



JIMAR Plans for FY 2022

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Ecosystem Forecasting

Open Source ADMB Project

P.I.: Erik Franklin

Releasing the Automatic Differentiation Model Builder (ADMB) to twice a year instead of once has proven to produce better quality software. Users are able to use the fixes and improvements earlier and provide feedback. There will be two planned releases for the next fiscal year (FY) 2021–2022. The first release is expected in the second half of 2021 and the second release is expected in the first half of 2022. Both releases will include fixes and improvements to the documentation, installation, software testing, program runtime, and source code. The new features that are being investigated and developed are using move constructor to reduce resources used by temporary variables, building programs using multiple files instead of a simple tpl file, and looking to create a tool to translate ADMB tpl to Template Model Builder (TMB). The project will continue to test and review the multi-processor branch with other users and developers and their programs to check for stability and usage issues. The project will also investigate updating to International Organization for Standardization/ International Electrotechnical Commission (ISO/IEC) C++17 standard for building and running ADMB programs. ISO/IEC C++14 and C++11 should be supported when possible for older compilers. The project will continue to support and help users and developers with using and developing for the ADMB software. The planning for Developers Workshop 2021 has been discussed, but will be delayed until after the travel restrictions due to the current global pandemic is lifted. The workshop objectives will be similar to previous workshops where developers will discuss new ideas, test new features including the multi-processor changes and work in small groups to resolve software issues.

Ecosystem Monitoring

Ecosystem Structure and Function

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

During the next year, JIMAR will maintain full-time laboratory technical staff to analyze a range of samples — lancetfish stomachs, zooplankton and micronekton samples — from previous and upcoming cruises, and continue to assess patterns in the biomass and distribution of mid-trophic level organisms in the Hawai'i longline fishing ground and in Hawai'i waters.

In addition, a Graduate Assistant from the University of Hawai'i at Mānoa's Department of Oceanography will be employed by the project to investigate the sensitivities and future projections of the North Pacific subtropical gyre due to the effects of climate change. The Eastern North Pacific (ENP) is a productive marine region that exhibits high levels spatio-temporal variability in physical conditions with implications for living marine resources. The sensitivity of the ENP to future climate change is dependent on the large-scale structure of the North Pacific (e.g., mixing and ventilation of the subtropical and subarctic water masses) as well as on local processes (e.g., stratification and local wind stress). This work seeks to contribute to the oceanographic community's understanding of the future ecological state of the region by characterizing its lateral boundary conditions, tracing the origin of its source waters beyond the regional domain, and describing the influence of North Pacific basin-scale processes on these source-water properties.

Ecosystems Observations and Research Program: Research Support Project

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

Aquaculture System Management. JIMAR staff (led by Aaron Moriwake) will continue to provide system management support for the Marine Animal Recovery Facility (MARFAC), including coordinating activities,

maintaining and repairing equipment, training staff on system operations, modifying the facility to improve or suit staff needs and providing support for incoming animals.

Pacific Islands Region Fisheries Science Outreach and Education. Led by Ali Bayless, this project will support outreach and education activities such as community events, career fairs, and school programs on a quarterly basis representing Pacific Islands Fisheries Science Center (PIFSC) in partnership with JIMAR. Virtual platforms will continue as the standard into the new project year, including virtual internships, interactive webinars, and workshops. JIMAR will continue to develop and post online outreach products focused on current research and Science Center priorities, including feature stories, science blogs, and story maps coordinated with social media updates. In addition, the project plans to increase internship opportunities for students in the Marine Option Program at the University of Hawai'i at Mānoa.

Large Marine Ecosystem/Ecosystem-Based Fisheries Management Coordination. As information continues to be collated, the Large Marine Ecosystem (LME) effort (led by Taylor Souza) will be further socialized with key partners in the Marianas region, Pacific Islands Regional Office (PIRO), Western Pacific Regional Fishery Management Council (WPRFMC), PIFSC, and JIMAR, and inputs will be requested and integrated where possible throughout the document. Given the value tied to stakeholder engagement in the Marianas, the project will reach out to additional stakeholders in the region as the document continues to move forward. It is anticipated that the inputs from these partners will help fill information gaps and shape the effort to create a more valuable resource for the stakeholders. In addition to incorporating management, scientific and other stakeholder inputs into the document in FY 2021, the LME team will further seek formal designation of the Marianas as an LME and work toward publication of the effort.

Fisheries and Ecosystems Data Support in the Pacific Islands. The project led by Jesse Abdul will continue to build on the progress made this year and support projects with software development or data stewardship. Project staff will continue to contribute to regional data governance efforts. JIMAR will provide software development, data stewardship standards and best practices, and enterprise solutions that address shared software development or data needs. Enterprise data solutions will be evaluated and recommended by the Software Development Team (SDT), and software development tools, procedures, standards, or best practices will be evaluated by the SDT. The SDT will provide support, guidance and recommendations for software projects and data integration projects.

Genomics as a Tool for Fisheries Stock Assessment and Ecosystem Based Fisheries Management. The JIMAR genomics work will continue with JIMAR Graduate Assistants Evan Barba and Mykle Hoban, leading the effort, along with PIFSC scientists in the Ecosystem Sciences and Fisheries Research and Monitoring Divisions. These advanced techniques are making remarkable progress and could affect research directions and methodologies in the Center for decades.

