JIMAR Joint Institute for Marine and Atmospheric Research

JIMAR

Annual Report for Fiscal Year 2017 and Final Report

For Cooperative Agreement NA11NMF4320128 and NA15NMF4320128

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SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

Annual Report for Fiscal Year 2017 and Final Report

Performance Period July 1, 2016–September 30, 2017

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Introduction and Highlights

Douglas Luther, PhD, Director, beginning September 1, 2017

The Joint Institute for Marine and Atmospheric Research (JIMAR) administers 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 number NA11NMF4320128. 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;
- promote cutting edge science through the support of visiting scientists and post-doctoral scholars;
- foster the transition of research outcomes to operational products and services that benefit the Pacific Islands Region.

JIMAR is located at the University of Hawaii at Manoa, a research-intensive land-grant and Sea Grant institution, that maintains a service mission to the State as well as to the Pacific Islands Region, and has been designated a minority-serving institution. 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 Islands 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 interfaces 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 Islands Ocean Observing System (PacIOOS), and the Pacific ENSO Applications Climate (PEAC) Center.

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) tsunami and other long-period ocean waves.

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 forecasting, ecosystem monitoring, ecosystem-based management, and the protection and restoration of resources.

- Life-history traits of commercially-harvested fish species serve as foundations to predict and interpret population dynamics and ultimately guide management and policy. A study by JIMAR scientists Brett Taylor and Cassandra Pardee provides an assessment of age-based and reproductive biology for the redlip parrotfish. This species is the highest landed parrotfish species by mass in Hawaii, the CNMI, and American Samoa, and is the third most landed parrotfish in Guam. The authors combined life-history information from locations across the Indo-Pacific (including U.S. Territories) to examine the effect of ambient temperature on life span and body

size. This information provides fishery assessment scientists with high-quality age-based data enabling them to predict life-history traits for locations where this information does not exist. (Brett Taylor and Cassandra Pardee, 2017. Growth and maturation of the redlip parrotfish Scarus rubroviolaceus, J. Fish. Biol., 90, 2452-2461, doi:10.1111/jfb.13309).

- JIMAR scientist Marc Nadon collaborated with Jerald Ault from the University of Miami to develop a new tool to generate life history parameter estimates. Fisheries in tropical areas are usually data-limited. Typically, cost-effective length data are used to assess these stocks, but information related to growth, maturity, and longevity are often missing. To address this issue, a large dataset of published life history parameters was assembled, and statistical relationships between growth, maturity, and longevity parameters were established. With a local estimate of maximum length, it is possible to draw random estimates of missing life history parameters using these relationships to generate probability distributions. These distributions can be used directly in stock assessment, such as the recent Hawaii reef fish assessments. (Marc Nadon and Jerald Ault, 2016. A stepwise stochastic simulation approach to generate life history parameters for data-poor fisheries, Can. J. Fish. Aquat. Sci., 73 (12), 1874-1884, doi.org/10.1139/cjfas-2015-0303).
- Sharks captured in commercial fisheries are typically discarded at sea, due to finning or low-market values. The post-release fate of sharks is as yet unobserved, but three factors have been identified to have the largest effect on post-release survivorship; 1) the underlying physiology of some species make them more vulnerable to capture related stress; 2) the amount of time a shark spends struggling on the line; and 3) the handling and dispatch procedures the fishers use to remove an animal from the gear. In this ongoing study, JIMAR scientist Melanie Hutchinson and colleagues are working with longline tuna fishers and observers to tag sharks that are captured and released. These archival satellite tags validate the fate of the sharks whereby quantitative estimates of post-release mortality rates can be generated. The data will assist in the identification of best handling practices for discarding sharks from pelagic longline fishing gear to improve survivorship. (Melanie Hutchinson, Keith Bigelow, John Kelley, and Michael Marsik, 2016. Assessing shark bycatch condition and the effects of discard practices in the Hawaii-permitted tuna longline fishery, PIFSC Working Paper, WP-16-005).
- The Voluntary Guidelines for Securing Sustainable Small-scale Fisheries (SSF Guidelines) is a non-binding international agreement which uses a human rights based approach to assist in shaping the governance of small-scale fisheries, particularly in developing country contexts. Gender equity and equality is the fourth guiding principle of the SSF Guidelines, the inclusion of which is unprecedented, and effective implementation is the critical next step. JIMAR social researcher Danika Kleiber led an effort to bring together gender and small-scale fisheries experts from seven different geographic contexts to highlight the main gender equity and equality concerns for small scale fisheries in those regions. [Danika Kleiber et al, 2017. Promoting gender equity and equality through the Small-Scale Fisheries Guidelines: Experiences from multiple case studies. In: (Jentoft, Chuenpagdee, Barragán-Paladines, and Franz, eds.), The Small-Scale Fisheries Guidelines: Global Implementation, MARE Publication Series 14, Springer, 737-759)].
- As part of a project developed by the Center for the Advancement of Population Assessment Modeling (CAPAM), a study led by JIMAR scientists Felipe Carvalho and Yi-Jay Chang, in collaboration with scientists from the University of Washington, the Inter-American Tropical Tuna Commission, and the NOAA Southwest Fisheries Science Center, developed a set of critical diagnostics to add rigor to integrated stock assessment models. The study was published in a special issue of the journal Fisheries Research planned for papers developed by CAPAM and stayed for over two months on the top ten most downloaded articles in the journal's website. (Felipe Carvalho, André Punt, Yi-Jay Chang, Mark Maunder, and Kevin Piner, 2017. Can diagnostic tests help identify model misspecification in integrated stock assessments?, Fish Res, 192, 28–40).

Significant accomplishments have also been registered within JIMAR's several non-biological themes, including the following examples.

- A focus for JIMAR oceanographers over the past year has been on science outcomes that have direct societal applications. A key example has been the extension of regional and global sea level change studies by JIMAR researchers in the University of Hawaii Sea Level Center (UHSLC) to assessments and forecast tools of extreme sea level events in the Pacific Islands region. In particular, a decadal shift in Pacific trade winds led to unusually high water levels that have impacted the Hawaiian Islands region for over a year. This high water stand in combination with seasonally high tides and mesoscale eddy variability led to record water levels throughout the 2017 summer season, including the highest daily water level in the century-long Honolulu tide gauge record.

- Using new dynamical and statistical modeling techniques, the UHSLC was able to provide advance notice of potential flooding events, and assisted the National Weather Service with the issuance of public warnings. UHSLC staff members responded regularly to questions from the public regarding global and regional sea-level rise concerns. The high coastal water levels and nuisance flooding led to a flurry of media inquiries and opportunities to engage the public, including via a variety of media events and public lectures.
- The seasonal sea level forecasting assessments noted above that were established for the Pacific Islands will be extended to all U.S. coastlines under a recently funded NOAA MAPP project led by Matthew Widlansky, a JIMAR researcher hired in 2016. These coastal high water level forecasts will be conducted within a NOAA task team that will also consider forecasts for marine living resources.
- The longer-term (weeks to months) high water level forecasts just described are augmented in a few locations by short-term (1-6 days) forecasts of swell wave run-up produced by JIMAR and UH researchers within the NOAA Pacific Islands Ocean Observing System (PacIOOS; e.g., http://oos.soest.hawaii.edu/pacioos/data_product/SLpred/Wai_Exc.php). These empirically-based run-up forecasts have been created for the north and south shores of Oahu Island, and for Majuro and Kwajalein Islands in the Republic of the Marshall Islands. Their utility and subsequent popularity for warning of potential danger to lives and infrastructure has led NOAA to award a Coastal Resilience Grant to UH beginning October 1, 2017. The UH proposal will take the forecasts to the next level by developing a numerical-model based, high spatial resolution, forecast system to enhance coastal resiliency and preparedness for the surprisingly vulnerable West Maui coast; "surprising" because that coastline would appear to be sheltered from both north and south swells by the neighboring islands of Molokai, Lanai and Kaho'olawe, yet it is experiencing significant swell wave-driven coastal erosion. It is expected that this modeling system will eventually be expanded to much of the Hawaiian Islands and other appropriate Pacific islands. This effort to transition research into operational products is led by Melissa Iwamoto, Director of PacIOOS, Doug Luther, Director of JIMAR, and Tara Owens, UH Sea Grant Extension Agent in the Maui County Planning Department, with Volker Roeber, Visiting Professional Colleague, Martin Guiles, Sr. Oceanographic Research Specialist and Assaf Azouri, Postdoctoral Fellow.

JIMAR provides administrative support for all PacIOOS activities, which empower ocean users and stakeholders throughout the Pacific Islands by providing accurate and reliable coastal and ocean information, tools, and services. PacIOOS continued to operate and maintain over 30 deployed buoys, sensors and other instruments throughout the U.S. Pacific Islands. A variety of forecasts are also made available to the public, including wave, ocean, and atmospheric forecasts, as well as the aforementioned set of coastal inundation forecasts. PacIOOS' partners supported the refinement and validation of these coastal forecasts by providing on-the-ground documentation of flooding events. PacIOOS identified additional partners for the Water Quality Sensor Partnership Program, which allows resource managers and community groups to collect accurate nearshore water quality measurements to support monitoring efforts. PacIOOS works closely with state and federal agencies, non-profit organizations, academic institutions, and other partners to make coastal and oceanographic data publicly available. More than 1,600 individual datasets (both PacIOOS and partner data) are freely accessible through PacIOOS' data visualization platform 'Voyager' at http://pacioos.org/voyager. All of PacIOOS' data are also available on the PacIOOS website, http://pacioos.org.

Given JIMAR's remote locale, its Visiting Scientist Program (VSP) provides an important mechanism to engage with experts from around the world, as well as to sponsor trips by JIMAR researchers to international conferences and workshops relevant to our research themes. JIMAR researchers attracted, and the VSP supported, experts in coral reef assessment and monitoring, ecosystem vulnerability assessment, fisheries science, historical climate variability, tropical ocean dynamics, web portal outreach development, and many more (Appendix III).

Educational events and outreach activities sponsored by JIMAR during the reporting period were reported under the new Cooperative Agreement NA16NMF4320058 Annual Report for FY 2017.

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.

The Director of JIMAR is a regular member of the University of Hawaii faculty. 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 opportunities to promote scientific collaboration and cooperation.

Mark Merrifield, PhD, Director, through August 31, 2017

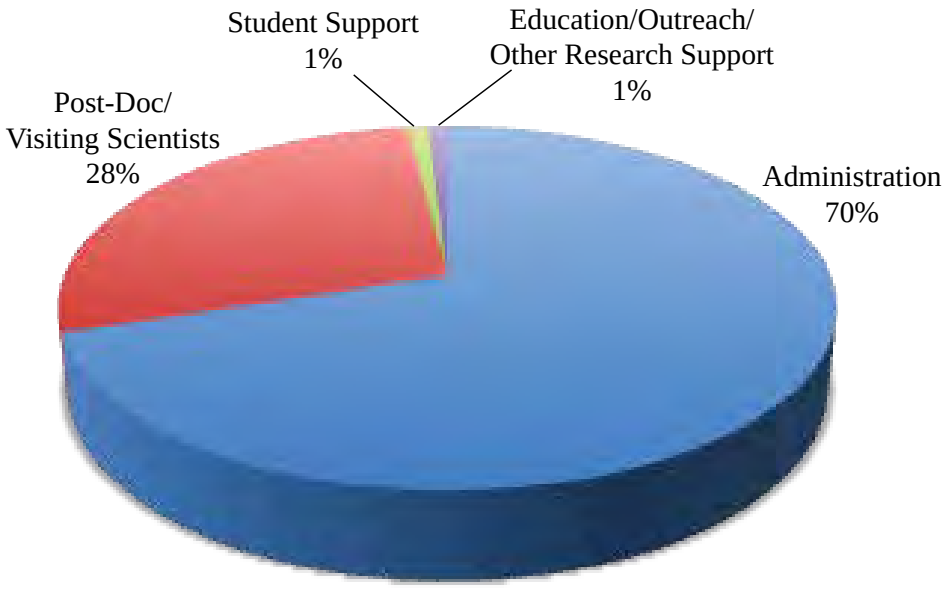
Dr. Mark Merrifield, JIMAR Director since late 2011, has resigned his position as Director in order to lead the new Center for Climate Change Impacts and Adaptation at the Scripps Institution of Oceanography. Under Dr. Merrifield's leadership, JIMAR successfully re-competed to become the administrator of NOAA's Cooperative Institute for the Pacific Islands Region. Dr. Merrifield was replaced as Director of JIMAR on September 1, 2017, by Dr. Douglas S. Luther, Professor of Oceanography at UH since 1995. Dr. Luther has served as a JIMAR Senior Fellow since 1995, and has had close ties with all three prior JIMAR Directors, Drs. Dennis Moore, Thomas Schroeder and Merrifield. Dr. Luther's Ph.D. work and early research interests were in equatorial oceanography, including the dynamics of El Nino. During his career, Dr. Luther has explored the dynamics of a variety of oceanic wave motions from infragravity waves to tides to Rossby waves, both external and internal, from the tropics to the Southern Ocean. The overall theme of his work is to acquire a better understanding of how energy flows through the oceans via its many free and trapped wave types, and what the impacts of these wave motions are when they finally give up their energy. Currently, his interests are focused on the creation, propagation, decay and impacts of internal tides, and on the creation, and subsequent impacts, of long period gravity waves that are forced at the coasts by storm-generated gravity wave swell.

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

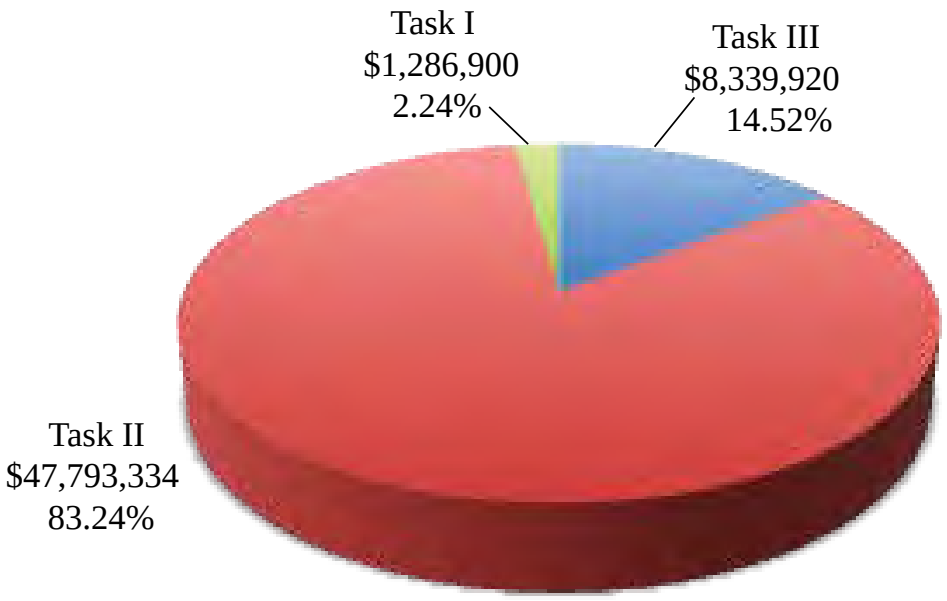
JIMAR Council of Fellows from the University of Hawaii are Dr. Steven Businger, Dr. Jeffrey Drazen, Dr. Eric Firing, Dr. Erik Franklin, Dr. Kim Holland, Dr. Margaret McManus, Dr. Anna Neuheimer, Dr. James Potemra, Dr. Brian Powell, Dr. Robert Toonen, and Dr. Bin Wang.

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 a portion of the salary of the Director. Funding percentages by activity are exhibited in the following chart.

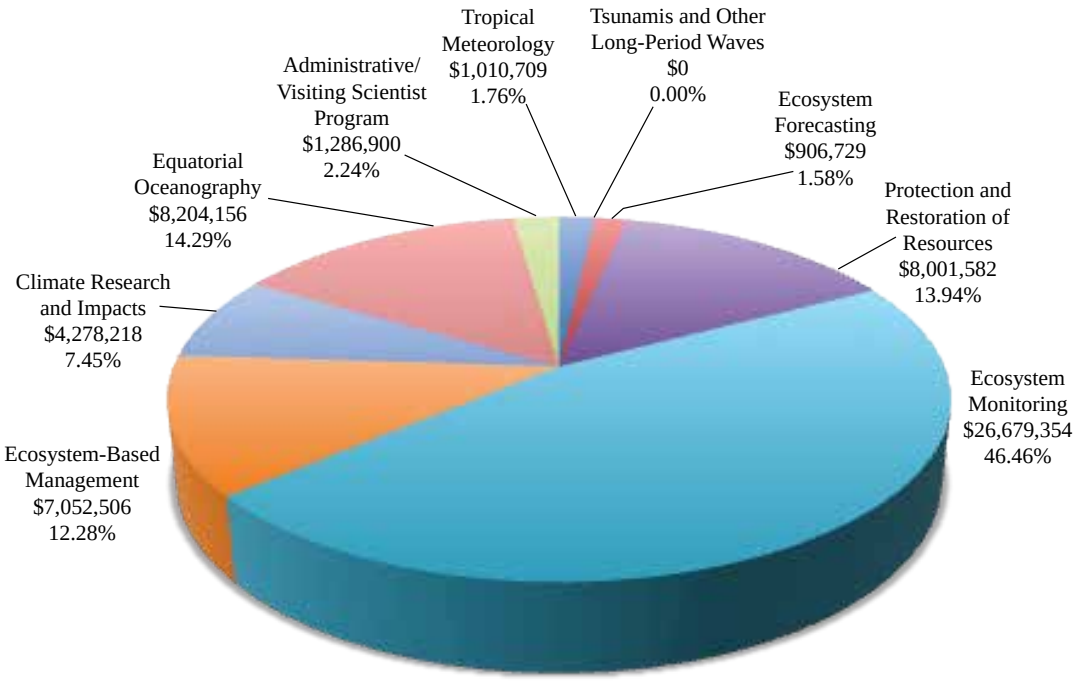
Distribution of JIMAR's Task I NOAA Funding by Activity



Distribution of NOAA Funding by Task (FY 2012-2017)



Distribution of NOAA Funding by Theme (FY 2012-2017)



Accomplishments for Fiscal Year 2017 and Final Reporting Period Ending September 30, 2017

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 in the USA and around the world.

Progress during FY 2017

During FY 2017, many improvements were made to the ADMB software. Since the release of ADMB-11.5, there have been more than 1,200 revisions to the main source code repository. Most of the changes included defect fixes, added function documentation, source code readability improvements and unit testing. ADMB-11.6 was released on December 2016 and included about 689 changes since the previous ADMB-11.5. One major feature contributed by the Template Model Builder (TMB) Project included with the release is tiny_ad which uses C++ templates for AD computations. This feature is an alternative approach to reverse mode differentiation in ADMB. The upcoming annual release will include another contribution from Cole Monnahan who is completing his PhD at the School of Aquatic and Fisheries Sciences, University of Washington. He ported and developed the No U-Turn Sampler (NUTS) algorithm for ADMB with assistance from the project members. NUTS is a new feature that speeds up the computation time for Markov chain Monte Carlo (MCMC) models.

The ADMB Developers Workshop 2017 was held August 14-18, 2017, in Copenhagen, Denmark. The main objectives of the workshop were to improve documentation, fix code defects, and discuss potential features for ADMB and TMB software. A notable fix was correcting an introduced defect in the ADMB profile likelihood code. A test was added to the testing suite to check and prevent the issue in future changes. Other changes from the workshop included updating the ADMB-IDE and integration with the commercial Rstudio IDE.

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

P.I.: 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

NOAA Goal(s):

- Healthy Oceans

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 2017

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 project was finalized and published in FY 2017 as a NOAA Technical Memorandum.

Bio-Sampling

P.I.: Douglas S. Luther [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

Figure 1. JIMAR Biosampling visiting scientist and collaborator Dr. Corey Wakefield examines fish otolith sections under a microscope during an international workshop on biology and management of deep-water snappers and groupers.

Purpose of the Project

This project facilitates fundamental life-history research on federally-managed coral reef fish and deep-water bottomfish species of commercial, ecological, and cultural value from Pacific Island areas under United States jurisdiction. This project uses extensive and existing Pacific Islands Fisheries Science Center (PIFSC) Commercial Fisheries Biosampling Programs (CFBP) within the Pacific Territories of Guam and American Samoa, as well as the Commonwealth of the Northern Mariana Islands (CNMI) and the State of Hawaii, to derive precise species-specific estimates of growth, life span, lengths and ages at reproductive maturity. All aspects of this project are closely associated with the PIFSC Life History Program (LHP) and rely on analytical facilities at the University of Hawaii, with the specific intentions of providing accurate life-history parameters to enhance ongoing and future fisheries population assessments.

Progress during FY 2017

During FY 2017, all ongoing studies were successfully concluded, objectives were met, and scientific results were published in peer-reviewed journals. Four published peer-reviewed manuscripts were produced as a result of the project's research activities (Wakefield et al. 2016 *ICES Journal of Marine* Science, Taylor et al. 2017 *Marine and Freshwater Research*, Taylor et al. 2017 *Journal of Fish Biology*, and Newman et al. 2017 *Marine Policy*). These manuscripts cover comprehensive age-based and reproductive biology of commercially-harvested species from the CNMI and American Samoa, and review the status and applicability of methods for life-history research for commercially-harvested deep-water snappers and groupers. Project staff also co-organized an international workshop in Western Australia on the biology of deep-water bottomfishes, attended and presented at the Maturity Assessment, Reproductive Variability, and Life Strategies (MARVLS) workshop at the NOAA Southwest Fisheries Science Center (SWFSC) in La Jolla, California, and completed the Fundamentals of Supervision course at the Hawaii Employers Council. Finally, JIMAR Biosampling project staff established an ORACLE APEX database for the life history data from the 2014 Life History Program research cruise to the Northern Mariana Islands.

Data Validation at the Hawaii MAPCO2 Buoy Network in Support of a Test-Bed for Technology Development: Phase I

P.I.: Douglas S. Luther, Eric Heinen De Carlo

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

NOAA Sponsor: Christopher Sabine

Budget Amount: $15,247

NOAA Goal(s):

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

Purpose of the Project

The primary objective of this project is to carry out expanded field sampling for inorganic carbon parameters in the water column of tropical coral reefs, particularly concurrent with the deployment of new technology by the project's research partners, and to carry out laboratory based data validation analyses that were previously not possible with the limited resources provided by other funding agencies supporting the project's Ocean Acidification (OA) research.

Progress during FY 2017

Project activities supported the broader agency (NOAA, Pacific Marine Environmental Laboratory) based efforts to develop technologies to monitor coastal processes with emphasis on the inorganic carbon system (CO2-carbonic acid system), which also support the goals of the national and global OA observing efforts. The project continued to collect and analyze bottle samples for subsequent laboratory determination of dissolved inorganic carbon (DIC) and total alkalinity (TA) at two week intervals (weather and sea conditions permitting) at the NOAA (PMEL, Ocean Acidification Program and Sea Grant) supported MAP-CO2 buoys that are deployed on coral reefs of the island of Oahu, Hawaii. In addition researchers carried out short term high intensity sampling experiments in conjunction with their academic colleagues whose objectives are to derive a better understanding of the processes driving coral reef metabolism near the fixed MAP-CO2 buoy sites. Most recently, the project participated in the National Science Foundation (NSF) and OAP sponsored inter-laboratory comparison project (for inorganic carbon system parameters) conducted by Dr. Andrew Dickson of Scripps Institution of Oceanography (SIO) and are pleased to report excellent results by the newest graduate student sponsored by a companion NOAA/UH Sea Grant project.

Ecosystem Modeling

P.I.: Douglas S. Luther [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, Donald Kobayashi

Budget Amount: $62,500

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project examines changes in the oceanography and ecology of the central North Pacific and in the catch rates of the Hawaii-based longline fishery and continues processing lancetfish stomachs provided by the Longline Observers Program.

Progress during FY 2017

JIMAR staff supported the trawling and plankton sampling operations on a research cruise off of leeward Oahu. One of the objectives of this cruise was to investigate the pelagic marine ecosystem and underlying oceanography of the region.

Project staff researched longline logbook, observers and landings data to investigate bigeye tuna size structure and spatial patterns in catch rates in the Hawaii-based longline fishery and presented results to the Science and Statistical Committee (SSC) of the Western Pacific Regional Fishery Management Council (WPRFMC). As a follow-up to that research, JIMAR staff developed a recruitment index for bigeye tuna that allows for forecasting fisheries catch based on catch rates of young bigeye tuna. This recruitment index, along with several other indicators, was included in the 2017 climate chapter of the WPRFMC Stock Assessment and Fisheries Evaluation report. This research culminated in a manuscript that is currently in preparation entitled, "Development of a recruitment index for bigeye tuna in the North Pacific allows forecasting of fisheries catch".

During July 2016–September 2017 approximately 1,000 lancetfish stomachs were processed, bringing the total number of stomachs analyzed as part of this JIMAR project to 2,200. This effort represents the highest resolution diet dataset for any midwater predatory fish and reveals that lancetfish diet varies across oceanographic boundaries in the North Pacific Ocean. This suggests that the midwater community they feed on also varies across these features. This observation demonstrates that lancetfish are a uniquely useful tool for monitoring the response of midwater prey communities to oceanographic variability, and future analyses will directly address variability in lancetfish diet with respect to oceanographic conditions.

As a result of the project's success, the research program at NOAA was expanded to include studies of lancetfish growth and life history. Approximately 30 whole lancetfish were dissected by JIMAR and NOAA staff, from which white muscle tissue (collected for molecular barcoding) and otoliths (for ageing studies) were sampled. JIMAR staff also assembled sampling kits for fisheries observers to collect lancetfish gonads. The gonads will provide information on size-specific fecundity, which in concert with the age-at size data determined from the otoliths, will be used to do a stock assessment and significantly improve understanding of the biology of these bizarre midwater predators. JIMAR staff also worked with the Pacific Islands Regional Office (PIRO), Office of Outreach and Education to develop an outreach program, "Learning with Lancetfish", which uses lancetfish and their bizarre prey as an engaging way to introduce students (grades 6-8) to oceanic ecology.

Ecosystems Observations Research Program

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

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

NOAA Sponsor: Michael P. Seki, Evan Howell

Budget Amount: $1,195,500

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The JIMAR Ecosystems Observations and Research Program (EORP) monitors and conducts research on ecosystems that involve marine species and resources of concern to NOAA in the Pacific Islands Region. The project activities enable scientists to provide advice to those charged with management of the resources as mandated by legislation (e.g., Reauthorized Magnuson Stevens Act, Marine Mammals Protection Act, Endangered Species Act, etc.). Current project activities are summarized below.

Enhanced Environmental Data Management to Support Fisheries and Ecosystem Research. This JIMAR effort 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, data management, data application development, and Geographic Information System (GIS) support to scientists

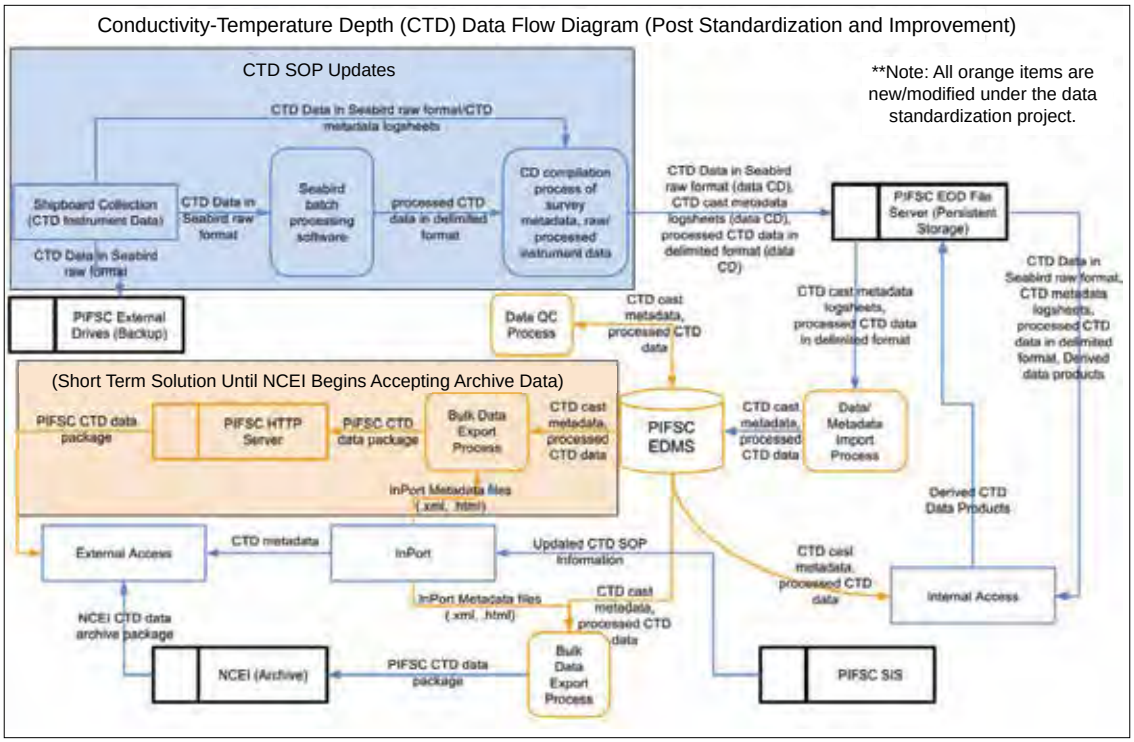


Figure 1. Data flow diagram for the proposed data system in the CTD data standardization project.

and resource managers at the Pacific Islands Fisheries Science Center (PIFSC) to facilitate quality scientific research and resource management.

