for the summer internship program for undergraduate scientists. Additionally, JIMAR's Project Lead serves as the mentor to the chosen undergraduate student doing a project within the MTBAP.
- The green turtle nesting season is off to a great start up in the FFS. As of June 16, 2016, JIMAR staff already attached four satellite tags to nesting and basking turtles, and documented at least 57 individual nesters.

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

P.I.: Mark A. Merrifield

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

NOAA Sponsor: Christopher Sabine, William S. Kessler

Budget Amount: $115,696

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 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 to: 1) characterize the spatial and temporal scales, subsurface structure and evolution of the meso/submesoscale eddies in low latitudes; 2) diagnose the dynamics of the eddies, including their generation mechanisms and seasonal modulation; and 3) 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 2016

During FY 2016 the project's goals were to: 1) establish the measurability of eddy signals in the Solomon Sea by glider; and 2) refine the understanding of submesoscale dynamics in this low-latitude region with strong flow-topography interactions.

Establish the measurability of eddy signals in the Solomon Sea by glider. The interior Solomon Sea is characterized by energetic intraseasonal variability, that matches in magnitude that of the seasonal cycle. Analysis of altimetric sea surface height shows that the intraseasonal surface variability in the Solomon Sea is dominated by a signal with a 50-60 day period, westward phase propagation, and basin-size lateral scale (~400km), suggestive of the excitation of low-order resonant basin modes. Signature of the surface intraseasonal eddy signal seen in altimetry can be found in the vertically averaged, glider measured velocity, suggesting a large vertical scale. Because the time needed by the glider to a complete a section across the Solomon Sea is comparable to the 50-60 day period of the eddies, the background conditions in the Solomon Sea change significantly during sampling. This explains to a large degree the observed big section-to-section differences in transport estimates from the glider.

Refine the understanding of submesoscale dynamics in this low-latitude region with strong flow-topography interactions. In an effort lead by research partners at UCLA and a series of progressively higher spatial resolution nested numerical models, the project studied the relative dominance and generation mechanisms of submesoscale eddies, fronts and filaments in the near-surface southwest Pacific Ocean. Three dynamically-different regions

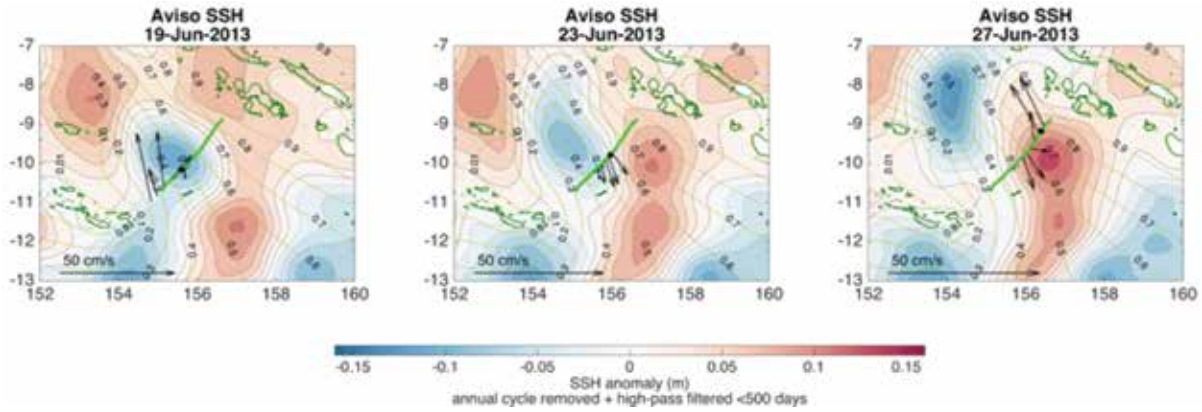


Figure 1: A series of three consecutive snapshots, spaced 4 days apart, showing the high-pass filtered sea surface height from AVISO (color shading) in the Solomon Sea. Overlaid in green is part of a glider track, with the black dot showing the glider position at that particular date, and the arrows, the 0-700m vertically-averaged velocity from the glider, daily-averaged for the 5 preceding days.

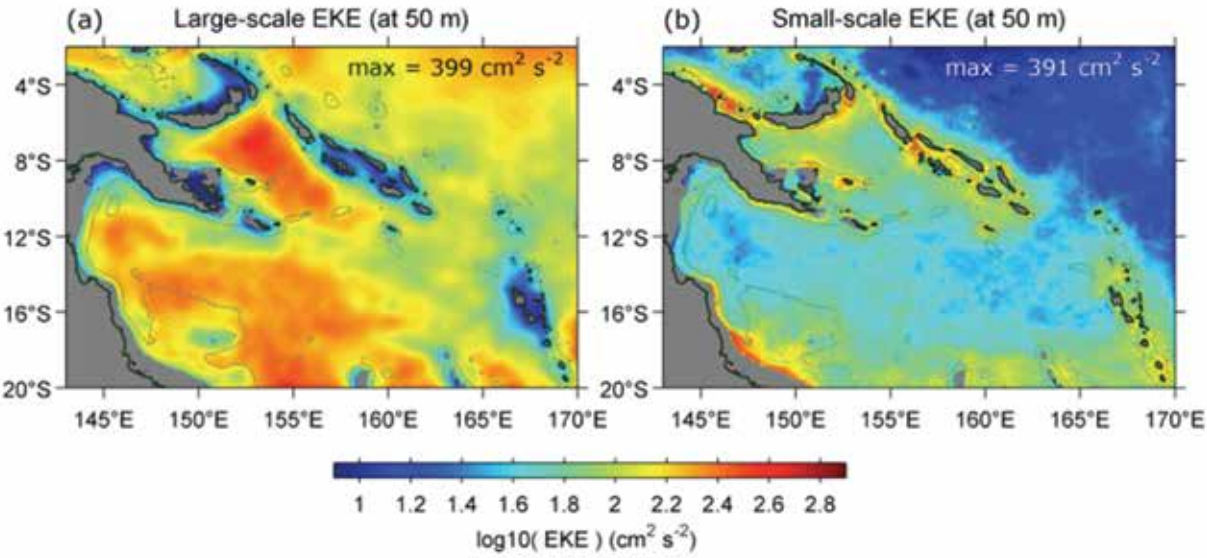


Figure 2: Estimates of the eddy kinetic energy (EKE) for the southwest Pacific Ocean from a numerical model simulation (ROMS, 4km). The EKE is split by spatial scales (cutoff 80 km), with (a) showing the contribution from the large scale (mesoscale) field, and (b) showing the small-scale (submesoscale) contribution.

were identified: 1) the more typical winter-time "submesoscale soup" in the Coral Sea consisting of baroclinic mixed-layer eddies and filaments, induced by both surface cooling and enhanced winds in the strong trades winter season; 2) the "submesoscale desert" in the east Solomon Sea where there is a persistent lack of submesoscale signals (consistent with glider observations) but the surface variability is dominated instead by large, basin-filling mesoscale eddies; and 3) the topographically dominated near-coastal Solomon and Bismarck Seas, where intense submesoscale coherent vortices result form a combination of near equatorial proximity, and small scale topographic obstacles with a smaller contribution from river outflows. A manuscript in its final stages before submission is in preparation (A submesoscale geography of the near-surface southwest Pacific Ocean in a high-resolution model, K. Srinivasan, J.C. McWilliams, L. Renault, H. Hristova, J. Molemaker, and W. Kessler).

Optimizing Routine Ocean Current Measurements by the NOAA Fleet

P.I.: Eric Firing

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

NOAA Sponsor: Cecile Benigni and Donald E. Jones

Budget Amount: $183,314

NOAA Goal(s)

- NOAA Enterprise-wide Capabilities: Science and Technology Enterprise; Engagement Enterprise; Organization and Administration Enterprise

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; but without suitable data acquisition and processing software installed, and used routinely, this potential is not realized. The purpose of this project is for researchers to extend their software knowledge and expertise, gained via years of experience with the academic oceanographic research fleet, to the NOAA fleet.

Progress during FY 2016

For the second year of the project the primary goal was to install University of Hawaii Data Acquisition System (UHDAS) on 4-5 more ships. This was accomplished by project researcher Toby Martin with new installations on the *Okeanos Explorer*, the *Gordon Gunter*, the *Oscar Elton Sette*, and the *Pisces*. As a head start for next year, systems have been configured and shipped to the *Henry B. Bigelow*, the *Ferdinand Hassler*, and the *Thomas Jefferson*. Unfortunately, the ship-owned ADCPs on the *Sette* and the *Pisces* have failed, so they will be unable to take advantage of UHDAS until the instruments can be repaired and reinstalled. Maintenance of previously installed systems involved the *Nancy Foster*, the *Ron Brown*, and the *Bell Shimada*. On all three of these, the UHDAS computer was replaced with the NOAA-approved model for this project. Troubleshooting of heading sensors on the *Ron Brown* and the *Bell Shimada* was documented (http://currents.soest.hawaii.edu/reports/ship_reports/2015_ronbrown_mahrs_posmv/, http://currents.soest.hawaii.edu/reports/ship_reports/2015_bellshimada_posmv/), and in the former case led to repair of the instrument before a cruise on which its use was critical. The ADCP on the *Nancy Foster* was damaged in the shipyard and is currently out for repair, but a temporary substitute was installed and integrated into UHDAS in time for the next cruise. Additional evaluation, troubleshooting, and software maintenance was done on all three of these systems and others, involving NOAA email systems as well as the ADCP-related instrumentation.

Dr. Julia Hummon conducted a half-day training session in December 2015, as part of the NOAA Survey Technician training meeting in Norfolk, VA. The following month she gave a presentation at the NOAA Environmental Data Management meeting in Washington, D.C. She participated via WebEX in ship users' meetings for the *Ron Brown* and the *Nancy Foster*.

The University of Hawaii Sea Level Center

P.I.: Mark A. Merrifield

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

NOAA Sponsor: David Legler

Budget Amount: $1,194,393

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 climate, oceanographic, ocean engineering, and geophysical research. While UHSLC assembles time series from a large number of tide gauge stations, the project's primary focus is the set of stations that constitute the 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. Because of their importance for global and regional sea level reconstructions, vertical land motion monitoring is recommended at all GLOSS and GCOS stations and the UHSLC maintains 11 continuous Global Positioning System (GPS) receivers at these stations. A primary objective of the UHSLC is to maintain two tide gauge datasets: the Fast Delivery dataset, which provides preliminary, quality-assured, hourly tide gauge data within 4-6 weeks of collection, and the Research Quality dataset, which is an archive of hourly tide gauge data that have undergone a complete quality assessment generally within one year of collection. The Research Quality database is maintained in collaboration with the National Oceanographic Data Center. The UHSLC acquires tide gauge data from nearly 500 tide gauge stations maintained by 65 international agencies. UHSLC technicians and data analysts collaborate directly with international partners to maintain more than 80 high-profile stations that are important for the global sea level observing effort. UHSLC involvement ensures that research quality 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.

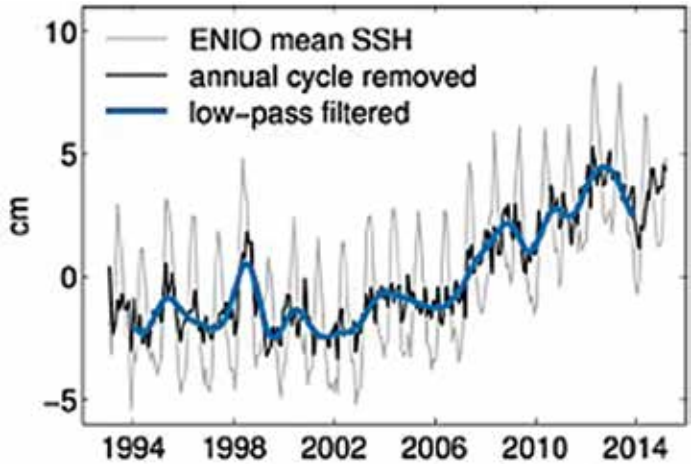


Figure 1. Monthly mean AVISO sea surface height (SSH) in the Equatorial and North Indian Ocean (ENIO) north of 5°S before filtering (gray), after removal of the mean annual cycle (black), and after applying the low-pass filter (blue). Project results show that the low-frequency increase in SSH averaged over this region is primarily caused by mechanisms of wind-driven heat redistribution with the Indian Ocean basin.

Progress during FY 2016

During FY 2016 the project accomplished all its objectives for data management and station operations as the Fast Delivery and Research Quality database was updated and expanded to accommodate new station datasets. GPS installations at tide gauges were maintained with assistance from the Pacific GPS Facility at the University of Hawaii. These data are provided to the GLOSS TIGA data center. UHSLC technicians visited and serviced 16 stations, which met the project's quota for the year, and assisted remotely with over 30 station repairs. The project

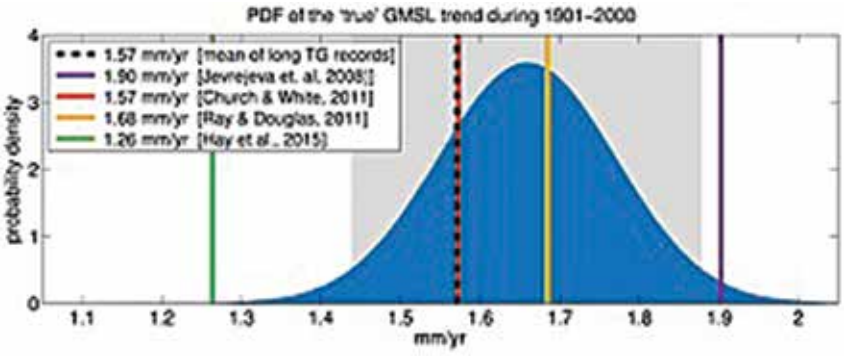


Figure 2. Probability density function (PDF) for the `true' rate of 20th century GMSL rise given how the longest and highest-quality tide gauges sample spatial structure in sea level change (blue). Gray shading represents 95% confidence intervals (±0.23 mm/yr) about the central value of the distribution (1.66 mm/yr). The black dashed line shows the sample mean of the observed GIA-corrected (ICE-6G VM5a) trends from the tide gauge records; solid lines denote the linear rate of GMSL rise during 1901-2000 from four prominent 20th century sea level reconstructions. These results demonstrate that 20th century rates of GMSL rise at the lower end of published estimates are not consistent with rates of change from the best tide gauge records available.

is committed to one new GPS installation at a tide gauge station and anticipates its completion by the end of calendar year 2016. During FY 2016, project researchers developed and launched a new UHSLC website capable of more dynamic content and increased usability. This website is a big step forward and includes areas to highlight project research and operations as well as providing the UHSLC with the foundation needed to host and readily update application-driven sea level products that are currently under development. Work continued on updating all the internal data processing software to modern languages and user interfaces.