Ecosystems Observations and Research Program: Science Operations Project

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

Analysis and Evaluation of Fishery Independent Data and Collection Methods for Insular Fish Stocks in the Pacific Islands Region. Analysts will complete video analysis for fish abundance and lengths for the 2021 Bottomfish Fishery-Independent Survey in Hawai'i with resulting data set product delivered to the Fisheries Research and Monitoring Division (FRMD) Stock Assessment program and continue annual reporting on Modular Underwater Stereoscopic System (MOUSS) camera errors. Analysts will also continue testing and training of the Video and Image Analytics for a Marine Environment (VIAME) automated image analysis toolkit, using a new Windows-based operating system and web-based Graphical User Interface (GUI) software for the creation of annotation training data. Finally, analysts will conduct video analysis and evaluation of bench and field-testing videos using artificial Light Emitting Diode (LED) light prototypes for bottomfish surveys beyond the current 250-meter ambient light depth limit.

Operations and Logistics Services to Support Pacific Islands Fisheries Science Center Research Missions and Projects. The Science Operations Division (SOD) Field Operations Team will continue to provide high quality, effective logistical, operational, small boat, and Marine Instrumentation Laboratory (MIL) research support services while striving to 'lead the standard' in safety for PIFSC research activities.

Advanced Survey and Sampling Technology Development. Next year, JIMAR staff in the Survey and Sampling Technologies Program (SSTP) will continue to develop an in-house stereo camera system and begin lab and

field-testing of a next-generation MOUSS Digital Video Recorder (DVR) unit to eventually upgrade and replace the existing MOUSS DVRs at a lower price point. Continued development and in-water testing evaluating depth rating and measurable distance to target of prototype artificial lighting systems and housings for the MOUSS will be furthered, and a comparison of field performance with existing underwater light technologies will be conducted. Continued maintenance and upgrades to the MOUSS systems will be performed and participation in maintenance and surveys of the jointly-owned autonomous underwater vehicle (AUV) with Northwest Fisheries Science Center (NWFSC) will continue.

Geospatial Products & Marine National Monuments of the Pacific. In the upcoming year any geospatial data products will be incorporated into the Enhanced Fisheries Research Data Management Project.

National Ocean Acidification Observing Network—Oahu NCRMP Class III

P.I.: Christopher Sabine

With increased funding from National Oceanic and Atmospheric Administration (NOAA)/Ocean Acidification Program (OAP) and National Science Foundation (NSF), the coral reef instrumented platform-2 (CRIMP-2) and Kaneohe mooring sensor suite will be expanded to include a newly developed autonomous potential of hydrogen (pH) and total alkalinity (TA) sensor. This will add a new parameter, TA, to the high-frequency observations that is very relevant to understanding the calcification and coral reef dynamics of this region. Depending on sensor performance, this new sensor package may become standard for NOAA ocean acidification (OA) sites. The moorings will be used, along with drifters also instrumented with this new sensor package to further study the effects of OA on coral reef health in Kaneohe Bay.

NCRMP Pacific Reef Assessment and Monitoring Program (RAMP)

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

During the coming project year, the major objective is to plan and execute the Marianas Archipelago National Coral Reef Monitoring Program (NCRMP) cruise in spring 2022 aboard the NOAA *R/V Rainier*. As this vessel is a new platform for NCRMP cruise execution, additional planning time is anticipated to determine the feasible scope and scale of the field mission, as well as how to best leverage the fewer number of small boats available for survey execution from *R/V Rainier*. Following the mission, staff will complete data quality control (QC) checks and data cleaning and then submit datasets to the archive for public access.

Ocean Remote Sensing

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

In the coming year, JIMAR will conduct a recruitment for the OceanWatch Researcher position to lead and organize the project. There is a recruitment in progress to bring scientific talent into the project as soon as reasonable.

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

P.I.: Christopher Sabine

With increased funding from NOAA/OAP and NSF, the CRIMP-2 and Kaneohe mooring sensor suite will be expanded to include a newly improved Briggs autonomous pH and TA sensor for an extended period (i.e., full year). This will add a new parameter, TA, to the high-frequency observations that is very relevant to understanding the calcification and coral reef dynamics of this region. Depending on sensor performance, this new sensor package may become standard for NOAA OA sites. The Submersible Autonomous Moored Instrument for alkalinity (SAMI-alk) system will also continue to be tested once an updated system is available.

Pacific Fisheries Monitoring Program

PI.i.: Douglas S. Luther [JIMAR Project Lead: Frances Tong]

Fisheries Monitoring. The project will continue to monitor Hawai'i's pelagic longline fishery at the same high level to allow quarterly and annual reports to be done within the allotted time. JIMAR staff will complete weekly bigeye and striped marlin catch updates for the Fast-Track system to allow for timely and accurate forecasting and fishery closures to comply with annual Western and Central Pacific Fisheries Commission (WCPFC) and Inter-American Tropical Tuna Commission (IATTC) requirements. Fast-Track is expected to wind down as the fleet approaches 100% electronic reporting (ER).