Coordinated Main Hawaiian Islands Bottomfish Population Assessments. Bottomfish research and stock assessment in the Hawaiian Islands and U.S. Territorial waters is one of the cornerstones of the insular fisheries research effort conducted at PIFSC. JIMAR plays key roles in these research areas with several existing and proposed JIMAR projects to PIFSC focused on bottomfish research (see JIMAR annual reports on Main Hawaiian Islands Commercial Fisheries Fast Track Data Project, Territorial Biosampling, Ecosystems Observations and Research Program: Science Operations Project and the Stock Assessment Research Program). In addition, JIMAR and PIFSC scientists are active in bottomfish research areas, including technical and analytical efforts in the Stock Assessment, Life History, Ecosystems and Oceanography, and Coral Reef Ecosystems Programs.

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

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

Main Hawaiian Islands Bottomfish Benthic Habitat Mapping. The objectives of this JIMAR effort are to address the lack of integrated benthic habitat mapping in the Main Hawaiian Islands. The project will create synthesized benthic habitat substrate characterization maps and a synoptic survey stratification product.

Analysis of Deepwater Surveys in the U.S. Line Islands. In 2005, a series of seven dives were undertaken with the University of Hawaii Pisces IV and V unmanned submersibles to survey the little known Pacific reef systems around Jarvis Island, Kingman Reef, and Palmyra Atoll. Data were video recorded and archived, but they had not been analyzed and synthesized until this year. The project employed expertise of existing staff in the University of Hawaii's Hawaii Undersea Research Laboratory (HURL) who have experience with Video Annotation and

Referencing Software (VARS) and video annotation protocols. VARS records are exportable and convertible to other formats such as Excel spreadsheets and various standard relational databases utilized by NOAA. The bulk of the work was conducted at the HURL offices at the University of Hawaii, along with collaboration with JIMAR and PIFSC staff at the NOAA Inouye Research Center (IRC).

GIS Mapping Tools for the Marianas Trench Marine National Monument Waters. This project planned the development of a web browser-based Geographic Information System (GIS) mapping tool for the Marianas Trench Marine National Monument (MTMNM). This work will serve as an example to effectively integrate coral reef monitoring data, fisheries cruise survey data, and site–specific data collected by local agencies. The GIS mapping tool habitat layers will include microhabitat distribution and utilization, fish/coral species, and human usages.

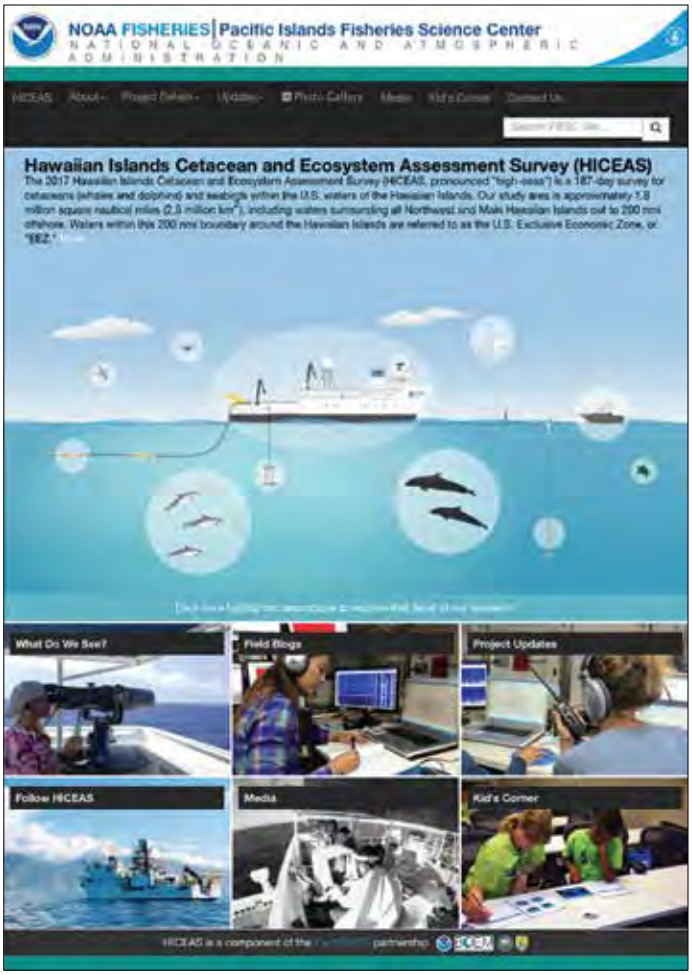


Figure 2. The project website for the Hawaiian Islands Cetacean and Ecosystem Assessment Survey (HICEAS) includes an interactive graphic to explore research and view detailed species descriptions and illustrations, field blogs, Story Map with project updates and photographs, a "Kid's Corner," and social media. JIMAR staff plays a key role in assembling the website.

Progress during FY 2017

Enhanced Environmental Data Management to Support Fisheries and Ecosystem Research. Led by Jesse Abdul, the project set an objective to conduct an assessment on each PIFSC division's data streams, data management workflows, infrastructure, and internal capacity to identify common needs and ability to develop necessary data solutions. While working on the PIFSC initiative to satisfy Public Access to Research Results (PARR) requirements, JIMAR developed documentation of common data needs and procedures and data tools to facilitate the documentation and dissemination of scientific data. JIMAR staff subsequently developed an application to track PARR compliance, manage custom scientific data set information, and review/annotate identified data package validation issues.

The project also facilitated development of centralized data tools to satisfy common data needs and helped with overall data management improvements. The project worked with PIFSC to: 1) perform formalized and documented data quality control (QC) on Oracle relational databases; 2) develop a generalized database version control module to track upgrade/update histories; and 3) coordinate efforts for data management improvement plans across the various PIFSC research divisions. Another JIMAR accomplishment was to develop Standard Operating Procedures (SOPs) and distribute them to each PIFSC division to document methods for data management and development activities.

JIMAR led the Conductivity Temperature and Depth (CTD) data standardization project for the collection, processing, and management of CTD data collected by PIFSC in a centralized database to increase the accessibility. JIMAR drafted an implementation plan, compiled technical specifications, and collected information from other appropriate NOAA stakeholders to assess CTD data workflows.

Overall, the project succeeded in developing methods and tools to increase the accessibility of scientific data within the Science Center. In addition, the project facilitated integration of data sets across PIFSC divisions and

Figure 3. As part of "The Amazing World of Marine Plankton" module in the 2016 NOAA Fisheries Science Camp, students identify zooplankton under microscopes using a simple dichotomous key.

set a goal to increase internal GIS, database development, data management, and application development skills and capacity within each division in PIFSC.

Coordinated Main Hawaiian Islands Bottomfish Population Assessments. Led by Kyle Koyanagi, the project facilitated staff participation from each PIFSC division in several research expeditions on board the NOAA *R/V Oscar Elton Sette* and *R/V Hi'ialakai* during the reporting period, including the Hawaiian Islands Reef Assessment and Monitoring Program (HARAMP) in the summer of 2016. Project support was also provided for bottomfish investigations with other collaborating JIMAR projects: JIMAR Cetaceans Research Program, JIMAR Socioeconomics of Pacific Fisheries project, JIMAR Ecosystem Structure and Function project, JIMAR West Hawaii Integrated Ecosystem Assessment project, JIMAR Stock Assessment Program, JIMAR Fishing Impacts on Non-target Species project, and JIMAR Sustaining Healthy Coastal Ecosystems project.

A coordinated fishery research program for bottomfish species to provide size-structured abundance estimates of bottomfish assemblages was implemented by PIFSC to improve understanding of bottomfish ecology and habitat and monitor bottomfish populations through non-extractive sampling techniques. Active acoustics, stationary camera systems, and mobile platforms were used to gather pertinent bottomfish information needed to improve stock assessments and ecological surveys. JIMAR staff in the Science Operations Division's (SOD) Survey and Sampling Technologies Program (SSTP) provided technical and analytical support for ongoing 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.

JIMAR staff continued to fine-tune 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. The MOUSS is a stereo-video survey tool that provides non-extractive size-structured relative abundance estimates of fish species in their natural habitat. MOUSS surveys were undertaken during the Main Hawaiian Islands (MHI) Fall Bottomfish Fishery-Independent Survey conducted October 13, 2016–November 4, 2016. A total of 192 camera deployments were conducted and video were annotated for "Deep 7" bottomfish, with sized-structured abundance data delivered to PIFSC Fisheries Research and Monitoring Division's Stock Assessment Program in January 2017.

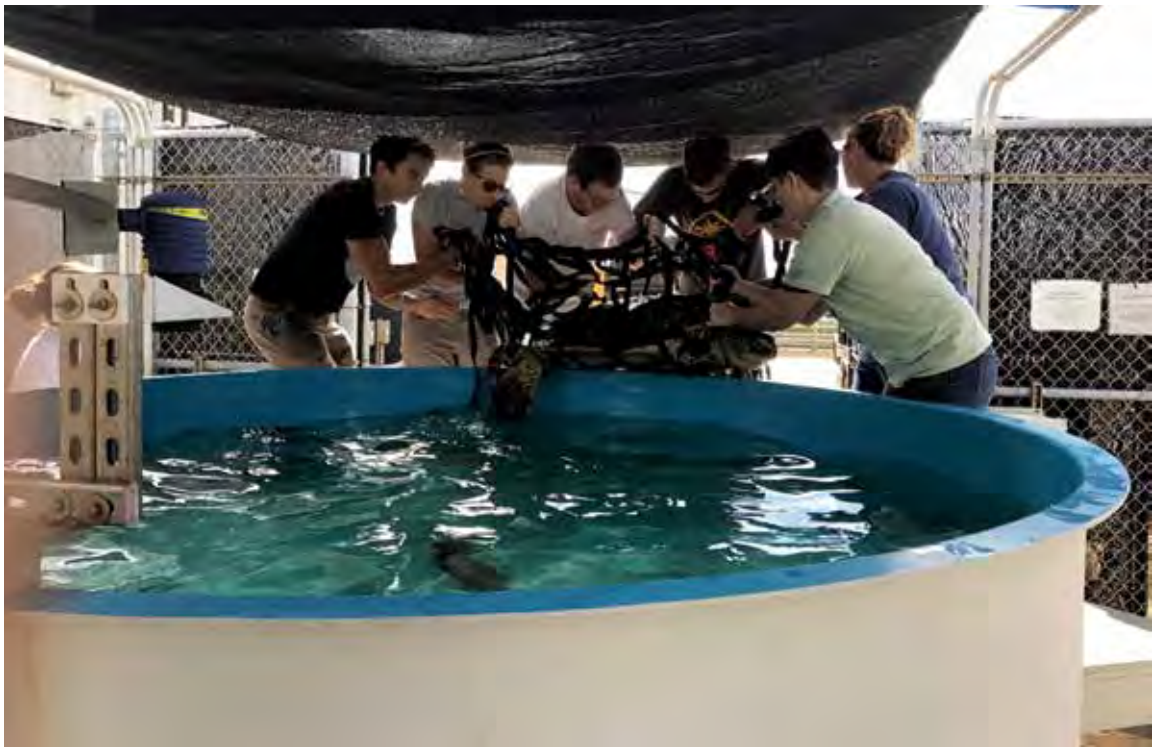


Figure 4. Large turtle carried out of the tank for release by the turtle team at the IRC seawater facility.

JIMAR staff also assisted in the design and development of a prototype 360-degree camera housing that can operate in tandem with MOUSS units to supplement MOUSS data sets. Unfortunately, during testing aboard the NOAA Ship *Oscar Elton Sette*, the instrument package, including the 360-degree camera, became entangled in the props and was lost on November 3, 2016, off the south shore of Molokai. Despite the loss of this prototype the NOAA Fisheries Advanced Sampling Technology Working Group (ASTWG) funded the SOD SSTP to develop and evaluate the use of multiple off-the-shelf 360-degree cameras as a novel method to capture essential data in fisheries surveys and validate results using the MOUSS. The resulting SSTP evaluation and report will serve as a guide to other NOAA Fisheries Science Centers, highlighting the most appropriate camera model or suite of features necessary for a given survey application.

Additionally, SSTP began collaborating with University of Hawaii's Hawaii Institute of Marine Biology (HIMB) to assess the feasibility and effectiveness of Dual-frequency IDentification Sonar (DIDSON) and BlueView sonar systems for future Main Hawaiian Islands Fall Bottomfish Fishery-Independent Surveys. The use of DIDSON and BlueView-like sonar systems will help begin addressing the limitations of the MOUSS due to lack of ambient light in deeper waters.

Aquaculture Systems Management. During the reporting period, JIMAR staff (led by Aaron Moriwake) implemented a weekly exercise program and a year-round maintenance schedule to ensure system readiness for incoming animals in the four distinct units (monk seal, turtle, fish, and multi-purpose). Based on JIMAR staff recommendations, one three-horsepower (HP) pump from each turtle system was replaced with a one HP pump to allow running one tank at a time. This change also reduced the strength of the current (swirling or vortex) in the tank allowing for a gentler environment for the rehabilitating turtle and was a cost savings especially during long recovery time for injured turtles.

When animals were housed at the SWS facility JIMAR staff provided critical 24/7 emergency support through email/text alarm alerts, remote access control of cameras, and the Supervisory Control and Data Acquisition (SCADA) system. The SWS facility and JIMAR staff supported the PIFSC Protected Species Division (PSD) with the rehabilitation of three monk seals and twelve sea turtles. The project also supported the Survey and Sampling Technologies Program (SSTP) by providing a mechanism to test and calibrate Modular Optical Underwater Survey System (MOUSS) stereo camera systems.

Figure 5. Small boat MOUSS operations off the NOAA R/V Oscar Elton Sette *(SE-16-07).*

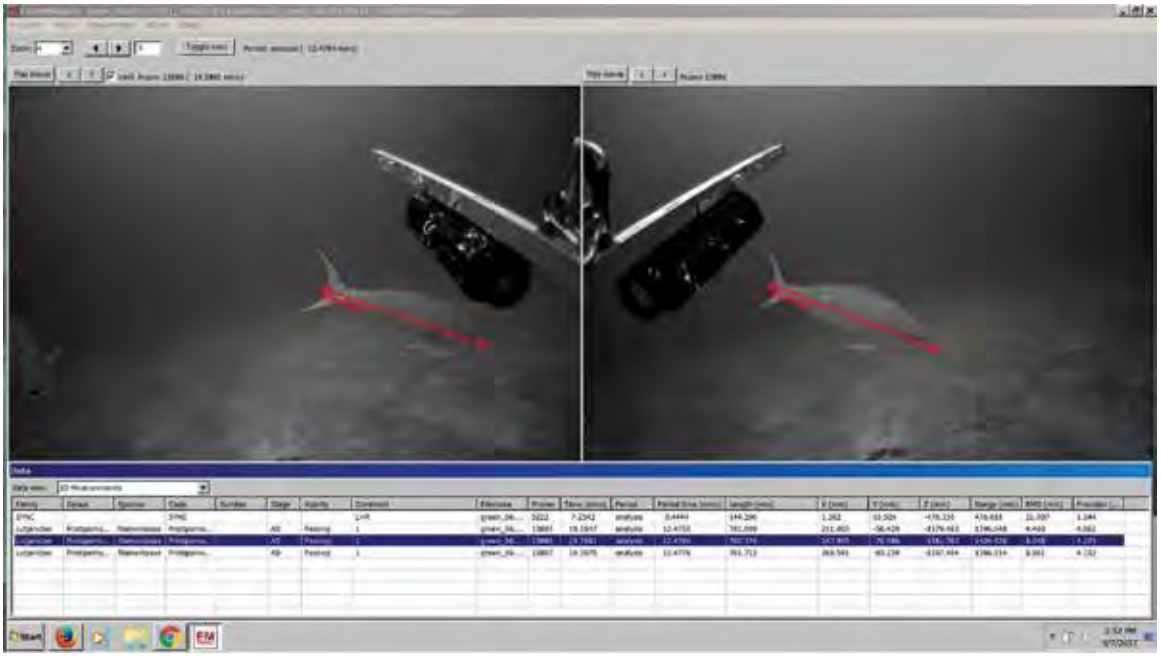


Figure 6. Post SE-16-07 cruise annotation using the GIS EventMeasure Software, showing one of the Deep 7 fishes, Opakapaka.

Figure 7. JIMAR and PIFSC staff preparing for MOUSS, DIDSON, and BlueView testing at Coconut Island.

Pacific Islands Region Fisheries Science Outreach and Education. Led by Amanda Dillon, the project delivered scientific outreach and education products, programs, and services including community events, Science Camp, PIFSC Young Scientist Opportunity, and printed and online products. Descriptions of selected outreach events are as follows.

The highly successful Fourth Annual NOAA Fisheries Science Camp, jointly coordinated between PIFSC, PIRO, and JIMAR, was held July 10-15, 2017 at the NOAA Inouye Regional Center. Many NOAA federal staff, JIMAR staff, and hired student assistants developed and taught six different science modules to provide the campers a unique hands-on experience in current fisheries research areas of: marine debris; fish sampling techniques and stock assessments; marine food webs; plankton; Hawaiian monk seals; and fisheries-dependent data.

The PIFSC Young Scientist Opportunity (PYSO) is another highly successful collaborative program coordinated by PIFSC and JIMAR that offers qualified undergraduate college science student participants professional scientific research experience and formal training opportunities tailored to meet their educational and professional goals and interests. In 2017, the PYSO program hired four highly-qualified undergraduate students to participate in summer research with JIMAR and federal staff at PIFSC.

Main Hawaiian Islands Bottomfish Benthic Habitat Mapping. Led by Annette DesRochers, the project evaluated and post-processed multibeam echo-sounder bathymetry data (high-resolution EM3002D and medium-resolution EM300 sonars) acquired from the NOAA Ship *R/V Hi'ialakai* within ~50–500 m depths during the 2015 American Samoa Reef Assessment and Monitoring Program (ASRAMP), 2016 Hawaiian Islands Reef Assessment and Monitoring Program (HARAMP), and 2017 Marianas Reef Assessment and Monitoring Program (MARAMP) cruises that support deep sea coral research.

It was intended that the final processed data would be incorporated with existing previously acquired bathymetry data (i.e., gap filling) in each region to create seamless digital bathymetric models and update the associated data products to be published and archived online. However, due to a number of issues affecting data quality, new data products were only produced for a small number of surveyed sites, including Howland, Baker, and Guam. Quality data was acquired at other sites during the 2015–2017 RAMP cruises, but those areas had been previously surveyed so the data were not used to update existing products.

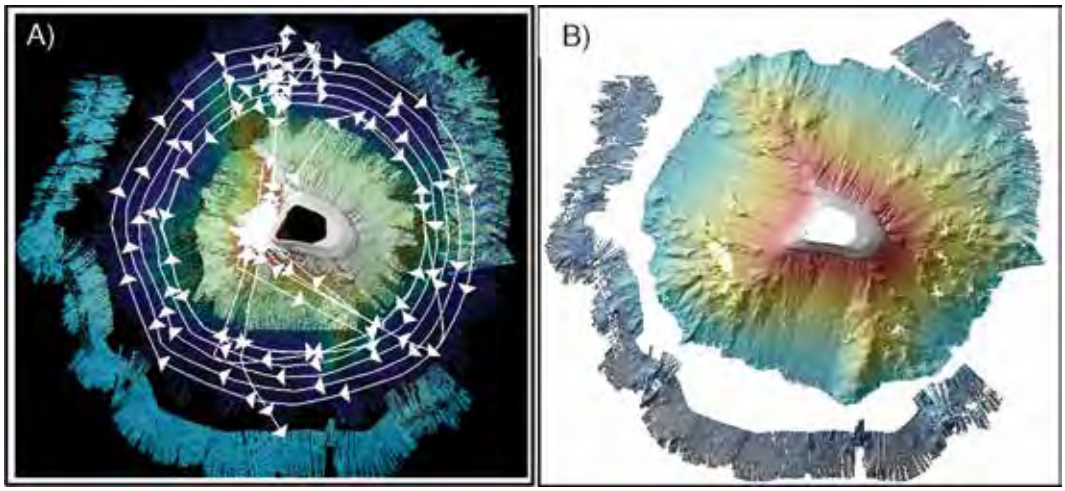


Figure 8. Inset A) shows the location of new EM300 ASRAMP data at Baker Island (white lines) from 2015 with reference to existing PIBHMC 40 m resolution surface. Inset B) shows the new combined surface of the PIBHMC data and the processed ASRAMP 2015 data.

Updated digital bathymetric models for Howland, Baker, and Guam are accessible on the Pacific Islands Benthic Habitat Mapping Center (PIBHMC) website and processed data are archived at the NOAA National Centers for Environmental Information. All other data and derived surfaces are preserved on the PIFSC network for potential future investigation.

When the sonar and associated hardware are working well, and when data acquisition protocols and best practices are adhered to, high quality bathymetric data can be acquired from the NOAA vessel. Such data, where available, provide a fundamental resource that supports and enables a great range of scientific research and monitoring. Unfortunately, for each of the RAMP surveys there were a number of significant problems that inhibited the consistent acquisition of high-quality data (e.g., absence of, or nonstandard, sea trials resulting in undetected faulty sonar head and roll-bias; poor sound-velocity control of water column to accurately calibrate seafloor depth; and potentially imprecise differential GPS positioning). These issues resulted in deficiencies in the acquired data—limited mapping extent, poorly-constrained vertical control, and inaccurate horizontal positioning—that variably affected much of the RAMP data. Despite efforts to identify, discuss, and address these issues following the 2015 and 2016 RAMP surveys, several problems persisted throughout the surveys in 2017. The project is actively engaging with PIFSC to maintain high quality survey standards going forward.

Analysis of Deepwater Surveys in the U.S. Line Islands. Led by Virginia Moriwake, the project delivered a comprehensive annotation of historical Line Islands dive video. Over 8,300 entries were logged from seven dives around Jarvis Island, Kingman Reef, and Palmyra Atoll. The video encompassed over 37 hours and the annotation included over 39,000 identified animals with many hundreds of observed species of fish, coral, invertebrates, etc., sorted by class, family, genus, and order, as well as simultaneous characterizations of habitat and benthic coverage. This comprehensive work will be registered and made available for future researchers who visit these areas and this data will provide a reference point to observe potential changes around these uninhabited Pacific reef areas.

GIS Mapping Tools for the Marianas Trench Marine National Monument Waters. Led by Kyle Koyanagi, JIMAR staff developed a series of new web-based geographic information system (GIS) mapping tools for the Pacific Marine National Monuments, including the Marianas Trench Marine National Monument. The collection of thematic online mapping tools highlight various Pacific Islands Fisheries Science Center (PIFSC) objectives including: fisheries research; cetacean surveys; coral reef monitoring; benthic habitat mapping; oceanographic information; and PIFSC research cruises. These data are distributed using a combination of ArcGIS Online and ArcGIS Server technologies. In addition to providing the online platform for viewing the data, the tools also include the ability to download data, access metadata, perform data queries, and create printable maps and figures. JIMAR is also expanding the tool to additional regions within the U.S. Pacific Islands, adding new data for the existing Mariana region, expanding the capabilities of the tool to include printing features, and improving the data management workflow. JIMAR staff also created a storymap to consolidate and highlight four web mapping

applications that include an introduction to the project, description, and link to each application. It will provide users with easier navigation and a centralized access point and be posted on the PIFSC website in the near future.

Fisheries Monitoring and Support

P.I.: Douglas S. Luther [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 presently 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 2017

The JIMAR staff supports fishery monitoring activities in a timely fashion 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-permitted 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 also encompasses striped marlin landings due to stock concerns. JIMAR staff has been cross training during the year to maintain coverage for the multiple facets of fast track duties. The monitoring data are compiled weekly or as necessary as the fish quota is caught. Additional quality control procedures and cross checks of relevant databases have been implemented as needed to continually improve the results, quality 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 validate and improve the quality of these data. The general Hawaii-permitted 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 include American Samoa longline logbooks. 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 new PIFSC/JIMAR longline Electronic Reporting Initiative is in progress. The electronic reporting system, which uses handheld tablets to record logbook information at sea and through JIMAR and PIFSC staff efforts, is currently in the testing and certification stages. During this process, JIMAR staff distribute tablets, train captains on the use of the tablets and the applications, and facilitate the transition, collecting, and editing of the electronic forms.

The PIFSC/JIMAR Electronic Monitoring Initiative is a project to test the installation of camera systems on longline vessels and comparing species composition data collected between cameras and simultaneous at-sea human observers. As of June 30, 2017, project performance was improved with cameras installed on 18 vessels and video from these cameras being collected by a JIMAR staff member.

Investigation of Ecological Constraints for Bumphead Parrotfish

P.I.: Douglas S. Luther [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: $57,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The bumphead parrotfish (*Bolbometopon muricatum*) is among the most iconic coral reef-associated fishes in existence, and documented or perceived declines of this species across its range have elicited concerns for its sustainability. This species spans the Indo-Pacific, from the Red Sea to French Polynesia and is globally designated as 'Vulnerable' by the International Union for the Conservation of Nature Red List. The original purpose of the project was to survey the abundance of juvenile *Bolbometopon* at Wake Island. This project ceased after fieldwork was completed in FY 2014. Most recently, the project conducted a meta-analysis of factors limiting the extant abundance and distribution patterns of *B. muricatum* and other large excavators across their geographic ranges, with particular emphasis on the U.S.-affiliated Pacific Islands, including the U.S. Territories (American Samoa and Guam), the Commonwealth of the Northern Mariana Islands, and the Marine National Monument areas. These U.S.-affiliated Pacific territories include coral reef ecosystems and *Bolbometopon* habitat that spans gradients in human population as well as environmental conditions. This includes some of the most densely populated and human-impacted reefs in the Pacific, as well as the most remote and pristine reef systems on the planet. These islands also include vastly different reefal systems, from oligotrophic oceanic island systems that lack complex and diverse habitat structures to coral reef systems associated with continental structures and high islands with large land masses. The gradient of human inhabitation from heavily populated to isolated and highly protected coral reefs under U.S. jurisdiction facilitates an extremely comprehensive analysis of anthropogenic constraints on large bio-eroding parrotfishes.

Progress during FY 2017

The objectives for this period were to collate abundance data sources of the bumphead parrotfish and other large excavating parrotfishes from across the Indo-Pacific region, and develop an analytical framework to assess ecological constraints on their abundance globally and within U.S. federal and state habitats. Dr. Howard Choat of the James Cook University (Townsville, Australia) was invited as a JIMAR visiting scientist to collaborate on this project. Dr. Choat facilitated the combination of multiple large datasets from the Pacific (including from the PIFSC Coral Reef Ecosystem Program) and Indian Oceans. During and after the workshop with Professor Choat, staff scientists derived environmental and anthropogenic factors from *in situ* and satellite-derived data. As a result, the project collated *Bolbometopon* data from the following locations into one analysis-ready database: the U.S.-affiliated Pacific territories, Micronesia, the Philippines, Papua New Guinea, Timor Leste, the Great Barrier Reef, western Australia, Christmas Island, Cocos-Keeling, Seychelles, the Red Sea, Madagascar, Mozambique, Tanzania, and Kenya.

A draft manuscript is currently in preparation. It assesses the biological, physical, and anthropogenic constraints on the abundance patterns of *Bolbometopon* and other large excavating parrotfish species across the Indo-Pacific region, including every U.S.-affiliated location throughout the Pacific Islands. Additional data sources offered by collaborating scientists held up the final analyses. However, it was determined that these data will provide a valuable addition to the study. This manuscript will be completed and submitted during FY 2018.

Figure 1. Juvenile Bolbometopon muricatum *(Photo: Tane Sinclair-Taylor).*

Figure 2. Adult Bolbometopon muricatum *(Photo: Mark Priest).*

Kona Integrated Ecosystem Assessment

P.I.: Douglas S. Luther [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, Jamison Gove

Budget Amount: $205,850

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project directly supports the Kona (or West Hawai‘i) Integrated Ecosystem Assessment (IEA), a program focused on the interactions of social and ecological systems to better understand and effectively conserve the marine resources and associated ecosystem services in West Hawai‘i. The West Hawai‘i IEA recognizes that human activities are integral parts of the ecosystem and highlight the critical importance of preserving the basic structure of the ecosystem as a whole. The objective of the IEA is to develop integrated management strategies for defined ecological regions rather than for individual ocean use sectors such as fisheries, aquaculture, shipping, tourism, and recreation. By recognizing human activities as essential elements of coastal and marine ecosystems, such activities both affect the ecosystem and are affected by natural changes in these systems. While marine ecosystems exhibit varying levels of resiliency to different threats and impacts, it is clear that human actions have the capacity to adversely affect ecosystem structure and function. These alterations can, in turn, affect the sustainable delivery of the ecosystem services so vital to human well-being.