During FY 2016, long-standing research projects were completed and significant progress was made toward ongoing research goals. Most importantly, the project completed a research project devoted to understanding a recent increase in the rate of upper ocean temperature and sea surface height (SSH) in the Equatorial and North Indian Ocean (Figure 1). Two mechanisms of wind-driven heat redistribution in the region that account for this change are identified. The first is the Indian Ocean Cross-Equatorial Cell, which is driven by equatorial wind-stress curl, and the second is zonal wind stress at the equator that drives a deep upwelling leading. Together, these mechanisms suppressed global sea level rise in the region during the first decade of satellite altimetry. A reversal of the wind forcing resulted in recovery of the SSH and elevated rates of change during the second decade of satellite altimetry. The project also led a team of sea level researchers in understanding how the best historical tide gauge records sample spatial structure in sea level change and whether these gauges might—as some have suggested—overestimate 20th century sea level rise. On the contrary, the project PI finds that the best tide gauge records are more likely to underestimate the rate of global mean sea level rise. UHSLC researchers also contributed a variety of sea-level-related research projects, including: 1) a description of the sea level response to the recent El Nino along the west coast of North America; 2) a study of the effect of vertical land motion on the estimates of global mean sea level rise from tide gauges; 3) an assessment of the effect of atmospheric pressure on sea level variability in long tide gauge records; and 4) a review of the dynamics and forcing of sea level patterns related to internal modes of climate variability.

University of Hawaii Sea Level Center (GNSS installation at NOAA CO-OPS stations)

P.I.: Mark A. Merrifield, James Foster, Todd Ericksen

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

NOAA Sponsor: David Legler

Budget Amount: $100,000

NOAA Goal(s)

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

Purpose of the Project

UH will fabricate and install continuous Global Navigation Satellite System (GNSS) stations at two NOAA Center for Operational Oceanographic Products and Services (CO-OPS) maintained tide gauge sites based on agreed upon NOAA priorities and contingent upon securing necessary permits and permissions. The installed GNSS stations will conform to Global Sea Level Observing System/ International GNSS Service-GPS Tide Gauge Benchmark Monitoring station guidelines for continuous and permanent operation, recording daily files of 30 s sample data transmitted via the best available telemetry.

Figure 1. Continuous GNSS site MQSI installed next to the Midway tide-gauge. The GNSS antenna (gray dome) is anchored to the sea wall and is set low in order to present minimal risk for sea birds. The MQSI solar panel and instrument box (under the solar panel) are located next to the tide-gauge equipment hut.

Progress during FY 2016

The two continuous sites were installed and are fully operational. Data files are being acquired and transferred to the NOAA archive via satellite internet telemetry. Both installations were built on the solid concrete sea-walls close to the tide-gauge sensors in order to ensure that any local vertical motions can be detected and removed from the tide-gauge records in order to recover absolute sea-level changes. Power at both sites is from solar panels and batteries. Telemetry is through nearby existing satellite communications operated by the U.S. Geological Survey.

Figure 2. Continuous GNSS site WQSL installed next to the Wake Island tide-gauge. The GNSS antenna (gray dome) is anchored to the sea wall to the left of the tide gauge meteorological mast and instrument hut. The MQSI solar panel and instrument box (under the solar panel) are located next to the tower.

University of Hawaii Sea Level Center (Ship-Based Tsunami Detection and Characterization)

P.I.: Mark A. Merrifield, James Foster, Todd Ericksen

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

NOAA Sponsor: David Legler

Budget Amount: $521,096

NOAA Goal(s)

- Resilient Coastal Communities and Economies

Purpose of the Project

This three year pilot project will build a network of ten ships providing accurate position solutions for tsunami detection and characterization. The project will equip ten ships operating between North America, Hawaii and Asia with a geodetic Global Positioning System (GPS) installation to measure ship vertical positions to better than 10 cm RMS, and a satellite communications antenna to transmit the data in real-time to processing computers at the University of Hawaii.

Progress during FY 2016

RESULTS: Illapel Earthquake 16th Sep 2015. Eight ships equipped with GPS installations were operational during the tsunami generated by the Mw8.3 earthquake near Illapel, Chile. There was no tsunami detectable in the ships' time-series, in agreement with the little energy from this event that was transmitted into the North Pacific. Maximum amplitudes predicted at the ships' locations were all less than 2.5 cm, which is below the project's expected detection threshold. One time-series, from the *Maersk Soroe*, does however show an intriguing change in character at the predicted time of arrival of the tsunami wave. Project researchers will be further examining the time-series to understand the nature of this possible anomaly.

Work accomplished during this reporting period involved extensive testing and validation of the system and this work continues. The project is developing a protocol to validate sea-surface height perturbation estimates, quantify and characterize their noise spectra, and define event detection thresholds. Project researchers are currently performing the analyses of the time-series collected to date to determine data completeness, accuracy and robustness and to establish the best filtering approach. This analysis will guide overall project strategies both for improving operational performance and for time-series filtering and event detection.

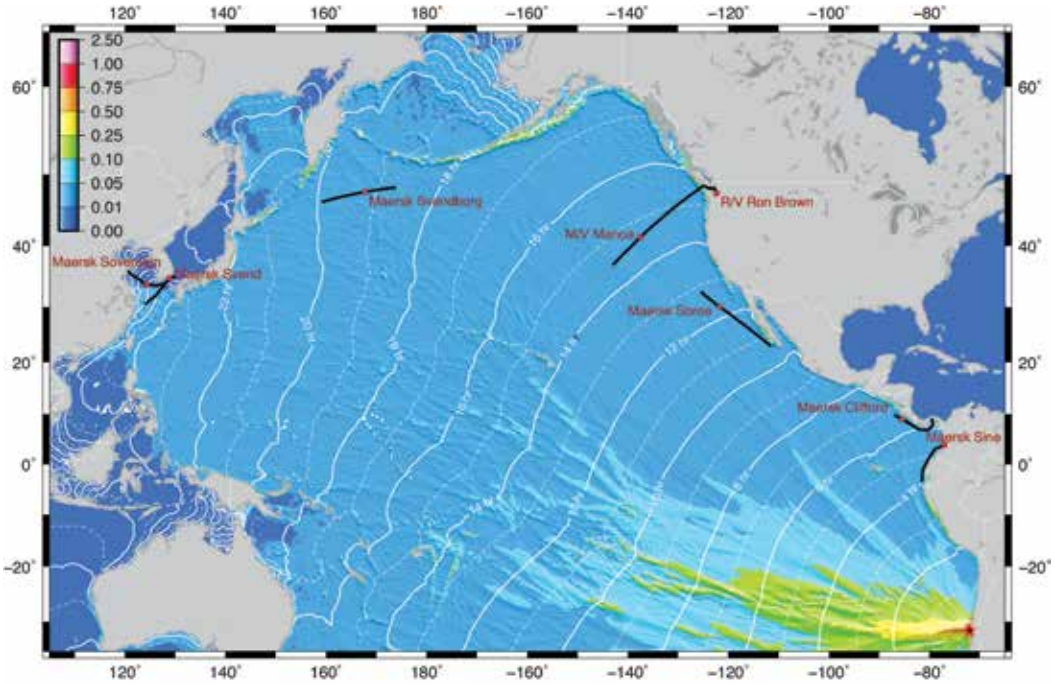


Figure 1. Map of the predicted maximum amplitude and travel time for the tsunami generated by the 16th Sept 2015 M8.3 earthquake at Illapel, Chile. Tracks of the ships active in this tsunami detection network for the period from the time of the earthquake to the end of the second full day afterwards (18th Sept) are shown. Red dots are the estimated tsunami arrival time at the ship based on tsunami travel time predictions.

Figure 2. Tsunami detection package installed on the Svend Maersk. *Six Maersk ships, operating between Panama and East Asia, and two Matson ships operating between Hawaii and the west coast of the U.S. form the core of this project's network.*

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 Niño Southern Oscillation) Applications Center (PEAC).

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

P.I.: Kelvin Richards

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

NOAA Sponsor: Howard Diamond

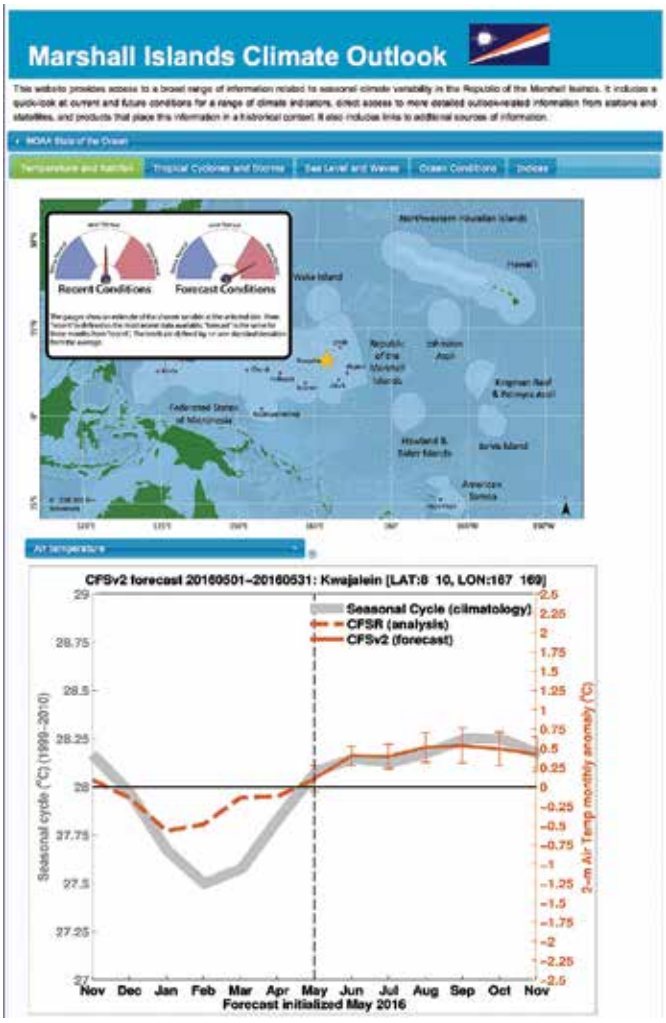
Budget Amount: $93,827

NOAA Goal(s)

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

Purpose of the Project

This project helps sustain and promote activities at the Asia-Pacific Data-Research Center (APDRC) and through extension climate research within the International Pacific Research Center (IPRC) at the University of Hawaii. The project's overall goals are: 1) to meet critical regional needs for ocean, climate and ecosystem information; 2) to enhance activities in support of the Global Earth Observation System of Systems (GEOSS) and the NOAA Pacific Climate Information System (PaCIS); and 3) to provide infrastructure in support for research that enhances understanding of climate variability and change in 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 two main objectives: providing integrated data server and management systems for climate data and products; and developing and serving new climate-related products for research and applications users.



Example dashboard web site developed for the Republic of the Marshall Islands (RMI). The web site shows regularly updated forecasts of different variables from the NOAA Coupled Forecast System (CFS) version 2. Additional climate indicators such as ENSO state are also available. This site was developed for the agroforestry sector of RMI to help with planting schedules.

Progress during FY 2016

The APDRC maintains a wide array of data servers. Data transport servers provides data to clients via OPeNDAP, and the APDRC manages both THREDDS and GrADS DODS Servers (TDS and GDS, respectively). Web-based data browse tools operated by the APDRC include a Live Access Server (LAS) and Dchart. These servers continue to be maintained and there were no dramatic changes to these services in the past year.

During this reporting period the APDRC continued to support three main efforts. The first is climate services within NOAA's Pacific Climate Information System (PaCIS). APDRC personnel work closely with John Marra, Director of NOAA's Pacific Climate Information System (PaCIS) to provide custom data products for Pacific Island Communities. This is done mainly through web-based "dashboard" pages. One set (http://www.pacificcis.org/dashboard/) is updated quarterly and provides seasonal climate outlooks for the region. Other pages provide thematic-based information for different sectors, including one for coral reefs and another for freshwater resources. One specific project from the past year included a seasonal rainfall predictor for Vanuatu.

Second, the APDRC supported IPRC research activities associated with Pacific climate studies done in collaboration with JAMSTEC. Scientists at the IPRC are working with colleagues at JAMSTEC on various projects that require access to large data sets and also need a mechanism to share their project-generated data. Examples include management of output from the Earth Simulator and output from the CMIP-5 models. This work was accomplished by leveraging funding from NOAA (this project) and from JAMSTEC.

Finally, the APDRC has been working with the Pacific Islands Climate Science Center (PICSC), which is an USGS-funded effort managed by the IPRC. The PICSC funded projects include high-resolution regional climate models, and APDRC staff continues to provide data management support for these model runs.

Mechanisms of Atmospheric Mercury in Transport and Transformation in the Remote Pacific Marine Free Troposphere Measured in Hawaii

P.I.: Mark A. Merrifield

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

NOAA Sponsor: Russell Schnell [Darryl T. Kuniyuki, Winston Luke]

Budget Amount: $427,728

NOAA Goal(s)

- Weather-Ready Nation

Purpose of the Project

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 (HgP) 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 HgP 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. Some data and theories will be placed on the MLO website and other types of media for outreach purposes

Progress during FY 2016

Activity was centered on continuing additional tests and measurements to remedy and mitigate observed mercury measurement artifacts at MLO. Prior testing at MLO provided conclusive evidence for the presence of Hg0-HgP measurement artifacts in the inlet glassware of the commercial system. In addition, measurement

(left) Figure 1. Additional Tekran® mercury detection equipment and reactive gaseous mercury (RGM) calibration system from Utah State University. (right) Figure 2. The Utah State University RGM calibration apparatus.

biases in the monitoring of RGM have also been identified. The additional instrumentation installed by the P.I. in March-April 2015 was used to test differing methodologies to measure Hg0 and total mercury, and to calculate reactive mercury (RM: RM = RGM + HgP) by difference. Researchers from Utah State University briefly installed and operated a prototype instrument for RGM calibration in the summer of 2015. This system was removed in August 2015 and the additional Tekran® instrumentation was turned off in mid-December 2015. The instrumentation will be started again in early FY 2017 for a short period of time to test design improvements to the system, and to allow for continued assessment of the accuracy, and potential artifacts and biases, of all the different measurement techniques deployed at the site over a variety of conditions. A NOAA-built RGM calibration system will be deployed for a short period of time in FY 2017 to allow a more quantitative assessment of measurement capabilities under all conditions.