JIMAR ER staff will allocate a greater portion of their time and efforts to supporting the ER effort. The ER team will continue to distribute tablets to the longline fleet and train captains in submitting electronic logs. The ER team will continue working with the Council-contracted translator to help with training; other translation services may also be used to translate documentation to Korean. The team will also continue working with the application developer as well as a PIFSC Information Technology (IT) Specialist to implement new features, simplify equipment and deployment and address software issues. Outreach, training and timely assistance to captains and vessel owners remain key to the success of the ER rollout.

When the entire Hawai'i longline fleet has tablets by the end of 2021, electronic reporting will substantially reduce the need for manual entry of logbooks; however, manual preparation of logbooks for keypunching, data entry and verification will remain with JIMAR data staff because all vessels will carry paper logbooks as a backup to tablets.

The team will continue to enter data for the Pacific tuna fishery purse seine fleet and non-longline logbooks. PIFSC staff are developing a program that will automatically transfer daily regional purse seine log sheets (RPL) data into the South Pacific Tuna Treaty (SPTT) database. However, JIMAR staff will still verify data for accuracy and completeness, and final out turn receipts (FOT) and unloading and trans-shipment log sheets (UL) will still be entered manually into the database.

The logbook archival scanning project will continue its work with the American Samoa longline logbooks along with scanning the Hawai'i logbooks as they are submitted. The team will continue to foster positive and cooperative relationships among PIFSC, the fishing industry, and other interested parties through our daily onsite monitoring activities.

Electronic Monitoring. JIMAR staff will perform all system maintenance of the Electronic Monitoring (EM) systems installed on Hawai'i longline vessels. In addition, staff will collect EM disks from each trip and archive the data. EM footage will be reviewed for trips with protected species interactions and those that are part of a catch handling study. In addition, EM footage will be used for annotation of images to build an artificial intelligence (AI) library used for training algorithms for the automatic detection of fish and protected species.

JIMAR EM staff will continue to investigate data gaps discovered during the initial investigation of EM efficacy. A catch handling study will begin in June 2021 that evaluates detection accuracy for sharks brought to different designated locations within the camera field of view. The study will occur on four vessels during five observed trips. Because only 20% of trips are observed, the project may take over a year once initiated. Results of the research will be important in establishing regulatory frameworks to implement EM.

In order to determine if data can be collected with EM to assess post interaction mortality rates on protected species, JIMAR staff will continue to collaborate with protected species staff to review any marine mammal or sea turtle interactions recorded on EM vessels. In addition, EM staff will work on lab and field simulations with protected species models to determine what criteria can be assessed with current EM systems and if any fishing gear or camera modifications can improve the assessment of post interaction mortality. The results of these investigations will inform how an implemented EM system will be structured, as data on the likelihood of post release mortality of protected species is needed to ensure the fishery does not exceed the number of allowable protected species interactions.

Staff will continue to work on annotation of images and streamlining workflow for automatic annotation of images. These images will be added to the AI library for training the automatic detection of fish and protected species from EM footage. A focus will be placed on adding images of sea turtles.

In addition, project staff will participate in meetings of the electronic technologies steering committee to work towards EM implementation.

Pacific Islands Territorial Science Initiative (PITSI)

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

Activity on this project has ended, and no further work is planned in the future.

Pacific Tuna Fishery Data Management

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

The project has completed, and no further work is planned.

Sustaining Healthy Coastal Ecosystems

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

The focus for the next year includes leveraging existing Ecosystem Sciences Division (ESD) monitoring and other available data to provide analyses to support activities of jurisdictional and federal management agencies and serve as a resource on best practices, methods development, and analyses as applied to coral reef ecosystem research to inform management actions. In FY 2022, the project will focus on: 1) developing a Center of Excellence to advance structure from motion applications and artificial intelligence (AI) technology; 2) analyzing the vital rates of corals from the Hawaiian Islands; 3) analyzing spatial patterns in carbonate chemistry across the United States (U.S.) tropical Pacific; and 4) expanding the portfolio of research focused on collecting Land Based Sources of Pollutions (LBSP) datasets in American Samoa. Many of these information products, services, and analyses are aimed at responding to specific requests (i.e., coral reef restoration, assessment of specific management actions, etc.) received during on-going collaborative discussions with our local and jurisdictional partners in Hawai'i, American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI), as well as other Federal partners.

Territorial Biosampling

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

During the next year, analysis of the reproductive life history for one Management Unit Species (MUS) (*Etelis coruscans*) across three regions (Main Hawaiian Islands, Guam, and CNMI) is underway and will be completed. The reproductive life history for the Hawaiian population of the deep-water snapper (*Etelis coruscans*) is in preparation and is expected to be submitted to peer-review in FY 2022. A draft of the manuscript for the spatial variability in life history traits (age, growth and maturation) of the blue trevally, *Caranx melampygus*, for CNMI is expected to be completed in the following year. Additionally, the data-collection for one MUS and one coral reef species to explore the sensitivity in fish growth rate responses to a changing climate is expected to be completed. Several trips to the territories are planned for data collections in the next year. Two Life History Program (LHP) team trips to American Samoa are planned to develop relationships with local partners and fishers, collect life history samples for MUS, and examine options for re-establishment of the Commercial Fisheries Biosampling Program in American Samoa. A LHP cruise in CNMI is rescheduled for FY 2022 so that fishery-independent life history data for territorial MUS can be collected. Project staff have also planned at least one collaborative research trip to work with territorial partners or participate in an international conference, the Indo-Pacific Fish Conference in Auckland New Zealand, July 2022.