Progress during FY 2017

During the reporting period, JIMAR scientists supported the mission and objectives of the West Hawai‘i IEA through a variety of accomplishments. The first ever Ecosystem Status Report was developed and published as a NOAA Technical Report for the region. The report represents a comprehensive assessment of West Hawai‘i’s marine ecosystem, detailing the trends and status of 30 ecosystem indicators across key social, ecological, and climate and ocean aspects of the region. This report will play a central role in the resource management efforts and policy decision-making in the region and represents a milestone for NOAA’s efforts towards the implementation of Ecosystem Based Fisheries Management.

In September 2016, the West Hawai‘i IEA research team participated in a multidisciplinary research cruise aboard the NOAA Ship *Oscar Elton Sette* to study the marine ecosystem along the west coast of Hawai‘i Island. Over the 20-day cruise, JIMAR scientists investigated the factors that makes Hawai‘i and other tropical marine ecosystems function as hotspots in productivity and species diversity that in turn help populate fisheries and provide coastal protection.

For the first ten days of the expedition, JIMAR researchers focused on an area of high abundance of deep-water organisms located in the South Kona region. This group of organisms, termed the “mesopelagic boundary layer community”, lives within a mile from shore in relatively deep water (400–600 m). The mesopelagic boundary layer community is thought to be an important food resource for higher trophic groups that frequent the waters off West Hawai‘i, such as dolphins and whales.

The second half of the expedition focused on a project entitled SLICK: Surface Lines In Coastal Kona. Surface lines, or “slicks”, are narrow, meandering lines that are associated with increased water tension that dampens surface ripples and produces a visibly smooth, ribbon-like feature in the coastal ocean. The areas within and around slicks appear to function as biological hotspots because they collect floating material and attract organisms in areas where food resources are otherwise sparse and dispersed. Preliminary results indicate that slicks may contribute to the recruitment and retention of early life history stages of marine organisms, such as pelagic and reef fishes.

Main Hawaiian Islands Deep 7 Bottomfish Fast Track Project

P.I.: Douglas S. Luther [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

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

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

The 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-Hawaii Division of Aquatic Resources (DLNR-HDAR) implemented a new Administrative Rule in 2011 requiring commercial fishermen who catch Deep 7 species to submit reports within five days of their trip end date. JIMAR staff work in collaboration with DLNR-HDAR to fast-track Deep 7 bottomfish fishing and dealer data in order to successfully monitor the fishery. The fishing year for the Deep 7 bottomfish fishery opens annually on September 1st and closes either when the total landings are predicted to reach the ACL or on August 31 (whichever occurs first).

Progress during FY 2017

JIMAR staff successfully processed and fast-tracked Main Hawaiian Islands (MHI) commercial catch and dealer data, including the Deep 7 bottomfish fishery that is managed by a federal ACL.

The MHI Deep 7 bottomfish 2016-2017 federal fishing year closed on August 31, 2017 with a total of 338 commercial fishers that made 2,307 trips and landed 234,299 pounds of Deep 7 bottomfish, or 73.7% of the ACL (318,000 pounds).

Ocean Remote Sensing

P.I.: Douglas S. Luther [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, Evan Howell

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 portal 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, and high-resolution (1.1 km) thermal infrared High Resolution Picture Transmission (HRPT) imagery from the NOAA Advanced Very High Resolution Radiometer (AVHRR) satellites. The HRPT data is collected daily by the AVHRR receiving station located in Ewa Beach, Oahu (Hawaii).

Progress during FY 2017

In addition to maintaining all data streams and servers and servicing data to OWCP users, this project finalized the development of site-specific Sea Surface Temperature (SST), chlorophyll a concentration (Chl-a), and eddy kinetic energy (EKE) indices for NOAA's Kona Integrated Ecosystem Assessment Program. These indices are provided as interactive graphs and updated monthly on the OWCP website to provide online visualizations of indicators of conditions in the region to a variety of users.

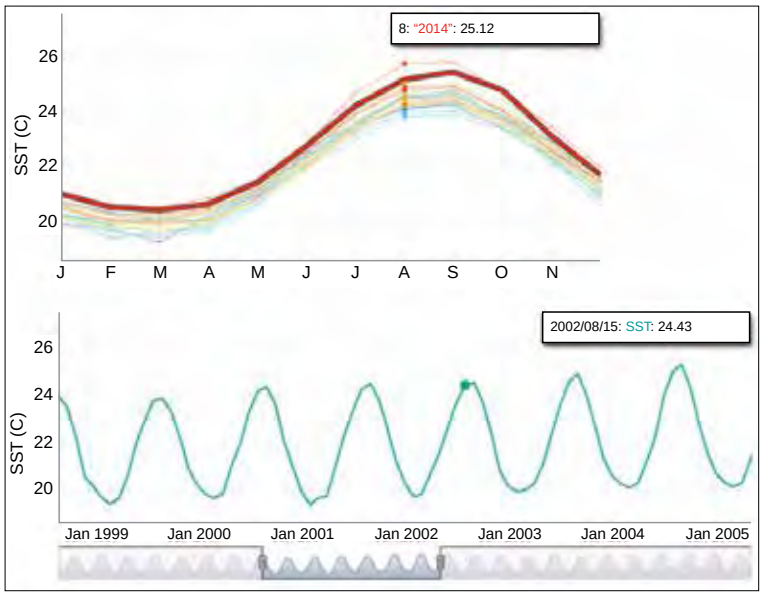


Figure 1. Examples of interactive graphs provided on the OWCP website.

Similarly, OWCP provided time-series and maps of quarterly climatologies and anomalies for SST, Chl-a and EKE to be included in the Western Pacific Regional Fishery Management Council's annual Stock Assessment and Fisheries Evaluation report. These graphs are also available online on the OWCP website as interactive graphs.

Two servers and a data array with 60TB of data storage capacity were installed to replace aging computer equipment and accommodate new data formats and libraries, allow storage of newer and higher-resolution data streams, and improve user experience and presentation capabilities. In addition, due to changes in the formats that the data providers are currently using, OWCP modified the work flow and processing scheme for all data streams to reduce data replication.

Project staff also wrote tutorials for R and ArcGIS users which were added to the website to increase data use and build user capacity. Finally, JIMAR staff attended the annual CoastWatch meeting in July 2017 to present

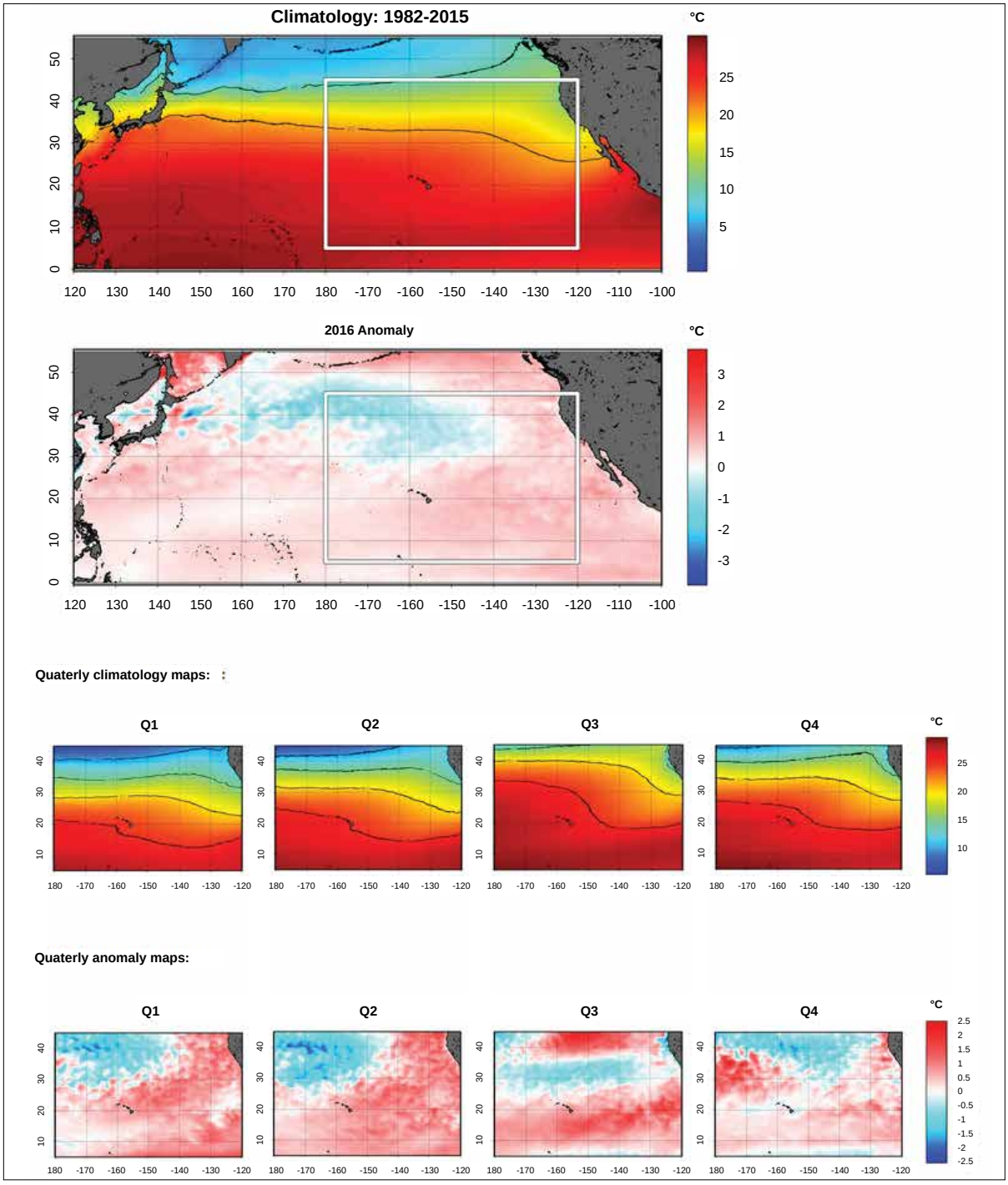


Figure 2. Examples of climatology and anomaly plots provided for the SAFE Report.

updates on OWCP activities, and attended a satellite course in August 2017 to evaluate content and delivery with the goal of bringing the course to Central Pacific scientists and managers.

Pacific Islands Territorial Science Initiative

P.I.: Douglas S. Luther [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 the Pacific Islands Territorial Science Initiative (TSI) project is to improve the volume and quality control of catch data from the fisheries of the U.S. Pacific territories of Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands (CNMI). Lack of data collection and quality control in these territories has resulted in a paucity of fisheries information to guide management actions mandated by the Magnuson-Stevens Act and other federal laws. The small size and modest budgets of territorial governments, relatively low commercial value of the diverse and small-scale fisheries, and limited physical presence of National Marine Fisheries Service (NMFS) staff in these islands 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. The TSI project collaborates with several other JIMAR projects and Pacific Islands Fisheries Science Center (PIFSC) programs to promote better communication with management agencies in the territories, establish and improve protocols for fisheries monitoring and sampling, and develop tools for data expansion and summary analyses.

Figure 1. American Samoa Department of Marine and Wildlife Resources staff work with the Territorial Fisheries Data Associate to identify marine invertebrates during the first of a series of workshops conducted for them.

Progress during FY 2017

The project Territorial Fisheries Data Specialist completed many data and analytical requests, including an analysis of variability in the aerial survey correction factor for the Guam creel survey and generalized additive modeling to identify environmental factors that influence shore-based fishing catch-per-unit-effort in American Samoa. Automated creel survey scheduling applications were updated to reflect changes requested by creel

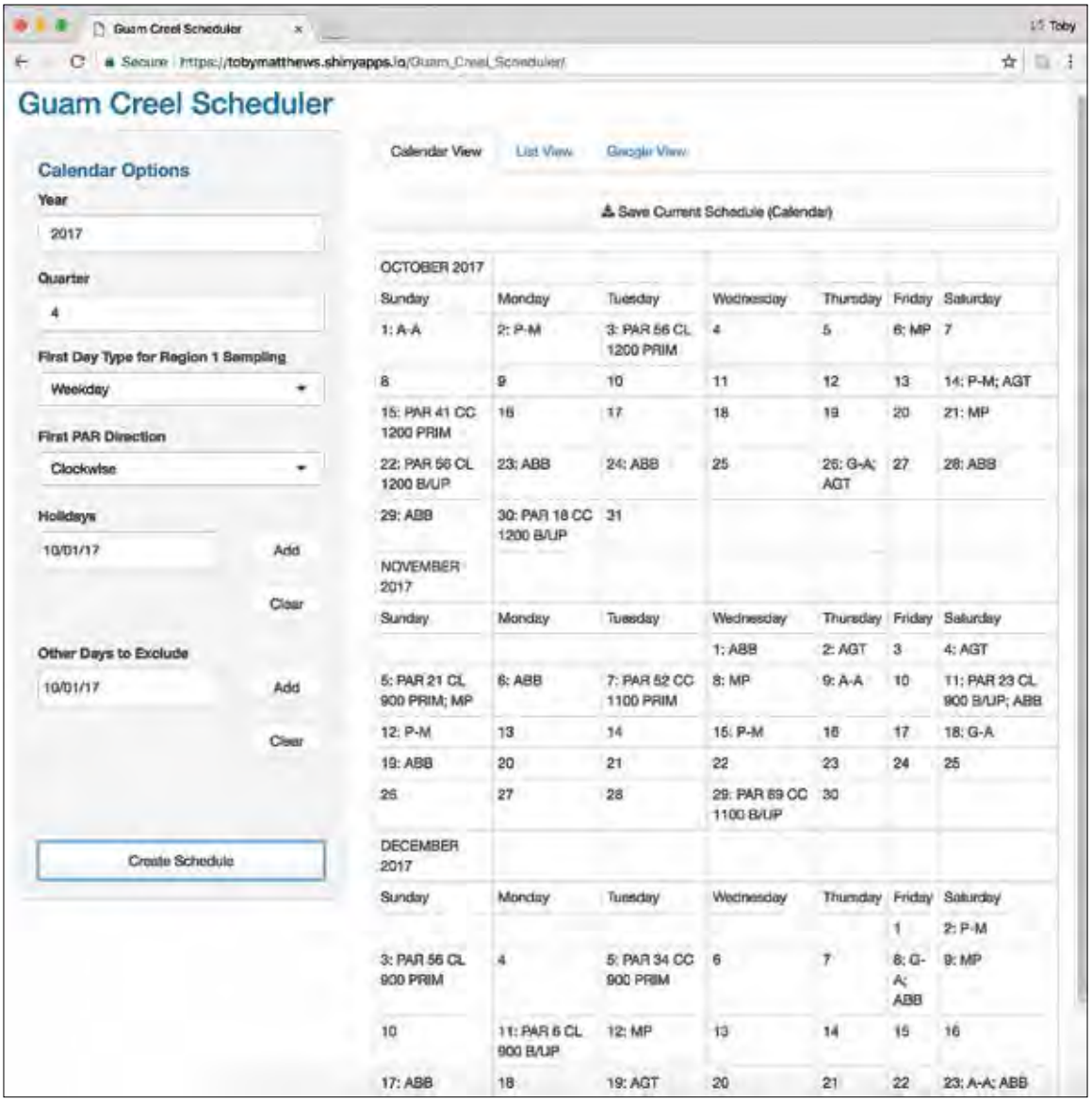


Figure 2. A screen capture of the creel survey scheduling application created by the Territorial Fisheries Data Specialist. This application automates the otherwise tedious process of creating a randomized schedule and provides several formatted outputs for creel survey supervisors.

survey supervisors. Documentation was produced for most of the creel data expansions, rewritten in R from their original Visual FoxPro. The Territorial Fisheries Associate on Guam contributed many surveys to the Guam Division of Aquatic and Wildlife Resources (DAWR) creel program, performed quality control on all creel data, and assisted with database issues.

Along with PIFSC federal staff and territorial agency staff, the Territorial Fisheries Data Specialist and Territorial Fisheries Associate conducted two workshops for staff at the American Samoa Department of Marine and Wildlife Resources (DMWR). The first workshop introduced a species information manual and covered the use of species identification keys, and the second workshop explained the theory and applications of length sampling and survey design. All but one of the objectives established for the fiscal year have been satisfied. The exception is that final creel survey manuals could not be finished for American Samoa DMWR or CNMI Division of Fish and Wildlife (DFW). Drafts were completed but could not be reviewed by local supervisors due to the absence of a creel supervisor at CNMI DFW and time constraints on creel supervisors at American Samoa DMWR.

Pacific Tuna Fishery Data Management

P.I.: Douglas S. Luther [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, tuna fisheries monitors and fisheries managers and policy makers. JIMAR staff develops tools to enable access to these data and a system for sustained data management. The project coordinates with several NOAA National Marine Fisheries Service (NMFS) offices to develop the data management system and also with several Pacific Islands Fisheries Science Center (PIFSC) research projects and the Pacific Islands Regional Office (PIRO) for subsequent access and analysis functions and to meet monitoring and reporting requirements.

Progress during FY 2017

The project continued to develop data entry systems and database structure for logsheet, turn out receipts, and sampling forms from the fishers. The project began developing new applications to manage the data streams and migrate them to the PIFSC enterprise database. In addition, quality control measures were developed for various

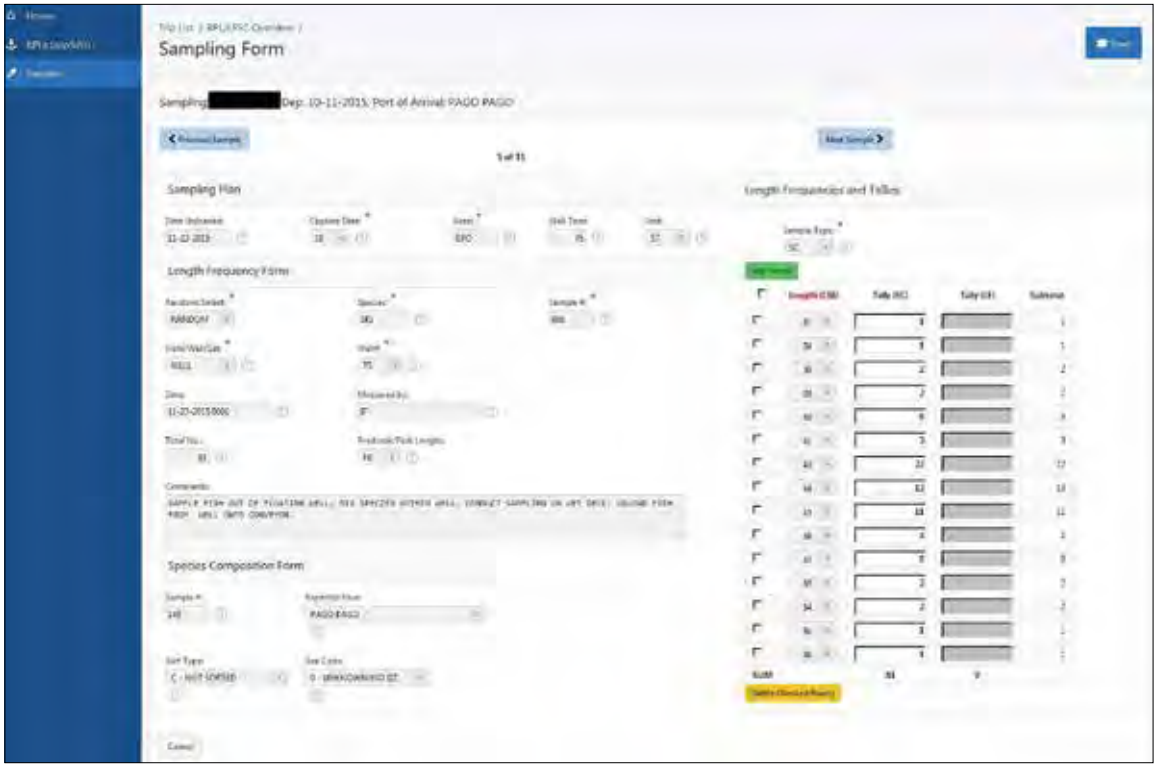


Figure 1. Screenshot of the sampling data management application, the confidential information has been redacted.

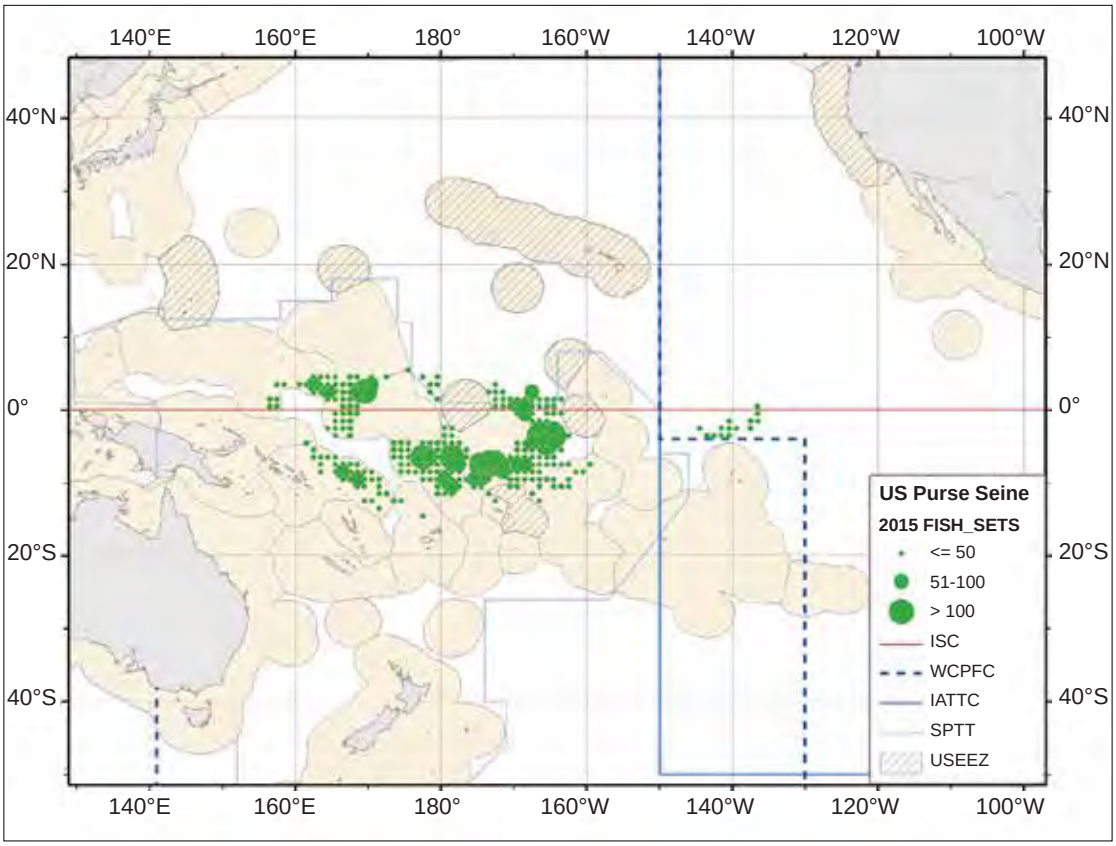


Figure 2. Distribution plot of the SPTT purse seine effort in fishing sets using graduated symbols for the calendar year 2015 showing jurisdiction areas of the Western and Central Pacific Fisheries Commission (WCPFC), Inter-American Tropical Tuna Commission (IATTC), and the International Scientific Committee for Tuna and Tuna-like Species (ISC).

data streams. The project investigated alternative data entry systems and participated on a review of existing data management systems for PIFSC. Project staff also supported the PIFSC electronic reporting project by assisting with migration of data directly from the fishing fleet.

The top objective for the year was developing a process to receive electronic reporting data and create reports to calculate fishing days and other statistics. The project also collaborated with PIFSC and PIRO on secure file transfers, built databases and data entry systems for fishing information forms, and designed a database model for the discard form data stream.

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: Craig Russell

Budget Amount: $48,981

NOAA Goal(s)

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

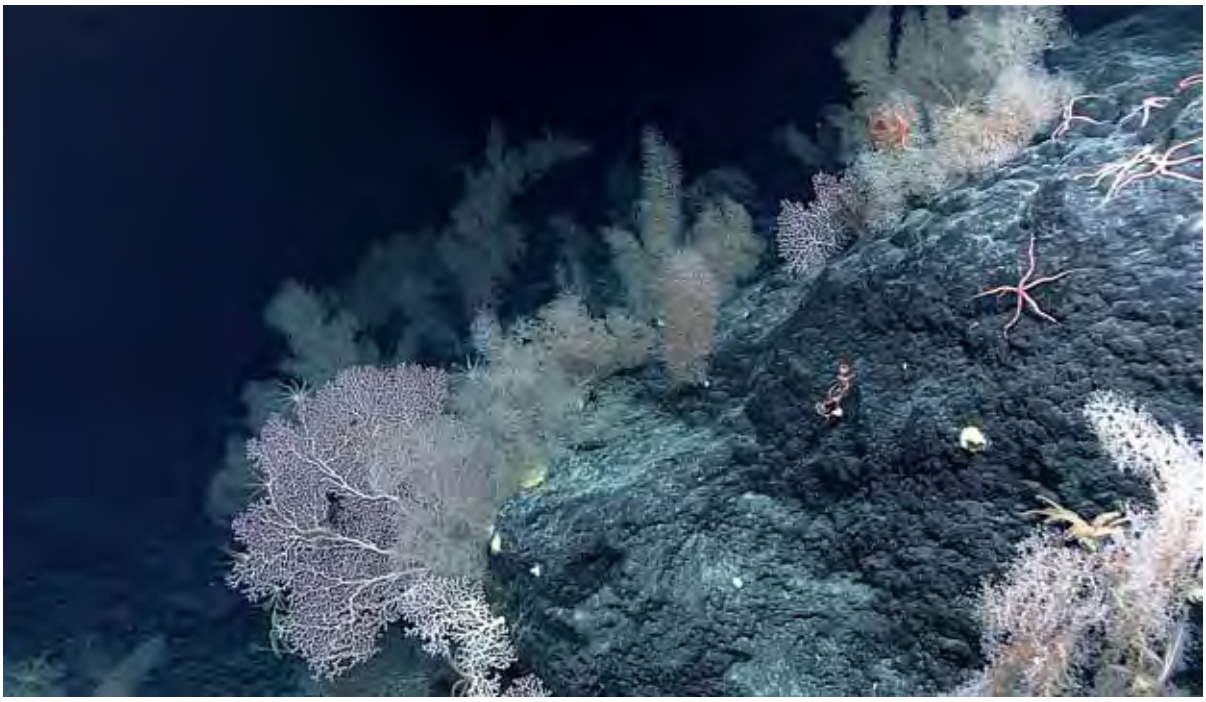


Figure 1. Site: Sibelius Seamount. On September 10, 2017, while exploring Sibelius Seamount, the team observed this garden of coral at a depth of 2,465 meters (8,080 feet). This garden was one of two high-density communities observed during the dive (Photo and caption: NOAA Office of Ocean Exploration and Research, Deep-Sea Symphony: Exploring the Musicians Seamounts*).*

Figure 2. Site: Schumann Seamount. This large rippled sponge, approximately four meters (13.1 feet) in length, looks to be the same animal discovered during the Okeanos Explorer 2015 Hohonu Moana expedition. It may be in the hexactinellid family Rossellidae and subfamily Lanuginellinae. The sponge was found at 2,150 meters (7,054 feet) (Photo and caption: NOAA Office of Ocean Exploration and Research, Deep-Sea Symphony: Exploring the Musicians Seamounts*).*

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 2017

The PI continued the work under this proposal along with another related but separate proposal. As detailed in this proposal's "description of work" section, he has responsibilities related to: 1) out-year planning; 2) expedition planning; 3) expedition execution; and 4) post expedition deliverables. His work for this report period began with item 3 because the PI was one of the two onboard scientists for the sixth 2017 ROV cruise (EX1706) to the Johnston Unit of the Pacific Remote Islands Marine National Monument (PRIMNM) that took place from July 7 to August 2. The PI assisted with the planning for EX1707 that was a mapping cruise from August 7-31. The final 2017 cruise, which was also the final cruise for the entire CAPSTONE project, took place from September 6 -30. The PI assisted with the planning for this cruise to the Musicians seamounts and also actively participated remotely via the University of Hawaii Exploration Command Center (ECC).

During the reporting period, the PI was primarily occupied with responsibilities related to items 1, 2, and 4. Because these were the final cruises for the CAPSTONE project, very little work was required under item 1. With respect to item 2, he helped develop science priorities and plans for EX operations around Johnston Atoll and the Musicians Seamounts, and assisted OER staff in the identification of the core and auxiliary science teams in collaboration with external partners and the science community. Priorities and dive plans were presented to OER staff, NOAA and external partners, and interested members of the science community via the usual routes that included teleconferences, webinars, and in person presentations. Regarding item 4, the PI first completed a draft of the report for the Johnston Atoll cruise in early August. As with previous years, he then personally took custody of all of the biological and geological samples obtained during EX1706 and subsequently shipped the biological specimens to the Smithsonian. He also took custody of the biological and geological samples from EX1708. These along with the geological samples taken during EX1706 are in his laboratory and will be shipped to the Smithsonian and Oregon State University Geological repository in November. He took aliquots of the corals and sponges to Bishop Museum and worked with the invertebrate collections manager to transfer them into their collections.