Pacific ENSO Applications Center

P.I.: Mark A. Merrifield

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

NOAA Sponsor: Raymond Tanabe

Budget Amount: $217,000

NOAA Goal(s)

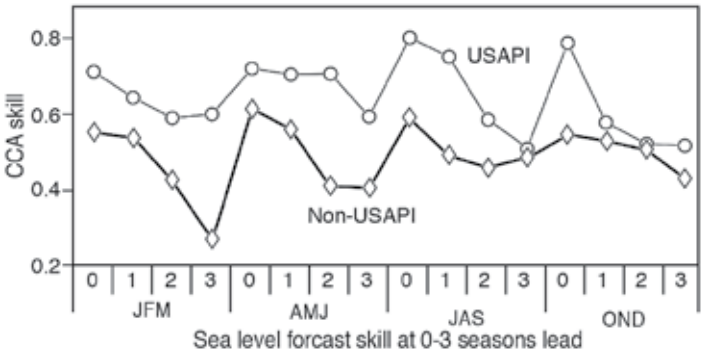
- Weather-Ready Nation
- Climate Adaptation and Mitigation
- Resilient Coastal Communities and Economies

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 US-Affiliated Pacific Islands (USAPI). PEAC provides ongoing summaries of current ENSO conditions and seasonal forecasts, as well as outlooks of probable ENSO impacts in the USAPI region related to rainfall, sea level, and tropical cyclone activity. An 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.

Sea Level Forecasts—Expanding Cooperation in the South Pacific: *The PEAC Center recently developed seasonal sea level outlooks tailored toward coastal flooding/erosion risk warning and water resources management for neighboring island communities to the USAPI . Overall forecast skills tend to be slightly weaker for the non-USAPI region (Fig. 1). Of the four seasons, JAS has the highest predictability in both regions as ENSO responses tend to be more pronounced during boreal winter.*



Comparison of SST-U-based average sea level forecast skills for all USAPI and non-USAPI stations for seasons JFM, AMJ, JAS, and OND at 0-3 season leads. (Note that USAPI Stations are: Guam, Malakal, Yap, Pohnpei, Majuro, Kwajalein, and Pago Pago; and non-USAPI stations are: Nauru, Honiara, Funafuti, Penrhyn, Kanton, Christmas, Rarotonga, Papeete, and Rikitea). [Reproduced from Chowdhury and Chu, 2015 96(3)]

Progress during FY 2016

PEAC staff worked closely with Integrated Water Level Service (IWLS) partners, including the NOAA NESDIS National Centers for Environmental Information, the International Pacific Research Center, New Zealand National Institute for Water and Atmospheric Research and Met Service, Australia's Bureau of Meteorology, and the Commonwealth Scientific and Distribution Research Center, to develop and implement an expanded ensemble mean sea level anomaly forecasting scheme for the Pacific basin. The ensemble is based on statistical and dynamical model forecasts, including the operational sea level product developed at PEAC. The expanded product benefits a greater range of island inhabitants, which enhances their ability to plan for ENSO-related sea level extremes. PEAC continued development of a suite of National Weather Service operational products that are now distributed through the NWS long wire system AWIPS. Proposed plans to expand the forecast product to include wave as well as water level impacts were delayed due to the departure of a staff member during the year.

Over the past year the PEAC graduate research assistant conducted research to better understand the performance and skill of the PEAC rainfall-forecasting suite, especially during periods when disaster level droughts have occurred in the USAPI region. While the PEAC rainfall forecasting suite performs extremely well during El Niño events, with very high skill scores obtained throughout the 2015-2016 El Niño event for example, forecast performance degrades during non- El Niño periods, notably during the disaster drought of 2013 in the Northern Mariana Islands. Ongoing research is being conducted to characterize the 2013 drought event, to determine if similar events have occurred in the past, and to establish an improved basis for prediction.

PMEL-UH Ocean Carbon Project

P.I.: Matthew J. Church

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

NOAA Sponsor: Christopher Sabine

Budget Amount: $5,311

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The primary mission of this project is to evaluate the variability in air-sea CO_2 fluxes by conducting high resolution time-series measurements of atmospheric boundary layer and surface ocean CO_2 partial pressure (pCO_2). The Moored Autonomous pCO_2 ($MAPCO_2$) system collects CO_2 data from surface seawater and marine

boundary air every three hours for up to a year at a time before they need servicing. Daily summary files of the measurements are transmitted back to PMEL where the data are examined and plots of the results are posted to the web in near-real time.

Progress during FY 2016

As with previous reporting periods, this project provided two weeks of salary support for a member of the Hawaii Ocean Time-series (HOT) program staff (Dan Sadler) to oversee maintenance of instrumentation used for remote and shipboard measurements of atmospheric and seawater CO_2. Sadler oversaw installation and testing of instrumentation used as part of NOAA's Pacific Marine Environmental Laboratory (PMEL) measurements of the partial pressure of CO_2 (pCO_2) and pH in the tropical and subtropical Pacific Ocean. His primary effort focused on installation and servicing of instruments on the Woods Hole Oceanographic Time-series Station (WHOTS) mooring, a collaborative mooring program, funded jointly by NOAA and NSF, led by scientists at Woods Hole Oceanographic Institution (WHOI) and the University of Hawaii. Sadler served as the local (Hawaii-based) liaison between PMEL and the University of Hawaii, and in this role provided data on seawater carbonate system measurements from Station ALOHA. Funds from this award partially offset time devoted by Sadler to these PMEL projects.

Profiling CTD Float Array Implementation and Ocean Climate Research

P.I.: Mark A. Merrifield

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

NOAA Sponsor: Gregory C. Johnson

Budget Amount: $262,251

NOAA Goal(s)

- Climate Adaptation and Mitigation

Purpose of the Project

JIMAR works with U.S. and International Argo Project partners, especially NOAA/PMEL, on two aspects of the Argo Program. The first objective involves float testing, deployment, and data/engineering evaluation. The second objective involves climate research using data from Argo floats and other sources.

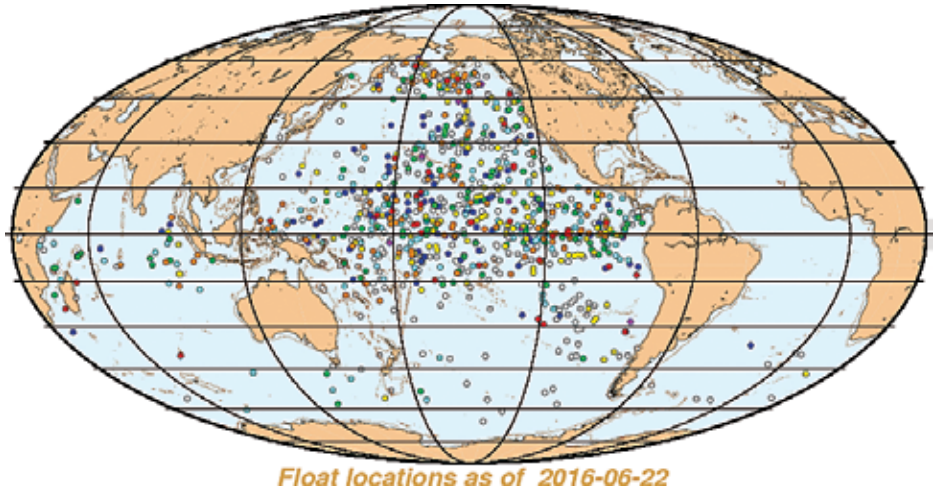


Figure 1. Locations (filled circles) of Argo floats prepared by JIMAR float research coordinator E. Steffen as of 22 June 2016. Grey indicates floats that have not reported for the last 20 days or more, colors indicate more recently reporting floats.

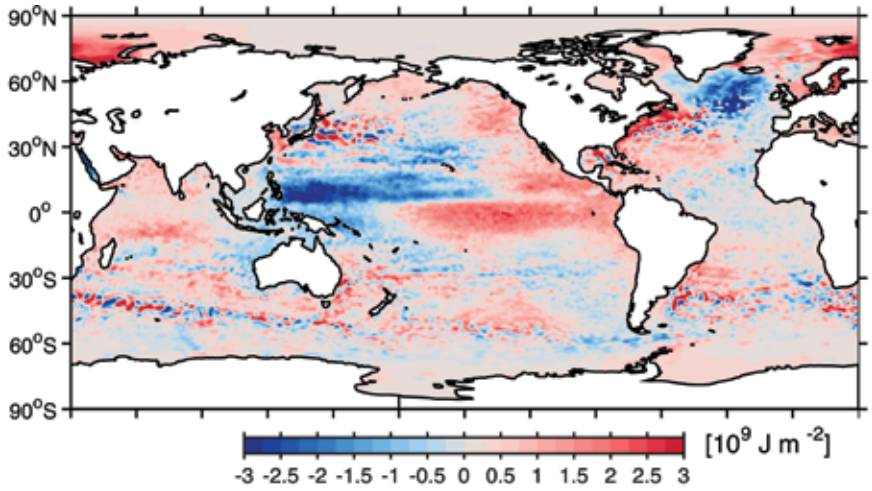


Figure 2. Upper Ocean (0–700 dbar) Ocean Heat Content Anomaly [109 J m-2] for 2015 relative to 1993–2015 estimated using in situ (mostly from Argo in recent years) temperature data and satellite altimeter sea surface height data (in colors, with red being warm and blue cold).

Progress during FY 2016

Dr. Elizabeth Steffen and the PMEL float lab took delivery of 70 Argo floats this year. Dr. Steffen tested floats, monitored float performance, diagnosed and coordinated repairs of problems discovered with the floats, and worked with the manufacturer to resolve problems including warranty replacements as well as troubleshooting a laboratory testing CTD. She continued to work with the project's new Iridium service provider on improving service, arranged for float deployments, and notified the national and international databases. She traveled to load floats on various ships and train deployers. Stated project goals were met.

Along with JIMAR Senior Fellow Dr. Gregory Johnson, Dr. John Lyman produced and analyzed yearly maps of global upper ocean heat content from 1993 through 2015 (Figure 2), combining in situ thermal data and satellite altimetry data, as well as yearly maps of sea surface salinity from 2005 through 2015. They continued working on estimating uncertainties in and improving estimates of global ocean heat content anomalies and their trends. Dr. Lyman also continued work on updating scientific delayed-mode quality control software for the PMEL Argo floats, and performed quality control on PMEL Argo float data. This year Dr. Lyman was co-author on four journal articles (he was first author on one of those, and two are annual *State of the Climate in 2014* report sections). Stated project goals were met.

Sensitivity of Built and Natural Infrastructure to Coastal Flooding under a Changing Climate

P.I.: Mark A. Merrifield

NOAA Office (of the primary technical contact): National Ocean Service, Office for Coastal Management

NOAA Sponsor: Adam Stein

Budget Amount: $24,000

NOAA Goal(s)

- Weather-Ready Nation
- Resilient Coastal Communities and Economies

Purpose of the Project

This project seeks to improve understanding of the sensitivity of built and natural infrastructure along the Kohala Coast on the Island of Hawaii to coastal flooding under a changing climate. In addition to built infrastructure

such as park facilities, roads and hiking trails, the Kohala Coast on the Island of Hawaii contains unique natural infrastructure in the form of wetlands, fishponds, and anchialine pool ecosystems. This location is both a NOAA Sentinel Site and a Habitat Blueprint area, and is of interest to the U.S. National Park Service and The Nature Conservancy. Work has been carried out in this area by numerous investigators, including an initial round of leveling conducted by the National Geodetic Survey with funds provided by the NOAA Coastal Storms Program. Building on these previous efforts, a series of activities was conducted to help local decision-makers assess the potential impacts of changes in coastal flooding due to sea level rise on specific elements of built and natural infrastructure in the Kohala area.

Progress during FY 2016

A series of analyses were conducted to assess the potential for coastal flooding and erosion in light of a changing climate. The results will support visualization of flooding along the study site under different sea level rise (SLR) and storm scenarios, as well as supporting the analysis of groundwater levels in the unconfined coastal aquifers typical of Hawai‘i. Specifically, long-term datasets of historical water levels in tide stations and wave buoys were analyzed using stationary and non-stationary extreme value analysis and other statistical techniques and along with results from previous studies were used to create a set of future coastal flooding scenarios that take into account sea level changes and climate variability. Scenarios include projected: 1) Still Water Level (SWL) elevations for the area from Kawaihae to Kailua-Kona; 2) Dynamic Still Water Level (SWL) elevations that include wave setup for the area from Kawaihae to Kailua-Kona; 3) Total Water Level (TWL) elevations that do include storm wave run-up for Kaloko-Honokohau; and 4) Shoreline Retreat distances based on TWL for Kaloko-Honokohau. Additional analyses focusing on flood frequency are pending.

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.: Mark A. Merrifield

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

NOAA Sponsor: Raymond Tanabe

Budget Amount: $156,100

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 2016

During FY 2016, the NWS Fellowship Program provided ongoing educational support to the Geology and Geophysics (G&G), Atmospheric Sciences (formerly Meteorology) and Oceanography departments. 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.

Two Department of Atmospheric Sciences (DAS) graduate students were supported by the NWS funds. Chris Goodman is working with DAS Professor Jennifer Griswold and just completed his second year. His interest is in how ENSO and other planetary scale phenomena affect commercial aviation. His thesis entitled "Impacts of weather and climate variability on commercial aviation operations" looks at the long-term datasets from various airports to see how the frequencies of such conditions as icing, sleet, strong convection and varying wind direction have changed. All these factors have a major impact on the cost to both the airlines and the passengers who may endure delays. He recently submitted his thesis for review and is scheduled to finish his degree this summer.

Dillon Dodson is also a graduate teaching assistant with DAS and just completed his first year. He is also working with Dr. Griswold. His thesis entitled, "Analyzing turbulence in shallow cumulus using droplet clustering: the effects of aerosols and cloud height" focuses on in situ aircraft data along with other meteorological observations and how they are used to investigate turbulence and droplet spacing within the cumulus clouds

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): Pacific Marine Environmental Laboratory

NOAA Sponsor: Christopher Sabine

Budget Amount: $22,111

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 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, since 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 development of both harbor surge and beach flooding nowcasts and forecasts for NOAA's PacIOOS. PacIOOS and JIMAR continued funding support of graduate student Assaf Azouri, who has been analyzing the 13 years of PTWC sea level data from Haleiwa Harbor in ARSHSL to determine the relationships between Haleiwa's suite of infragravity wave fluctuations and their many forcing pathways (e.g., wind-generated swell directly forcing harbor infragravity waves; versus, swell forcing coastal infragravity waves that then force harbor infragravity waves). Mr. Azouri has been working with PacIOOS product developers (especially, Dr. Martin Guiles) to create and refine a product* for PacIOOS that will forecast the occurrence of potentially damaging infragravity wave currents in Haleiwa Harbor up to a few days into the future. This work will be extended to other harbors, using the archived high-resolution sea level data in ARSHSL to establish the initial set of parameters of the transfer functions from swell to harbor infragravity waves.