West Hawai'i Integrated Ecosystem Assessment

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

The West Hawai'i Integrated Ecosystem Assessment (IEA) will continue to conduct novel and interdisciplinary research to help elucidate key socioeconomic factors, oceanographic processes, and ecological interactions that drive nearshore and pelagic marine food-web dynamics. JIMAR continues to process and analyze the extensive amounts of biological samples and physical data collected during historical PIFSC expeditions to the region, and

a JIMAR supported graduate student is working with this project and the JIMAR Ecosystems Observations and Research Program to analyze environmental DNA (eDNA) via metabarcoding. The method can be utilized to quickly assess biodiversity deemed essential to this ecosystem. These efforts will be synthesized into a number of reports, peer-reviewed journal articles and outreach materials, highlighting novel findings and key insights on food-web dynamics necessary to support ecosystem-based management in the region.

Western Pacific Fisheries Information Network (WPacFIN)

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

JIMAR programmers will finish rewriting and converting the remaining Hawai'i Visual Fox Pro (VFP) database applications to MySQL/C# for WPacFIN Central and Hawai'i Division of Aquatic Resources (HDAR). Once the short list of Hawai'i projects has been completed, Hawai'i will go into maintenance mode.

The following is a list of Hawai'i projects slated for FY 2022:

- Merge Fisher Reporting System (FRS), Dealer Reporting System (DRS) and Historical applications to Fisher Reporting and Dealer System (FRDS);
- Rewrite the Digital Image Archiving System (DIAS) VFP application and deploy the new application to HDAR, Hawai'i longline team and each of the territories;
- Rewrite the Integrated Dealer application to use the new FRDS database; and
- Retire VFP databases, applications and processes, including DIAS.

The data modernization project for the territories is expected to begin Summer 2021 with database development and data migration expected to be completed by end of 2022. Work includes creating a new database using commonly accepted database design principles, data cleanup and validation, and consolidation of datasets followed by data migration to the new database.

The following is a list of territory projects slated for FY 2022:

- Integrate territory CatchIt LogIt and CatchIt SellIt commercial landing datasets to the WPacFIN commercial landing dataset;
- Collaborate with the territories when they move to electronic reporting for commercial landings;
- Provide the JIMAR Territory Electronic Reporting Project staff with technical expertise and support, database administration and system administration; and
- Design and develop the territory database and import territory data into the new database.

Ecosystem-Based Management

Marine Debris Mitigation Project

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

The Fall 2021 marine debris removal mission in the Northwestern Hawaiian Islands (NWHI) is currently planned for 24 August 2021–22 September 2021 (30 days-at-sea). This project will be led by JIMAR divers and coxswains from ESD, with participation and support from Papahānaumokuākea Marine Debris Project (PMDP). The project team includes thirteen JIMAR staff, along with partners from PMDP. The focus of this project is to remove in-water marine debris (primarily derelict fishing net and other associated gear) from the shallow coral reef environments of Pearl and Hermes Atoll, Maro Reef, Midway Atoll, and Kure Atoll. Secondly, the project will remove shoreline debris and other entanglement hazards from French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Atoll, Midway Atoll, and Kure Atoll. Following the mission, JIMAR staff will enter, assess quality, and archive data from the mission, and conduct statistical analyses on shoreline debris and in-water debris accumulation patterns in the NWHI. Several outreach and educational efforts will accompany the Fall 2021 mission.

Socioeconomics of Western Pacific Fisheries

PI.: Douglas S. Luther [JIMAR Project Lead: Adam Ayers]

In FY 2022, JIMAR will support the following socioeconomic research efforts:

- Evaluation of economic impacts of the purse seine fishery in American Samoa;
- Document U.S. purse seine fishery effort, landings and revenue;
- Pilot and summarize the structure a multi-stakeholder engagement project in Guam;
- Summarize feedback from key fisheries stakeholders on Pacific Island Vulnerability Assessment (PIVA)/ Community Social Vulnerability Indicators (CSVI) analysis of fishing community responses to climate change;
- Conduct gender sub-analysis of key stakeholders and summarize findings into a report;
- Characterize recreational and non-commercial fishing communities in Hawai'i to enhance fisher engagement;
- Develop an engagement strategy to improve communication, outreach, and participation with non-commercial fishers in the federal fisheries management process.

Stock Assessment Research Program

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

JIMAR researchers within the PIFSC Stock Assessment Program (SAP) will be involved in investigations of insular and pelagic fisheries in the next reporting year. The primary focus of the insular team will be to work on new approaches to American Samoa bottomfish assessments. The team will seek to implement new data-limited approaches focused on using the stock synthesis model and size composition data. This is a critical project that will span multiple years. Stock assessments for American Samoa will only be due in FY 2023 but it will be the primary duty of some JIMAR staff in the coming year.

JIMAR project staff will also continue working on the development of the automated reporting tools for the annual bycatch estimates for seabirds and sea turtles in the IATTC area and for the Hawaiian deep-set and shallow-set fisheries. Next steps also include the development of automated reporting tools for the seabird bycatch divided into the areas North and South of 23 degrees North latitude and a code to automate the National Bycatch Report totals for PIFSC. Further development to the Age Structured Projection (AGEPRO) Code Refactoring project will continue into FY 2022 and work to update the SAP GitHub site is ongoing.