Sustaining Healthy Coastal Ecosystems

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

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

NOAA Sponsor: Michael P. Seki, Russell Brainard

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 is a multi-disciplinary research endeavor that monitors and assesses the reef ecosystems in: the Main Hawaiian Islands (MHI); the Northwestern Hawaiian Islands (NWHI); the Pacific Remote Island Area (PRIA) including Midway, Wake, Johnston, Palmyra, Howland, Baker, Jarvis, and Kingman islands/atolls; the Commonwealth of Northern Marianas Islands (CNMI); American Samoa; and Guam. This monitoring effort provides for effective management of the health and vitality of the coral reef systems. The extensive spatial range and depth of this effort requires coordinated research from the JIMAR staff in the NOAA/National Marine Fisheries Service (NMFS) Pacific Islands Fisheries Science Center (PIFSC) Coral Reef Ecosystems Program (CREP) across several research teams: Fish Ecology and Monitoring; Benthic Ecology and Monitoring; Ocean and Climate Change; Ecospatial Information; Marine Debris Response and Operations; Data Management; and International Capacity Building.

Progress during FY 2017

Coral Reef Fish Research. The JIMAR Coral Reef Fish Research team (led by Adel Heenan) met their stated goals for the reporting period including: 1) continued baseline assessments and analyses of the condition and status of the coral reef fish assemblages within U.S.-affiliated Pacific Islands; 2) provided information and assistance across the Pacific to aid in determining population status of select target coral reef fishery species and in establishing Annual Catch Limits (ACLs) for coral reef fisheries as mandated by the Magnuson-Stevens Act; 3) evaluated the importance of herbivorous fish functional groups to the condition of coral reef ecosystems across the Pacific; 4) provided data management and analysis support to the Hawaii State Division of Aquatic Resources (DAR) coral reef monitoring program; 5) worked with partners to evaluate the effectiveness of management actions in Marine Protected Areas, including Kahekili, Maui; 6) improved data collection programs that provide accurate information for ecosystem-based management and conservation efforts; and 7) provided Integrated Ecosystem Approaches to Fisheries Management (IEAFM) guidance and training to the countries of the Coral Triangle.

Notable accomplishments by the team included participation in the successful execution of reef fish monitoring surveys as part of HARAMP, MARAMP, and an auxiliary coral bleaching cruise to Jarvis Island. Through collaborations with NOAA partners at the Monuments Program, the fish team helped lead fish diver trainings and acted as the fish survey lead on the Monument's Northwest Hawaiian Islands monitoring cruise. Finally, to advance PIFSC's fish survey techniques, the fish team assisted with field training and deployment of new underwater video sampling gear during various fish research cruises including a Baited Remote Underwater Video System and Modular Optical Underwater Survey Systems.

JIMAR fish team personnel supported completion of numerous products including: peer-reviewed manuscripts; quarterly reports to the Western Pacific Regional Fishery Management Council; cruise summary briefs and full reports; and survey method standard operating procedures (SOPs). Progress on the following deliverables proposed in FY 2017 are still underway, including: assessing the socio-environmental climate change vulnerability in American Samoa; establishing biomass baselines for the MHI; and performing a Pacific-wide biomass accumulation curve analysis.

Benthic Research. The JIMAR Benthic Research Team (led by Bernardo Vargas-Angel) met their stated goals for the reporting period including: 1) conducted assessments and monitoring of the status and trends of the coral reef benthic assemblages within U.S.-affiliated Pacific Islands; 2) continued to assess and monitor the health and incidence of disease and bleaching in the coral reef ecosystems in the U.S.-affiliated Pacific Islands, in particular, the effects of the global 2015–2016 bleaching event; 3) continued jurisdiction-wide analyses of digital imagery to monitor spatial trends in reef benthic composition; 4) updated methods and timeliness of data dissemination to NOAA partners and the public; 5) improved research and data collection methods and analysis that provide information for ecosystem-based management and conservation efforts; and 6) continued providing support for Endangered Species Act (ESA) and IEAFM projects.

Notable accomplishments during the reporting period include supporting the successful execution of benthic Rapid Ecological Assessment (REA) surveys for coral community structure, demographics, and condition as part of HARAMP, MARAMP, and an auxiliary coral bleaching cruise to Jarvis Island. The JIMAR benthic team recently completed four brief monitoring summary reports for the surveys conducted during the 2017 MARAMP cruise (Jarvis Island, Wake Atoll, Southern Mariana Islands, and Northern Marianas Island). A primary focus during this reporting period was to collect monitoring data to document the effects of the 2015 and 2016 coral

Figure 1. Photograph from the all-day workshop hosted by the Government of Timor-Leste's Ministry of Agriculture and Fisheries (MAF), led by NOAA's Coral Reef Ecosystem Program (NOAA CREP), and funded by the U.S. Agency for International Development (USAID). From left to right: Acacio Guterres, Director General for Fisheries (MAF); Raimundo Mau, Program Manager, Conservation International; former Timor-Leste President Jose Ramos-Horta; Estanislau Aleixo da Silva, Minister of MAF; Karen Stanton, U.S. Ambassador; Diana Putman, USAID Mission Director; Molly Timmers (NOAA CREP); Flavia da Silva (USAID); and Annette DesRochers (NOAA CREP).

bleaching episodes within the study region. These efforts included supporting the establishment of permanent transects in West Maui to track changes in the benthic community at fixed sites through time, and supporting efforts by DAR and U.S. Geological Survey partners to establish baselines for benthic structure and coral demography within the West Maui Priority Watersheds.

JIMAR benthic team scientists made progress on two analytical projects aimed at developing habitat use outputs and linking them to environmental drivers to improve the population assessment of ESA-listed corals. The first of these projects, the Isopora project, will be completed at the end of 2017 in conjunction with Marie Ferguson's Master of Science defense at University of Hawaii. The Protected Species Toolbox Project is scheduled to be completed in 2018.

JIMAR benthic team personnel supported completion of numerous products, including metadata records for the benthic survey data, revising the SOP for the REA Benthic Surveys, and finalizing a scientific publication addressing the demographic, biological, and environmental correlates of coral diseases in the U.S.-affiliated Pacific Islands.

Ocean and Climate Change Research. The JIMAR Climate and Ocean Change Research Team (led by Tom Oliver) met their stated goals for the reporting period including: 1) continued baseline assessments of the oceanographic conditions that affect the health of the coral reef ecosystems within the U.S.-affiliated Pacific Islands; 2) monitored oceanographic conditions and changes in these U.S.-affiliated Pacific Islands, particularly those relating to coral bleaching and ocean acidification; 3) improved understanding of coral reef ecosystems through assessment and long-term monitoring of pertinent oceanographic parameters throughout the Pacific; 4) enhanced coral reef ecosystem management and conservation; 5) supported the Coral Triangle Initiative with a field mission to the Philippines. This mission will retrieve Calcification Accretion Units (CAU), temperature sensors and a number of Autonomous Reef Monitoring Structures (ARMS); 6) improved research and data collection methods and analysis that provide information for ecosystem-based management and conservation efforts; 7) developed effective ecosystem models that integrate physical, climate, habitat, ecological and fisheries

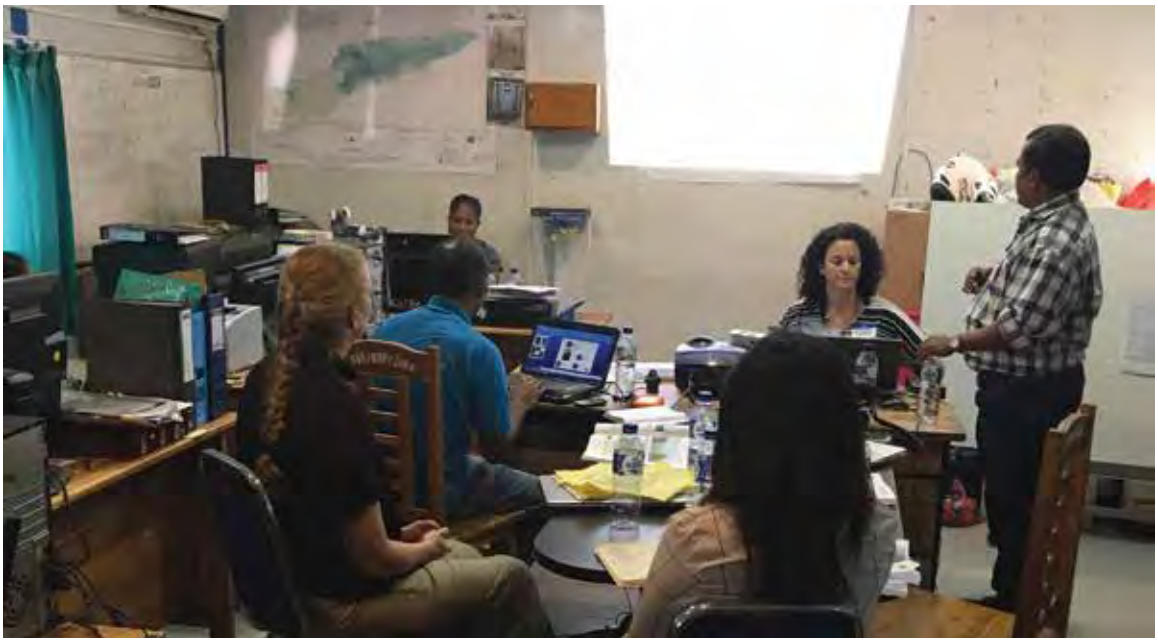


Figure 2. JIMAR staff conducted a hands-on training for Timor-Leste's Ministry of Agriculture and Fisheries staff on how to access and convert the survey data so it can be displayed in mapping software with other spatial data. Participants learned several new techniques to work with and display spatial data.

data so that managers can better understand the dynamics in coral reef ecosystems and threats to their health; and 8) improved methods and timeliness of data dissemination to our partners and the public.

Accomplishments during the reporting period include measuring environmental drivers and responses of coral reef ecosystems to the impacts of warming and ocean acidification as part of the HARAMP, MARAMP, and an auxiliary coral bleaching cruise to Jarvis Island. The Ocean and Climate Change Team continued implementation of NOAA's National Coral Reef Monitoring Program (NCRMP)-climate efforts involving a standard suite of oceanographic and ecological information throughout each of NOAA's jurisdictions in the Pacific to assess coral reef ecosystem health and quantify spatial and temporal variability related to a changing climate. The team improved the methods and timeliness of data dissemination by developing a methodological approach to assess island and atoll scale carbonate chemistry information across the U.S. Pacific Islands.

JIMAR Ocean and Climate team members supported completion of numerous products including peer-reviewed manuscripts, quarterly reports to the Western Pacific Regional Fishery Management Council, and several presentations at international conferences.

Several deliverables are currently in progress including: 1) continuing to incorporate analysis and interpretation of data collected during MARAMP, ASRAMP and HARAMP into a series of data products; 2) drafting peer-reviewed papers on seawater chemistry and CAU datasets for a September 30, 2017 submission to a peer-reviewed journal (e.g., a manuscript entitled, "Environmental drivers of coral reef carbonate accretion in the U.S. Pacific"); and 3) analyzing CAUs from HARAMP 2016 to allow remote, long-term monitoring of ocean acidification conditions affecting the coral reef ecosystems across the Pacific.

Marine Debris Response and Operations. The JIMAR Marine Debris Response and Operations Support Team (led by James Morioka) met their stated goals for the reporting period including: 1) conducted marine debris survey and removal operations in the NWHI; 2) developed protocols to improve measuring the impacts of derelict fishing gear on shallow coral reef ecosystems; 3) developed research driven projects to improve understanding the characteristics, impacts and accumulation of marine debris—including microplastics—in the NWHI; 4) disseminated information about marine debris issues to management agencies and the public; 5) opportunistically provided aid in local marine debris related emergency responses; and 6) opportunistically conducted marine debris survey and removal operations in the MHI.

Specific accomplishments during this reporting period include supporting the planning, operational support, and execution of numerous RAMP research cruises, Reef Fish Survey cruises, and marine debris removal efforts.

JIMAR Marine Debris and Operations staff also continued support and collaboration with the Protected Species Division Hawaiian Monk Seal Research Program (HMSRP) to execute marine debris surveys and removal in and around known monk seal habitats. The team made significant progress towards establishing standing stock surveys for marine debris accumulation at all HMSRP field camp stations with survey efforts and removals conducted in April-May 2016 and April-August, 2017.

International Capacity Building. The JIMAR International Capacity Building Team (led by Supin Wongbusarakum) met their stated goals for the reporting period including the following. 1) Improved capacity and proficiency among key staff in NOAA and partner organizations in Micronesia and the State of Hawai'i for using socioeconomic monitoring as a tool to improve coral reef conservation planning and management. In particular, the trained participants will serve as trainers for their jurisdictions and at the regional level. 2) Improved understanding of the socioeconomic conditions of reef-dependent communities and their relationships with bio-physical factors in the Habitat Blueprint site Manell-Geus. Data from the socioeconomic assessment will apprise management of the effectiveness of their decisions and activities, and help target outreach and education efforts to improve their effectiveness. 3) Established integrated monitoring that takes into consideration socioeconomic surveys. Such work will provide a more holistic understanding of the linkages between bio-physical and social factors and better inform management.

Specific accomplishments during this reporting period include supporting efforts to establish and strengthen social science applications to enhance ecosystems management that takes into consideration human well-being and balancing it with ecological health through good governance. These efforts include supporting the Micronesia Socioeconomic Monitoring (SEM) Team through training led by JIMAR staff in Micronesia for representatives from CNMI, Yap, Chuuk, Pohnpei, Kosrae, Marshalls Islands, Palau and Guam. JIMAR's International Capacity Building team continued to support the Pacific Islands Regional Office (PIRO) Pacific Islands Marine Protected Areas Community Project (PIMPAC) in developing SEM objectives, form strategic plans, and conducting in-country SEM training workshops.

JIMAR's International Capacity Building personnel supported completion of numerous products including: peer-reviewed manuscripts; presentations at international conferences; contributions to PIFSC Socioeconomic Program reports; SEM monitoring plans for Guam's Manell-Geus; and final SEM trainings agendas and survey questionnaires for partner organizations in Micronesia and the State of Hawai'i.

Ecospatial Information Research. The JIMAR Ecospatial Information Research Team (led by Annette DesRochers) met their stated goals for the reporting period including: 1) developed map-based products and dissemination tools covering entire coral reef ecosystems to enhance research, management, and conservation of marine resources; 2) improved understanding of the distribution of coral reef ecosystem communities and resources within the U.S. Pacific Islands; 3) collaborated with projects conducting ecological monitoring of coral reef ecosystem communities to improve understanding of organism–habitat associations; 4) researched, developed, tested, and implemented methods to process remotely sensed (satellite) data to support the classification of near-shore benthic habitats in the insular Pacific; and 5) developed survey designs and protocols and supported research projects through geographic information system (GIS) training, managing geospatial data, and administering GIS infrastructure.

Specific accomplishments during this reporting period include supporting the successful development of benthic habitat map layers for MHI and providing these map layers to the CREP Fish Team to predict reef fish distributions. The team produced satellite-derived bathymetry for five islands in the PRIMNM and completed maps to be used in the PRIMNM monitoring report. In addition, new benthic habitat mapping data products were completed to support PIRO with the critical habitat designation for the Pacific ESA-listed coral species. During this reporting period, the Ecospatial Information Team supported web map projects for the Pacific Marine National Monuments and RAMP efforts, provided geospatial support to DAR, and continued to update the Pacific Islands Benthic Habitat Mapping Center web site.

Data Management. The JIMAR Data Management Team (led by Troy Kanemura) met their stated goals for the reporting period including: 1) provided data management and application development services for effective stewardship of CREP's data holdings; 2) provided data management services to meet guidelines and directives of NCRMP, including data access, documentation, and archiving; 3) provided data management and application development services to aid local coral reef resource management agencies in effective stewardship of their coral reef monitoring program data sets and facilitated efficient integration of monitoring data sets between these agencies and CREP; 4) provided guidance and support to achieve the goals and milestones laid out in the recent NOAA and NMFS data-related Policy and Procedural Directives; and 5) accurately documented and archived

coral reef data collected by CREP, thus meeting requirements of the NOAA Plan for Public Access to Research Results (PARR).

Throughout this reporting period, JIMAR staff continued to provide analytical support to DAR and also responded to requests for CREP RAMP data. The Data Management team led PIFSC efforts to meet PARR requirements for the Center.

Western Pacific Fisheries Information Network (WPacFIN)

P.I.: Douglas S. Luther [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: $350,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The objective of the Western Pacific Fisheries Information Network (WPacFIN) project is to provide the best available fisheries monitoring data for research and sustainable management of fisheries in the Pacific Islands Region. WPacFIN partners with agencies in Guam, the Commonwealth of the Northern Mariana Islands (CNMI), Hawaii, and American Samoa. JIMAR and Pacific Islands Fisheries Science Center (PIFSC) federal staff work with island agency staff, contractors, fishermen, and fish dealers to create data systems that implement quality

Figure 1. Anna Regis, JIMAR Fisheries Database Assistant on Guam, together with Guam Division of Aquatic and Wildlife Resources staff at the 2017 Kid's Fishing Derby.

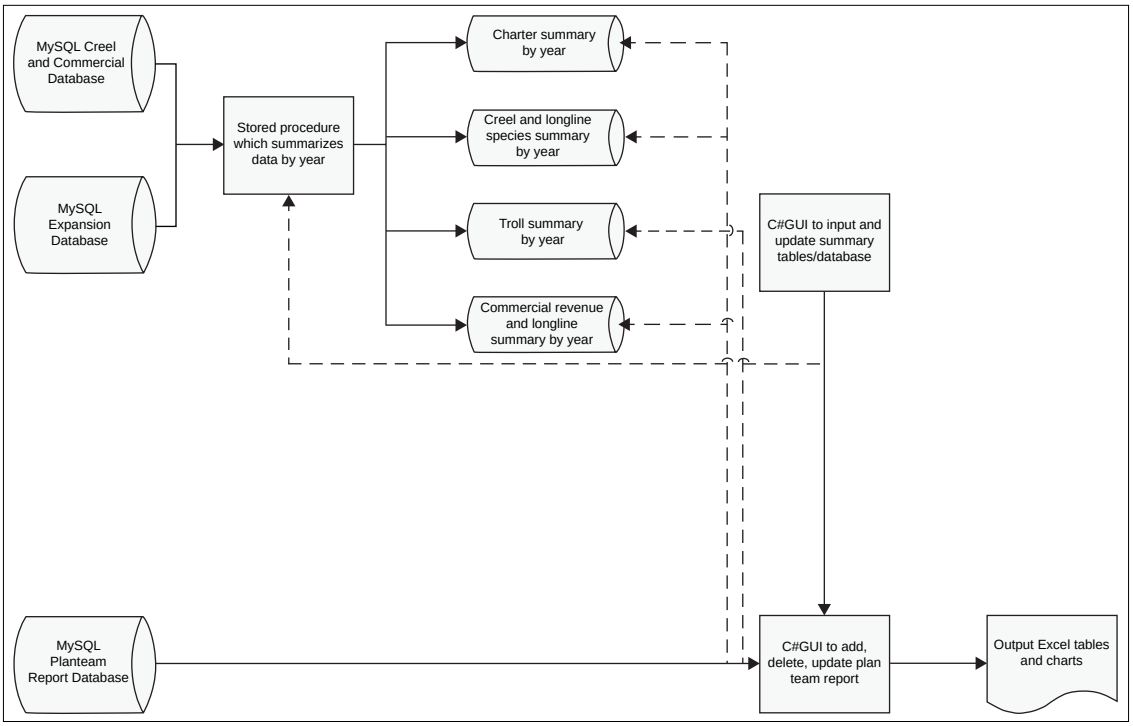


Figure 2. Schematic for the upcoming MySQL and C# Pelagic Plan Team report application.

control measures and synthesize fishery-dependent monitoring data. This technical support enables PIFSC and partner agencies to produce timely reports of the best available fisheries data from each island area.

Progress during FY 2017

WPacFIN staff supported a number of regular tasks related to local, territory, and federal needs, and these needs were satisfied throughout the fiscal year. Tasks included maintaining the WPacFIN Central database system, providing technical support to data processing systems of the partner island agencies, and completing data requests for researchers, regulators, and other members of the scientific and local communities.

Outside of these regular duties, WPacFIN staff continued converting the Visual FoxPro (VFP) database applications to MySQL and C# for WPacFIN Central and all partner agencies. The goal was to complete planning for the Document Imaging Archival System (DIAS) and the Guam Division of Aquatic and Wildlife Resources (DAWR) data system. Planning these two systems is critical because DIAS will be implemented across the partner agencies, and the Guam data system will be used as the basis for data systems in American Samoa and the CNMI.

These accomplishments satisfy the objectives established for the year, with the exception of those related to the Hawaii Division of Aquatic Resources (DAR) database. Hawaii Information Consortium (HIC) data was made compatible with DAR's MySQL database directly through MySQL adjustments without the need for a separate C# interface. However, a C# interface must still be created to allow users to perform data summaries. This delay was caused by unexpected issues that arose in the conversion process for DAR's new online fisher report data and consequential changes in the plan of how to implement the new MySQL and C# system.

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

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

NOAA Sponsor: Michael P. Seki, Justin Hospital

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 the seafood market in the Pacific Islands Region.

Progress during FY 2017

The project was 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.

Figure 1. Small boats in Honokohau Harbor, Kailua, Hawaii.

Project activities accomplished during the reporting period include: 1) a NOAA technical report was completed for the Guam and Commonwealth of Northern Mariana Islands small-boat fisheries and is currently under PIFSC internal review; 2) a database was created and data entry completed for the cost-earnings study of the American Samoa longline fishery; 3) a NOAA technical report for the cost-earnings study of the Hawaii bottomfish fishery was published in June 2017; and 4) a model for the Hawaii longline fleet dynamic using positive mathematical programming (PMP) was disaggregated into policy relevant regions and presented at the International Institute of Fisheries Economics and Trade (IIFET) 2016 conference in Aberdeen, Scotland.

Human Dimensions of Fishing and Marine Ecosystems in the Western Pacific

P.I.: Douglas S. Luther [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. Sign advertising fish for sale at a "brick and mortar" roadside fish vendor in Saipan, CNMI, June 2016.

Progress during FY 2017

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

For the CNMI fishing community profile project, more formal fieldwork was conducted in September-October 2016. A diverse set of secondary data sourceswere included to support the fishing community profile update based upon meetings with CNMI government staff. A presentation on the CNMI fishing community profile update was delivered during the PIFSC Socioeconomics External Program Review held July 31-August 3, 2017. A draft of the fishing community profile update cleared

Figure 2. Sunrise at Pier 38 behind the Honolulu Fish Auction in January 2017.

external review in August 2017 and will be submitted for PIFSC internal review in September 2017. The Fishing Community Profile Update will be published as a NOAA Technical Memorandum.

Social Vulnerability Indicators were further developed by adapting Applied Geographic Solutions variables to the Hawaii Census County Subdivision geographic scale. Social Vulnerability Indicators using 2010 decadal census data were also developed for Hawaii, Guam, CNMI, and American Samoa. This data was then juxtaposed with coral reef resilience indices and reports were generated for each area. These reports are currently under review.

For rights-based management alternatives for the Hawaii longline fishery, a longline feedback report summarizing research findings was distributed to fishers at Pier 17 and Pier 38, POP Fishing & Marine, NOAA Pier 38 Office, and the Honolulu Fish Auction in February 2017. Research findings were also presented at an international conference, "Resilience 2017: Resilience Frontiers for Global Sustainability", held August 20-23, 2017, in Stockholm, Sweden. A manuscript on the effects of 2015 regulatory closure will be submitted for PIFSC internal review in September 2017 and then submitted to the peer-reviewed academic journal *Marine Policy*.

Pacific Islands Region Outreach and Education Program

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

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)

Figure 1. Student participants and organizers for the 2017 NOAA Fisheries Science Camp, July 10-14, 2017, at the NOAA Inouye Regional Center.

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 serve as resource, advisors, and points 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 2017

During the final year of activity, the project primarily supported the 2017 NOAA Fisheries Science Camp, which is a jointly coordinated activity between PIFSC, PIRO, and JIMAR. The camp was held July 10-14 at the NOAA Inouye Regional Center and is designed to primarily welcome up to forty-five 8th grade students from underserved communities and charter schools on Oahu. Nearly 40 NOAA federal and JIMAR staff and students collaborated to develop science modules that provided campers a unique hands-on experience in the following fisheries research areas: marine debris mitigation; fish sampling techniques and stock assessments; marine food webs; protected species; and fisheries data. The Science Camp also included a trip to the He‘eia Fishpond, which is an ancient walled fish breeding aquaculture pond. This camp is a remarkable success and is an outstanding example where JIMAR resources, combined with NOAA/PIFSC and PIRO facilities, can have direct community impacts. Student participant costs are covered by project funds in coordination with JIMAR’s Ecosystems Observations and Research Program (EORP), and include items such as daily lunch and t-shirts for the participating students, lab equipment, supplies, printing costs, and temporary docent hires.

Pacific Islands Region Sustainable Fisheries Initiative

P.I.: Douglas S. Luther [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 the general public, fishermen, non-government organizations and government agencies via outreach. In addition, JIMAR staff assist the Pacific Islands Regional Office (PIRO) Sustainable Fisheries Division (SFD) staff with various NOAA fisheries initiatives in the Region, as appropriate.

Progress during FY 2017

The project concluded all activities at the start of the reporting year.

Stock Assessment Research Program

P.I.: Douglas S. Luther [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)

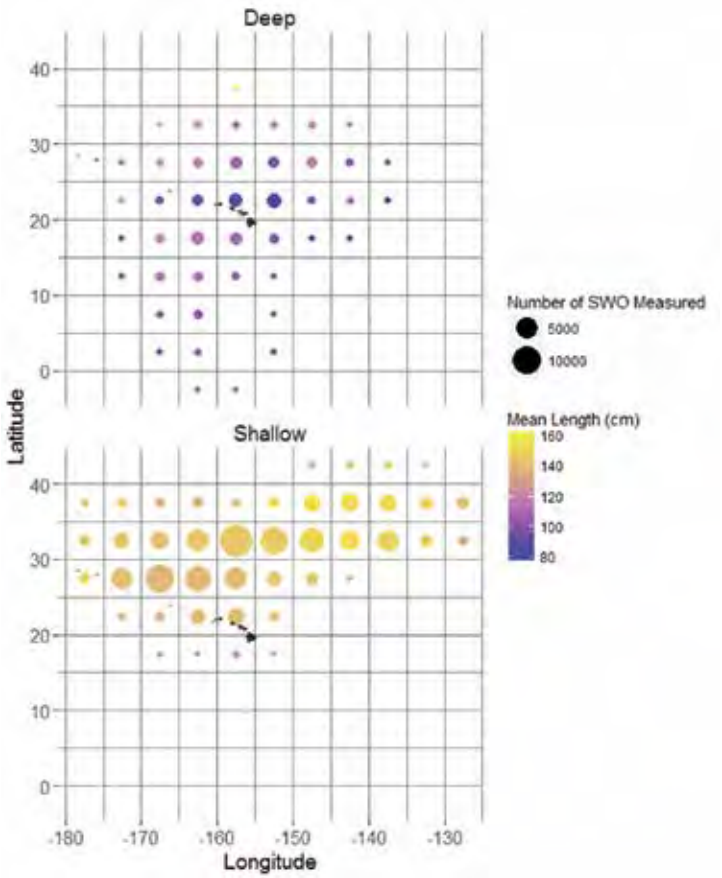
- Healthy Oceans

Purpose of the Project

PIFSC and JIMAR staff conduct 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.