Progress during FY 2016

Per the plans for this past year, modernization of the extensive, mostly automated, code enabling ARSHSL's real-time data acquisition, editing and archiving activities began in earnest in Spring 2016 through both JIMAR and PacIOOS funding support. Large parts of this effort are a generalization of the code to accept different data and transmission formats as new stations are brought online, and a rebuilding of the Graphic User Interface (GUI) to make editing and archiving (the hands-on portions of the data handling) simpler and faster. This effort was about 80% completed at the end of June 2016.

**http://oos.soest.hawaii.edu/pacioos/data_product/harborsurge/index.php*

Also per the plans for this past year, the ARSHSL was maintained on the World Wide Web (http://ilikai.soest.hawaii.edu/arshsl/techrept/arshsl.html) by M. Luther and D. Luther in collaboration with the NOAA-funded U. H. Sea Level Center (M. Merrifield, Director). One-minute and six-minute data from six NOS gauges are being retrieved from NOAA's Tides & Currents web site (http://tidesandcurrents.noaa.gov/), rather than through the special communications pathways originally established for ARSHSL. While the project hoped to re-establish real-time data acquisition from the 14 PTWC sea level gauges this past year, that data acquisition remains suspended until the new acquisition code and GUI mentioned above are completed.

The University of Hawaii Sea Level Center—Tsunami Research

P.I.: Mark A. Merrifield

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

NOAA Sponsor: Michael Angove

Budget Amount: (funds are budgeted within The University of Hawaii Sea Level Center project budget)

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 nine 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 all 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 comply with global sea level observing system requirements for oceanographic and climate research.

Progress during FY 2016

For the Pacific Ocean, UHSLC technicians visited and serviced six stations (Acajutla, Quepos, La Libertad, Legaspi, Hiva Oa, and Nuku Hiva), which exceeded project expectation of five visits. The Legaspi station is scheduled for relocation due to construction activities. For the Caribbean, UHSLC technicians visited four stations (Limon, Dominica, Curacao, and Grenada) during FY 2016, which fell short of the expected five station visits. Due to scheduling issues, the project chose to visit one extra Pacific station in place of a Caribbean station that are all functioning at full capacity. All tsunami station data underwent daily, monthly, and annual quality assessments, with the final data archived at the UHSLC Fast Delivery and Research Quality datasets.

JIMAR Publications

Author(s) Name	Publication Date	Title	Published In (Journal Name, volume and page number)	Type of Publication	Citation No. or hyperlink	Project Title
Abecassis, M., and J. Polovina	1/26/16	OWCP-Products and applications	CoastWatch Program Meeting, Honolulu, HI, Jan. 26, 2016	Presentation		Ocean Remote Sensing
Abecassis, M., and J. Polovina	4/4/16	OWCP-Products and applications	PIFSC External Review, Honolulu, HI, April 4, 2016	Presentation		Ocean Remote Sensing
Abecassis, M., J. Polovina, R. Baird, A. Copeland, J. Drazen, R. Domokos, E. Oleson, Y. Jia, G. Schorr, D. Webster, and R. Andrews	11/25/15	Characterizing a foraging hotspot for short-finned pilot whales and Blainville's beaked whales located off the west side of Hawai'i Island by using tagging and oceanographic data	PLOS ONE, Nov. 25, 2015	Journal Article	http://dx.doi.org/10.1371/journal.pone.0142628	Ecosystem Modeling
Agustin, A.E., M.A. Merrifield, J.T. Potemra, and C. Morishige	11/11/15	Temporal variability of marine debris deposition at Tern Island in the Northwestern Hawaiian Islands	Mar. Pollut. Bull., 101, 200-207	Journal Article		Seasonal Fluctuations in Pacific Island Marine Debris Deposition
Aires-da-Silva, A. M., M.N. Maunder, K.M. Schaefer, and D.W. Fuller	2015	Improved growth estimates from integrated analysis of direct aging and tag–recapture data: An illustration with bigeye tuna (*Thunnus obesus*) of the eastern Pacific Ocean with implications for management	Fish. Res., 163, 119-126	Journal Article		ADMB Open Source Project
Andrews, A.H., E.E. DeMartini, J.A. Eble, D.C. Lou, B.M. Taylor, and R.L. Humphreys	in press	Age and growth of bluespine unicornfish (*Naso unicornis*): A half-century lifespan for a keystone browser, with a novel approach to bomb radiocarbon dating in the Hawaiian Islands	Can. J. Fish. Aquat. Sci.	Journal Article		Bio-Sampling
Asher, J.M., I.D. Williams, and E.S. Harvey	6/19/16	Roving predators reloaded: An investigation of shark and jack populations in shallow (0-30 m) and mesophotic depths (30-100 m) in the Hawaiian Archipelago	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://sgmeet.com/icrs2016/	Sustaining Healthy Coastal Ecosystems
Ayotte, P., K. McCoy, A. Heenan, I. Williams, and J. Zamzow	12/1/15	Coral Reef Ecosystem Program standard operating procedures: collection for Rapid Ecological Assessment fish surveys	Pacific Islands Fisheries Science Center Administrative Report H-15-07, 36 pp	Report	https://pifsc-www.irc.noaa.gov/library/pubs/admin/PIFSC_Admin_Rep_15-07.pdf	Sustaining Healthy Coastal Ecosystems
Bailey H., D. Swanson, and B. Vargas-Angel	6/20/16	Paterns of coral bleaching in American Samoa	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://sgmeet.com/icrs2016/	Sustaining Healthy Coastal Ecosystems
Bayless, A.R., E.M. Oleson, T. Tran, A. Simonis, and S. Martin	12/14/15	Acoustic monitoring of the Hawaii longline fishery through voluntary trips across the Hawaii longline fleet	21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA, USA, Dec. 13-18, 2015	Presentation		Cetacean Research Program

Bohlander, J.L., M. Barbieri, S. Robinson, and C. Littnan	12/14/15	Persistent organic pollutants (POPs) and hematological values in Hawaiian monk seals (*Neomonachus schauinslandi*)	21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA, USA, Dec. 13-18, 2015	Presentation		Hawaiian Monk Seal Research Program
Brenden, T. O., J.R. Bence, W. Liu, I. Tsehaye, and K.T. Scribner	7/1/15	Comparison of the accuracy and consistency of likelihood-based estimation routines for genetic stock identification	Meth. Ecol. Evol., 6(7), 817-827, July 2015 (online 21 April 2015)	Journal Article	doi: 10.1111/2041-210X.12377	ADMB Open Source Project
Briscoe, D., D. Parker, G. Balazs, M. Kurita, T. Saito, H. Okamoto, M. Rice, J. Polovina, and L. Crowder	6/1/16	Active dispersal in loggerhead sea turtles (*Caretta caretta*) during the 'lost years'	Proc. R. Soc. B 283:20160690, June 1, 2016	Journal Article	http://dx.doi.org/10.1098/rspb.2016.0690	Turtle Research Program
Carvalho, F.	10/23/15	Can diagnostic tests help identify and solve the problem of model structure misspecification?	Center for the Advancement of Population Assessment Methodology (CAPAM) Workshop, La Jolla, CA, USA, Oct. 19-23, 2015	Presentation		Stock Assessment Research Program
Carvalho, F., W. Walsh, and Y.J. Chang	1/20/16	Standardized catch-rates of blue marlin for Taiwanese distant-water longline fishery in the Pacific Ocean for 1964-2010	ISC Billfish Working Group, Honolulu, HI, USA, Jan. 13-20, 2016, ISC/16/BILL-WG-1/5	Workshop Proceedings	http://isc.fra.go.jp/pdf/BILL/ISC16_BILL_1/WP5_Carvalho_final.pdf	Stock Assessment Research Program
Chan H., and M. Pan	2/15/16	Spillover effects of environmental regulation for sea turtle protection in the Hawaii longline swordfish fishery	2016 Western Regional Science Association (WRSA) Annual Meeting, Waikoloa, HI, USA, Feb. 14-17, 2016	Presentation		Economics of Fisheries Initiative
Chan H., and M. Pan	4/25/16	A brochure summarizing 2014 Hawaii small boat survey results	Mailed to 1,767 small boat fishermen who received the Hawaii small boat survey	Presentation		Economics of Fisheries Initiative
Chan H., and M. Pan	6/1/16	Results from the Hawaii small boat survey 2014	123rd Meeting of the Scientific and Statistical Committee, Western Pacific Regional Fishery Management Council, Honolulu, HI, May 31-June 2, 2016	Presentation		Economics of Fisheries Initiative
Chan H., and M. Pan	6/16/16	Does holding a commercial fishing license make a fisherman fishing commercially? A recent study on Hawaii small boat fishery	Scientific Committee on Research (SCOR) meeting, PIFSC, Honolulu, HI, June 16, 2016	Presentation		Economics of Fisheries Initiative
Chan H., and M. Pan	7/1/16	Spillover effects of environmental regulation for sea turtle protection in the Hawaii longline swordfish fishery	Mar. Res. Econ., 31(3), 259-279	Journal Article	http://www.journals.uchicago.edu/doi/full/10.1086/686672	Economics of Fisheries Initiative
Chang, Y.J., B. Langseth, H. Ijima, and M. Kai	3/30/16	Stock assessment update for blue marlin (*Makaira nigricans*) in the Pacific Ocean through 2014	ISC Billfish Working Group, Busan, Korea, March 22-30, 2016, ISC/16/BILLWG-2/1	Workshop Proceedings	http://isc.fra.go.jp/pdf/BILL/ISC16_BILL_2/WP1_Chang_final.pdf	Stock Assessment Research Program

Chang, Y.J.	10/23/15	Comparison of weighting methods for size composition data: A case study for the North Pacific striped marlin stock assessment	Center for the Advancement of Population Assessment Methodology (CAPAM) Workshop, La Jolla, CA, USA, Oct. 19-23, 2015	Presentation		Stock Assessment Research Program
Chang, Y.J., A. Yau, and J. Brodziak	1/13/16	Summary of blue marlin (*Makaira nigricans*) catch and size data from the Western and Central Pacific Fisheries Commission and the Inter-American Tropical Tuna Commission	ISC Billfish Working Group, Honolulu, HI, USA, Jan. 13-20, 2016, ISC/16/BILL-WG-1/4	Workshop Proceedings	http://isc.fra.go.jp/pdf/BILL/ISC16_BILL_1/WP4_Chang_final.pdf	Stock Assessment Research Program
Chowdhury, M.R.	12/2/15	Water, climate, and local governance: Experience from the Pacific Islands	2nd Conference on Water Resource Sustainability Issues on Tropical Islands, Honolulu, HI, USA, Dec. 1-3, 2015	Presentation		Pacific ENSO Applications Center (PEAC)
Chowdhury, M.R.	12/14/15	The variability of ENSO and predictability of seasonal climate: Bangladesh	International Symposium on El Ninõ/La Niña and Climate Variability, Chittagong University of Engineering & Technology (CUET), Bangladesh, Dec. 14, 2015	Presentation		Pacific ENSO Applications Center (PEAC)
Chowdhury, M.R.	5/3/16	Sundarbans fires: Early preparation for disaster mitigation	The Financial Express, http://www.thefinancialexpress-bd.com/2016/05/03/28881/Sundarbans-fires:-Early-preparation-for-disaster-mitigation	Workshop Proceedings	http://www.thefinancialexpress-bd.com/2016/05/03/28881/Sundarbans-fires:-Early-preparation-for-disaster-mitigation	Pacific ENSO Applications Center (PEAC)
Choy, C.A., C. Wabnitz, M. Weijerman, P. Woodworth-Jefcoats, and J. Polovina	5/10/16	Finding the way to the top: How the composition of oceanic mid-trophic micronekton groups determines apex predator biomass in the central North Pacific	Mar. Ecol. Prog. Ser., 549, 9-25, 2016	Journal Article	doi: 10.3354/meps11680	Ecosystem Modeling
Conrad, J., A. Louise, J. Bibian, K.L. Weinersmith, D. De Carion, M.J. Young, P. Crain, E.L. Hestir, M.J. Santos, and A. Sih	2/26/16	Novel species interactions in a highly modified estuary: Association of Largemouth bass with Brazilian waterweed *Egeria densa*	Trans. Am. Fish. Soc., 145(2), 249-263	Journal Article	doi: 10.1080/00028487.2015.1114521	ADMB Open Source Project
Copeland, A., W. Au, A. Bradford, and J. Polovina	4/8/16	Relative abundance of sound scattering organisms in the Northwestern Hawaiian Islands (NWHI) is a driver for some odontocete foragers	41st Annual Albert L. Tester Memorial Symposium, Honolulu, HI, April 6-8, 2016	Presentation		Ecosystem Modeling
Copeland, A., W. Au, A. Bradford, E. Oleson, and J. Polovina	5/24/16	Relative acoustic abundance in the Northwestern Hawaiian Islands (NWHI) is a driver of some odontocete foragers	Acoustical Society of America Spring 2016 Meeting, Salt Lake City, UT, USA, May 23-27, 2016	Presentation		Ecosystem Modeling
Coral Reef Ecosystem Program, Pacific Islands Fisheries Scince Center, NOAA Fisheries	7/16/15	Reef fish surveys main Hawaiian Islands 2015. Fish monitoring brief	Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-15-017, 2 pp	Report	https://pifsc-www.irc.noaa.gov/library/pubs/DR-15-017.pdf	Sustaining Healthy Coastal Ecosystems