Protection & Restoration of Resources

Cetacean Research Program

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

In FY 2022, the project plans to develop artificial intelligence (AI) and machine learning approaches to more effectively incorporate photo and telemetry data into insular cetacean assessments. This includes the Artificial Intelligence initiative for automated image processing for dolphin individual identification, which is a key input to mark-recapture assessments, as well as early stages of developing a central Hawai'i cetacean catalog within the online platform Flukebook.

Comprehensive island-wide surveys are required to support a high-priority PIRO request for abundance information for all Main Hawaiian Islands (MHI) spinner dolphin stocks (O'ahu-4-Islands, Hawai'i Island, Kaua'i), providing a baseline to evaluate management actions to reduce the impacts of swim-with dolphin programs in the State. The Cetacean Research Program (CRP) and partner Hawai'i Institute of Marine Biology (HIMB) will conduct line-transect surveys around Oahu during the summer of 2021. In 2022, the team will begin line-transect and mark-recapture surveys for spinner dolphins in the nearshore waters around Hawai'i Island to derive an island-wide estimate of abundance for this stock.

CRP will continue to maintain the Pacific Islands Passive Acoustic Network (PIPAN) deployments and datasets and support development and use of acoustic analysis tools to enable efficient use of this dataset. The PIPAN dataset represents one of the longest passive acoustic time series in National Marine Fisheries Service (NMFS) for examining cetacean occurrence and ocean noise metrics. The valuable dataset provides occurrence, seasonality,

and relative abundance data for portions of our region that cannot otherwise be monitored, and will serve as a goldmine for new assessments.

Fishing Impacts on Non-target Species

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

During the next fiscal year this project will compile data from the last few tags deployed in the shark bycatch post release survival (PRS) study that was delayed due to COVID-19 and rerun the analyses. The updated outcomes will be synthesized into a peer reviewed manuscript. In addition, JIMAR will begin to lead a large collaborative study with researchers from over ten agencies to build species distribution models (SDMs) using existing telemetry data generated by this project and our partners for seven target and non-target key or management unit shark, marlin and tuna species. The SDMs will identify the environmental parameters that may predict hot spots or aggregation times or areas to assist fishers with avoidance of protected species. The results from this endeavor will be integrated into climate change models to elucidate how changing oceanographic conditions will affect the availability of preferred habitat and how this may impact these species' vulnerability to fishery interactions.

The large citizen science initiative will continue working with communities and resource users to understand the population demographics and habitat requirements for the U.S. Endangered Species Act listed oceanic whitetip shark (OCS). This project has engaged over 200 participants from all Hawaiian Islands to understand the nature and frequency of interactions with the species and to gauge how outreach and education for conservation may be most effective. Project staff will continue to train fishers in tagging techniques, deployment of tags and recovery of data. The project will also continue to build a large photo identification library to improve our understanding of OCS demographics in the region. The data generated by the Hawai'i Community Tagging Program (HCTP) participants has greatly improved handling of a threatened species and has assisted regional fishery managers to meet conservation mandates and to create meaningful measures to reduce mortality to listed species.

Hawaiian Monk Seal Northwestern Hawaiian Islands Research Seasonal Support

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

The first leg of the 2021 field season departed July 10 to deploy the French Frigate Shoals (FFS) and Laysan field sites, and will return to Honolulu and depart on July 20 to deploy the remaining field staff. During the project period, it is expected that JIMAR staff and one federal partner will establish camps at the five field sites and begin conducting Hawaiian monk seal population research and enhancement activities.

JIMAR Hawaiian Monk Seal Research Program (HMSRP) staff will continue to collaborate with NMFS scientists to collect monk seal survey and life history data and conduct enhancement activities primarily in the NWHI. JIMAR staff will perform field studies, tag and mark animals for identification, collect specimens for genetic studies, conduct boating operations, collect non-invasive samples for foraging studies, and monitor for health and disease opportunistically through necropsies and non-invasive sampling techniques. Non-invasive specimens will also be collected for ongoing foraging studies. Ongoing survival enhancement activities may include collection of dangerous debris off beaches, disentanglement of seals, translocation of weaned pups within FFS, and reuniting mother-pup pairs. Special enhancement projects may include continuation of shark monitoring and removal, vaccinating seals against morbillivirus, and translocation of pups between breeding sites. Advanced technologies (i.e., remote cameras) may also be utilized to monitor the population. Field personnel may also assist other programs and agencies which may include sound trap deployment/retrieval, turtle nesting and other turtle data, Laysan duck surveys and feather collection, collect shark bite DNA swabs, possible *Verbesina* mitigation at Pearl and Hermes (PHR), monitor for and report on invasive species, conduct insect surveys, and detect and mitigate wildlife entrapments (particularly at FFS).