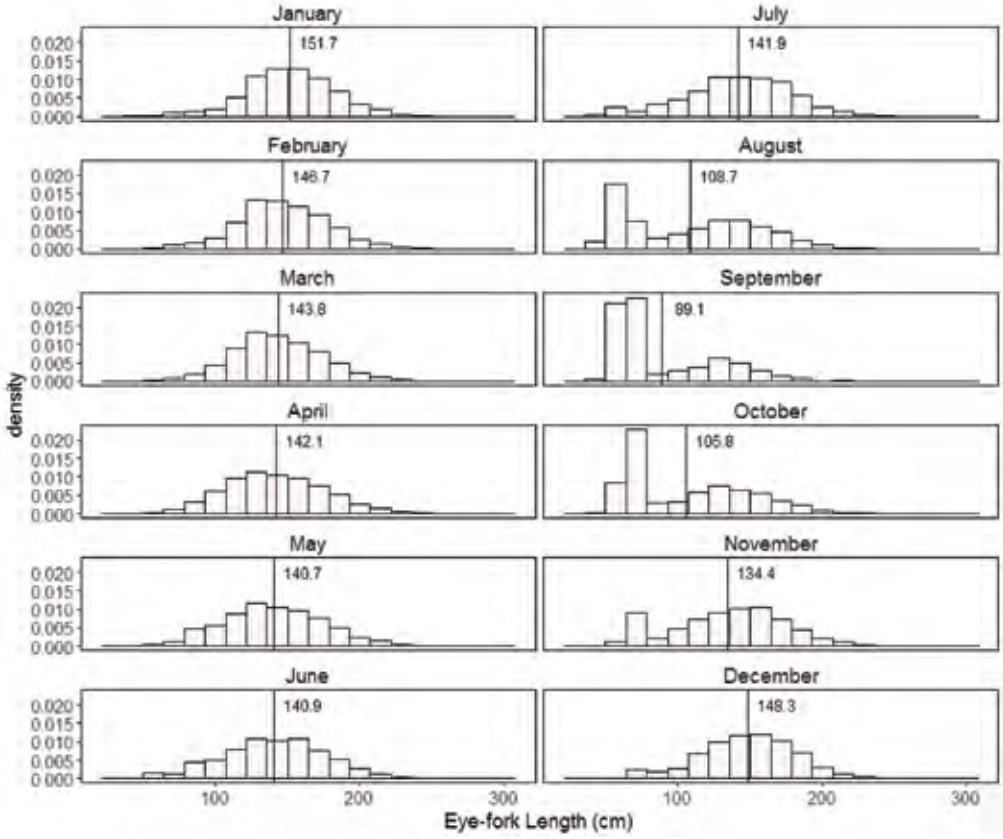
Progress during FY 2017

For the pelagic assessment work, JIMAR researchers participated in a suite of international scientific workshops and symposia. The pelagic team published a series of working documents related to the assessment of north



(left) Figure 1. Spatial distribution of mean swordfish length in 5° × 5° squares for the deep-set sector (top panel) and shallow-set sector (bottom panel) from the Hawaiian Longline Observer Program plotted over the Hawaiian Archipelago.

(below) Figure 2. Histogram of swordfish length by month for the combined deep- and shallow-set sectors from the Hawaiian Longline Observer Program. Vertical line indicates median length. The smaller median lengths in August–October reflect an influx on young-of-the-year individuals to the fishery.



Pacific blue sharks. These working papers included work on gear selectivity, catch per unit effort standardization, as well as a final stock assessment and population projections report. Other work included data preparation for the upcoming Pacific blue marlin assessment with a focus on life history and length composition data exploratory analyses. JIMAR staff led most of these efforts and collaborated closely with federal staff on others. A paper on using fishery indicators for pelagic sharks is currently under review.

For the insular assessment work, JIMAR researchers published a paper using statistical relationships between pairs of life history parameters to generate probability distributions of missing parameters in data-limited situations.

Western Pacific Fisheries Economic Integration

P.I.: Douglas S. Luther [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

This 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.

Figure 1. Students engaging in the socioeconomics module in the NOAA Science Camp.

Figure 2. In the socioeconomics module, one of the board game materials, chopsticks, represented "fishing gear". Students used the chopsticks to catch the fish, although they were limited by their experience and skill with the "fishing gear".

Progress during FY 2017

During the reporting period, project accomplishments include the following.

For integration of Hawaii fisheries data and description of fishery dynamics, JIMAR staff compiled fisheries catch and economic summaries at various geographic scales to support a community snapshot web tool (https://www.pifsc.noaa.gov/socioeconomics/hawaii-community-snapshots.php). 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 Hawaii fisher report and dealer data to generate an integrated data set and a NOAA Technical Memorandum was published in June 2017.

For the rights-based management alternatives for the Hawaii-based longline fishery, JIMAR staff assisted in production and distribution of outreach material.

For Hawaii-based longline vessel monitoring systems (VMS) data processing and integration, this project has not been fully completed due to staffing change.

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

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

NOAA Sponsor: Michael P. Seki, Erin Oleson

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 2017

The Hawaiian Islands Cetacean and Ecosystem Survey (HICEAS) is a 187-day survey for cetaceans and seabirds within U.S. waters of the Hawaiian Islands. It is a collaborative project with the Southwest Fisheries Science Center (SWFSC), Bureau of Energy Management (BOEM), U.S. Fish and Wildlife, and the U.S. Navy. Two NOAA ships (*Oscar Elton Sette* and the *Reuben Lasker*) were operating within the study area that is approximately 1.8 million square nautical miles (2.5 million km2), including waters surrounding all Northwestern and Main Hawaiian Islands out to 200 nmi offshore. The goals are to estimate how many cetaceans are in Hawai‘i, examine their population structure, and understand their habitat. Methods

Figure 1. Deploying a DASBR during HICEAS Leg 1 aboard the R/V Oscar Elton Sette.

to study cetaceans during the survey include passive acoustics and there are several different instruments that are used, such as a towed hydrophone array and Drifting Acoustic Spar Buoy Recorders (DASBRs).

During May 2017, the JIMAR Senior Passive Acoustics Associate worked in San Diego with colleagues at the SWFSC to build and test two towed hydrophone arrays for use on HICEAS. The towed array system is deployed 300 m behind the ship while staff monitor in real-time from sunrise to sunset and assist in tracking of cetaceans during visual efforts. In addition, high-quality recordings are made during all hours and will be processed after the completion of HICEAS. The DASBRs are passive acoustic recorders that are free floating. They are deployed from the ship and will drift on the currents for 2-4 weeks at which time they will be tracked by their iridium (satellite) transmitters and retrieved. The DASBRs deployed during HICEAS will be used to collect beaked whale recordings for abundance estimation.

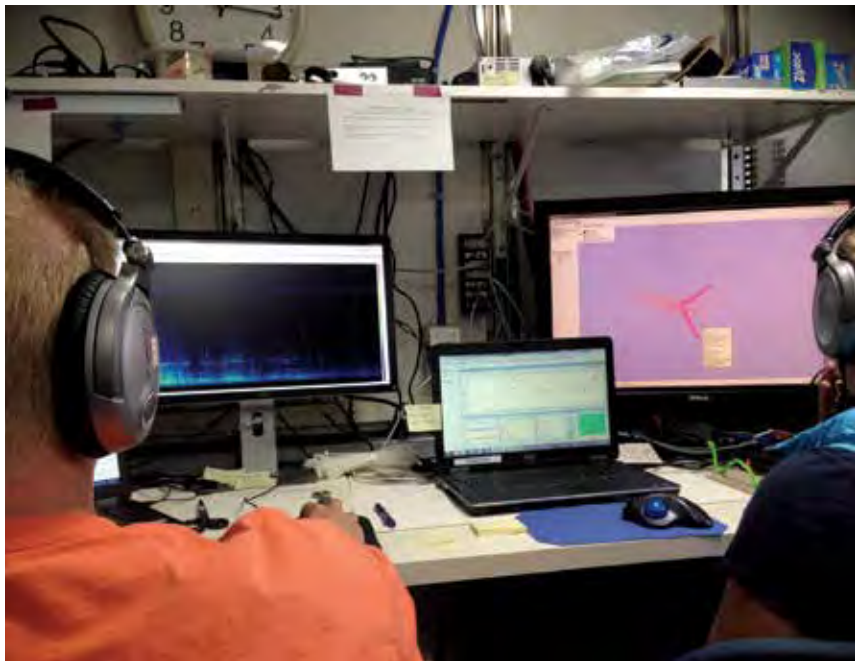


Figure 2. Acousticians in the electronics lab of the R/V Oscar Elton Sette *monitor real-time data from the towed hydrophone array.*

During the first leg of HICEAS aboard the NOAA *R/V Oscar Elton Sette* (July 6-August 2) there were 123 acoustic detections of cetaceans on the towed hydrophone array which included sperm whales, beaked whales, false killer whales, pilot whales, pygmy sperm whales, and dolphins. Eight DASBRs were deployed during the first week and three were retrieved during the last week.

High-frequency Acoustic Recording Packages (HARPs) are an integral part of the CRP's work. They are moored passive acoustic recorders, typically deployed at depths of 600 m to 800 m, whose primary purpose is to detect cetaceans by recording their vocalizations (e.g., clicks, whistles). The data collected from the recordings are used to access the year-round occurrence of cetacean species in remote locations where regular visual surveys are not possible. In addition, HARPs are used to monitor ocean ambient noise, which is important to assess in order to understand the potential effects on cetacean populations.

The CRP maintains HARPs at selected permanent locations: Kona, Hawai'i; Pearl and Hermes Reef, Papahānaumokuākea Marine National Monument; Wake Atoll; Saipan, CNMI; and Tinian, CNMI. HARPs are typically deployed at each of these locations for a period of a year after which time they are recovered, recycled, and redeployed. The exception is the HARP off of Kona, which is turned over approximately every four months. This past year additional HARPs were deployed off of Kaua'i, Howland Island, and on Cross Seamount (approximately 270 km southwest of Hawai'i Island). The Kaua'i HARP was deployed during the Hawaiian Islands Technology for the Ecology of Cetaceans (HITEC) survey in 2016 and will be recovered in September 2017 during HICEAS. The data will be used in a collaborative project with other NOAA line offices and Scripps Institute of Oceanography, studying ocean ambient noise. The Howland Island HARP project is a collaboration with the Coral Reef Ecosystem Project (CREP) and part of their monitoring effort at Howland. The HARP at Cross Seamount was deployed and recovered during the HITEC survey in July 2016. This was done as part of an on-going effort to understand and identify the currently unseen and unidentified Cross Seamount Beaked Whale. Additionally, a HARP that was deployed off of Pagan, CNMI, during the 2015 Mariana Archipelago Cetacean Survey (MACS) was recovered during the 2017 Mariana Archipelago Reef Assessment and Monitoring Program (MARAMP). The data from the Pagan HARP will be used to look for the occurrence of humpback whales in the winter.

Deep Sea Coral Submersible Dives

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

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

NOAA Sponsor: Michael P. Seki, Frank Parrish

Budget Amount: $110,769

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project supported two dives of submersible vehicles operated by the University of Hawaii to survey deep coral sites and to recover and re-deploy instrumentation established at these locations. Deep corals in the Hawaiian Islands are characterized as being at depths greater than 200 m and have been investigated by submersible dives over the past twenty years or so. Several suites of instruments are currently deployed near the dive sites and it is necessary to revisit the sites to sample the conditions with the submersible and to cycle the instrumentation. Data from the deployments will be shared with partners in the JIMAR Pacific Islands Deep Sea Corals and Sponge Initiative project and other PIFSC programs.

Progress during FY 2017

In coordination with the NOAA PIFSC Deep Sea Coral Research and Technology Program, two dive operations were conducted in September 2016 using the Pisces submersible vehicles from the University of Hawaii's Hawaii Undersea Research Laboratory. Dive operations are summarized below.

A dive was conducted using the Pisces V submersible (Dive 857) on September 4, 2016. The site of the dive was the Makapuu coral bed at location 21° 16.590, 157° 32.620, mean depth 411 m. During this dive two PIFSC oceanographic instruments that were deployed at the site a year earlier were successfully recovered. Three other instruments were not recovered due to positioning problems with the ship's sub tracking system.

A second dive was conducted using the Pisces IV submersible (Dive 297) on September 5, 2016. The site of the dive was the Kona site at location 19° 39.044, 156° 02.854, mean depth 890 m. This dive was conducted in support of a cross contour survey and deployment of thermographs for Hawaii Pacific University collaborators. Six instruments were deployed across depths of 900 m to 220 m and voucher specimens collected where needed.

Fishing Impacts on Non-target Species

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

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

NOAA Sponsor: Michael P. Seki, Keith Bigelow

Budget Amount: $50,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

Shark bycatch in commercial fisheries targeting tuna and billfish is having a negative impact on some pelagic populations. As a result, both silky (*Carcharhinus falciformis*) and oceanic whitetip (*C. longimanus*) sharks are now overfished and overfishing is still occurring, however, the most recent stock assessment of north Pacific blue sharks (*Prionace glauca*) found the population to be stable. In this study researchers are assessing the impact

of tuna longline fishing in Hawaii and American Samoa on silky, oceanic whitetip, blue and bigeye thresher (*Alopias superciliosus*) sharks to quantify post release mortality rates of discarded species and identify best handling and dispatch methods. Fishery observers tag candidate sharks with pop-off archival satellite tags (PAT) on commercial fishing trips in collaboration with fishers that are voluntarily participating in this study.

Figure 1. SharkTagger.org logo developed by the project.

Progress during FY 2017

During the reporting period, significant progress was achieved on the two major components to this shark post release fate study. The first was the development, testing and implementation of more comprehensive data codes for observers to collect information on the condition, handling and damage of discarded elasmobranchs captured in both the Hawaii and American Samoa longline fisheries. Observers recorded this additional data during 92 fishing trips. The second component is the tagging study where researchers can verify post release fate of discarded animals when observers tag sharks during commercial tuna trips with satellite linked archival tags. To date, the project developed tagging training materials, conducted seven observer tagging trainings and trained 27 observers. Observers were placed on 82 tagging trips and deployed over 100 satellite tags on sharks. Additionally, there are 52 vessels voluntarily participating in this study. During this performance period, 57 satellite tags were deployed on four shark species incidentally captured during commercial fishing operations (blue shark n=13, bigeye thresher n=9, oceanic whitetip n=14, silky n=21). This year the project trained 11 NMFS fishery observers and placed them on 34 different longline vessels during commercial tuna trips.

Three shark tagging trainings for Pacific Islands Regional Office Observers Program staff/contractors were conducted either in Honolulu or American Samoa during the reporting period. This consisted of classroom lectures on the 'Shark Focus Study' where observers were asked to collect additional data on shark condition and handling or discard practices, and trained to use new data codes. Observers were also provided hands-on

Figure 2. Observer tagging an oceanic whitetip shark during a commercial tuna longline trip with a survival satellite-linked pop-off tag (SPAT).

tagging training and taught how to place satellite tags on sharks during commercial longline trips. JIMAR worked closely with the fishing captains who voluntarily allowed access to their vessels during the trainings and assisted observers when tagging sharks during their trips.

The project expanded the scope of the study to address the question of long-term survivorship when sharks are released with trailing gear. Over the course of this study it is found most sharks are released by cutting the fishing line, which leaves between 0.5–15 m of trailing gear attached to the animal. In the Hawaii tuna sector this includes a wire leader and a 45 gram weighted swivel. To assess the effects of the trailing gear, observers also tagged blue sharks with long-term archival tags programmed for year-long deployment periods. To date all these tags were deployed and JIMAR continues to monitor data returns from these tags.

Hawaiian Monk Seal Northwestern Hawaiian Islands Research Seasonal Support

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

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

NOAA Sponsor: Michael P. Seki, 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 implements monk seal population assessment, health and disease, survival enhancement, foraging, and behavioral research, as well as standard enhancement activities. Research and enhancement activities are conducted primarily in the 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 conduct field studies opportunistically at Mokumanamana, Nihoa, Niihau, and within the main Hawaiian Islands. Field research activities include visual and photographic monitoring, tagging, pelage bleach marking, health screening, necropsies, specimen collection, and vocalization and foraging studies. Field staff also participate in translocation and other recovery actions including hazing or removal of aggressive male seals, shark predation mitigation and deterrence, entrapment

Figure 1. Seals at French Frigate Shoals in a holding pen for a few days to habituate to their environment before being released back into the wild after undergoing rehabilitation to increase their chances of survival (Photo: M. Sullivan under NMFS permit no. 16632).

surveys, behavioral modification, vaccination research, disentanglement, reuniting mother-pup pairs, abscess treatment, marine debris removal, inter- and intra-atoll translocation, evaluation and capture of seals for rehabilitation, and feeding and soft release of rehabilitated seals. Field staff also provided assistance to other programs and agencies, which may include establishing and maintaining marine debris plots, conducting insect, plant, and Laysan duck surveys, and collecting sea turtle nesting data.

Figure 2. Field researcher conducting monk seal survey on N'ihau with Lehua Island in the distance (Photo: R. Ronco under NMFS permit no. 16632).

Progress during FY 2017

Activities undertaken by the JIMAR HMSRP encompassed the latter part of the 2016 field season and the beginning of the 2017 field season, and involved establishing field research camps at French Frigate Shoals (FFS), Laysan, Lisianski, Pearl and Hermes Reef, and Kure Atoll. Monk seal surveys were also conducted at Midway Atoll during both field seasons. During the 2016 field season, staff and volunteers were deployed through August 26. On the return cruise via the NOAA *R/V Oscar Elton Sette*, monk seal surveys were conducted at Nihoa, Mokumanamana, Midway Atoll, and Niihau. Remote cameras stationed at Nihoa were also maintained and data retrieved from the cameras are used to monitor the seal population (e.g., document births, identify individual animals). Upon return to Honolulu, field staff cleaned, inventoried, and stored gear, equipment, and supplies, and field camp leaders compiled reports on population assessment and recovery activities.

Training for the 2017 field season began on March 27, 2017, and included small boat operations training, data collection techniques, Wilderness First Aid, animal handling and abscess treatment, training to administer vaccinations, and specimen collection and necropsy techniques. Field personnel participated in securing and packing quarantine clothing, testing boats, communication systems, and other equipment, and loaded all supplies and equipment on the NOAA *R/V Oscar Sette* before departure on May 12, 2017. Other activities during this training period were reported under JIMAR project 6105287 (NA16NMF4320058). During the deployment cruise, surveys were conducted at Nihoa, Mokumanamana, and Niihau, and data was retrieved from remote cameras maintained on Nihoa.

Project activities during the combined two field seasons included: collecting survey and life history data and specimens; tagging and marking seals for long-term identification; documenting males exhibiting aggressive behaviors towards other seals; and 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 collected specimens for dietary and genetic analysis and a partial necropsy was conducted on a seal early in the 2017 field season. Interventions to improve the survival chances of individual seals included uniting a mother/pup pair, performing an umbilical snip on a newly born pup when the placenta did not detach, abscess treatment, and disentanglement from marine debris.

An unusual event documented for the first time during the 2016 field season was an eel lodged in the nostril of an immature seal that was causing breathing problems for the seal. Field personnel successfully intervened and extracted the eel from its nostril. Translocation activities were conducted within FFS to mitigate shark predation. During the reporting period, four immature seals were captured at the end of the 2016 field season and taken to the Marine Mammal Center's captive care facility Ke Kai Ola (KKO) in Kona for rehabilitation. These animals were returned to the wild during the 2017 field season deployment cruise in May.

Two immature seals were captured during the May 2017 deployment cruise and were transported to KKO for rehabilitation. Field staff began administering vaccinations and booster shots against morbillivirus to wild seals in NWHI subpopulations during the 2017 field season. This was part of the first ever large scale vaccination effort in the NWHI. Sea turtle nesting sites were monitored, marine debris plots were established, and a vocalization study was conducted at Lisianski during the 2016 field season. The FFS field team also rescued wildlife from entrapment from a collapsing seawall on Tern Island and provided boating support for JIMAR marine turtle researchers, and the Laysan field team conducted opportunistic Laysan duck surveys on Laysan Island.

Hawaiian Monk Seal Research Program

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

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

NOAA Sponsor: Michael P. Seki, 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 residing entirely within U.S. jurisdiction. There are approximately 1,400 monk seals remaining, the majority of which occur at the six highly studied sites in the Northwestern Hawaiian Islands (NWHI) where abundance is estimated to have declined by two thirds since the late 1950s. Apparent stability or population growth in the NWHI in recent years substantially influences overall trends, and for the past three years the overall population has been increasing by approximately 3% annually. 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.

Progress during FY 2017

Accomplishments during the reporting period included ongoing population monitoring and assessment, survival enhancement, foraging ecology characterization, health and disease evaluation, and behavioral research. JIMAR staff played a crucial role in the breakdown of the 2016 field camps and establishment of the 2017 camps in the NWHI. Project staff served as field operation leads on deployment and pick up research cruises during both field seasons. A JIMAR staff member was deployed at the French Frigate Shoals field camp during the 2016 field season and another staff member served as field camp leader at Pearl and Hermes Reef in 2017. Project staff also provided logistical support to all remotely deployed field staff and assisted with rehabilitation and transport of four immature seals brought in for rehabilitation at the end of the 2016 field season, and their subsequent release back into the wild at the beginning of the 2017 field season. JIMAR staff also assisted with the rehabilitation and transport of two immature seals captured during the deployment and transported for rehabilitation to Ke Kai Ola Monk Seal Hospital in the Marine Mammal Center in Kona, Hawaii.

In July 2017, staff presented research findings at the Hawaii Conservation Conference. JIMAR staff and collaborators developed an ecosystem model to understand the main drivers and recovery potential for the endangered Hawaiian monk seals. Key dynamics that influence the energy flow and ecosystem structure, and hence the monk seal populations at two different breeding locations, were evaluated. Project staff collected ongoing survey and life history data and specimens in the main Hawaiian Islands (MHI) and continued ongoing vaccinations on wild seals against morbillivirus in the MHI.

Figure 1. Capture of adult male seal RE74 (a.k.a. "Benny") to assess for hook ingestion (Photo: B. Billand, work conducted under NMFS permit No. 18786).

Emergency responses during the reporting period included the capture and hook removal for seals on Kauai and Oahu and capture and assessment of stranded seals on Oahu. Staff also participated in three necropsies, including a necropsy conducted on a stranded seal that died shortly after undergoing a veterinary procedure after being brought into captivity due to stranding. A fishhook removal surgery was also performed on another seal. The foraging ecology program deployed telemetry equipment on three seals on Oahu and two seals on Kauai to document individual HMS movements. One seal that had been instrumented was discovered in a gillnet by members of the public but the carcass disappeared before it was recovered. Biomedical samples for disease surveys in the MHI were collected in conjunction with telemetry deployments and from stranded animals, and samples were sent for analysis to 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 specimen reorganization and barcoding 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.: Douglas S. Luther [JIMAR Project Lead: Jeffrey Hare]

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

NOAA Sponsor: Michael P. Seki, Frank Parrish

Budget Amount: $390,000

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

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

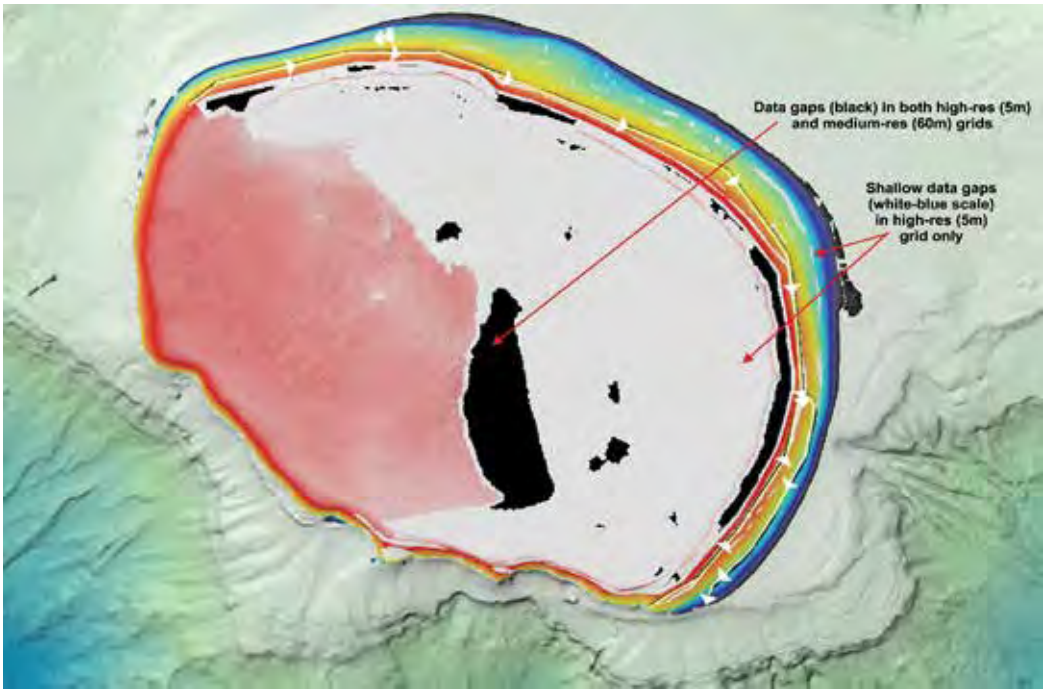


Figure 1. French Frigate Shoals from 2016 HARAMP survey line/coverage (white arrows) overlain on high-resolution 5m bathymetry data (rainbow color scale), which is in turn overlain on the coarser resolution (60 m) bathymetry synthesis (blue color scale). New HARAMP data do not significantly fill existing gaps in the existing high-resolution grid. This effort demonstrates that technical and data acquisition issues aside, poor coverage (i.e., failure to infill existing data gaps) of the new survey data precludes many of the datasets from being used to update existing data products.

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), Northwestern Hawaiian Islands (NWHI), Papahānaumokuākea Marine National Monument (PMNM), Pacific Remote Islands Marine National Monument, Marianas Trench Marine National Monument, 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) at the School of Ocean and Earth Science and Technology (SOEST) at the University of Hawaii at Manoa (UHM).

Progress during FY 2017

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

Multibeam Data Collection. This project coordinated with the JIMAR Ecosystems Observations and Research Program project and worked with multibeam echo sounder data collected from the NOAA *R/V Hi'ialakai* during several Reef Assessment and Monitoring Program (RAMP) cruises in the Hawaiian Islands (HARAMP), American Samoa (ASRAMP), and Mariana Islands (MARAMP). Although some high quality maps were developed for ASRAMP surveys, much of the data from the other RAMP cruises resulted in poor or inadequate benthic coverage. These surveys were the first mapping efforts from that vessel after about eight years and

much of the data quality assurance and best practices approaches were not sufficient to ensure high data quality. These recent survey data highlighted that changes are required in order for the *R/V Hi'ialakai* to maintain mapping capabilities into the future. The issues are not the result of insufficient motivation or expertise within participating groups (JIMAR, PIFSC, Ecosystems Sciences Division, ship personnel, etc.), but rather that the requisite resources (funding, organization, survey support) were insufficient and underestimated to successfully resurrect and support mapping. Future multibeam echo sounder surveys will require a better supported, dedicated effort that involves more effective integration between onshore and offshore activities from pre-cruise planning, surveying, and throughout to post-cruise processing.

ASRAMP Cruise. In 2015, *R/V Hi'ialikai* surveyed at Johnston, Howland, Baker, Swains, Palmyra, Tutuila, and Jarvis, using both echo sounder systems. The sonar systems were sea-trialed prior to ASRAMP, and ultimately ASRAMP data suffered from fewer data quality issues than HARAMP and MARAMP. It is primarily because of data coverage (i.e., new data not covering significant gaps in existing data) that much of the ASRAMP data are not being used to update data products.

HARAMP Cruise. In 2016, *R/V Hi'ialikai* surveyed at French Frigate Shoals, Pearl and Hermes, Lisianski, and Kure islands, using both systems. Due to problems of mapping extent, vertical control, and positioning, none of the bathymetry data acquired during HARAMP have been used to update existing products. It should also be noted that relatively little data was acquired at each island, particularly in the shallows. As such, even with high-quality data it is unlikely that many of the existing data gaps can be filled.

MARAMP Cruise. In 2017, *R/V Hi'ialikai* surveyed at Guam and Aguijan using the medium resolution echo sounder. Following results from the patch-test conducted en route, it became clear that the high resolution system was effectively inoperable due to a faulty transducer. The resulting data set from Guam, despite some constraints, covered significant areas of previously un-surveyed seafloor and therefore have been used to update existing data products. The data acquired at Aguijan were very high quality with good vertical control due to correctly acquired sound velocity data, however, the data have not been used to update mapping products as they cover areas of seafloor that were previously surveyed.

Data processing and analysis were conducted by the University of Hawaii (UH) component of the project. Project researchers are Dr. Christopher Kelley, Program Biologist for HURL, Virginia Moriwake, Deep Sea Animals Research Specialist, and Sarah Bingo and Meagan Putts, Deep Sea Corals Research Associates.

Dr. Kelley's responsibilities for the project are to provide cruise planning and execution for expeditions on the NOAA *R/V Okeanos Explorer* (EX) and EX post cruise deliverables. Moriwake is responsible for assisting with EX post cruise deliverables and extracting and formatting additional HURL coral and sponge annotation records for DSCRTP. Bingo and Putts assisted with processing of EX post cruise deliverables.

The JIMAR staff retrieved and processed specimens and samples acquired during the cruises, including data, imagery, and video from the ship. Staff synthesized the information into time series in coordination with the video primarily of the seafloor. Identification of species, particularly deep sea corals and sponges, is a cornerstone of the effort. Several cruises were planned from mid-February 2016 through the end of the project period, and the analysis and products from these cruise data have been reported by JIMAR. Resulting data are archived at UH and at PIFSC.

Protected Resources Environmental Compliance Initiative (PRECI)

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

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
- Resilient Coastal Communities and Economies

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 conducting 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 2017

Early in the reporting period, the project finalized several outreach products related to protected species in the Pacific Islands. Staff worked for limited periods with the Pacific Islands Regional Office (PIRO) on outreach engagement with the local communities and on messaging and awareness for tourists at Honolulu hotels.

Sea Turtle Bycatch and Mitigation Research

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

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

NOAA Sponsor: Michael P. Seki, Keith Bigelow

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 marine turtle bycatch have been developed for pelagic longline fisheries. By contrast, few bycatch reduction strategies exist for gillnet fisheries, so identifying strategies to increase selectivity in gillnet fisheries and reduce bycatch is a global fisheries management priority. Small-scale fisheries (SSF) supply more than half of global fish catch, yet many SSF are bycatch data-limited. 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 agencies. The project's primary objective for this report period was to expand existing sea turtle bycatch mitigation efforts internationally by providing fishers in Indonesia and the Philippines with light emitting diode (LED) devices to conduct paired trials in gillnet fisheries that have high sea turtle interaction rates on populations known to migrate into and out of U.S. waters.