Coral Reef Ecosystem Program, Pacific Islands Fisheries Scince Center, NOAA Fisheries	8/20/15	Results Brief: 5 years of protection at Kahekili Herbivore Fisheries Management Area	Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-15-018, 2 pp	Report	https://pifsc-www.irc.noaa.gov/library/pubs/DR-15-018.pdf	Sustaining Healthy Coastal Ecosystems
Coral Reef Ecosystem Program, Pacific Islands Fisheries Scince Center, NOAA Fisheries	4/26/16	Summary report of baseline surveys and installations conducted in 2015 in the National Marine Sanctuary of American Samoa	Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-16-007, 247 pp	Report	doi:10.7289/V5N014J6	Sustaining Healthy Coastal Ecosystems
Ferguson, J.M., F. Carvalho, O. Murillo-Garcia, M.L. Taper, and J.M. Ponciano	1/1/16	An updated perspective on the role of environmental autocorrelation in animal populations	Theoret. Ecol., 9(2), 129-148	Journal Article		Stock Assessment Research Program
Foster, J., T. Ericksen, and J. Avery	12/15/15	A novel new tsunami detection network using GNSS on commercial ships	Eos Trans. AGU Fall Meeting, San Francisco, CA, USA, Dec. 14-18, 2015, Suppl. 2015	Conference Proceedings		University of Hawaii Sea Level Center (Ship-Based Tsunami Detection and Characterization)
Frambach, A., and M.M. Bell	8/6/15	Dual-polarization radar characteristics of convection in Hawaii observed during HERO	16th American Meteorological Society Conference on Mesoscale Processes, Boston, MA, USA, Aug. 2-6, 2015	Presentation		National Weather Service Pacific Region Fellowship Program
González, Edgar J., Carlos Martorell, and Benjamin M. Bolker	2/21/16	Inverse estimation of integral projection model parameters using time series of population-level data	Meth. Ecol. Evol., 7(2), 147-156	Journal Article	doi: 10.1111/2041-210X.12519	ADMB Open Source Project
Gorospe, K.D., I. Williams, A. Heenan, R. Sparks, B. Walsh, P. Murakawa, T. Ogawa, and M. Donahue	6/19/16	Understanding drivers of herbivore abundance to support resilience-based management in Hawaii	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://sgmeet.com/icrs2016/	Sustaining Healthy Coastal Ecosystems
Gove, J., M. McManus, A. Neuhemier, J. Polovina, J., Drazen, C. Smith, M. Merrifield, A. Friedlander, J. Ehses, C. Young, A. Dillon, and G. Williams	2/16/16	Near-island biological hotspot in barren ocean basins	Nature Comm.	Journal Article	http://www.nature.com/ncomms/2016/160216/ncomms10581/full/ncomms10581.html, doi:10. 1038/ncomms10581	Kona Integrated Ecosystem Assessment
Gove, J., M. McManus, A. Neuhemier, J. Polovina, J., Drazen, C. Smith, M. Merrifield, A. Friedlander, J. Ehses, C. Young, A. Dillon, and G. Williams	6/24/16	Ocean oases: Near-island biological hotspot in barren ocean basins	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://www.sgmeet.com/icrs2016/viewabstract.asp?AbstractID=29755	Kona Integrated Ecosystem Assessment
Hamlington, B., P. Thompson, W. Hammond, G. Blewitt, and R. Ray	6/20/16	Assessing the impact of vertical land motion on 20th century global mean sea level estimates	J. Geophys. Res.-Oceans	Journal Article	doi: 10.1002/2016JC011815	The University of Hawaii Sea Level Center
Hamlington, B., S. Cheon, P. Thompson, M. Merrifield, R. Nerem, R. Leben, and K. Kim	5/9/16	An ongoing shift in Pacific Ocean sea level	J. Geophys. Res.-Oceans	Journal Article	doi: 10.1002/2016JC011815	The University of Hawaii Sea Level Center
Heenan, A., A. Hoey, G. Williams, and I. Williams	8/3/15	Monitoring herbivore reef fish for ecosystem resilience and management in the U.S. Pacific	23rd Annual Hawaii Conservation Conference, Hilo, HI, USA, Aug. 3-6, 2015	Presentation	http://www.hawaii-conservation.org/conference/past-conferences/2015-hawaii-conservation-conference	Sustaining Healthy Coastal Ecosystems

Heenan, A., J. Gove, J. Link, J. Polovina, and I. Williams	06/24/16	The trophic fingerprint of coral reef fishes	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://www.sgmeet.com/icrs2016/viewabstract.asp?AbstractID=28901	Kona Integrated Ecosystem Assessment
Heenan, A., J. Gove, J. Link, J. Polovina, F. Pranovi, J. Weijerman, and I. Williams	6/19/16	Using ecosystem properties to detect transitional states in coral reef fish assemblages	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://sgmeet.com/icrs2016/	Sustaining Healthy Coastal Ecosystems
Heenan, A., K. Gorospe, I. Williams, A. Levine, P. Maurin, M. Nadon, J. Rooney, M. Timmers, S. Wongbusarakum, and R. Brainard	3/9/16	Ecosystem monitoring for ecosystem-based management: Using a polycentric approach to balance information trade-offs	J. Appl. Ecol.	Journal Article	http://onlinelibrary.wiley.com/doi/10.1111/1365-2664.12633/epdf	Sustaining Healthy Coastal Ecosystems
Hill, M.C., E.M. Oleson, S. Baumann-Pickering, A.M. VanCise, A.D. Ligon, A.R. Bendlin, A.C. Ü, J.S. Trickey, and A.L. Bradford	2/5/16	Cetacean monitoring in the Mariana Islands Range Complex, 2015	Prepared for the U.S. Pacific Fleet Environmental Readiness Office. PIFSC Data Report DR-16-01, 33 pp + appendix	Report	https://pifsc-www.irc.noaa.gov/library/pubs/DR-16-001.pdf	Cetacean Research Program
Hill, M.C., A.L. Bradford, A.D. Ligon, A.C. Ü, J. Rivers, R.K. Uyeyama, R.L. Brownell Jr., and E.M. Oleson	6/1/16	Are humpback whales (*Megaptera novaeangliae*) breeding and calving in the Mariana Islands?	Report for the 2016 Meeting of the International Whaling Commission Scientific Committee, Bled, Slovenia, June 4-20, 2016, SC/66b/O/02, 9 pp	Report	https://archive.iwc.int/pages/search.php?search=!collection24461&bc_from=themes.SC/66b/O/02	Cetacean Research Program
Hill, M.C., A.R. Bendlin, A.D. Ligon, A.C. Ü, A. Milette-Winfree, M.H. Deakos, and E.M. Oleson	12/14/15	Short-finned pilot whales of the Marianas	21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA, USA, Dec. 13-18, 2015	Presentation		Cetacean Research Program
Hospital, J., K. Kalberg, and T. Tran	10/13/15	2015 Hawaii bigeye tuna closure: Socioeconomic perspectives	121st Meeting of the Scientific and Statistical Committee, Western Pacific Regional Fishery Management Council, Honolulu, HI, Oct. 13-14, 2015	Presentation		Human Dimensions of Fishing and Marine Ecosystems in the Western Pacific
Ingram, R., K. Oelson, and J. Gove	6/24/16	Using conceptual ecosystem modeling to support ecosystem-based management in West Hawai'i	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://www.sgmeet.com/icrs2016/viewabstract.asp?AbstractID=29542	Kona Integrated Ecosystem Assessment
Jardim, E., C.P. Millar, I. Mosqueira, F. Scott, G.C. Osio, M. Ferretti, N. Alzorriz, and A. Orio	2015	What if stock assessment is as simple as a linear model? The a4a initiative	ICES Journal of Marine Science: Journal du Conseil, 72, 1, 232-236	Journal Article	doi: 10.1093/icesjms/fsu050	ADMB Open Source Project
Johnson, G.C., J.M. Lyman, and N.G. Loeb	6/23/16	Improving estimates of Earth's energy imbalance	Nature Clim. Change, 6, 7, 639-640	Journal Article	doi: 10.1038/nclimate3043	Profiling CTD Float Array Implementation and Ocean Climate Research
Johnson, G.C., J.M. Lyman, and S.G. Purkey	11/25/15	Informing deep Argo array design using Argo and full-depth hydrographic section data	J. Atmos. Oceanic Tech., 32, 11, 2187–2198	Journal Article	doi: 10.1175/JTECH-D-15-0139.1	Profiling CTD Float Array Implementation and Ocean Climate Research
Johnson, G.C., J.M. Lyman, G.S.E. Lagerloef, and H.Y. Kao	8/6/15	Global Oceans: Sea surface salinity [in: "State of the Climate in 2014"]	Bull. Am. Meteorol. Soc., 96, 7, S71–S74	Journal Article	doi: 10.1175/2015BAMS Stateofthe Climate.1	Profiling CTD Float Array Implementation and Ocean Climate Research

Johnson, G.C., J.M. Lyman, J. Antonov, N. Bindoff, T. Boyer, C.M. Domingues, S.A. Good, M. Ishii, and J.K. Willis	8/6/15	Global Oceans: Ocean heat content [in: "State of the Climate in 2014"]	Bull. Am. Meteorol. Soc., 96, 7, S64–S66, S68	Journal Article	doi: 10.1175/2015BAMS Stateofthe Climate.1	Profiling CTD Float Array Implementation and Ocean Climate Research
Johnson, K.F., C.C. Monnahan, C.R. McGilliard, K.A. Vertpre, S.C. Anderson, C.J. Cunningham, F. Hurtado-Ferro, R. Licandeo, M. Muradian, K. Ono, C.S. Szuwalski, J.L. Valero, A.R. Whitten, and A.E. Punt	2015	Time-varying natural mortality in fisheries stock assessment models: identifying a default approach	ICES J. Mar. Sci., 72(1), 137-150	Journal Article	doi: 10.1093/icesjms/fsu055	ADMB Open Source Project
Jonsen, Ian	2/8/16	Joint estimation over multiple individuals improves behavioural state inference from animal movement data	Sci. Rep. 2016, 6, 20625	Journal Article	doi: 10.1038/srep/20625	ADMB Open Source Project
Kaufman, A., M. Barbieri, S. Robinson, J. Baker, and C. Littnan	12/14/15	Establishing hematology and serum chemistry reference ranges for wild Hawaiian monk seals	21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA, USA, Dec. 13-18, 2015	Conference Proceedings		Hawaiian Monk Seal Research Program
Kelley, C., S. France, F. Parrish, D. Wagner, M. Gerringer, and M. Garcia	2016	CAPSTONE's First Year: 2015 Hohonu Moana: Exploring Deep Waters off Hawai'i Expedition	In Oceanography, Supplement: New Frontiers in Ocean Exploration: The E/V Nautilus and NOAA Ship Okeanos Explorer 2015 Field Season, vol 29, number 1	Journal Article	http://dx.doi.org/10.5670/oceanog.2016.supplement.01	Scientific Advice and Coordination for NOAA Office of Ocean Exploration and Research's 2015-2016 "CAPSTONE" Operations in the Pacific
Kelley, C.D., T. Kerby, P.M. Sarradin, J. Sarazin, and D. Lindsay	2016	Chapter 13: Submersibles and remotely operated vehicles	Clark, Consalvey, and Rowden (eds.), Biological Sampling in the Deep Sea, John Wiley and Sons	Report		Pacific Islands Deep Sea Coral and Sponge Initiative
Kramer, K.L., S.P. Cotton, M.R. Lamson, and W. J. Walsh	06/24/16	Bleaching and catastrophic mortality of reef-building corals along West Hawai'i Island: Findings and future directions	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://www.sgmeet.com/icrs2016/viewabstract.asp?AbstractID=29019	Kona Integrated Ecosystem Assessment
Langseth, B., and E. Fletcher	1/20/16	Size composition for blue marlin (*Makaira nigricans*) in the Hawaii-based pelagic longline fishery, 1994-2014	ISC Billfish Working Group, Honolulu, HI, USA, Jan. 13-20, 2016, ISC/16/BILL-WG-1/9	Workshop Proceedings	http://isc.fra.go.jp/pdf/BILL/ISC16_BILL_1/WP9_Langseth_final.pdf	Stock Assessment Research Program
Legler, D.M., H.J. Freeland, R. Lumpkin, G. Ball, M.J. McPhaden, S. North, R. Crowley, G.J. Goni, U. Send and M.A. Merrifield	10/14/15	The current status of the real-time in situ Global Ocean Observing System for operational oceanography	J. Operat. Ocean., 8:sup2, s189-s200	Journal Article	http://dx.doi.org/10.1080/1755876X.2015.1049883	The University of Hawaii Sea Level Center
Ludert, Alejandro	2015	Pacific Region ENSO update and seasonal outlook	Special Seminars at NOAA Inouye Regional Center, Honolulu, HI. Seminars held on Nov. 6, 2015, Feb. 5, 2016, and June 9, 2016	Presentation		Pacific ENSO Applications Center (PEAC)

McCoy K., A. Heenan, J. Asher, P. Ayotte, K. Gorospe, A. Gray, K. Kino, J. Zamzow, and I. Williams	3/4/16	Pacific Reef Assessment and Monitoring Program. Data report : ecological monitoring 2015 : reef fishes and benthic habitats of the main Hawaiian Islands, Northwestern Hawaiian Islands, Pacific Remote Island Areas, and American Samoa	Pacific Islands Fisheries Science Center, PIFSC Data Report DR-16-002, 94 pp	Report	doi: 10.7289/V5G73BQJ	Sustaining Healthy Coastal Ecosystems
McCoy, K.	8/3/15	A more accurate estimate of catch and production of nearshore fish	23rd Annual Hawaii Conservation Conference, Hilo, HI, USA, Aug. 3-6, 2015	Presentation	http://www.hawaiiconservation.org/conference/past-conferences/2015-hawaii-conservation-conference	Sustaining Healthy Coastal Ecosystems
McCoy, K., A. Friedlander, I. Williams, J. Kittinger, and L. Teneva	6/19/16	Estimating nearshore fisheries catch for the main Hawaiian Islands	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://sgmeet.com/icrs2016/	Sustaining Healthy Coastal Ecosystems
Mercer, T., K. Gobush, J. Henderson, B. Becker, and C. Littnan	12/18/15	Impacts of nearshore fisheries on monk seals in the Main Hawaiian Islands	21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA, USA, Dec. 13-18, 2015	Presentation		Hawaiian Monk Seal Research Program
Meyer, C., J. Anderson, D. Coffey, M. Hutchinson, M. Royer, and K. Holland	5/1/16	Spatial dynamics of tiger sharks (Galeocerdo cuvier) around Maui and Oahu	Report to the Hawaii Department of Land and Natural Resources	Report	http://dlnr.hawaii.gov/dar/files/2016/05/Maui_tiger_shark_spatial_dynamics_final.pdf	Fishing Impacts on Non-target Species
Misa, W.F.X.E., B.L. Richards, G.T. DiNardo, C.D. Kelley, V.N. Moriwake, and J.C. Drazen	3/2/16	Evaluating the effect of soak time on bottomfish abundance and length data from stereo-video surveys	J. Exper. Mar. Biol. Ecol., 479, 20-34	Journal Article	doi: 10.1016/j.jembe.2016.03.001	Ecosystem Observations and Research Program
Moews-Asher, M.A., M. Abbey, R.E. Brainard, S. Capezzuoli, S. Funge-Smith, R. Gregory, C. Grose, R. Hermes, R. Pomeroy, D. Staples, and S. Wongbusarakum	6/20/16	Ecosystem Approach to Fisheries Management for Leaders, Executives and Decision Makers (LEAD)	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Conference Proceedings	https://sgmeet.com/icrs2016/viewabstract.asp?AbstractID=29074	International Ecosystem Approach to Fisheries Management Project
Nadon, M.O.	6/24/16	Assessment of data-poor fish populations using a stepwise approach to estimate life history parameters	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://sgmeet.com/icrs2016/	Stock Assessment Research Program
Nadon, M.O. and J.S. Ault	in press	A stepwise stochastic simulation approach to estimate life history parameters for data-poor fisheries	Can. J. Fish. Aqu. Sci.	Journal Article		Stock Assessment Research Program
Nadon, M.O., J.S. Ault, I.D. Williams, S.G. Smith, and G.T. DiNardo	8/12/15	Length-based assessment of coral reef fish populations in the Main and Northwestern Hawaiian Islands	PLoS ONE, 10,8, e0133960. doi: 10.1371/journal.pone.0133960	Journal Article	http://dx.doi.org/10.1371/journal.pone.0133960	Stock Assessment Research Program
Newman, S.J., A.J. Williams, C.B. Wakefield, S.J. Nicol, B.M. Taylor, and J.M. O'Malley	in press	Review of the life history characteristics, ecology and fisheries for deep-water tropical demersal fish in the Indo-Pacific region	Rev. Fish Biol Fisher.	Journal Article	doi: 10.1007/s11160-016-9442-1	Bio-Sampling