Hawaiian Monk Seal Research Program

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

Over the next reporting year, to the degree possible given the uncertainty of the impacts of program activities due to the pandemic, the JIMAR HMSRP plans to continue collecting survey and life history data on monk seals and conduct enhancement activities primarily in the MHI. JIMAR staff will collaborate with NMFS scientists to conduct Hawaiian monk seal (HMS) field studies, analyze data and perform daily maintenance, operations, and training for field camps. JIMAR staff expect to coordinate and respond to stranded seals, conduct boating operations, train and lead field personnel, and continue to update and maintain existing databases. Foraging and dietary studies are planned in the MHI, and health and disease monitoring will occur opportunistically through necropsies and non-invasive sampling techniques in conjunction with foraging studies or via directed studies. Vaccination of wild seals against morbillivirus is expected to continue. Ongoing survival enhancement activities may include collection of dangerous debris off beaches, disentanglement of seals, translocation of weaned pups, and reuniting mother-pup pairs. Special enhancement projects may include continuation of shark monitoring and removal, collection of undersized seals for rehabilitation, and translocation of pups between breeding sites. The program plans to continue to advance behavioral research and may design studies to test techniques to modify monk seal behavior and develop tools and protocols for application in future management activities as well as continue with vocalization studies. Uncrewed Aerial Systems (UAS) activities and fish pen research may also be conducted.

Marine Turtle Recovery in the Pacific Islands Region

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

JIMAR field researchers at FFS will continue to monitor the nesting abundance of green sea turtles during this 2021 field season and will be deployed again in the spring of 2022. Permanent JIMAR staff will continue to support the field staff through training, preparing equipment, analyzing data, and writing reports. JIMAR staff will participate in field captures of marine turtles on Oahu and periodically on outer islands, as well as during the annual rapid assessment of green sea turtles at Rose Atoll, American Samoa. JIMAR will conduct studies on age and growth of sea turtles within the Main Hawaiian Islands (MHI) and will continue the utilization of the newly developed sea turtle endocrinology laboratory for research projects investigating sex, sex ratio, capture stress, and age of sexual maturity.

Pacific Islands Deep Sea Coral and Sponge Initiative

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

During the next project year, JIMAR staff will continue to work to gather information on deep-sea coral and sponge communities. Annotation of animal observations from 2019 remotely operated vehicle (ROV) dives, including completion of cruise EX1905 and cruises to the Line Islands (cruise NA110) and the Howland Baker island area (NA114), will be completed and the records will be submitted to the Deep Sea Coral Research and Technology Program (DSCRTP) for inclusion in their national database. Additional annotation work will be completed after prioritization with the DSCRTP staff. Further, we are refining a deepwater animal guide with webmap and data query for the Papahānaumokuākea Marine National Monument.

Papahānaumokuākea Marine National Monument Monitoring and Research

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

JIMAR staff are currently planning for two charter cruises to Papahānaumokuākea Marine National Monument (PMNM) to look more closely at invasive algae, buoy damage, hurricane effects and bleaching recovery. Project staff will also continue coordinating logistics and planning for a National Centers for Coastal Ocean Science funded multi-year mesophotic research project in American Samoa slated to begin early in 2022 and last for four years. Staff will continue processing 3D models and will continue analyzing data from previous expeditions

as well as preparing manuscripts. The Resource Protection Program will continue to participate in activities to protect the marine ecosystems of the NWHI, including hull inspections, marine debris removal planning, and coordinating efforts to monitor damages caused by grounded National Weather Service buoys and/or lost shipping containers. PMNM Collaborative Laboratories (CoLab) will develop remote sensing capabilities and the analysis of satellite, UAS, and underwater imagery.

Equatorial Oceanography

Observation and Dynamics of Oceanic Variability in the Solomon Sea

PI. Douglas S. Luther

For the next fiscal year, the expectation is that glider operations in the Solomon Sea will resume. The plan is to restart the production and distribution of near real time Solomon Sea transport values. Collaborations with modeling groups are planned to continue to analyze the downstream consequences of Solomon Sea transport and its impact on the tropical strip.

Optimizing Routine Ocean Current Measurements by the NOAA Fleet 2017–2021

PI.: Eric Firing

Assuming our renewal proposal is funded, JIMAR will continue the work along the same lines as during previous years. The *Thomas Jefferson* is expected to become ready for a University of Hawai‘i Data Acquisition System (UHDAS) installation during the coming year. Development of the NOAA to NOAA (N2N) data pipeline has gone slower than expected, but JIMAR anticipates bringing it to operational status in the coming year.

University of Hawai‘i Sea Level Center

PI.: Philip Thompson

Plans include making scheduled updates to Fast Delivery and Research Quality databases with incorporation of any new Global Sea Level Observing System (GLOSS) Core Network or Global Climate Observing System (GCOS) stations as they become available. Assuming travel restrictions due to COVID-19 are lifted, the plan is to make maintenance visits to 14 core University of Hawai‘i Sea Level Center (UHSLC) stations, five Pacific tsunami stations, and five Caribbean tsunami stations (24 total visits). Similarly, the plan is to install one new cGPS station and make maintenance visits to three existing cGPS stations. The plan is to continue updating products and tools that communicate sea-level information to stakeholders in scientific and coastal communities, including the sea-level section in the Bulletin of the American Meteorological Society (BAMS) State of the Climate Report; a tide-gauge index of global mean sea level for Climate.gov; monthly sea level forecasts for Pacific Islands; and the UHSLC Station Explorer for exploring data and metadata from UHSLC-operated tide gauges. The plan is to continue contributions to peer-reviewed literature concerning sea level trends, variability, and extremes. In particular, JIMAR will partner with NOAA Center for Operational Oceanographic Products and Services (CO-OPS) to assess a 40-year model reanalysis of coastal water levels for the Continental U.S. and U.S.-affiliated Pacific Islands. Through this work, the UHSLC will support improvement of two products produced by NOAA related to determination of extreme water level probabilities and seasonal prediction of the daily likelihood of high-tide flooding.