Figure 1. Green light LED being tested in Indonesian gillnet fisheries to reduce sea turtle bycatch.

Progress during FY 2017

During the reporting period, LEDs were distributed to international partners for continuation of research. Under guidance from PIFSC staff, fishers in Indonesia were identified to conduct paired LED and control experiments with gillnets on catch rates of target and bycatch species. During 2016-2017, controlled studies were conducted on gillnet sets, where one net was illuminated with green LEDs while a control net was not illuminated.

Researchers found the use of LEDs increased the target and retainable catch while reducing bycatch of sea-turtles by half. The use of the LED also reduced shark bycatch. Post-release survivorship was also assessed by attaching JIMAR's pop-off archival tags to released sharks. All tags were shed prematurely but indicated that tagged animals survived between 5-14 days. In the Philippines, LEDs were provided to fishers identified during outreach and networking efforts.

Turtle Research Program (TRP)

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

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

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

Budget Amount: $304,930

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The JIMAR Marine Turtle Biology and Assessment Program (MTBAP) project aligns its efforts with the Pacific Islands Fisheries Science Center (PIFSC) Protected Species Division efforts on marine turtles. Research focuses on population assessment, climate impacts research, fisheries interactions, basic biology and ecology, strandings and salvage, and data and sample management for the various Pacific marine turtle species. In addition, JIMAR MTBAP provides assistance to and collaborations with the PSD Hawaiian Monk Seal Research Program (HMSRP) and the Cetacean Research Program (CRP), both of which also sponsor JIMAR projects.

Figure 1. JIMAR employee, Dr. Camryn Allen (right), explains aspects of the module she lead on "Sea turtle sex and climate change effects" to a sub-group of local middle school students participating in the NOAA Science Camp held at IRC.

Figure 2. JIMAR Field Camp Researchers Jan Willem Staman (left), Marylou Staman (center), and Alex Reininger (right) crowd around their satellite phone to call MTBAP team members in Honolulu each week to provide an update on well-being and green sea turtle nesting data collected each week at FFS in the NWHI.

Progress during FY 2017

Research accomplishments by the MTBAP project staff include the following.

Population Assessments. Three JIMAR Field Camp Researchers completed the abundance assessment of green sea turtles nesting within the French Frigate Shoals (FFS) in the Northwest Hawaiian Islands (NWHI). They counted a total of 867 male and female turtles basking on the islands with 469 females confirmed nesting. JIMAR staff also conducted snorkel surveys (and capture) of sea turtles in Guam and the Commonwealth of the Northern Mariana Islands to determine the abundance, movements, and sex ratio of the foraging aggregations of green and hawksbill sea turtles in those regions.

Climate Impacts and Basic Biology and Ecology. Dr. Camryn Allen, the JIMAR Marine Biological Researcher, conducted in-water research on green and hawksbill sea turtles in Guam to collect additional samples for her study on the effects of climate change on sea turtle sex ratios at foraging grounds within the Pacific. JIMAR student assistants working in the University of Hawaii's Marine Option Program as well as JIMAR field camp researchers (Marylou Staman, Jan Willem Staman, and Alexandra Reininger) completed data entry for stranded and/or nesting sea turtles.

Fisheries Interactions and Strandings and Salvage. JIMAR staff participated in necropsies of deceased sea turtles incidentally captured by the Hawaii longline fishery or stranded live/dead due to interaction with recreational fishing gear, fibropapilloma, poor health, etc. JIMAR student assistants were integral participants in stranding response and necropsy of dead stranded sea turtles.

Collaborations with other PIFSC PSD Programs. Dr. Allen was awarded funding to determine reproductive parameters via endocrine analysis in adult female monk seals.

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.: Douglas S. Luther

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

NOAA Sponsor: Christopher Sabine, William S. Kessler

Budget Amount: $54,069

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; and 2) 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 2017

During FY 2017 the project's primary goals related to characterizing the role of meso and submesoscale eddies in the Solomon Sea circulation, in particular how they impact the interpretation of in situ data (glider, Argo).

The interior Solomon Sea is characterized by energetic intraseasonal variability, which 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 (~400 km), suggestive of the excitation of low-order resonant basin modes. The 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, background conditions in the Solomon Sea change significantly during sampling. This explains the large observed section-to-section differences in transport estimates from the glider.

During FY 2017, the potential aliasing of slow in situ sampling was quantified by the altimetric analyses. This enabled proper choices of spatial and temporal averaging towards credible descriptions of the vertical and horizontal structures across the Solomon Sea. This in turn enabled project scientists to characterize the mass and heat fluxes through the Solomon Sea towards the equator, with full understanding of the errors introduced by the eddy aliasing.

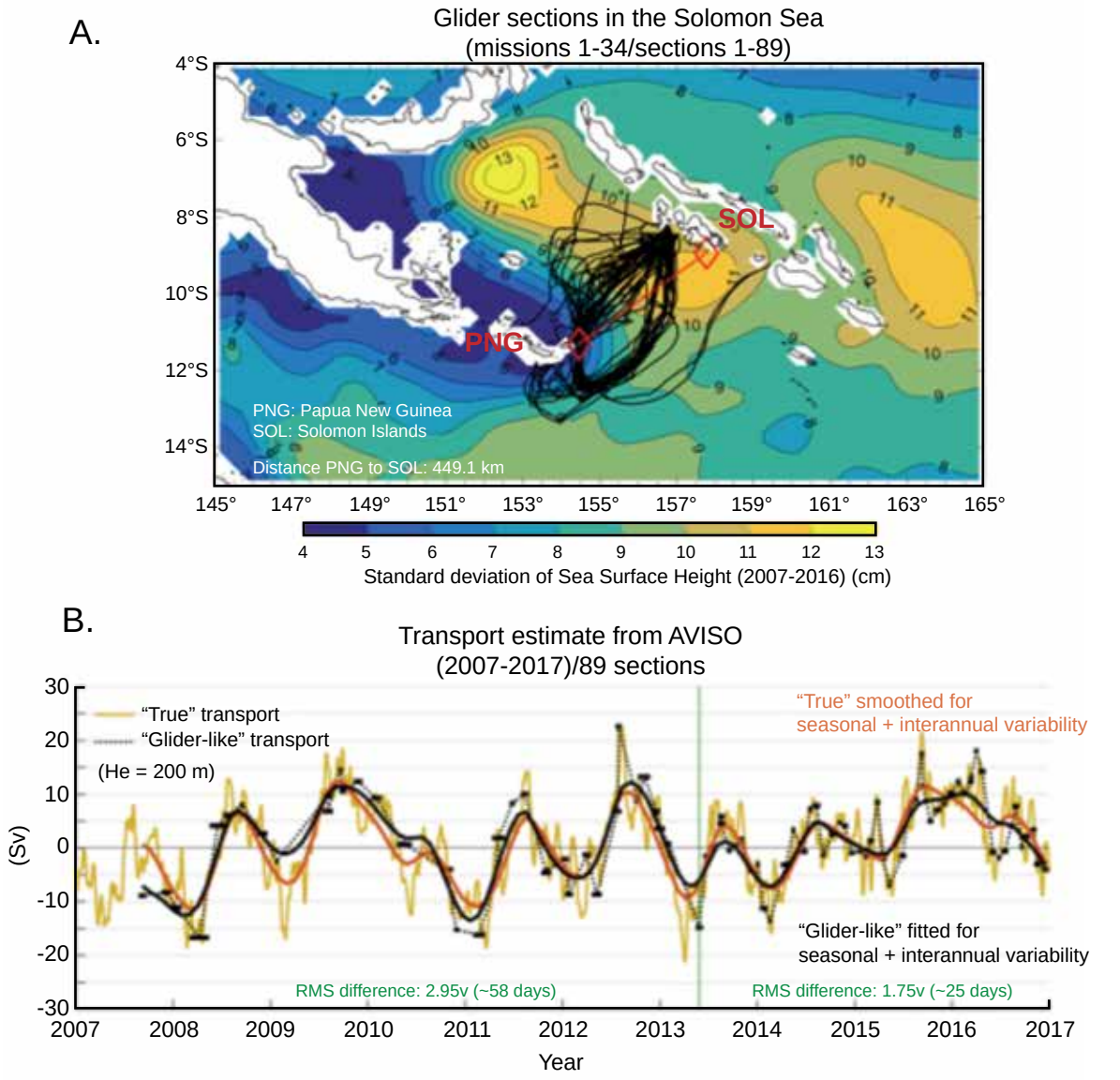


Figure 1. Estimating glider sampling errors using sea surface height (SSH) from AVISO. A. Map of standard deviation of SSH for the Solomon Sea. Shown in black are 89 glider sections since 2007. B. Two ways to estimate cross-sea transport, both using SSH from AVISO. "True transport" (yellow line) is based on a simple daily cross-sea SSH difference (red section in panel A). A second, "glider-like transport" samples AVISO at the times and locations of each glider dive (black section in panel A), finding transport by integrating the cross-track velocity segments as is done for the actual glider data (black boxes show times of each glider transect). Both the "true" and "glider-like" AVISO-derived time series are filtered to represent the low frequency signals of interest here (heavy red and black lines, respectively). The difference is the effect of intraseasonal aliasing on glider-measured transport.

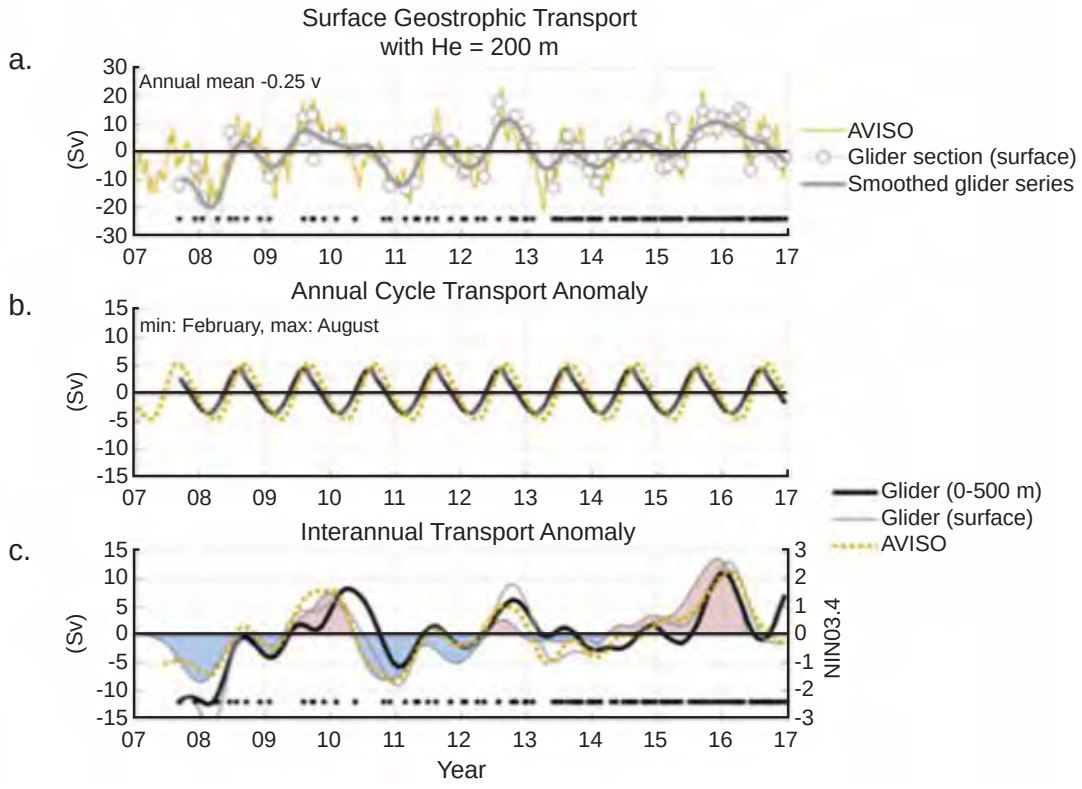


Figure 2. Estimating Solomon Sea transport using sea surface height (SSH) from AVISO. From the glider data, researchers first determine by least square fit an equivalent depth He = 200 m so that the magnitude of surface transport variations matches that of the 0-500 m transport. Using this vertical scale He researchers can then compute transport from the SSH difference across the Solomon Sea. a. Comparison of surface transport across the Solomon Sea from SSH (yellow line), and as measured by the glider. Gray circles represent individual sections and the heavy gray line is the filtered glider series that represents the low frequency signal. Panels b and c show comparison for the annual cycle and interannual components, respectively. In both panels, the heavy black line shows the actual 0-500 m transport as measured by the glider. The annual cycle can be determined well from SSH variations only using He, but the fit is not as good for the interannual signal.

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 contribute to the global climatology of ocean current measurements. However, without suitable data acquisition and processing software installed, and used routinely, this potential is not realized. The 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 2017

For the reporting period the project's primary goals were to: 1) finish installing the University of Hawaii Data Acquisition System (UHDAS) on all suitable NOAA ships; 2) continue monitoring, maintenance, and training activities; and 3) work with NOAA personnel in developing the "data pipeline" between the UHDAS installations and the National Centers for Environmental Information (NCEI). The goals were met via new installations on the *Ferdinand R. Hassler* and the *Reuben Lasker*, re-installations to support new or refurbished transducers on *Pisces* and *Oscar Elton Sette*, and a variety of other activities.

The system on the *Henry B. Bigelow* was brought online. Major system updates were made on the *Gordon Gunter*, *Pisces*, *Okeanos Explorer*, and *Ron Brown*. Toby Martin conducted 1.5 days of UHDAS training at the NOAA Survey Technician training workshop in December 2016 at Newport, OR. In January 2017 he participated in the NOAA Environmental Data Management Workshop, and in April he participated in the NOAA R2R meeting.

The University of Hawaii Sea Level Center

P.I.: Philip R. Thompson

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

NOAA Sponsor: David Legler

Budget Amount: $480,490

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 many tide gauge stations, the 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.

Progress during FY 2017

During the report period, project objectives for data management and station operations were accomplished as the Fast Delivery and Research Quality database were updated and expanded to accommodate new data and stations. After successfully completing service trips to eight UHSLC stations in Malaysia, Indonesia, and Peru during June 2017, UHSLC technicians are preparing for the next round of service trips this fall. 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 Tide Gauge Benchmark Monitoring Project (TIGA) data center. The project

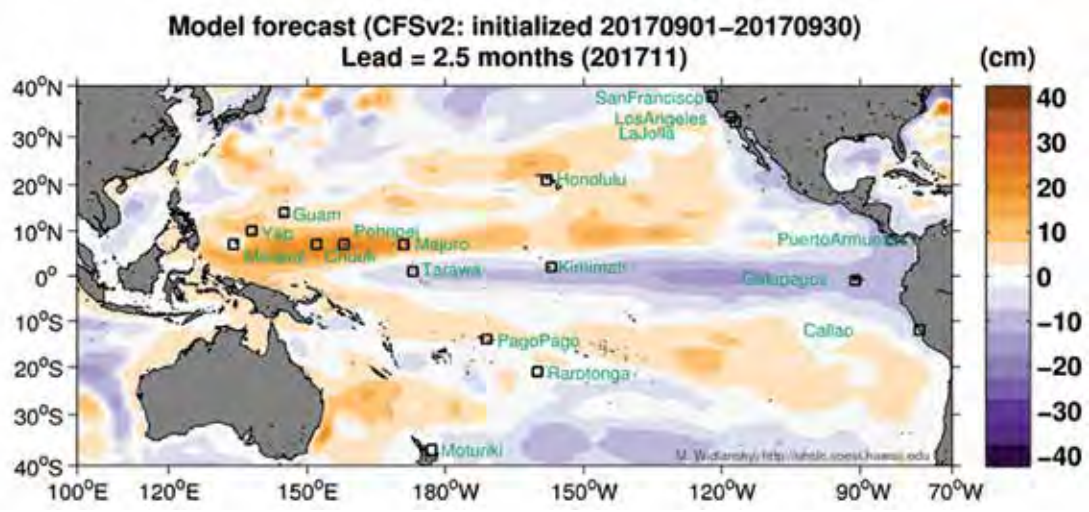


Figure 1. Monthly sea level anomalies for November 2017 forecasted by the CFSv2 model simulation in September 2017. Black boxes and labels correspond to island and coastal regions for which detailed sea level forecasts are provided.

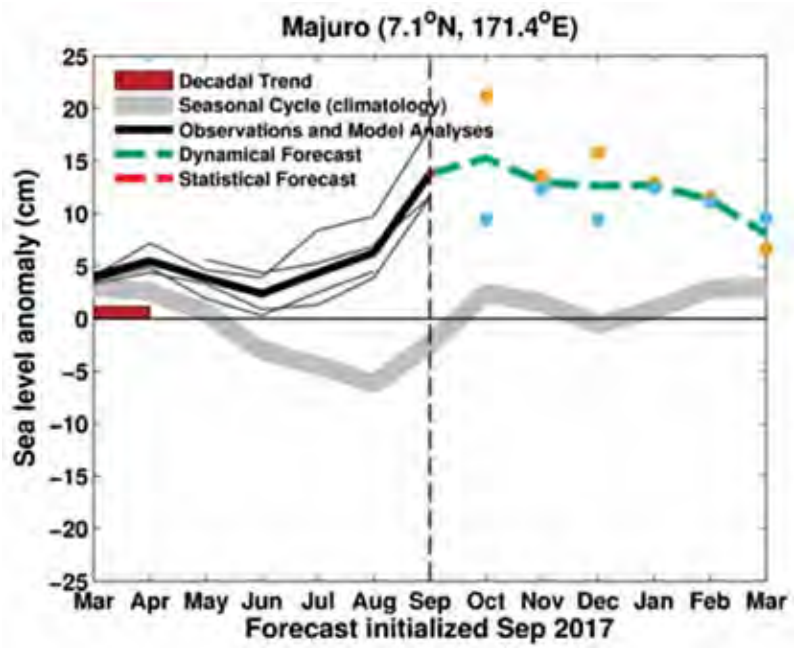


Figure 2. A multi-model ensemble forecast initialized in September 2017 for the Majuro Atoll in the context of recent observations (black), decadal trend (red), and the seasonal cycle (gray).

is committed to one new GPS installation at a tide gauge station and anticipates completing this during FY 2018. Candidate sites are being considered amongst the GLOSS Core Network stations that the project currently maintains. During FY 2017, researchers continued with UHSLC website development, which now includes a sea level forecast page for tropical Pacific Islands. By compiling monthly sea level anomaly predictions from multiple statistical and dynamical (coupled ocean-atmosphere general circulation) models through an international collaboration, improved outlooks of relative monthly sea level anomalies are achieved (Figs. 1 and 2). This new product is generating significant interest around the Pacific and will help to drive users to the UHSLC website and datasets. Researchers collaborated with the University of Colorado and NASA Jet Propulsion Laboratory (JPL) to

develop a sea level explorer tool that will allow users to more readily interact with UHSLC data and compare with satellite altimetry. The explorer tool will launch later this year. Over the past year, a substantial amount of effort was dedicated to developing server-side software that modernizes the dataflow within the center. The outcomes of this effort will be realized during FY 2018 with the roll-out of a new Environmental Research Division Data Access Platform (ERRDAP) data server and data acquisition tools. Since July 1, 2017 the project focused on developing near-real-time processing and web-based data viewers for up-to-date monitoring of sea level from UHSLC stations.

During FY 2017, a variety of studies were published related to long-standing research projects. This includes a paper 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, which was found to be related to mechanisms of wind-driven heat redistribution in the region. 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 and average rate from the best records might be biased relative to the 'true' rate of 20th century sea level rise. UHSLC researchers were the lead authors on the sea level section in the 2016 State of Climate Report, to be published later this summer, technical contributors to the National Climate Assessment for the Pacific Islands, and authors on a case study on inundation frequency for the report. Collaboration is a key component of UHSLC research goals and project staff collaborated with researchers outside the center on a variety of sea-level-related research projects including: 1) a review of the effect of internal climate variability on sea level; and 2) an assessment of the effect of atmospheric pressure on sea level variability in long tide gauge records.

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 enhances activities at the Asia-Pacific Data-Research Center (APDRC) in support of climate research within the International Pacific Research Center (IPRC) at the University of Hawaii. The project's primary goal is to meet critical regional needs for ocean, climate and ecosystem information. The APDRC does this through local support of climate research activities but also by generating relevant data products for a broad spectrum of users throughout the Asia-Pacific region. The vision of the APDRC is to link data management and preparation activities to research activities within a single center, and provide one-stop shopping for climate data and products to local researchers and collaborators, the national climate research community, and the public. The APDRC is organized around three main goals: 1) providing integrated data server and management systems for

climate data and products; 2) developing and serving new climate-related products for research and applications users; and 3) conducting climate research in support of the IPRC and NOAA research goals.

Progress during FY 2017

The APDRC maintains a wide suite of data transport and discovery servers, including: OPeNDAP-based THREDDS DODS Server (TDS), GrADS DODS Server (GDS) and DAPPER; a Live Access Server (LAS); and DCHART. These servers continue to be maintained. One highlight was the release and subsequent implementation of a major upgrade to LAS. The APDRC is now running LAS-8.4 in parallel with earlier versions as its functionality is tested.

The APDRC data archives increased due in part to regular updates to the Argo products, various new data sets (e.g., CFSv2) and continued acquisition of coupled climate model output from the CMIP-5 runs. These CMIP-5 runs are heavily used within IPRC research activities. In addition to the Navy operational HYbrid Coordinate Ocean Model (HYCOM), the APDRC servers output from a local implementation of HYCOM. In all, the APDRC has archived almost 238 TB of data: 31% of this is output from the Earth Simulator (OFES/AFES/CFES); coupled climate model output from CMIP experiments accounts for about 31%; and the remaining 37% is spread across the remaining data sets (approximately 114 in total). Upgrades to the APDRC web pages include new additions to the projects page that lists a brief description of the projects that the ADPRC supports, along with direct links to these projects (http://apdrc.soest.hawaii.edu/projects).

The APDRC continued working with Pacific island communities to develop specific data products and services to help with activities in the insular Pacific. This was primarily done by support of real-time climate "dashboards" and quarterly reports. An on-going effort was focused on the design and implementation of a similar dashboard specific to the region of the Marshall Islands. These dashboards were developed via dialog between various federal and local agencies, local stakeholders, and researchers. The implementation of the web-based tools was then done by the APDRC.

Another major activity was in support of the developing Regional Climate Center (RCC) for Region V sponsored and led by the World Meteorological Office (WMO). The APDRC developed a central website for the RCC and some regionally-specific data products.

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

P.I.: Douglas S. Luther

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

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

Budget Amount: $72,048

NOAA Goal(s)

- Weather-Ready Nation

Purpose of the Project

The primary purpose of this project is the collection of atmospheric mercury speciation data. The project collects and analyzes semi-continuous high altitude (11,144 feet) measurements of elemental mercury (Hg0), reactive gaseous mercury (RGM), and particulate mercury (HgP) at the Mauna Loa Observatory (MLO), Hawaii. The objectives of this task are 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 that 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 are to be organized and archived in a database.

Progress during FY 2017

Activity was centered on continuing additional tests and measurements to mitigate observed mercury measurement artifacts at MLO. Prior testing at MLO provided conclusive evidence for the presence of Hg0-HgP measurement artifacts in the inlet glassware of the commercial system. In addition, measurement biases in the monitoring of RGM have also been identified. Additional instrumentation installed by the P.I. in September 2016 was used to continue testing differing methodologies to measure Hg0 and total mercury, and to calculate reactive mercury (RM: RM = RGM + HgP) by difference.

The P.I. and his team also deployed a novel RGM calibration system to directly inject HgBr2 vapor (a key component of RGM) into the instrument inlets. Testing with this new device continued until December 9, 2016 under the direction of MLO staff.

Pacific ENSO Applications Climate 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 U.S.-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.

Progress during FY 2017

As a new initiative in FY 2017, PEAC conducted research that examined the impact of climate variability and change on water resources for the vulnerable USAPI region. An island-wide projection of future variability of temperature, rainfall, sea level, and ENSO information was explored using the latest IPCC-AR5 GCMS protocol (CMIP5) with 38 GCMs and up to 105 model runs.

PEAC scientists continued working closely with Integrated Water Level Service (IWLS) partners to implement the expanded ensemble mean sea level anomaly forecasting scheme for the Pacific basin during 2016-17 and in 2017, several new stations were added. The ensemble is based on statistical and dynamical model forecasts including the operational sea level product developed at PEAC.

Over the past year the PEAC graduate research assistant conducted research to better understand the performance and skill of the PEAC rainfall-forecasting suite during El Niño and non-El Niño events. It was observed that PEAC rainfall forecasting suite performs extremely well during El Niño events but degrades during non-El Niño periods.

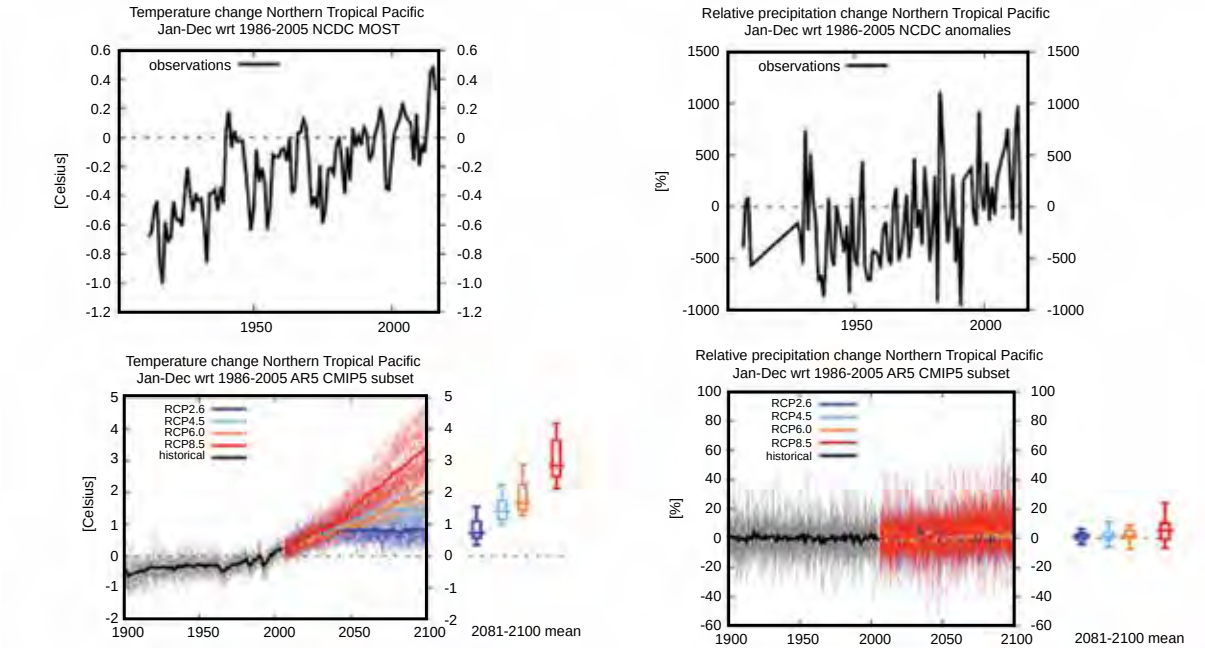


Figure 1. Preliminary results of IPCC-AR5-model-based projections of temperature and rainfall. As part of its exploratory research the project examined the climatology of temperature and rainfall variability and change from the perspective of IPCC-AR5-GCMs. A time series plots of annual relative mean temperature (left) and rainfall (right) trend (anomalies w.r.t 1986-2005) over tropical north Pacific (Data source: National Climatic Data Center (NCDC) MOST). Bottom panel: Mean annual (Jan-Dec) relative temperature (left) and rainfall (right) change projections (anomalies with respect to 1986-2005) over tropical north Pacific for RCPs 2.6, 4.5, 6.0, and 8.5. The heavy black line denotes historical changes from 1900 to 2016.

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 the Pacific Marine Environmental Laboratory (PMEL) where the data are examined and plots of the results are posted to the web in near-real time.

Progress during FY 2017

As with previous reporting periods, this project provided one week 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, maintenance, and testing of instrumentation used as part of NOAA's 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, which is 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.: Douglas S. Luther

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 three aspects of the Argo Program. The first objective involves conventional float testing, deployment, and data/engineering evaluation. The second objective involves deep Argo float testing, deployment, and data/engineering evaluation. The third objective involves delayed-mode quality control of conventional and deep Argo float data and ocean climate research using data from these floats and other sources.

Progress during FY 2017

At the PMEL float lab Dr. Elizabeth Steffen continued to test floats, monitor float performance, diagnose and coordinate repairs of problems discovered with the floats, and work with the manufacturer to resolve problems. She continued to work with other members of the group to deal with increased IT security restrictions, arrange for float deployments, and notify the national and international databases. In July 2017, Alexandra Brewer began work at the PMEL float lab as part of Deep Argo spin-up. She began learning float operations in preparation for the arrival of Deep Argo floats in 2018. Stated goals were met.