Oki, K., A. Toshimitsu, and D. Parker	3/1/16	Satellite tracking of loggerhead sea turtles and green sea turtle in Amami Island	36th Annual Symposium on Sea Turtle Biology and Conservation, East Asia Regional Meeting, Lima, Perú, Feb. 29-March 4, 2016	Presentation		Turtle Research Program
Oleson, E.M., A. Širović, L.M. Munger, P. Fisher-Pool, K.P. Merkens, M.C. Hill, and A.D. Ligon	12/14/15	Acoustic monitoring reveals the seasonal occurrence of five species of baleen whales in the Marianas Archipelago	21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA, USA, Dec. 13-18, 2015	Presentation		Cetacean Research Program
Ono, K., R. Licandeo, M.L. Muradian, C.R. Cunningham, S.C. Anderson, F. Hurtado-Ferro, K.F. Johnson, C.F. McGilliard, C.F. Monnahan, C.S. Szuwalski, J.L. Valero, K.A. Vert-pre, A.R. Whitten, and A.E. Punt	2015	The importance of length and age composition data in statistical age-structured models for marine species	ICES J. Mar. Sci., 72, 1, 31-43	Journal Article		ADMB Open Source Project
Ortiz, N., J. Mangel, J. Wang, J. Alfaro-Shigueto, S. Pingo, A. Jimenez, T. Suarez, Y. Swimmer, F. Carvalho, and B.J. Godley	3/1/16	Reducing green turtle bycatch in small-scale fisheries using illuminated gillnets: the cost of saving a sea turtle	Mar. Ecol. Progr. Ser., 545, 251-256	Journal Article	doi: 10.3354/meps11610	Sea Turtle Bycatch Mitigation Research
Parker, D.	2/29/16	Partnership overview of Southern Hemisphere loggerhead satellite tracking between 2007 and 2014	36th Annual Symposium on Sea Turtle Biology and Conservation, East Asia Regional Meeting, Lima, Perú, Feb. 29-March 4, 2016	Presentation		Turtle Research Program
Parker, D., G. Balazs, E. Kabua, M. Langidrik., K. Frutchey, and K. Botok	10/31/15	Conservation considerations revealed by the movements of post-nesting green turtles from the Republic of the Marshall Islands	Micronesica, 2015, 03, 1-9	Journal Article	https://pifsc-www.irc.noaa.gov/library/pubs/Parker_etal_Micronesica_2015.pdf	Turtle Research Program
Parker, D., G. Balazs, S. Kolinski, J. Cruce, and K. Frutchey	3/2/16	Western Pacific Green Turtles: International ambassadors	36th Annual Symposium on Sea Turtle Biology and Conservation, East Asia Regional Meeting, Lima, Perú, Feb. 29-March 4, 2016	Presentation		Turtle Research Program
Priest, M.A., J.D. DiBattista, J.L. McIlwain, B.M. Taylor, N.E. Hussey, and M.L. Berumen	4/1/16	A bridge too far: Dispersal barriers and cryptic speciation in an Arabian Peninsula grouper (*Cephalopholis hemistiktos*)	J. Biogeogr., 43, 820-832	Journal Article	http://onlinelibrary.wiley.com/doi/10.1111/jbi.12681/full	Bio-Sampling
Reitan, Trond, and Anders Nielsen	2/12/16	Do not divide count data with count data: A story from pollination ecology with implications beyond	PLoS ONE,11, 2, e0149129, doi:10.1371/journal.pone.0149129	Journal Article	http://dx.doi.org/10.1371/journal.pone.0149129	ADMB Open Source Project
Rhodes, K.L., B.M. Taylor, D. Hernandez-Ortiz, and J. Cuetos-Bueno	5/1/16	Growth and reproduction of the highfin grouper *Epinephelus maculatus*	J. Fish Biol., 88, 1856-1869	Journal Article	http://onlinelibrary.wiley.com/wol1/doi/10.1111/jfb.12953/abstract	Bio-Sampling

Richards, B.L., S.G. Smith, J.S. Ault, G.T. DiNardo, D. Kobayashi, R. Domokos, J. Anderson, J. Taylor, W. Misa, L. Giuseffi, A. Rollo, D. Merritt, J.C. Drazen, M.E. Clarke, and C. Tam	6/7/16	Design and implementation of a bottomfish fishery-independent survey in the Main Hawaiian Islands	U.S. Dept. Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-53, 54 pp	Report	doi: 10.7289/V5RR1W87	Ecosystem Observations and Research Program
Richards, R.A., and L.D. Jacobson	2016	A simple predation pressure index for modeling changes in natural mortality: Application to Gulf of Maine northern shrimp stock assessment	Fish. Res., 179, 224-236	Journal Article		ADMB Open Source Project
Schumacher, B.D.	3/9/16	CoralNet: A user's perspective	WACV 2016: IEEE Winter Conference on Applications of Computer Vision, Lake Placid, NY, USA, March 7-9, 2016	Presentation		Sustaining Healthy Coastal Ecosystems
Schumacher, B.D.	6/20/16	Multi-factor analysis of resilience potential of coral reefs in the Main Hawaiian Islands, based on data from the NOAA Coral Reef Ecosystem Program	13th International Coral Reef Symposium, Honolulu, HI, June 19-24, 2016	Presentation	https://sgmeet.com/icrs2016/	Sustaining Healthy Coastal Ecosystems
Shimada, T., C. Limpus, R. Jones, J. Hazel, R. Groom, and M. Hamann	1/8/16	Sea turtles return home after intentional displacement from coastal foraging areas	Mar. Biol., 163(8), 1-14	Journal Article	doi: 10.1007/s00227-015-2771-0	ADMB Open Source Project
Sibert, John	3/10/16	Feasibility of developing a stock assessment model for Main Hawaiian Islands yellowfin tuna fishery - Part Two	122nd Meeting of the Scientific and Statistical Committee, Western Pacific Regional Fishery Management Council, Honolulu, HI, Mar. 8-10, 2016	Presentation		ADMB Open Source Project
Sullivan, M., S. Robinson, and C. Littnan	12/18/15	#Monkseal: Social media as a tool for science, conservation, and public relations for Hawaiian monk seals	21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA, USA, Dec. 13-18, 2015	Presentation		Hawaiian Monk Seal Research Program
Sundberg, M., R. Humphreys, M.K. Lowe, E. Cruz, J. Gourley, and D. Ochavillo	12/1/15	Status of life history sampling conducted through the commercial fisheries bio-sampling programs in the western Pacific Territories of American Samoa and Guam and in the Commonwealth of the Northern Mariana Islands	Pacific Islands Fisheries Science Center Administrative Report H-15-08, 56 pp	Report	doi: 10.7289/V5XD0ZP5	Bio-Sampling
Swanson, D.	8/21/15	Pacific Reef Assessment and Monitoring Program. Benthic monitoring summary: Pacific Remote Island Areas (PRIAs) 2015	Pacific Islands Fisheries Science Center, PIFSC Data Report, DR 15-014, 3 pp	Report		Sustaining Healthy Coastal Ecosystems
Swanson, D.	8/21/15	Pacific Reef Assessment and Monitoring Program. Benthic monitoring summary: American Samoa 2015	Pacific Islands Fisheries Science Center, PIFSC Data Report, DR 15-015, 3 pp	Report		Sustaining Healthy Coastal Ecosystems

Swanson, D.	6/23/16	Quantitative assessment of ESA coral populations and the application of resource selection theory	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://sgmeet.com/icrs2016/	Sustaining Healthy Coastal Ecosystems
Sweeney, J., H. Howitt, H. Chan, M. Pan, and P. Leung	9/21/15	How do fishery policies affect Hawaii's longline fishery? Calibrating a positive mathematical programming model	Seminar in Energy and Environmental Policy, Economics Department, UH Manoa, Honolulu, HI, Sept. 30, 2015	Presentation		Economics of Fisheries Initiative
Sweeney, J., H. Howitt, H. Chan, M. Pan, and P. Leung	2/15/16	How do fishery policies affect Hawaii's longline fishery? Calibrating a positive mathematical programming model	2016 Western Regional Science Association (WRSA) Annual Meeting, Waikoloa, HI, USA, Feb. 14-17, 2016	Presentation		Economics of Fisheries Initiative
Sweeney, J., H. Howitt, H. Chan, M. Pan, and P. Leung	2/18/16	How do fishery policies affect Hawaii's longline fishery?	Ecosystem Sciences Division Brown Bag Seminar, at NOAA Inouye Regional Center, Honolulu, HI, Feb. 18, 2016	Presentation		Economics of Fisheries Initiative
Sweeney, J.	6/23/16	Estimating supply and demand elasticity for fish: An evaluation of welfare effects from price stabilization	Ecosystem Sciences Division Brown Bag Seminar, at NOAA Inouye Regional Center, Honolulu, HI, June 23, 2016	Presentation		Economics of Fisheries Initiative
Szuwalski, C., M. Castrejon, D. Ovando, and B. Chasco	2016	An integrated stock assessment for red spiny lobster (Panulirus penicillatus) from the Galapagos Marine Reserve	Fish. Res., 177, 82-94	Journal Article		ADMB Open Source Project
Taylor, B.M., M. Kapur, M.L. Berumen, E.E. DeMartini, A.S. Hoey, S.J. Newman, T.A. Oliver, M.A. Priest, T. Sinclair-Taylor, C.B. Wakefield, and J.H. Choat	6/21/16	Global patterns of life-history variation reveal hierarchical importance of environmental drivers in widespread coral reef fishes	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://sgmeet.com/icrs2016/	Bio-Sampling
Tsehaye, I., T. Brenden, J. Bence, W. Liu, K. Scribner, J. Kanefsky, K. Bott, and R. Elliot	2016	Combining genetics with age/length data to estimate temporal changes in year-class strength of source populations contributing to mixtures	Fish. Res., 173(3), 236-249	Journal Article		ADMB Open Source Project
Van Houtan, K., D. Francke, S. Alessi, T. Jones, S. Martin, L. Kurpita, C. King, and R. Baird	2/4/16	The developmental biogeography of hawksbill sea turtles in the North Pacific	Ecol. Evol., 6(8), 2378-2389	Journal Article	doi: 10.1002/ece3.2034	Turtle Research Program
Vargas-Angel, B.	5/16/16	Land-based pollution impacting coral reefs in Vatia Bay	NOAA Fisheries Pacific Islands Fisheries Science Center, PIFSC, Special Publication, SP-16-001	Report	doi:10.7289/V5BZ6417	Sustaining Healthy Coastal Ecosystems
Vargas-Angel, B.	6/22/16	Determining the effectiveness of watershed management activities to reduce land-based pollution obn West Maui	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://sgmeet.com/icrs2016/	Sustaining Healthy Coastal Ecosystems

Vargas-Angel, B., C. Richards, P. Vroom, N. Price, T. Schils, C. Young, J. Smith, M. Johnson, and R. Brainard	12/7/15	Baseline assessment of net calcium carbonate accretion rates on U.S. Pacific reefs	PLoS One	Journal Article	http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0142196	Sustaining Healthy Coastal Ecosystems
Venegas, R.	6/20/16	Coral Triangle fisheries vulnerability in a changing climate: Skipjack tuna thermal spawning habitats	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Conference Procedings	https://sgmeet.com/icrs2016/viewabstract.asp?AbstractID=29529	International Ecosystem Approach to Fisheries Management Project
Wagner, D., and C. Kelley	5/24/16	The largest sponge in the world?	Mar. Biodiver., 2016	Journal Article	doi: 10.1007/s12526-016-0508-z	Pacific Islands Deep Sea Coral and Sponge Initiative
Wenger, A.S., J. Whinney, B.M. Taylor, and F. Kroon	in press	The impact of individual and combined abiotic factors on daily otolith growth in a coral reef fish	Nature Sci. Rept.	Journal Article		Bio-Sampling
Williams, I.D., R.T. Sparks, D.J. White, K.C. Lino, and E.L. Kelly	6/19/16	Impacts of 6 years of herbivore protection at Kahekili Herbivore Fisheries Management Area (KHFMA), Maui	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://sgmeet.com/icrs2016/	Sustaining Healthy Coastal Ecosystems
Wongbusarakum, S., J. Link, M. Fogarty, R. Pomeory, and L. Adrianto	6/20/16	Ecosystem based management of coral reef fisheries	13th International Coral Reef Symposium, Honolulu, HI, USA, June 19-24, 2016	Presentation	https://www.sgmeet.com/icrs2016/sessionschedule.asp?SessionID=61	International Ecosystem Approach to Fisheries Management Project
Xu, X., E. Cantoni, J.M. Fleming, and C. Field	2015	Robust state space models for estimating fish stock maturities	Can. J. Stat., 43(1), 133-150			ADMB Open Source Project
Yoklavich, M., M.E. Clarke, T. Laidig, E. Fruh, L. Krigsman, J. Anderson, J. Taylor, and C. Romsos	3/22/16	A characterization of deep-sea coral and sponge communitites in areas of high bycatch in bottom trawls off northern California	NOAA Fisheries Southwest Fisheries Science Center, SWFSC, NOAA-TM-NMFS-SWFSC-556	NOAA Technical Memorandum	doi: 10.7289/V5/TM-SWFSC-556	Ecosystem Observations and Research Program
Young, C.N., J. Carlson, M. Hutchinson, D. Kobayashi, C. McCandless, M.H. Miller, S. Teo, and T. Warren	4/1/16	Status review report: common thresher shark (Alopias vulpinus) and bigeye thresher shark (Alopias superciliosus). Final report to National Marine Fisheries Service, Office of Protected Resources	NOAA National Marine Fisheries Service, March 2016, 199 pp	Report	http://www.fpir.noaa.gov/Library/PRD/common_thresher_shark/Status_Review_Report_of_Common_and_Bigeye_Thresher_Sharks.pdf	Fishing Impacts on Non-target Species