University of Hawai‘i Sea Level Center cGPS

PI.: Philip Thompson, James Foster

Plans include completing the upgrade of the communications system at the Bahamas Global Navigation Satellite System (GNSS) site BHMA replacement site to bring it into full operation. Maintenance visits are planned to the GNSS sites in the Cape Verde Islands (site TGCV), and the Maldives (sites HULE and ADDU). Data from

existing sites will be received, archived locally, and transmitted to the international data archives for global public access.

Climate Research and Impacts

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

P.I.: Mark A. Merrifield

The completion of the mixed distribution report are anticipated by September 2021. The Level 1 impacts analysis and Geographic Information System (GIS)-related tabular/graphics products will be completed in the fall of 2021. The final report will be completed by winter of 2021/2022.

Atmospheric Gases in the Remote Pacific Marine Free Troposphere Measured in Hawai'i

P.I.: Douglas S. Luther [Brian Vasel, Darryl T. Kuniyuki]

Dr. Akane Yamakawa from the National Institute for Environmental Studies (NIES), Japan, will travel to Mauna Loa Observatory (MLO) in 2022 to continue her collaboration with Air Resources Laboratory (ARL) and MLO personnel in the coming year. Dr. Yamakawa's research will focus on the collection and analysis of air samples for mercury isotope composition, which arises from both mass-dependent and mass-independent fractionation. Competing processes (e.g., natural and anthropogenic emissions, transport, oxidation/reduction, deposition, and re-emission, etc.) are characterized by different fractionation mechanisms, and measuring mercury's isotopic composition at a number of locations can be a powerful tool to trace the sources, sinks, and transformational cycles of atmospheric mercury. This understanding is needed to better inform policy-relevant global mercury models, such as that developed at ARL, to explain spatio-temporal trends in atmospheric mercury deposition and provide scientifically robust information to aid efforts to reduce mercury contamination around the globe.

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

P.I.: Niklas Schneider

A proposal has been submitted to continue operations at the Asia-Pacific Data Research Center (APDRC) in the coming year. However, the funding opportunity has reduced funding compared to the current year, and so all efforts will be focused on maintaining the APDRC hardware and data services. New data and updates to existing datasets will be done only as time and resources allow. The collaboration with NOAA Climate Services and World Meteorological Office (WMO) Regional Alliance Five (RA-V) efforts will hopefully continue via separate funding.

Profiling CTD Float Array Implementation and Ocean Climate Research

P.I.: Douglas S. Luther [Gregory C. Johnson]

In the next fiscal year, JIMAR collaboration with Pacific Marine Environmental Laboratory (PMEL) and other Argo partners will continue, with testing, deployment, and performance monitoring for more Core and Deep Argo floats, as the COVID-19 pandemic allows. Ocean climate studies will continue using Argo data, including analysis of global ocean heat content and sea surface salinity variations, with more work on delayed-mode quality control for the PMEL Argo floats.

Tsunamis & Other Long-Period Ocean Waves

Archive of Rapidly-Sampled Hawaiian Sea Level

PI.: Douglas S. Luther

The ongoing application of the rapidly-sampled sea level records in Pacific Islands Ocean Observing System (PacIOOS) efforts to diagnose the causes of harbor sea level variations, as well as coastal inundation events, demonstrates that the collection, processing, archiving, concatenation, and dissemination through the Archive of Rapidly-Sampled Hawaiian Sea Level (ARSHSL) of rapidly-sampled Hawaiian sea level are important activities that will therefore be continued. The intention is to convert ARSHSL 1-minute repository to NOAA's new publicly available structure and bring that data back into regular updating. Along with this change JIMAR will then continue to QC and store the data. A portion of the code was written to automate year end cataloging with the intention on finishing that as well as go back through the existing ARSHSL records and make easily accessible long time period segments (one year) available. As funding permits, JIMAR will continue to move forward with the re-establishment of the full ARSHSL archiving activities; that is, along with JIMAR funding, PacIOOS resources will be used to accomplish the resumption of real-time data acquisition from several Pacific Tsunami Warning Center (PTWC) gauges for archiving in ARSHSL. However, the low priority and light funding of ARSHSL means this will be a multi-year activity.

Tsunami Research and Modeling

PI.: Douglas S. Luther

- Work for the upcoming Fiscal Year is planned along three lines of research.
- Completion of the forecast accuracy assessment study between the Deep-ocean Assessment and Reporting of Tsunamis (DART) and Global Navigation Satellite System (GNSS) forecasts.
 - Assistance with the computation of source propagation for an American Society of Civil Engineers (ASCE)-compliant, Probabilistic Tsunami Hazard Assessment study for the island of Maui (Effort funded by Hawai'i Civil Defense).
 - Development of deterministic Tsunami Inundation Maps for evacuation mapping for several international communities (TBD) as part of a collaborative effort funded by the International Tsunami Information Center (ITIC). (Contingent on contract award).

The University of Hawai'i Sea Level Center—Tsunami Research

PI.: Philip Thompson

During FY 2022, the team plans to meet project objectives by servicing five Pacific Tsunami gauges and five Caribbean Tsunami gauges.