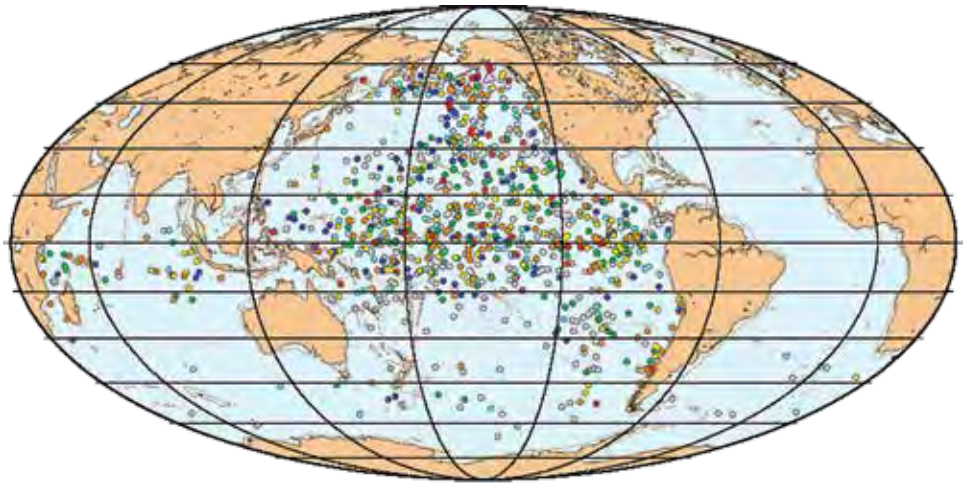


Figure 1. Recent locations of the PMEL Argo floats, for which JIMAR Float Research Coordinator Dr. Elizabeth Steffen performs the logistics, testing, and much of the monitoring. Near the end of September 2017, 632 floats (colored circles) reported in the past 30 days.

Dr. John Lyman continued work on updating scientific delayed-mode quality control software for the PMEL Argo floats, and performed scientific delayed-mode quality control on data from substantial numbers of PMEL Argo float profiles. Stated 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
- Climate Adaptation and Mitigation
- 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 2017

One particularly important consequence from rising sea levels is the increased frequency of coastal flooding due to storms, tides, and other climatic forcings. The gap between mean sea level and a flood threshold decreases, allowing for smaller storm surges or the highest tides to exceed the flood level. A flood frequency analysis was conducted on water levels from a tide station to identify the annual number of days the still water level elevation exceeded a given flooding threshold. Projected future flood frequency scenarios were produced for the area from Kawaihae to Kailua-Kona. A technical report describing the complete methodology and results was completed in March 2017 and presented to the National Park Service in June 2017.

Tropical Meteorology

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

National Weather Service Pacific Region Fellowship Program

P.I.: Douglas S. Luther

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

NOAA Sponsor: Raymond Tanabe

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 2017

During FY 2017, 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 support via undergraduate student helpers, and acquire scientific software and research supplies; and 3) provide scientific equipment and supplies to support the Oceanography Department's Global Environmental Science (GES) program. An estimated 64 GES students and four Oceanography PhD students were supported and benefitted from this program.

During the reporting period, the Program provided funding support for G&G graduate student Brett Walker. Ms. Walker completed her field work at the end of summer 2016 focusing on the east rift zone of Kilauea, around Napau Crater, at Hawaii Volcanoes National Park. She collected lavas to assess why so many eruptions have occurred in this area and evaluate the petrology of the 2011 eruption. She defended her thesis, "Petrologic Insights into Rift Zone Magmatic Interactions Under Kilauea's Napau Crater (1963-2011)" in summer of 2017. Two other G&G undergraduate students were also supported by the fellowship program during this period.

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 are not generally available to the public or research communities; that is, the data is not prepared and offered to the public by the agency (PTWC) responsible for maintaining the gauges because these activities are not part of the mission of that agency. Therefore, this data archiving and dissemination activity is intended to provide as complete a dataset as possible of sea level fluctuations along 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. Recent users of the archive since the last report focused on infragravity waves at periods of 2 minutes to several hours in support of the development and maintenance of both harbor surge and beach flooding nowcasts and forecasts for NOAA's PacIOOS.

Progress during FY 2017

The modernization of the extensive, mostly automated, code enabling ARSHSL's real-time data acquisition, editing and archiving activities was primarily completed before July 2017, as reported recently, having been accomplished under both JIMAR and PacIOOS funding by Martin Guiles. Large parts of this effort were 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. The GUI also provides simple analysis tools, such as tidal harmonic analysis; these tools will be enhanced in the future under PacIOOS funding. Currently, the GUI is capable of automatically accessing and storing for hands-on editing, all 1-minute and 6-minute sampled data from the six NOS gauges in Hawaiian harbors. During the past few months, a number of bugs were fixed so that incorporation into the GUI of real-time acquisition and editing of data from the 14 PTWC sea level gauges can now begin in earnest.

Also per the plans in the last report, the ARSHSL has been maintained online (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. Luther retired as of August 31, 2017. Appropriately, M. Guiles has now taken over her archival duties.

The University of Hawaii Sea Level Center—Tsunami Research

P.I.: Philip R. Thompson

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 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. A typical tsunami water level station is shown in Figure 1 for Quepos, Costa Rica.

Figure 1. UHSLC tsunami water level station at Quepos, Costa Rica.

Progress during FY 2017

For the Pacific Ocean, five stations (Quepos, French Frigate Shoals, Callao, Matarani, and Talara) were visited by UHSLC technicians, which met project objectives. In addition, technicians visited Cocos Island in Costa Rica as part of the field trip to Quepos. They inspected the site for a possible new tsunami station that will be acquired by research colleagues in Costa Rica. Also during the reporting period five stations were visited in the Caribbean (Limon, El Porvenir, Grenada, San Andres, and Santa Marta), which met the expected five station visit quota. All tsunami station data underwent daily and monthly quality assessments, with data archived at the UHSLC. Annual inspection for the research quality dataset is underway and expected to be completed by October 2017.

JIMAR Publications

Author(s) Names	Publication Date	Title	Published In (Journal Name, volume and page number)	Type of Publication	Citation No. or hyperlink	Project Title
Ayers, A.L.	8/1/16	The importance of social movements in overcoming barriers to integrating traditional and local knowledge into contemporary management	International Marine Conservation Congress IV, St. Johns, Newfoundland, Canada, July 30-Aug. 3, 2016	Presentation	http://birenheide.com/IMCC2016/program/singlesession.php3?sessid=SY63	Socioeconomics of Western Pacific Fisheries
Ayers, A.L.	7/11/17	Transaction costs, design principles and co-management of Hawai‘i coral reef fisheries	XVI Biennial International Association for the Study of the Commons Conference, Utrecht, The Netherlands, July 10-14, 2017	Presentation	https://www.iasc2017.org/sessions/	Human Dimensions of Fishing and Marine Ecosystems in the Western Pacific
Ayers, A.L., and J. Hospital	8/21/17	Socioeconomic monitoring reveals differential impacts and unintended consequences of bigeye tuna conservation	Resilience 2017: Resilience Frontiers for Global Sustainability, Stockholm, Sweden, Aug. 20-23, 2017	Presentation	http://media.resilience2017.org/2017/08/Resilience-2017_Final-pdf-program.pdf	Human Dimensions of Fishing and Marine Ecosystems in the Western Pacific
Bakker, D.C.E., et al	9/15/16	A multi-decade record of high quality fCO2 data in version 3 of the Surface Ocean CO2 Atlas (SOCAT)	Earth Syst. Sci. Data, 8, 383-413	Journal Article	https://doi.org/10.5194/essd-8-383-2016	PMEL-UH Ocean Carbon Project
Barbieri M.M., L. Kashinsky, D.S. Rotstein, K.M. Colegrove, K.H. Haman, S. L. Magargal, A.R. Sweeny, A.C. Kaufman, M.E. Grigg, and C.L. Littnan	9/26/16	Protozoal-related mortalities in endangered Hawaiian monk seals Neomonachus schauinslandi	Dis. Aquat. Organ., 121, 85-95	Journal Article	http://www.int-res.com/abstracts/dao/v121/n2/p85-95/	Hawaiian Monk Seal Research Program
Boyle, S., V. De Anda, K. Koenig, E. O'Rielly, T. Schafer, T. Acoba, A. Dillon, A. Heenan, T. Oliver, D. Swanson, B. Vargas-Angel, M. Weijerman, I. Williams, L. Wegley Kelly, and R. Brainard	7/25/17	Coral reef ecosystems of the Pacific Remote Islands Marine National Monument: a 2000-2016 overview	Pacific Islands Fisheries Science Center Special Publication, SP-17-003, 66 pp	Report	https://doi.org/10.7289/V5/SP-PIFSC-17-003	Sustaining Healthy Coastal Ecosystems
Briscoe D.K., D.M. Parker, S. Bograd, E. Hazen, K. Scales, G.H. Balazs, M. Kurita, T. Saito, H. Okamoto, M. Rice, J.J. Polovina, and L.B. Crowder	10/3/16	Multi-year tracking reveals extensive pelagic phase of juvenile loggerhead sea turtles in the North Pacific	Move. Ecol., 4, 23	Journal Article	http://movement-ecologyjournal.biomedcentral.com/articles/10.1186/s40462-016-0087-4	Turtle Research Program
Carvalho, F.	11/21/16	Standardized CPUE for blue shark (Prionae glauca) caught by the longline fisheries based in Hawaii (1995-2015)	ISC Shark Working Group Workshop, Busan, Korea, Nov. 14-21, 2016, ISC/16/SHARK-WG-1/16	Workshop Proceedings	http://isc.fra.go.jp/pdf/SHARK/ISC16_SHARK_1/ISC2016-SHARK-WG-1-16_Carvalho_HI_LL_CPUE.pdf	Stock Assessment Research Program

Carvalho, F., and H. Winker	11/21/16	Stock assessment of North Pacific blue shark (Prionace glauca) using a catch-based method	ISC Shark Working Group Workshop, Busan, Korea, Nov. 14-21, 2016, ISC/16/SHARK-WG-1/18	Workshop Proceedings	http://isc.fra.go.jp/pdf/SHARK/ISC16_SHARK_1/ISC2016-SHARK-WG-1-18_Carvalho_BSH_catch_only_assessment.pdf	Stock Assessment Research Program
Carvalho, F., and T. Sippel	11/21/16	Direct estimates of gear selectivity for the North Pacific blue shark using catch-at-length data: Implications for stock assessment	ISC Shark Working Group Workshop, Busan, Korea, Nov. 14-21, 2016, ISC/16/SHARK-WG-1/13	Workshop Proceedings	http://isc.fra.go.jp/pdf/SHARK/ISC16_SHARK_1/ISC2016-SHARK-WG-1-13_Carvalho_BSH_fishery_selectivities.pdf	Stock Assessment Research Program
Carvalho, F., et al	Aug. 2017	Can diagnostic tests help identify model misspecification in integrated stock assessments?	Fish. Res., 192, 28-40	Journal Article	https://doi.org/10.1016/j.fishres.2016.09.018	Stock Assessment Research Program
Carvalho, F., H. Winker., and J. Brodziak	11/21/16	Stock assessment and future projections for the North Pacific blue shark (Prionace glauca): An alternative Bayesian state-space surplus production model	ISC Shark Working Group Workshop, Busan, Korea, Nov. 14-21, 2016, ISC/16/SHARK-WG-1/17	Workshop Proceedings		Stock Assessment Research Program
Chan, H. L.	3/29/17	Cost-earnings data collection for the Hawaii small boat fishery	North American Association of Fisheries Economists Forum (NAAFE Forum 2017), La Paz, Baja California, Mexico, March 22-24, 2017	Presentation	https://www.xcdsystem.com/naafe/program/SOt7Dbu/index.cfm?pgid=41&speakerid=27481	Economics of Fisheries Initiative
Chan, H.L., and M. Pan	6/1/17	Economic and social characteristics of the Hawaii small boat fishery 2014	U.S. Dept. Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-63, 97 pp	Report	https://doi.org/10.7289/V5/TM-PIFSC-63	Economics of Fisheries Initiative
Christiansen, F., N.F. Putman, R. Farman, D.M. Parker, M.R. Rice, J.J. Polovina, G.H. Balazs, and G.C. Hays	9/28/16	Spatial variation in directional swimming enables juvenile sea turtles to reach and remain in productive waters	Mar. Ecol. Prog. Ser., 557, 247-259	Journal Article	http://www.int-res.com/articles/meps_oa/m557p247.pdf	Turtle Research Program
Comfort, C.M., K.A. Smith, M. McManus, A.B. Neuheimer, J.C. Sevadjian, and C.E. Ostrander	3/1/17	Observations of the mesopelagic micronekton boundary community's diel migration at O'ahu, Hawai'i based on backscatter data	ASLO 2017 Aquatic Sciences Meeting, Honolulu, Hawai'I, Feb. 26-Mar. 3, 2017	Presentation	https://www.sgmeet.com/aslo/honolulu2017/viewabstract.asp?AbstractID=30123	Kona Integrated Ecosystem Assessment
Comfort, C.M., K.A. Smith, M. McManus, A.B. Neuheimer, J.C. Sevadjian, and C.E. Ostrander	7/10/17	Observations of the Hawaiian mesopelagic boundary community in daytime and nighttime habitats using estimated backscatter	AIMS Geosci., 3(3), 304-326	Journal Article	doi:10.3934/geosci.2017.3.304	Kona Integrated Ecosystem Assessment
Dichmont, C., et al	Nov. 2016	A review of stock assessment packages in the United States	Fish. Res., 183, 447-460	Journal Article	https://doi.org/10.1016/j.fishres.2016.07.001	Stock Assessment Research Program

Duffy, L., P. Kuhnert, H. Pethybridge, J. Young, R. Olson, J. Logan, N. Goñi, E. Romanov, V. Allain, M. Staudinger, M. Abecassis, A. Choy, A. Hobday, M. Simier, F. Galván-Magaña, M. Potier, and F. Ménard	6/1/17	Global trophic ecology of yellowfin, bigeye, and albacore tunas: Understanding predation on micronekton communities at ocean-basin scales	Deep Sea Res. II, 140, 55-73	Journal Article	https://doi.org/10.1016/j.dsr2.2017.03.003	Ocean Remote Sensing
Gove, J., J. Polovina, W. Walsh, A. Heenan, I. Williams, L. Wedding, R. Ingram, J. Lecky, K. Oleson, H. Walecka, S. Heron, C. Couch, and E. Howell	10/1/16	West Hawai'i integrated ecosystem assessment: Ecosystem trends and status report	NOAA Fisheries Pacific Science Center, PIFSC Special Publication, SP-16-004, 47 pp	Report	doi:10.2789/V5/SP-PIFSC-16-004	Kona Integrated Ecosystem Assessment
Hutchinson, M.	7/31/16	Assessing shark bycatch condition and the effects of discard practices in the Hawaii-permitted tuna longline fishery (Rev 1)	Western and Central Pacific Fisheries Commission Scientific Committee 12th Regular Session, Bali, Indonesia, Aug. 3-11, 2016, Working Paper WCPFC-SC12-2016/EB-WP- 07, 10 pp	Conference Proceedings	https://www.wcpfc.int/node/27513	Fishing Impacts on Non-target Species
Ingram, R., K. Oleson, and J. Gove	7/18/17	Defining social and ecological interactions in West Hawai'i	24th Annual Hawai'i Conservation Conference, Honolulu, HI, USA, July 18-20, 2017	Presentation		Kona Integrated Ecosystem Assessment
Johnson, G.C., J.M. Lyman, T. Boyer, C.M. Domingues, J. Gilson, M. Ishii, R. Killik, D. Monselesan, and S.E. Wijffels	8/1/17	Global Oceans: Ocean heat content [in: "State of the Climate in 2016"]	Bull. Am. Meteorol. Soc., 98(8), S66-S69	Journal Article	doi:10.1175/2017BAMSStateofthe Climate.1	Profiling CTD Float Array Implementation and Ocean Climate Research
Johnson, G.C., J.M. Lyman, T. Boyer, C.M. Domingues, M. Ishii, R. Killik, D. Monselesan, and S. E. Wijffels	8/2/16	Global Oceans: Ocean heat content [in: "State of the Climate in 2015"]	Bull. Am. Meteorol. Soc., 97(8), S66-S70	Journal Article	doi:10.1175/2016BAMSStateofthe Climate.1	Profiling CTD Float Array Implementation and Ocean Climate Research
Johnson, G.C., J. Reagan, J. M. Lyman, T. Boyer, C. Schmid, and R. Locarnini	8/6/16	Global Oceans: Salinity [in: "State of the Climate in 2015"]	Bull. Am. Meteorol. Soc., 97(8), S70-S74,	Journal Article	doi:10.1175/2016BAMSStateofthe Climate.1	Profiling CTD Float Array Implementation and Ocean Climate Research
Johnson, G.C., J. Reagan, J.M. Lyman, T. Boyer, C. Schmid, and R. Locarnini	8/1/17	Global Oceans: Salinity [in: "State of the Climate in 2016"]	Bull. Am. Meteorol. Soc., 98(8), S69-S75	Journal Article	doi:10.1175/2017BAMSStateofthe Climate.1.	Profiling CTD Float Array Implementation and Ocean Climate Research
Kapur, M., J. Brodziak, E. Fletcher, E., and A. Yau	6/7/17	Summary of life history and stock assessment results for Pacific blue marlin, western and central North Pacific striped marlin, and North Pacific swordfish	ISC Billfish Working Group, Keelung, Chinese-Taipei, June 1-7, 2017, ISC/17/BILL-WG-1/2	Workshop Proceedings	http://isc.fra.go.jp/pdf/BILL/ISC17_BILL_1/ISC17_BILLWG_WP1-2.pdf	Stock Assessment Research Program
Kleiber, D., K. Frangoudes, H. Snyder, et al	2017	Promoting gender equity and equality through the small-scale fisheries guidelines: Experiences from multiple case studies. In: Jentoft, S., et al. (eds.), The Small-Scale Fisheries Guidelines: Global Implementation	Springer Intl. Publishing, MARE Publication Series, vol 14, eBook ISBN 978-3-319-55074-9	Report	doi: 10.1007/978-3-319-55074-9	Human Dimensions of Fishing and Marine Ecosystems in the Western Pacific

Kohin, S., T. Sippel, and F. Carvalho	11/22/16	Catch and size of blue sharks caught in U.S. fisheries in the North Pacific	ISC Shark Working Group, Busan, Korea, Nov. 14-21, 2016, ISC/16/ SHARKWG-1/15	Workshop Proceedings	http://isc.fra.go.jp/pdf/SHARK/ISC16_SHARK_1/ISC2016-SHARKWG-1-15_Kohin_US_Fisheries_BSH_Catch_and_Size.pdf	Stock Assessment Research Program
Littnan, C., J. Baker, B. Harting, T. Johanos, T. Mercer, and S. Robinson	7/20/17	The power of proactive efforts to help turn a corner in Hawaiian monk seal recovery	24th Annual Hawai'i Conservation Conference, Honolulu, HI, USA, July 18-20, 2017	Presentation		Hawaiian Monk Seal Research Program
Marra, J., and A. Genz	3/30/17	Scenario-based analysis of the potential impacts of sea level rise on coastal flooding and shoreline retreat along the Kohala and Kona coasts, from Kawaihae to Kailua-Kona, on the island of Hawai'i		Report		Sensitivity of Built and Natural Infrastructure to Coastal Flooding under a Changing Climate
Mercer, T., K. Gobush, J. Henderson, B. Becker, and C. Littnan	7/20/17	Prevalence of interactions between Hawaiian monk seals and nearshore fisheries in the main Hawaiian Islands	24th Annual Hawai'i Conservation Conference, Honolulu, HI, USA, July 18-20, 2017	Presentation		Hawaiian Monk Seal Research Program
Minte-Vera, C.V., M.N. Maunder, J.M. Casselman, and S.E. Campana	8/1/16	Growth functions that incorporate the cost of reproduction	Fish. Res., 180, 31-44	Journal Article	https://doi.org/10.1016/j.fishres.2015.10.023	Open Source ADMB Project
Newman, S.J., et al	5/1/17	International workshop on advancing methods to overcome challenges associated with life history and stock assessments of data-poor deep-water snappers and groupers	Mar. Policy, 79, 78-83	Journal Article	10.1016/j.marpol.2017.02.009	Bio-Sampling
Sculley M., J. Brodziak, A. Yau and M. Kapur	7/10/17	An exploratory analysis of trends in swordfish (xiphias gladius) length composition data from the Hawaiian longline fishery	Pacific Islands Fisheries Science Center, PIFSC Working Paper, WP-17-002, 48 pp	Workshop Proceedings	https://doi.org/10.7289/V5/WP-PIFSC-17-002	Stock Assessment Research Program
Smith, K.A., M.A. Merrifield, and G.S. Carter	5/22/17	Coastal-trapped behavior of the diurnal internal tide at O'ahu, Hawai'i	J. Geophys. Res.-Oceans, 122(5), 4257-4273	Journal Article	doi: 10.1002/2016JC012436	Kona Integrated Ecosystem Assessment
Stamoulis, K.A., M. Poti, J.M.S. Delevaux, M.K. Donovan, A. Friedlander, and M.S. Kendall	10/13/16	Fishes-reef fish. In: Costa B.M., and M.S. Kendall (eds.), Marine biogeographic assessment of the main Hawaiian Islands: A collaborative investigation	NOAA Technical Memorandum NOS NCCOS 214 and OCS Study BOEM 2016-035, Silver Spring, MD	Report	http://dx.doi.org/10.7289/V5/TM-NOS-NCCOS-214	A Biogeographic Assessment of Reef Fishes, Fisheries, and Benthic Assemblages in Hawaii
Sullivan, M., S. Robinson, and C. Littnan	7/20/17	#monkseal. Social media for Hawaiian monk seal conservation	24th Annual Hawai'i Conservation Conference, Honolulu, HI, USA, July 18-20, 2017	Presentation		Hawaiian Monk Seal Research Program

Sutton, A.J., C.L. Sabine, R.A. Feely, W.-J. Cai, M.F. Cronin, M.J. McPhaden, J.M. Morell, J.A. Newton, J.-H. Noh, S.R. Ólafsdóttir, J.E. Salisbury, U. Send, D. Vandemark, and R.A. Weller	9/13/16	Using present-day observations to detect when anthropogenic change forces surface ocean carbonate chemistry outside preindustrial bounds	Biogeosciences, 13(17), 5065-5083	Journal Article	https://doi.org/10.5194/bg-13-5065-2016	PMEL-UH Ocean Carbon Project
Tagami, D., D. Curran, W. Machado, R. Ito, N. Chan, A. Tomita, and M. Iwane	7/7/17	2017 Annual report to the Western and Central Pacific Fisheries Commision, Part 1: Information on fisheries, research and statistics (for 2016)	WCPFC-SC13-AR/CCM-27, rev 2, Aug. 22, 2017	Report	https://www.wcpfc.int/node/29425	Pacific Tuna Fishery Data Management
Tagami, D., D. Curran, W. Machado, R. Ito, N. Chan, A. Tomita, and M. Iwane	7/1/17	National report of U.S.A. (U.S.A. fisheries and research on tuna and tuna-like fisheries in the North Pacific Ocean	ISC 17 Plenary Session, Vancouver, BC, Canada, July 12-17, 2017, ISC/17/Plenary/09	Report	http://isc.fra.go.jp/pdf/ISC17/ISC17plenary09-US_National_report.pdf	Pacific Tuna Fishery Data Management
Taylor, B., and C. Pardee	4/5/17	Growth and maturation of the redlip parrotfish Scarus rubroviolaceus	J. Fish Biol., 90(6), 2452-2461	Journal Article	doi: 10.1111/jfb.13309	Bio-Sampling
Taylor, B., J. Gourley, and M.S. Trianni	8/31/16	Age, growth, reproductive biology and spawning periodicity of the forktail rabbitfish (Siganus argenteus) from the Mariana Islands	Mar. Freshw. Res., 68(6), 1088-1097	Journal Article	https://doi.org/10.1071/MF16169	Bio-Sampling
Taylor, B.M.	11/3/16	Reproductive biology of commercially valuable coral reef-associated species in the US Pacific Territories	MARVLS Workshop, La Jolla, CA, USA, Nov. 3-5, 2016	Presentation		Bio-Sampling
Taylor, B.M.	11/3/16	Patterns and processes of life-history variation across multiple spatial scales	MARVLS Workshop, La Jolla, CA, USA, Nov. 3-5, 2016	Presentation		Bio-Sampling
Thompson, P., B. Hamlington, F. Landerer, and S. Adhikari	Submitted	Constraining 20th century global sea level rise	Nature Clim. Change	Journal Article		The University of Hawaii Sea Level Center
Thompson, P.R., C.G. Piecuch, M.A. Merrifield, J.P. McCreary, and E. Firing	9/13/16	Forcing of recent decadal variability in the Equatorial and North Indian Ocean	J. Geophys. Res.-Oceans, 121(9), 6762-6778	Journal Article	https://doi:10.1002/2016JC012132	The University of Hawaii Sea Level Center
Wakefield, C.B., J.M. O'Malley, A. J. Williams, and B.M. Taylor	7/29/16	Ageing bias and precision for deep-water snappers: evaluating nascent otolith preparation methods using novel multivariate comparisons among readers and growth parameter estimates	ICES J. Mar. Sci., 74, 193-203	Journal Article	doi: 10.1093/icesjms/fsw162	Bio-Sampling
Weijerman, M., S. Robinson, F. Parrish, J. Polovina, and C. Littnan	7/20/17	Monk seals and their ecosystems-what factors drive their population dynamics?	24th Annual Hawai'i Conservation Conference, Honolulu, HI, USA, July 18-20, 2017	Presentation		Hawaiian Monk Seal Research Program
Whitney, J.	2/9/17	The mysteries & marvels of miniature marine monsters	Hanauma Bay Outreach Seminar Series, Honolulu, HI, USA, Feb. 9, 2017	Presentation		Kona Integrated Ecosystem Assessment
Whitney, J., J. Gove, D. Kobayashi, J. Lecky, K. Smith, and M. McManus	8/11/17	Surface slicks as nursery habitat for diverse larvae in west Hawaii	XIth International Larval Biology Symposium, Honolulu, HI, USA, Aug. 10-13, 2017	Presentation		Kona Integrated Ecosystem Assessment

Williams, I.D., D.J. White, R.T. Sparks, K.C. Lino, J.P. Zamzow, E.L.A. Kelly, and H.L. Ramey	7/27/16	Responses of herbivorous fishes and benthos to 6 years of protection at the Kahekili Herbivore Fisheries Management Area, Maui	PLoS One, 11(7), e0159100	Journal Article	https://doi.org/10.1371/journal.pone.0159100	Sustaining Healthy Coastal Ecosystems
Work, T.M., P.D.R. Moeller, K.R. Beauchesne, J. Dagenais, R. Breeden, R. Rameyer, W.J. Walsh, M. Abecassis, D.R. Kobayashi, C. Conway, and J. Winton	3/6/17	Pufferfish mortality associated with novel polar marine toxins in Hawaii	Dis. Aquat. Organ., 123(2), 87-99	Journal Article	https://doi.org/10.3354/dao03096	Ocean Remote Sensing
Young, C.N., J. Carlson, M. Hutchinson, C. Hutt, D. Kobayashi, C.T. McCandless, and J. Wraith	12/1/16	Status review report: Oceanic whitetip shark (Carcharhinius longimanus). Final report to the National Marine Fisheries Service, Office of Protected Resources	November 2016, 162 pp	Workshop Proceedings	http://www.nmfs.noaa.gov/pr/species/Status%20Reviews/oceanic_whitetip_status_review_report.pdf	Fishing Impacts on Non-target Species

Appendix I List of Acronyms

ACL	Annual Catch Limit
AD	Automatic Differentiation
ADCP	Acoustic Doppler Current Profiler
ADMB	Automatic Differentiation Model Builder
APDRC	Asia-Pacific Data Research Center
APEX	Oracle Application Express
AR5	Fifth Assessment Report
ARL	Air Resources Laboratories
ARMS	Autonomous Reef Monitoring Structures
ARSHSL	Archive of Rapidly-Sampled Hawaiian Sea Level
ASRAMP	American Samoa Reef Assessment and Monitoring Program
ASTWG	Advanced Sampling Technology Working Group
AVHRR	Advanced Very High Resolution Radiometer
AVISO	Archiving, Validation, and Interpretation of Satellite Oceanographic Data
AWIPS	Advanced Weather Interactive Processing System
BET	Big Eye Tuna
BOEM	Bureau of Energy Management
CAPSTONE	Campaign to Address Pacific Monument Science, Technology, and Ocean Needs
CAU	Calcification Acidification Units
CCMA	Center for Coastal Monitoring and Assessment
CFBP	Commercial Fisheries Biosampling Program
CFSv2	Coupled Forecast System, version 2
Chl-a	Chlorophyll-a concentration
CIYN	Cetaceans in Your Neighborhood
CMIP-5	Coupled Model Intercomparison Project Phase 5
CNMI	Commonwealth of the Northern Mariana Islands
CPU	Central Processing Unit
CREP	Coral Reef Ecosystem Program
CRP	Cetacean Research Program
CTD	Conductivity Temperature and Depth
DAR	State of Hawaii Division of Aquatic Resources
DAPPER	Data Access Protocol server
DASBR	Drifting Acoustic Spar Buoy Recorder
DAWR	Division of Aquatic and Wildlife Resources (Guam)
DCHART	Web-based server for display of in situ and gridded data sets
DFW	Division of Fish and Wildlife (CNMI)
DIAS	Document Imaging Archival System
DIC	Dissolved inorganic carbon
DIDSON	Dual-frequency IDentification Sonar