Appendix I List of Acronyms

ACL	Annual Catch Limit
ACT	Annual Catch Target
AD	Automatic Differentiation
ADCP	Acoustic Doppler Current Profiler
ADD	Acoustic Deterrent Devices
ADMB	Automatic Differentiation Model Builder
AIASI	Automated Image Analysis Strategic Initiative
APASEEM	Asia Pacific Academy of Science Education, and Environmental Management
APDRC	Asia-Pacific Data Research Center
APEX	Oracle Application Express
AR5	Fifth Assessment Report
ARL	Air Resources Laboratories
ARMS	Autonomous Reef Monitoring Structure
ARSHSL	Archive of Rapidly-Sampled Hawaiian Sea Level
ASCRMP	American Samoa Coral Reef Monitoring Program
ASRAMP	American Samoa Reef Assessment and Monitoring Program
AUV	Autonomous Underwater Vehicle
AVHRR	Advanced Very High Resolution Radiometer
AVISO	Archiving, Validation, and Interpretation of Satellite Oceanographic Data
AWIPS	Advanced Weather Interactive Processing System
BCHP	Barbless Circle Hook Project
BET	Big Eye Tuna
BFAR	Philippines Bureau of Fisheries and Aquatic Resources
BMUs	Bioerosion Monitoring Units
BOEM	Bureau of Energy Management
BotCam	Bottomfish video Camera
BRT	Bycatch Reduction Technology
BRUVS	Baited Remote Underwater Video Station
CAPAM	Center for the Advancement of Population Assessment Methodology
CAPSTONE	Campaign to Address Pacific Monument Science, Technology, and Ocean Needs
CAU	Calcification Acidification Units
CBSFA	Community-Based Subsistence Fishing Area Program in Hawai‘i
CCD	Census County Division
CCMA	Center for Coastal Monitoring and Assessment

CEM	Conceptual Ecosystem Model
CFS	Coupled Forecast System
CIE	Center for Independent Experts
CIYN	Cetaceans in Your Neighborhood
CMIP5	Coupled Model Intercomparison Project Phase 5
CNMI	Commonwealth of the Northern Mariana Islands
CO-OPS	Center for Operational Oceanographic Products and Services
CoRIS	Coral Reef Information System
CPCe	Coral Point Count for Excel
CPUE	Catch Per Unit Effort
CRCP	Coral Reef Conservation Program
CREP	Coral Reef Ecosystem Program
CRP	Cetacean Research Program
CT	Coral Triangle
CSVI	Hawaii Community Social Vulnerability Indices
CTD	Conductivity-Temperature-Depth
CTI-CFF	Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security
DAR	State of Hawaii Division of Aquatic Resources
DARRP	Damage Assessment Remediation and Restoration Program
DAS	Department of Atmospheric Sciences
DAWR	Division of Aquatic and Wildlife Resources (Guam)
DENR-BMB	Philippines Department of Environment and Natural Resources, Biodiversity Management Bureau
DFW	Division of Fish and Wildlife (CNMI)
DLNR	Department of Land and Natural Resources
DLNR-DAR	Department of Land and Natural Resources - Division of Aquatic Resources
DM	Data Management
DMIP	Data Management Improvement Plan
DMWR	Department of Marine and Wildlife Resources (American Samoa)
DNA	Deoxyribonucleic Acid
DODS	Distributed Ocean Data System
DSCRTP	Deep Sea Coral Research and Technology Program
E-EAFM	Essentials Ecosystem Approach to Fisheries Management
EAFM	Ecosystem Approach to Fisheries Management
EAFM LEAD	Ecosystem Approach to Fisheries Management for Leaders Executives and Decision Makers
ECC	Exploration Command Center

ECOFISH	Ecosystems Improved for Sustainable Fisheries Project
EEZ	Exclusive Economic Zone
EK60	split-beam echo sounder
EKE	Eddy Kenetic Energy
EM	Electronic Monitoring
ENIO	Equatorial and Northern Indian Ocean
ENSO	El Niño Southern Oscillation
EOP	Ecosytems and Oceanography Program
EORP	Ecosystems Observations and Research Program
ER	Electronic Reporting
ERDDAP	Environmental Research Division Data Access Platform
ESA	Endangered Species Act
ESD	Ecosystem Sciences Division
EX	Okeanos Explorer
FFS	French Frigate Shoals
FMP	Fishery Management Plan
FOT	Final Outturn
FP	Fibropapillomatosis
FRMD	Fisheries Research and Monitoring Division
FSWP	Fishery Statistics of the Western Pacific
FUS	Fisheries of the United States
FY	Fiscal Year
G&G	Geology and Geophysics
GCOS	Global Climate Observing System
GDS	GrADS DODS Server
GEOSS	Global Earth Observation System of Systems
GES	Global Environmental Science
GIS	Geographic Information System
GLOSS	Global Sea Level Observing System
GMSL	Global Mean Sea Level
GNSS	Global Navigation Satellite System
GNOME	General NOAA Operational Modeling Environment
GPS	Global Positioning System
GrADS	Grid Analysis and Display System
GTS	Global Telecommunications System
GUI	Graphic User Interface

HAR	Hawaii Administrative Rules
HARAMP	Hawaiian Islands Reef Assessment and Monitoring Program
HARP	High-frequency Acoustic Recording Package
HFA	Habitat Blueprint Focus Area
Hg0	Elemental Mercury
HgP	Particulate Mercury
HIC	Hawaii Information Consortium
HICEAS	Hawaiian Islands Cetacean Ecosystem Assessment Survey
HIMB	Hawaii Institute of Marine Biology
HLF	Hawaii Longline Fishery
HMRG	Hawaii Mapping Research Group
HMS	Hawaiian Monk Seal
HMSRP	Hawaiian Monk Seal Research Program
HRPT	High Resolution Picture Transmission
HURL	Hawaii Undersea Research Laboratory
IACUC	Institutional Animal Care & Use Committee
IATTC	Inter-American Tropical Tuna Commission
ICRMP	Integrated Coral Reef Monitoring Program
ICRS	International Coral Reef Symposium
IEA	Integrated Ecosystem Assessment
IEAFM	International Ecosystem Approach to Fisheries Management
iFIMS	Integrated Fisheries Information Management System
InPort	Information Portal
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
IT	Information Technology
IUCN	International Union for Conservation of Nature and Natural Resources
IUCN WCC	International Union for Conservation of Nature and Natural Resources World Conservation Conference
IWLS	Integrated Water Level Service
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
JDBC	Java Database Connectivity
JIMAR	Joint Institute for Marine and Atmospheric Research
JSON	Java Script Object Notation

KBA	Key Biodiversity Areas
LAS	Live Access Server
LBSP	Land-Based Sources of Pollution
LEAD	Leaders, Executives and Decision-Makers
LED	Light-Emitting Diode
LHP	Life History Program
LSS	Life Support System
MAPCO2	Moored Autonomous pCO2 System
MARAMP	Marianas Archipelago Reef Assessment Monitoring Program
MC	Micronesian Challenge
MDP	Marine Debris Program
MHI	Main Hawaiian Islands
MLO	Mauna Loa Observatory
MMPA	Marine Mammal Protection Act
MOUSS	Modular Underwater Stereoscopic System
MPA	Marine Protected Areas
M.S.	Master of Science
MTBAP	Marine Turtle Biology and Assessment Program
NAF	North Atlantic Format
NASA	National Aeronautics and Space Administration
NCEAS	National Center for Ecological Analysis and Synthesis
NCEI	National Centers for Environmental Information
NCRMP	National Coral Reef Monitoring Program
NESDIS	National Environmental Satellite, Data, and Information Service
NIST	National Institute of Standards and Technology
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
Non-USAPI	Non-U.S. Affiliated Pacific Islands (Nauru, Honiara, Funafuti, Penrhyn, Kanton, Christmas, Rarotonga, Papeete, and Rikitea)
NOS	National Ocean Service
NSF	National Science Foundation
NWHI	Northwestern Hawaiian Islands
NWS	National Weather Service
OAR	Office of Oceanic and Atmospheric Research
OCC	Ocean and Climate Change
ODBC	Developer and Open DataBase Connectivity

OER	Office of Ocean Exploration and Research
OFRS	Online Fishing Reporting System
OGL	Ocean Genomic Legacy
OLE	Office of Law Enforcement, NOAA
OPeNDAP	Open-source Project for a Network Data Access Protocol
OTDPS	Oracle Turtle Data Processing System
OWCP	OceanWatch-Central Pacific
PacIOOS	Pacific Islands Ocean Observing System
PaCIS	Pacific Climate Information System
PACOM	Pacific Command
PARR	Public Access to Research Results
PDF	Portable Document Format
PEAC	Pacific ENSO Applications Climate Center
PI	Principal Investigator
PICSC	Pacific Islands Climate Science Center
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 Observer Program
PLOS	Public Library of Science
PMEL	Pacific Marine Environmental Laboratory
PMNM	Papahānaumokuākea Marine National Monument
PRD	Protected Resources Division
PRECI	Protected Resources Environmental Compliance Initiative
PRIMNM	Pacific Remote Islands Marine National Monument
PRSN	Puerto Rico Seismic Network
PSD	Protected Species Division
PTWC	Pacific Tsunami Warning Center
PYSO	PIFSC Young Scientist Opportunity
QC	Quality Control
RV	Research Vessel
RAMP	Reef Assessment and Monitoring Program
RDMA	Regional Development Mission of Asia
REA	Rapid Ecological Assessment
REST	Representational State Transfer

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
SAFE	Stock Assessment and Fishery Evaluation
SAP	Stock Assessment Program
SCADA	Supervisory Control and Data Acquisition
SE	NOAA research vessel Oscar Elton Sette
SEAFDEC	Southeast Asia Fisheries Development Center
SEAPODYM	Spatial Ecosystem and Population Dynamics Model
SEM	Socioeconomic Monitoring
SFD	Sustainable Fisheries Division
SFI	Sustainable Fisheries Initiative
S-K	Saltonstall-Kennedy
SLR	Sea Level Rise
SNAPP	Science for Nature and People Program
SOD	Science Operations Division
SOEST	School of Ocean and Earth Science and Technology
SPAT	Survival Pop-off Archival Tag
SPC	Secretariat of the Pacific Community
SPTT	South Pacific Tuna Treaty
SQL	Structured Query Language
SSF	Small-scale Fisheries
SSH	Sea Surface Height
SSRI	Social Science Research Institute
SSTP	Survey and Sampling Technologies Program
STCZ	Subtropical Convergence Zone
STR	Subsurface Temperature Recorder
SWFSC	Southwest Fisheries Science Center
SWL	Still Water Level
SWS	SeaWater System
TDS	THREDDS-DODS Server
THREDDS	Thematic Real-time Environmental Distributed Data Services
TIGA	Tide Gauge Benchmark Monitoring Project

TMB	Template Model Builder
TMMC	The Marine Mammal Center
ToT	Training of Trainers
TRP	Turtle Research Program
TSI	Territorial Science Initiative
TWL	Total Water Level
TZCF	Transition Zone, Convergence Front
UCLA	University of California Los Angeles
UH	University of Hawaii
UHDAS	University of Hawaii Data Acquisition System
UHM	University of Hawaii at Manoa
UHSLC	University of Hawaii Sea Level Center
UK	United Kingdom
UL	Unloading and Transshipment Logsheets
US	United States
USAID	United States Agency for International Development
USAPI	United States Affiliated Pacific Islands(Guam, Palau, Yap, Pohnpei, Majuro, Kwajalein, and Pago Pago)
USCRTF	U.S. Coral Reef Taskforce
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VIIRS	Visible Infrared Imaging Radiometer Suite
VARS	Video Annotation and Reference System
VFP	Visual Fox Pro
VMS	Vessel Monitoring System
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean
WESTPAC	Western Pacific
WHOI	Woods Hole Oceanographic Institution
WHOTS	WHOI Hawaii Ocean Time-series Station
WPacFIN	Western Pacific Fisheries Information Network
WPRFMC	Western Pacific Regional Fishery Management Council
WPSAR	Western Pacific Stock Assessment Review
WV2	WorldView 2
XML	Extensible Markup Language

Appendix II List of Awards and Related Amendment Numbers

JOINT INSTITUTE FOR MARINE AND ATMOSPHERIC RESEARCH (JIMAR)
COOPERATIVE AGREEMENT NA11NMF4320128 (and NA15NMF4320128*)
List of Projects described in the Annual Report for the period: July 1, 2015-June 30, 2016