List of Acronyms

3D	Three-Dimensional
ADMB	Automatic Differentiation Model Builder
AGEPRO	Age Structured Projection Model
AI	Artificial Intelligence
APDRC	Asia-Pacific Data Research Center
ARL	Air Resources Laboratory
ARSHSL	Archive of Rapidly-Sampled Hawaiian Sea Level
ASCE	American Society of Civil Engineers
AUV	Autonomous Underwater Vehicle
BAMS	Bulletin of the American Meteorological Society
cGPS	Co-located Global Positioning System
CNMI	Commonwealth of the Northern Mariana Islands
CoLab	Collaborative Laboratories
CO-OPS	Center for Operational Oceanographic Products and Services
COVID-19	Corona Virus Disease 2019
CRIMP-2	Coral reef instrumented platform-2
CRP	Cetacean Research Program
CSVI	Community Social Vulnerability Indicators
CTD	Conductivity Temperature and Depth
DAPPER	Data Access Protocol server
DAR	State of Hawai'i Division of Aquatic Resources
DART	Deep-ocean Assessment and Reporting of Tsunamis
DIAS	Digital Image Archiving System
DNA	Deoxyribonucleic Acid
DRS	Dealer Reporting System
DSCRTP	Deep Sea Coral Research and Technology Program
DVR	Digital Video Recorder
eDNA	Environmental Deoxyribonucleic Acid
EM	Electronic Monitoring
ENP	Eastern North Pacific
ER	Electronic Reporting
ESD	Ecosystem Sciences Division
FFS	French Frigate Shoals
FOT	Final Out Turn Receipt
FRDS	Fisher Reporting and Dealer System
FRMD	Fisheries Research and Monitoring Division
FRS	Fisher Reporting System
FSM	Federated States of Micronesia
FY	Fiscal Year
GCOS	Global Climate Observing System
GIS	Geographic Information System
GLOSS	Global Sea Level Observing System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System

GUI	Graphic User Interface
HCTP	Hawai‘i Community Tagging Program
HDAR	Hawai‘i Division of Aquatic Resources
HIMB	Hawai‘i Institute of Marine Biology
HMS	Hawaiian Monk Seal
HMSRP	Hawaiian Monk Seal Research Program
IATTC	Inter-American Tropical Tuna Commission
IEA	Integrated Ecosystem Assessment
IPRC	International Pacific Research Center
ISO/IEC	International Organization for Standardization/International Electrotechnical Commission
IT	Information Technology
ITIC	International Tsunami Information Center
JIMAR	Joint Institute for Marine and Atmospheric Research
LBSP	Land Based Sources of Pollutions
LED	Light Emitting Diode
LHP	Life History Program
LME	Large Marine Ecosystem
MARFAC	Marine Animal Recovery Facility
MHI	Main Hawaiian Islands
MIL	Marine Instrumentation Laboratory
MLO	Mauna Loa Observatory
MOUSS	Modular Underwater Stereoscopic System
MUS	Management Unit Species
N2N	NOAA to NOAA
NCRMP	National Coral Reef Monitoring Program
NIES	National Institute for Environmental Studies (Japan)
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
NWFSC	Northwest Fisheries Science Center
NWHI	Northwestern Hawaiian Islands
OA	Ocean acidification
OAP	Ocean Acidification Program (NOAA office)
OCS	Oceanic whitetip shark (FAO 3 alpha code)
PacIOOS	Pacific Islands Ocean Observing System
pH	Potential of hydrogen
PHR	Pearl and Hermes Reef
PIFSC	Pacific Islands Fisheries Science Center
PIPAN	Pacific Islands Passive Acoustic Network
PIRO	Pacific Islands Regional Office
PITSI	Pacific Islands Territorial Science Initiative
PIVA	Pacific Island Vulnerability Assessment
PMDP	Papahānaumokuākea Marine Debris Project
PMEL	Pacific Marine Environmental Laboratory
PMNM	Papahānaumokuākea Marine National Monument
PRS	Post release survival

PTWC	Pacific Tsunami Warning Center
QC	Quality Control
RAMP	Reef Assessment and Monitoring Program
RA-V	Regional Alliance Five (Pacific Islands)
ROV	Remotely Operated Vehicle
RPL	Regional Purse-Seine Log Sheet
R/V	Research Vessel
SAMI-alk	Submersible Autonomous Moored Instrument for alkalinity
SAP	Stock Assessment Program
SDM	Species Distribution Model
SDT	Software Development Team
SOD	Science Operations Division
SPTT	South Pacific Tuna Treaty
SQL	Structured Query Language
SSTP	Survey and Sampling Technologies Program
TA	Total alkalinity
TBD	To be determined
TMB	Template Model Builder
tpl	Template file
UAS	Uncrewed Aerial Systems
UHDAS	University of Hawai'i Data Acquisition System
UHSLC	University of Hawai'i Sea Level Center
UL	Unloading and Transshipment Log sheet
U.S.	United States
VFP	Visual Fox Pro
VIAME	Video and Image Analytics for Marine Environment
WCPFC	Western and Central Pacific Fisheries Commission
WMO	World Meteorological Office
WPacFIN	Western Pacific Fisheries Information Network
WPRFMC	Western Pacific Regional Fishery Management Council