DLNR	Department of Land and Natural Resources
DLNR-HDAR	Department of Land and Natural Resources – Hawaii Division of Aquatic Resources
DMWR	Department of Marine and Wildlife Resources (American Samoa)
DODS	Distributed Ocean Data System
DSCRTP	Deep Sea Coral Research and Technology Program
ECC	Exploration Command Center
EEZ	Exclusive Economic Zone
EKE	Eddy Kenetic Energy
ENIO	Equatorial and Northern Indian Ocean
ENSO	El Niño Southern Oscillation
EORP	Ecosystems Observations and Research Program
ERDDAP	Environmental Research Division Data Access Platform
ESA	Endangered Species Act
ESD	Ecosystem Sciences Division
EX	NOAA R/V Okeanos Explorer
FCMA	Fishery Conservation and Management Act
FEP	Fishery Ecosystem Plan
FFS	French Frigate Shoals
FRMD	Fisheries Research and Monitoring Division
FRS	Fisher Reporting System (Hawaii)
FSWP	Fishery Statistics of the Western Pacific
FUS	Fisheries of the United States
FY	Fiscal Year
G&G	Geology and Geophysics
GCMS	General Circulation Models
GCOS	Global Climate Observing System
GDS	GrADS DODS Server
GES	Global Environmental Science
GIS	Geographic Information System
GLOSS	Global Sea Level Observing System
GMSL	Global Mean Sea Level
GPS	Global Positioning System
GrADS	Grid Analysis and Display System
GUI	Graphic User Interface
HA	NOAA R/V Hi'ialakai
HARAMP	Hawaiian Islands Reef Assessment and Monitoring Program
HARP	High-frequency Acoustic Recording Package
HDAR	Hawaii Division of Aquatic Resources
Hg0	Elemental Mercury
HgP	Particulate Mercury
HIC	Hawaii Information Consortium

HICEAS	Hawaiian Islands Cetacean Ecosystem Assessment Survey
HIMB	Hawaii Institute of Marine Biology
HITEC	Hawaiian Islands Technology for the Ecology of Cetaceans
HMS	Hawaiian Monk Seal
HOT	Hawaii Ocean Time Series
HP	Horse Power
HMSRP	Hawaiian Monk Seal Research Program
HRPT	High Resolution Picture Transmission
HURL	Hawaii Undersea Research Laboratory
HYCOM	HYbrid Coordinate Ocean Model
IATTC	Inter-American Tropical Tuna Commission
IDE	Integrated Development Environment
IDEA	NOAA Integrated Data and Environmental Activities
IEA	Integrated Ecosystem Assessment
IEAFM	International Ecosystem Approach to Fisheries Management
IIFET	International Institute of Fisheries Economics and Trade
IPCC	Intergovernmental Panel on Climate Change
IPRC	International Pacific Research Center
IRC	Inouye Regional Center
ISC	International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean
ISO/IEC	International Organization for Standardization/International Electrotechnical Commission
IT	Information Technology
IUCN	International Union for Conservation of Nature and Natural Resources
IWLS	Integrated Water Level Service
JIMAR	Joint Institute for Marine and Atmospheric Research
JPL	Jet Propulsion Laboratory
KKO	Ke Kai Ola
LAS	Live Access Server
LED	Light-Emitting Diode
LHP	Life History Program
MACS	Mariana Archipelago Cetacean Survey
MAF	Ministry of Fisheries (Timor-Leste)
$MAPCO_2$	Moored Autonomous pCO_2 System
MARAMP	Marianas Archipelago Reef Assessment Monitoring Program
MARVLS	Maturity Assessment, Reproductive Variability, and Life Strategies
MCMC	Markov chain Monte Carlo
MHI	Main Hawaiian Islands
MLO	Mauna Loa Observatory
MMPA	Marine Mammal Protection Act
MOUSS	Modular Underwater Stereoscopic System

MTBAP	Marine Turtle Biology and Assessment Program
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
NEPA	National Environmental Policy Act
NESDIS	National Environmental Satellite, Data, and Information Service
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NSF	National Science Foundation
NUTS	No-U-Turn Sampler
NWHI	Northwestern Hawaiian Islands
NWS	National Weather Service
OA	Ocean acidification
OAP	Ocean acidification program (NOAA office)
OAR	Office of Oceanic and Atmospheric Research
OER	Office of Ocean Exploration and Research
OFES/AFES/CFES	Ocean/Atmosphere/Coupled model For the Earth Simulator
OGL	Ocean Genomic Legacy
OPeNDAP	Open-source Project for a Network Data Access Protocol
OWCP	OceanWatch - Central Pacific
PacIOOS	Pacific Islands Ocean Observing System
PaCIS	Pacific Climate Information System
PACOM	Pacific Command
PAT	Pop-off Archival Tag
PARR	Public Access to Research Results
PEAC	Pacific ENSO Applications Climate Center
PI	Principal Investigator
PIBHMC	Pacific Islands Benthic Habitat Mapping Center
PICES	Pacific International Council for the Exploration of the Sea-North Pacific Marine Science Organization
PIFSC	Pacific Islands Fisheries Science Center
PIMPAC	Pacific Island Managed and Protected Area Community
PIR	Pacific Islands Region
PIRO	Pacific Islands Regional Office
PMEL	Pacific Marine Environmental Laboratory
PMNM	Papahānaumokuākea Marine National Monument
PMP	Positive Mathematical Programming
PRD	Protected Resources Division
PRECI	Protected Resources Environmental Compliance Initiative
PRIA	Pacific Remote Island Area

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
R2R	Rolling Deck to Repository (software program)
RAMP	Reef Assessment and Monitoring Program
RCC	Regional Climate Center
REA	Rapid Ecological Assessment
RFMO	Regional Fishery Management Organization
RGM	Reactive Gaseous Mercury
RM	Reactive Mercury
ROMS	Regional Ocean Modeling System
ROV	Remotely Operated underwater Vehicle
R/V	Research Vessel
SAFE	Stock Assessment and Fishery Evaluation
SAP	Stock Assessment Program
SCADA	Supervisory Control and Data Acquisition
SEM	Socioeconomic Monitoring
SFD	Sustainable Fisheries Division
SFI	Sustainable Fisheries Initiative
SIO	Scripps Institution of Oceanography
SLICK	Surface Lines In Coastal Kona
SOD	Science Operations Division
SOP	Standard Operating Procedure
SOEST	School of Ocean and Earth Science and Technology
SPC	Secretariat of the Pacific Community
SPTT	South Pacific Tuna Treaty
SSC	Science and Statistical Committee
SSF	Small-scale Fisheries
SSH	Sea Surface Height
SST	Sea Surface Temperature
SSTP	Survey and Sampling Technologies Program
SWFSC	Southwest Fisheries Science Center
SWS	SeaWater System
TA	Total alkalinity
TB	Terabyte
TDS	THREDDS-DODS Server
THREDDS	Thematic Real-time Environmental Distributed Data Services
TIGA	Tide Gauge Benchmark Monitoring Project

TMB	Template Model Builder
TRP	Turtle Research Program
TSI	Territorial Science Initiative
UFA	United Fishing Agency (Hawaii)
UH	University of Hawaii
UHDAS	University of Hawaii Data Acquisition System
UHM	University of Hawaii at Manoa
UHSLC	University of Hawaii Sea Level Center
UNR	University of Nevada at Reno
URL	Uniform resource locator
UPS	Uninterrupted Power Supply
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)
VARS	Video Annotation and Reference System
VFP	Visual Fox Pro
VMS	Vessel Monitoring System
VSP	Visiting Scientist Program
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean
WHOI	Woods Hole Oceanographic Institution
WHOTS	WHOI Hawaii Ocean Time-series Station
WMO	World Meteorological Office
WPacFIN	Western Pacific Fisheries Information Network
WPRFMC	Western Pacific Regional Fishery Management Council

Appendix II List of Awards and Related Amendment Numbers

JOINT INSTITUTE FOR MARINE AND ATMOSPHERIC RESEARCH (JIMAR)
COOPERATIVE AGREEMENT NO. NA11NMF4320128 (AND NA15NMF4320128*)
List of Projects described in the Final Report for the period: July 1, 2016-September 30, 2017

TITLE	NOAA Technical Lead/Sponsor	Amendment Number(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, 160
Data Validation at the Hawaii MAPCO2 Buoy Network in Support of a Test-bed for Techonology Development: Phase I	Christopher Sabine	157
Deep Sea Coral Submersible Dives	Michael Seki	159
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, 40, 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
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, 158
National Weather Service Pacific Region Fellowship Program	Raymond Tanabe	34, 69, 90, 120, 124
Ocean Remote Sensing	Michael Seki	23, 45, 82, 127

*See Appendix IX for final report.

Optimizing Routine Ocean Current Measurements by the NOAA Fleet	Patrick Murphy Donald Jones	105, 128
Pacific Enso Applications Center (PEAC)	Raymond Tanabe	29, 35, 67, 112, 136
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
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	Craig Russell	118, 156
Sea Turtle Bycatch Mitigation Research	Michael Seki	19, 58
Sensitivity of Built and Natural Infrastructure to Coastal Flooding Under a Changing Climate	Adam Stein	125, 155
Stock Assessment Research Program	Michael Seki	25, 50, 94, 138
Sustaining Healthy Coastal Ecosystems	Michael Seki	3, 21, 73, 107, 145
The University of Hawaii Sea Level Center	David Leger	38, 76, 97, 130, 161
Turtle Research Program	Michael Seki	8, 59, 96, 139
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
06/20/16- 06/27/16	David Burdick Research Associate University of Guam Mangilao, Guam	To attend the International Coral Reef Symposium from June 20-24, 2016 and to participate in the Pacific ESA-Listed Coral Species Identification Workshop from June 25-27, 2016.
06/20/16- 06/27/16	Peter Houk Assistant Professor University of Guam Mangilao Guam	To attend the International Coral Reef Symposium from June 20-24, 2016 and to participate in the Pacific ESA-Listed Coral Species Identification Workshop from June 25-27, 2016.
06/20/16- 06/27/16	Steven Johnson Research Assistant University of Guam Mangilao, Guam	To attend the International Coral Reef Symposium from June 20-24, 2016 and to participate in the Pacific ESA-Listed Coral Species Identification Workshop from June 25-27, 2016.
06/20/16- 06/27/16	Lyza Johnston Lead Biologist CNMI Bureau of Environmental and Coastal Quality Saipan, MP	To attend the International Coral Reef Symposium from June 20-24, 2016 and to participate in the Pacific ESA-Listed Coral Species Identification Workshop from June 25-27, 2016.
06/20/16- 06/27/16	Alice Lawrence Reef Fish Monitoring Ecologist American Samoa DMWR-CRAG Pago Pago, American Samoa	To attend the International Coral Reef Symposium from June 20-24, 2016 and to participate in the Pacific ESA-Listed Coral Species Identification Workshop from June 25-27, 2016.
06/20/16- 06/27/16	Laurie Raymundo Professor University of Guam Mangilao, Guam	To attend the International Coral Reef Symposium from June 20-24, 2016 and to participate in the Pacific ESA-Listed Coral Species Identification Workshop from June 25-27, 2016.
06/20/16- 06/27/16	Mareike Sudek Benthic Ecologist American Samoa DMWR-CRAG Pago Pago, American Samoa	To attend the International Coral Reef Symposium from June 20-24, 2016 and to participate in the Pacific ESA-Listed Coral Species Identification Workshop from June 25-27, 2016.
07/05/16- 07/14/16	Nicolas Grisouard Assistant Professor Department of Physics University of Toronto Toronto, Canada	To interact with SOEST faculty, researchers, and students in the area of the modeling of processes associated with long waves, especially internal tides and mixing and to present a seminar on the topic.
07/05/16- 08/18/16	Thomas Stocker Professor, Climate and Environmental Physics Physics Institute, University of Bern Bern, Switzerland	To collaborate with Dr. Axel Timmermann, Dr. Mark Merrifield, and other IPRC and JIMAR members on a range of climate related topics and to present a lecture on climate change.

07/18/16- 07/21/16	Ashley Williams Senior Fisheries Scientist Australian Government Department of Agriculture and Water Resources Canberra City, Australia	To participate in the 2nd International Deepwater Snapper and Grouper Life History Workshop in Perth, Australia and to provide expertise in snapper age and growth research and analysis of age-based data across biogeographic scales.
07/25/16- 07/27/16	Brittany Huntington Program Manager Oregon Department of Fish and Wildlife Newport, Oregon	To meet with Coral Reef Ecosystems Program (CREP) senior management team and other CREP team leads to discuss coral reef assessment and monitoring, strategic planning, and administration of the coral reef program.
08/03/16- 08/10/16	Samantha Stevenson-Michener Project Scientist National Center for Atmospheric Research Denver, Colorado	To interact with SOEST faculty, students and researchers in research specialty areas to include analysis/diagnosis of oxygen isotope variability at Palmyra Atoll and its effects on climate reconstructions from coral samples.
01/23/17- 01/27/17	Michael Croteau Researcher University of Colorado, Boulder Boulder, CO	To complete the tide gauge / altimetry data viewer that will become a tool in the NASA Sea Level Change portal.
02/27/17- 03/03/17	Jean-Patrice Klein Scientist French Research Institute for Exploitation of the Sea Issy-les-Moulineaux, France	To participate in an IPRC workshop on sub-mesoscale processes and to interact with various JIMAR and OCN researchers.
02/13/17- 02/28/17	Richard Pyle Ichthyologist Bishop Museum Honolulu, Hawaii	To support deep reef surveys around American Samoa using advanced diving technology to look for new species of fish and coral in and around the National Marine Sanctuary. Project was in conjunction with partners from the Bishop Museum and NOAA.
02/27/17- 03/10/17	Gareth Williams Associate Professor School of Ocean Sciences, Bangor University Anglesey, United Kingdom	To conduct collaborative work on West Hawaii IEA research and participate in the West Hawaii Climate Vulnerability Assessment Workshop in Kona.
02/28/17- 03/02/17	Jeffrey Maynard Manager Marine Applied Research Center Wilmington, North Carolina	To support both CREP and EOP staff in providing guidance in ongoing climate vulnerability analysis.
03/27/17- 04/09/17	Michelle Jungbluth Research Fellow Romberg Tiburon Center for Environmental Studies San Francisco State University Tiburon, California	To participate in the PIFSC LOPEC cruise and to conduct Hawaiian zooplankton identification and ecology research. Also participated in pre-cruise project mobilization and post-cruise demobilization.

03/27/17- 04/09/17	John Denton Postdoctoral Fellow Dept. of Vertebrate Paleontology American Museum of Natural History New York, New York	To participate in the PIFSC LOPEC cruise and to conduct lantern fish analysis. Also participated in pre-cruise project mobilization and post-cruise demobilization.
04/30/17- 05/02/17	Lyza Johnston Coral Reef Ecologist Commonwealth Northern Marianas Islands Bureau of Environmental and Coastal Equality Saipan, CNMI	To participate in the NOAA-Coral Reef Ecosystem Program (CREP) Benthic Methods Training Workshop in Guam in preparation for participation in the 2017 Mariana Island Reef Assessment and Monitoring cruise.
05/07/17- 05/13/17	John Howard Choat Emeritus Professor, College of Science and Engineering James Cook University Townsville Queensland, Australia	To collaborate with PIFSC researchers in a workshop on the bump head parrotfish and other large excavating parrotfish and to provide guidance and expertise and facilitate project planning.
05/24/17- 06/22/17	Keisha Bahr Postdoctoral Researcher Hawaii Institute of Marine Biology University of Hawaii at Manoa Honolulu, HI	To participate in Leg 3 of the 2017 Mariana Reef Assessment and Monitoring Program Cruise to conduct diving activities and work with JIMAR staff to recover and deploy Autonomous Reef Monitoring Structures as well as assist with the processing of the accumulation on the devices.
05/27/17- 06/21/17	David Burdick Research Associate University of Guam Marine Laboratory Mangilao, Guam	To participate in Leg 3 of the NOAA Coral Reef Ecosystem Program Reef Assessment and Monitoring cruise as a benthic diver.
07/17/17- 07/21/17	Christopher Lepczyk Associate Professor Auburn University Auburn, AL	To participate in the Hawaii Conservation Conference from July 18-20, 2017 and to share expertise through a formal presentation to the Hawaiian Monk Seal Research Program (HMSRP) JIMAR staff on research on feral cats and toxoplasmosis on July 21, 2017 and an informal meeting on July 17, 2017.
07/18/17- 07/21/17	Grant Sizemore Director, Invasive Species Program American Bird Conservancy Washington, DC	To participate in the Hawaii Conservation Conference from July 18-20, 2017 including a symposium on invasive species and wildlife research and discussion panel on the impact of feral cats and toxoplasmosis on wildlife in Hawaii. In addition, worked with JIMAR staff on July 21, 2017 to help them improve their ability to communicate science to the public on important issues.
07/18/17- 07/21/17	Kathryn Atema Director Global Companion Animal Program International Fund for Animal Welfare Yarmouth Port, MA	To participate in the Hawaii Conservation Conference from July 18-20, 2017 and research collaboration at IRC on July 21, 2017.

07/31/17- 08/03/17	Melissa Poe Social Scientist University of Washington Seattle, WA	To participate in the 2017 Review of the PIFSC Socioeconomics Program from July 31-August 3, 2017 at IRC on Ford Island.
07/31/17- 08/03/17	Sherry Larkin Professor & Associate Dean University of Florida Gainesville, FL	To serve as the Chair of an external review panel of the NOAA PIFSC Socioeconomics Program from July 31-August 3, 2017 on Ford Island.
08/07/17- 09/07/17	Joseph Fader PhD Student Duke University Marine Lab Duke University Beaufort, NC	To collaborate on line-transect survey protocols for investigation of false killer whales and conduct research on their demographics and fishery interactions.

Appendix IV Workshops, Meetings and Seminars Hosted by JIMAR

- **Erica Rosenblum**, Graduate Student, Climate, Atmospheric Science & Physical Oceanography, Scripps Institution of Oceanography
  Three Reasons to Consider Sea Ice Sensitivity to Global Warming in Climate Models
  July 6, 2016, JIMAR Seminar, University of Hawaii at Manoa, Honolulu, HI

- **Nicolas Grisouard**, PhD, University of Toronto, Earth, Atmospheric and Planetary Physics and Atmospheric Physics, Department of Physics
  (Near-) Critical Surface Reflection of Internal Waves in Sub-Mesoscale Fronts
  July 8, 2016, JIMAR Seminar, University of Hawaii at Manoa, Honolulu, HI

- **Thomas Stocker**, PhD, Professor of Climate and Environmental Physics, University of Bern, Switzerland
  Mitigation Delay Sensitivity: A New Policy-Relevant Metric
  August 15, 2016, IPRC Seminar, University of Hawaii at Manoa, Honolulu, HI

- **Matthew J. Widlansky**, PhD, University of Hawaii Sea Level Center, University of Hawaii at Manoa
  Future Sea Levels for Tropical Pacific Islands
  February 23, 2017, JIMAR Seminar, University of Hawaii at Manoa, Honolulu, HI

- **David Griffin**, PhD, CSIRO Marine and Atmospheric Research, Australia
  Surface Drift and the Search for MH370
  March 2, 2017, JIMAR Seminar, University of Hawaii at Manoa, Honolulu, HI

- **Phil Thomson**, PhD, Associate Director UHSLC, University of Hawaii Sea Level Center, University of Hawaii at Manoa
  The University of Hawaii Sea Level Center
  April 6, 2017, JIMAR Seminar, University of Hawaii at Manoa, Honolulu, HI

Appendix V JIMAR Personnel

Information as of June 30, 2017*

Category	Number	High School	Associates	Bachelors	Masters	Ph.D.
Research Scientist	11	0	0	0	0	11
Visiting Scientist	0	0	0	0	0	0
Postdoctoral Fellow	0	0	0	0	0	0
Research Support Staff	14	0	0	5	6	3
Administrative	0	0	0	0	0	0
Total (≥ 50% support)	25	0	0	5	6	14
Undergraduate Students	4	4	0	0	0	0
Graduate Students	1	0	0	1	0	0
Employees that receive < 50% NOAA Funding (not including students)	0	0	0	0	0	0
Located at Lab (include name of lab)	24 - PIFSC					
Obtained NOAA employment within the last year	1					
Postdoctoral Fellows and Students from Subgrantees	Postdocs: 0 Students: 0					

* Personnel reported here are as of 6/30/17 and have been transferred to NA16NMF4320058 effective 10/1/17.

Appendix VI Graduates

Alyssa Agustin, Master of Science, Physical Oceanography Division, Department of Oceanography, University of Hawaii at Manoa, "Northwest swell variability at the Hawaiian Islands"

Jacob Asher, PhD, Department of Environment and Agriculture, Curtin University, Western Australia, "A deeper look at Hawaiian coral reef fish assemblages: A comparison of survey approaches and assessments of shallow to mesophotic communities"

Rebecca Ingram, Master of Science, Department of Natural Resources and Environmental Management, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, "Kona integrated ecosystem assessment"

Liana Roberson, Master of Arts, Department of Geography, University of Hawaii at Manoa, "A spatial-temporal analysis of the benthic habitat composition of Rose Atoll in response to the removal of vessel debris from the *Jin Shiang Fa* fishing vessel grounding"

Max Sudnovsky, Professional Master in Tropical Marine Ecosystems Management (PM-TMEM), University of the Philippines Diliman (UPD), "Devising a marine turtle conservation monitoring & evaluation tool (MTC-MET)"

Appendix VII 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	FY 17
Peer Reviewed	**JIMAR Lead Author**	16	18	9	13	9
	NOAA Lead Author	7	7	11	10	8
	Other Lead Author	18	21	13	25	9
Non Peer-Reviewed	**JIMAR Lead Author**	41	51	36	55	21
	NOAA Lead Author	12	9	9	9	6
	Other Lead Author	21	3	9	4	1

Appendix VIII List of Projects attached to Award NA11NMF4320128

TITLE	NOAA Technical Lead/Sponsor	Amendment Number(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, 160
Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations	Steven Bograd	6
Data Validation at the Hawaii MAPCO2 Buoy Network in Support of a Test-bed for Techonology Development: Phase I	Christopher Sabine	157
Database of Marine Culture Heritage Artifacts Offshore within the Hawaiian Islands	Hans Van Tilburg	115
Deep Sea Coral Submersible Dives	Michael Seki	159
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, 40, 65, 104, 122
Fisheries Monitoring and Support	Michael Seki	16, 44, 99, 141
Fishing Impacts on Non-Target Species	Michael Seki	154
Formulation of Localized Sea Level Rise/Coastal Inundation 'Extremes' Scenarios for Pacific Islands	John Marra	66
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
Improved Automation and Performance of VORTRAC Intensity Guidance	Chris Landsea	36
Investigation of Ecological Constraints for Bumphead Parrotfish	Michael Seki	2
JIMAR Task 1 (OAR Contribution)	Christopher Sabine	5
JIMAR Task 1	Michael Seki	Initial, 32, 75, 103, 110, 144
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, 158
National Weather Service Pacific Region Fellowship Program	Raymond Tanabe	34, 69, 90, 120, 124
NOAA NDBC Hawaiian Buoy Service Cruise	Jeff Jenner	121
NOAA PacPrawler (PICO) Cruise	Thomas Peltzer	89
NOAA Tropical Atmosphere/Ocean (TAO) Array Service Cruise	John Potts	42, 56, 77
Ocean Remote Sensing	Michael Seki	23, 45, 82, 127
Optimizing Routine Ocean Current Measurements by the NOAA Fleet	Patrick Murphy Donald Jones	105, 128
Pacific Enso Applications Center (PEAC)	Raymond Tanabe	29, 35, 67, 112, 136
Pacific Islands Deep Sea Coral and Sponge Initiative	Michael Seki	150
Pacific Islands Region Observer Program Initiative	Michael Tosatto	27, 54
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
Pelagic Fisheries Research Program (PFRP)	Michael Seki	26
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	Craig Russell	118, 156
Sea Turtle Bycatch Mitigation Research	Michael Seki	19, 58
Seasonal Fluctuations in Pacific Island Marine Debris Deposition	Courtney Arthur	33
Seasonal Forecasts and Extreme Event Projections for Pacific Island Sea Level	John Marra	15
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
The University of Hawaii Sea Level Center	David Leger	38, 76, 97, 130, 161

Tropical Pacific Testbed (TPT) for GOES-R Application Development	Steven Goodman	37
Turtle Research Program	Michael Seki	8, 59, 96, 139
Western Pacific Fisheries Economic Integration	Michael Seki	88, 132
Western Pacific Fisheries Information Network (WPacFin)	Michael Seki	14, 53, 84, 134

Appendix IX Final Report for NA15NMF4320128

Final Performance Report
International Ecosystem Approach to Fisheries Management Project
Cooperative Agreement No. NA15NMF4320128
For the period 7/1/16–9/30/16

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 supports 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 the Final Reporting Period 7/1/16–9/30/16

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 in these regions are listed below.

Philippines. The greatest accomplishment of EAFM activities in the Philippines over the years has been their role in the signing of Fisheries Office Order (FOO) #164 to adopt "Mainstreaming Ecosystem Approach to Fisheries Management (EAFM)" as a nationwide guiding framework by the Director and Undersecretary of the Philippines Department of Agriculture's Bureau of Fisheries and Aquatic Resources (BFAR). In the FOO, it is stated that all programs within BFAR shall be developed and implemented based on EAFM principles and be consistent with EAFM plans adopted by stakeholders in their respective fisheries management areas. The FOO lays out national goals toward selecting pilot sites, developing EAFM coordinating teams, EAFM planning and implementation, developing of stakeholder partnerships, and guiding timeframes for these goals.

During September 2016 the project team achieved the following milestones.

- Met with USAID and BFAR to discuss the progress and future efforts on oceanographic, climate change and fisheries efforts.
- Co-led the "Feedback Workshop on BFAR-USAID/NOAA Partnership Products on Climate Change and Fisheries in the Philippines" in Tagaytay with participants from USAID, 16 BFAR offices, National Fisheries

Figure 1. Participants of Feedback Workshop on BFAR/USAID/NOAA Partnership Products on Climate Change and Fisheries participants.

Research and Development Institute, Fisheries Information Management Center National Stock Assessment Program, University of the Philippines Marine Science Institute, ECOFISH, and private fisheries sector.

- Participated in the 7th Fisheries Sciences Conference in Tagaytay as guest-speakers.
- Gave a presentation titled "Potential uses of nighttime satellite imagery to combat IUU fishing in Southeast Asia" at the Sustainability Initiative in the Marginal Seas of South and East Asia Regional Symposium 2016 held in Quezon City, Philippines.

Other JIMAR IEAFM team accomplishments include the following.

- Developed a comprehensive workshop report and a trip report for Essential EAFM Workshops that were held in the spring of 2016. The workshop report summarized lessons learned and recommendations for materials of the Essential Ecosystem Approach to Fisheries Management curriculum and its delivery.
- Provided technical input to the Ecosystems Improved for Sustainable Fisheries (ECOFISH) USAID funded project in the Philippines toward the development of materials for the Mainstreaming EAFM (M-EAFM) Planning Workshop, EAFM Team Start up and Training of Trainers Workshop.

Timor Leste. The project team successfully performed troubleshooting on the computational methods that analyzed over 10 million sequences obtained from the next-generation sequencer to assess the diversity from the ARMS units. Datasets from 34 CAUs and 16 water samples were used to characterize the seawater carbonate system, and temperature time-series from 14 subsurface temperature recorders were incorporated into the final report template for Pacific Islands Fisheries Science Center review.

Publications

- Kelvin, D.G., W. Michaels, R. Pomeroy, C. Elvidge, P. Lynch, S. Wongbusarakum, and R.E. Brainard, 2016. The mobilization of science and technology fisheries innovations towards an ecosystem approach to fisheries management in the Coral Triangle and Southeast Asia. *Journal of Marine Policy,* 74:143-152.

- McKinnon, M.C., et al., 2016. What are the effects of nature conservation on human well-being? A systematic map of empirical evidence. *Environmental Evidence,* 5:8, doi 10.1186/s13750-016-0058-7.

Acronyms

ARMS	Autonomous Reef Monitoring Structures
BFAR	Philippines Dept of Agriculture Bureau of Fisheries and Aquatic Resources
CAUs	Calcification Accretion Units
EAFM	Ecosystem Approach to Fisheries Management
FOO	Philippines Fisheries Office Order
IEAFM	International Ecosystem Approach to Fisheries Management Project
M-EAFM	Mainstreaming Ecosystem Approach to Fisheries Management
NOAA	National Oceanic and Atmospheric Administration
USAID	United States Agency for International Development