TITLE	NOAA Technical Lead/Sponsor	Amendment Numbers(s)
A Biogeographic Assessment of Reef Fishes, Fisheries, and Benthic Assemblages in Hawaii	Matt Kendall	108
ADMB Open Source Project	Michael Seki	24, 74, 109, 147
Bio-Sampling	Michael Seki	9, 52, 101, 140
Cetacean Research Program	Michael Seki	28, 47, 78, 98, 142
Characterization & Dynamics of Mesoscale and Submesoscale Oceanic Variability in the Solomon Sea Simulated by a Nested ROMS Model	Christopher Sabine	62, 87, 114, 151
Economics of Fisheries Initiative	Michael Seki	18, 46, 85, 146
Ecosystem Modeling	Michael Seki	22, 68, 81, 129
Ecosystems Observations and Research Program	Michael Seki	10, 63, 102, 148
Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center (IPRC)	Howard Diamond	39, 65, 104, 122
Fisheries Monitoring and Support	Michael Seki	16, 44, 99, 141
Fishing Impacts on Non-target Species	Michael Seki	154
Hawaiian Monk Seal Northwestern Hawaiian Islands Research Seasonal Support	Michael Seki	64, 86, 117
Hawaiian Monk Seal Research Program	Michael Seki	7, 17, 61, 72, 91, 131
Human Dimensions of Fishing and Marine Ecosystems in the Western Pacific	Michael Seki	12, 60, 92, 143
International Ecosystem Approach to Fisheries Management Project*	Michael Seki	initial
Investigation of Ecological Constraints for Bumphead Parrotfish	Michael Seki	2
Kona Integrated Ecosystem Assessment	Michael Seki	137
Main Hawaiian Islands Deep 7 Bottomfish Fast Track Project	Michael Seki	31, 43, 106, 133
Mechanisms of Atmospheric Mercury in Transport and Transformation in the Remote Pacific Marine Free Troposphere Measured in Hawaii	Russell Schnell	1, 48, 80, 119, 152, 153
National Weather Service Pacific Region Fellowship Program	Raymond Tanabe	34, 69, 90,120, 124
Ocean Remote Sensing	Michael Seki	23, 45, 82, 127
Optimizing Routine Ocean Current Measurements by the NOAA Fleet	Mark Van Waes	105, 128
Pacific Enso Applications Center (PEAC)	Raymond Tanabe	29, 35, 67, 112, 136
Pacific Island Region Observer Program Initiative	Michael Tosatto	27, 54
Pacific Islands Deep Sea Coral and Sponge Initiative	Michael Seki	150
Pacific Islands Region Outreach and Education Program	Michael Tosatto	30, 57, 71, 100
Pacific Islands Region Sustainable Fisheries Initiative	Michael Tosatto	20, 49
Pacific Islands Territorial Science Initiative	Michael Seki	79, 95, 135
Pacific Tuna Fishery Data Management	Michael Seki	111, 149
PMEL-UH Ocean Carbon Project	Christopher Sabine	4, 55, 83. 123

Profiling CTD Float Array Implementation and Ocean Climate Research	Christopher Sabine	11, 70, 93, 126
Protected Resources Environmental Compliance Initiative (PRECI)	Michael Tosatto	13, 51
Scientific Advice and Coordination for NOAA Office of Ocean Exploration and Research's 2015-2016 "CAPSTONE" Operations in the Pacific	Jeremy Potter	118
Sea Turtle Bycatch Mitigation Research	Michael Seki	19, 58
Seasonal Fluctuations in Pacific Island Marine Debris Deposition	Peter Murphy	33
Sensitivity of Built and Natural Infrastructure to Coastal Flooding Under a Changing Climate	Adam Stein	125, 155
Ship-Based GPS Sensing of Precipitable Water	Mitchell Goldberg	116
Stock Assessment Research Program	Michael Seki	25, 50, 94, 138
Sustaining Healthy Coastal Ecosystems	Michael Seki	3, 21, 73, 107, 145
Turtle Research Program	Michael Seki	8, 59, 96, 139
University of Hawaii Sea Level Center	David Legler	38, 76, 97, 130
University of Hawaii Sea Level Center (GNSS Installation at NOAA CO-OPS Stations)	David Legler	97
University of Hawaii Sea Level Center (Ship-Based Tsunami Detection and Characterization)	David Legler	97
Western Pacific Fisheries Economic Integration	Michael Seki	88, 132
Western Pacific Fisheries Information Network (WPacFin)	Michael Seki	14, 53, 84, 134

Appendix III Visiting Scientists

DATE	NAME/AFFILIATION	PURPOSE OF VISIT
05/27/15-06/16/15	Robert Pomeroy Professor University of Connecticut Groton, CT	Served as a facilitor at two Ecosystem Approach to Fishery Management (EAFM) workshops in Manado, Indonesia.
05/30/15-06/04/15	Angela Orama Kwapena Fisheries Management Unit Officer National Fisheries Authority Papua, New Guinea	Participated in the Coral Triangle Initiative EAFM Technical Working Group meeting in Manado, Indonesia.
05/30/15-06/04/15	John Luxton Leqata Chief Fisheries Officer Ministry of Fisheries and Marine Resources Solomon Islands	Participated in the Coral Triangle Initiative EAFM Technical Working Group meeting in Manado, Indonesia.
05/30/15-06/04/15	Lino De Jesus Martins EAFM TWG Focal Point Ministry of Agriculture and Fisheries Dili, Timor Leste	Participated in the Coral Triangle Initiative EAFM Technical Working Group meeting in Manado, Indonesia.
05/30/15-06/04/15	Vagi Leke Rei Marine Ecosystems Manager Conservation and Environment Protection Authority Papua, New Guinea	Participated in the Coral Triangle Initiative EAFM Technical Working Group meeting in Manado, Indonesia.
07/01/15-07/31/15	Thomas M.S. Johnston Assistant Researcher Scripps Institution of Oceanography University of California, San Diego San Diego, CA	Collaborated with JIMAR scientists on issues related to ocean mixing.
07/01/15-07/31/15	Jennifer MacKinnon Associate Professor Scripps Institution of Oceanography University of California, San Diego San Diego, CA	Collaborated with JIMAR scientists on issues related to ocean mixing.

07/27/15-07/31/15	James Estes Professor University of California, Santa Cruz Santa Cruz, CA	Served as a panelist for the NOAA PIFSC 2015 Protected Species External Review.
07/27/15-07/31/15	Frank Paladino Distinguished Professor & Chair Indiana-Purdue University Fort Wayne, IN	Served as a panelist for the NOAA PIFSC 2015 Protected Species External Review.
10/26/15-10/30/15	Julian O'Grady Scientist Centre for Australian Weather and Climate Research Aspendale, Australia	Collaborated with JIMAR scientists on extreme sea level research.
10/25/15-11/03/15	Johan Reyns Lecturer UNESCO-IHE Institute for Water Education The Netherlands	Collaborated with JIMAR scientists on extreme sea level research.
10/25/15-11/07/15	Brian Schlining Software Engineer Monterey Bay Aquarium Research Institute Moss Landing, CA	Collaborated with JIMAR and UH researchers on software upgrades and facilitated the system's integration with ROV imagery.
11/10/15-11/10/15	Richard Carbone Chief Scientist for Strategic Development/Research NCAR, Earth Observing Laboratory Boulder, CO	Interacted with JIMAR scientists on topics related to tropical meteorology.
01/26/16-01/28/16	Rodney Tibbats Fisheries Biologist Guam Department of Agriculture Mangilao, Guam	Presented at the external program review of the Pacific Islands Regional Commercial Fisheries Bio-Sampling Program in Garapan, Saipan.
01/26/16-01/28/16	Steven Smith Research Professor Rosenstiel School of Marine and Atmospheric Science University of Miami Miami, FL	Served as a panelist at the external program review of the Pacific Islands Regional Commercial Fisheries Bio-Sampling Program in Garapan, Saipan.

01/26/16-01/28/16	Bradley Moore Coastal Fisheries Scientist Pacific Community (SPC) Noumea, New Caledonia	Served as a panelist at the external program review of the Pacific Islands Regional Commercial Fisheries Bio-Sampling Program in Garapan, Saipan.
01/26/16-01/28/16	Frank Camacho Associate Professor University of Guam Mangilao, Guam	Served as a panelist at the external program review of the Pacific Islands Regional Commercial Fisheries Bio-Sampling Program in Garapan, Saipan.
02/08/16-02/12/16	Arni Magnusson Senior Scientist Marine Research Institute Reykjavik, Iceland	Conducted software training at the Introductory TMB (and ADMB comparison) workshop in Seattle, WA.
02/29/16-03/30/16	Corey Wakefield Senior Research Scientist Department of Fisheries, Western Australia Hillarys, Western Australia	Participated in a cruise from Pago Pago, AS to Apia, Samoa to co-direct research objectives with JIMAR scientists on the biology of deep water snappers in the US South Pacific.
03/09/16-03/11/16	Corwith White Professor Center for Coastal Marine Sciences California Polytechnic State University San Luis Obisbo, CA	Collaborated with PIFSC JIMAR EOD program on Management Strategy Evaluation (MSE).
03/21/16-03/24/16	Robert Nerem Professor University of Colorado, Boulder Boulder, CO	Collaborated with JIMAR scientists on research related to global and regional sea level variability and presented a seminar.
03/22/16-04/01/16	Jeffrey Maynard Research Scientist SymbioSeas Wilmington, NC	Provided guide analysis on the CRCP funded project Climate Change Vulnerability Analysis for US Pacific Reefs-Integrating Exposure, Resilience, and Social Adaptive Capacity.

04/04/16-04/08/16	Anne Cohen Associate Scientist Woods Hole Oceanographic Institute East Falmouth, MA	Served as a panelist for the 2015 Ecosystem Sciences External Review.
04/09/16-04/15/16	Carlie Wiener Communications Manager Schmidt Ocean Institute NW Hawaiian Islands Research and Outreach Kaneohe, HI	Served as a facilitator for the UH Sea Level and PacIOOS panel at the 2016 Island Sustainability Conference in Guam.
04/11/16-04/12/16	Matthew Alford Professor Scripps Institution of Oceanography University of California, San Diego San Diego, CA	Collaborated with JIMAR scientists on research related to ocean mixing.
04/18/16-05/17/16	Shoshiro Minobe Professor Hokkaido University Sapporo, Japan	Collaborated with SOEST faculty, students and researchers in the analysis/ diagnosis of observed climate variability and presented a seminar.
05/09/16-05/13/16	Gareth Williams Lecturer School of Ocean Sciences Bangor University Anglesey, United Kingdom	Collaborated with PIFSC and JIMAR researchers on statistics and coral reef ecosystems and presented a seminar.
06/20/16-06/24/16	Casper Berg Researcher Danish Technical University AQUA National Institute of Aquatic Resources Charlottenlund, Denmark	Participated in the ADMB Developers Workshop in Seattle, WA.
06/20/16-06/24/16	Mollie Brooks Postdoctoral Researcher Population Ecology Research Group Institute of Evolutionary Biology & Environmental Studies University of Zurich Zurich, Switzerland	Participated in the ADMB Developers Workshop in Seattle, WA
06/20/16-06/24/16	Christopher Grandin Fisheries Scientist Pacific Biological Station Nanaimo, BC, Canada	Participated in the ADMB Developers Workshop in Seattle, WA.

06/20/16-06/24/16	John Sibert Emeritus Professor University of Hawaii Honolulu, HI	Participated in the ADMB Developers Workshop in Seattle, WA.
06/20/16-06/24/16	Hans Skaug Professor Universitetet i Bergen Matematisk Institutt Norway	Participated in the ADMB Developers Workshop in Seattle, WA.

Appendix IV Workshops, Meetings and Seminars Hosted by JIMAR

- **Steven R. Nerem**, PhD, University of Colorado, Boulder, Colorado Center for Astrodynamics Research, Department of Aerospace Engineering Sciences
  Challenges for Detecting an Acceleration of Sea Level Rise in the 23-year Satellite Altimeter Record
  March 22, 2016, JIMAR Seminar, University of Hawaii at Manoa, Honolulu, HI

- **Felix Landerer**, PhD, Jet Propulsion Laboratory, California Institute of Technology
  Atlantic Meridional Overturning Circulation: Insights into AMOC Variability and Latitudinal Coherence from GRACE Time-Variable Gravity
  April 5, 2016, JIMAR Seminar, University of Hawaii at Manoa, Honolulu, HI

- **Matthew Alford**, PhD, Professor, Marine Physical Laboratory, Scripps Institution of Oceanography
  Observing the Generation, Propagation and Dissipation of Internal Waves in the Ocean
  April 22, 2016, JIMAR Seminar, University of Hawaii at Manoa, Honolulu, HI

Appendix V JIMAR Personnel

Information as of June 30, 2016

Category	Number	High School	Associates	Bachelors	Masters	Ph.D.
Research Scientist	19	0	0	0	0	19
Visiting Scientist	0	0	0	0	0	0
Postdoctoral Fellow	0	0	0	0	0	0
Research Support Staff	105	3	5	68	25	4
Administrative	13	0	0	10	2	1
Total (≥ 50% support)	**137**	**3**	**5**	**78**	**27**	**24**
Undergraduate Students	19	19	0	0	0	0
Graduate Students	20	0	0	18	2	0
Employees that receive < 50% NOAA funding (not including students)	4	0	0	1	0	3
Located at lab (include name of lab)	3 - PMEL 3 - PIRO 113 - PIFSC 4 - ESRL					
Obtained NOAA employment within the last year	2					
Postdoctoral fellows and students from subgrantees	0					

Appendix VI Awards

Melanie Abecassis
- 2015 NOAA PIFSC Scientific Professional Team Member of the Year

Felipe Carvalho
- Nominee for 2015 RCUH Employee of the Year

Adrienne Copeland
- Tied for the Best Student Paper Award in Animal Bioacoustics at the Acoustical Society of America (ASA) Spring 2016 Meeting, Salt Lake City, UT, May 23-27, 2016

Brian Dieter
- 2015 NOAA PIFSC Scientific Technical Team Member of the Year

Jessica Guillermo
- 2015 NMFS/PIRO Team Member of the Year Award

Kevin Higaki
- 2015 NOAA PIFSC Team Member of the Year, JIMAR Administrative Professional

Candice Hino
- 2015 NOAA PIFSC Team Member of the Year, JIMAR Administrative Support

Mariska Weijerman
- Nominee for 2015 RCUH Employee of the Year

Appendix VII Graduates

Adrienne Copeland, PhD, University of Hawai‘i, Department of Biology
“Influences of spatial and temporal variability of sound scattering layers on deep diving odontocete behavior”

Andrew Gray, Master of Science, Biological Oceanography Division, Department of Oceanography, University of Hawai‘i at Manoa, “Using acoustic telemetry to study the feeding ecology of a seamount-associated fish”

Kaylyn McCoy, Master of Science, Department of Biology, Zoology, University of Hawai‘i at Manoa.
“Estimating nearshore fisheries catch for the main Hawaiian Islands”

Appendix VIII 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 13	FY 14	FY 15	FY 16
Peer Reviewed	**JIMAR Lead Author**	16	18	9	13
	NOAA Lead Author	7	7	11	10
	Other Lead Author	18	21	13	25
Non Peer-Reviewed	**JIMAR Lead Author**	41	51	36	55
	NOAA Lead Author	12	9	9	9
	Other Lead Author	21	3	9	4