JIMAR Joint Institute for Marine and Atmospheric Research



JIMAR

Annual Report for Fiscal Year 2010

For Cooperative Agreements NA17RJ1230, NA090AR4320075, and NA080AR4320910

Thomas A. Schroeder, PhD Director

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Table of Contents

V
1
3
6
21
23
77
85
87
93
98
102
103
104
105

Introduction

The Joint Institute for Marine and Atmospheric Research (JIMAR) is a cooperative enterprise between the National Oceanic and Atmospheric Administration (NOAA) and the University of Hawaii (UH). JIMAR research covers six themes, all aligned with the NOAA strategic plan and the University's Indo-Pacific mission. The themes are equatorial oceanography, tsunamis and other long-period ocean waves, climate, tropical meteorology, fisheries oceanography, and coastal research. The scope of these efforts spans the US affiliated Pacific Islands as well as the broader Pacific and Indian Ocean basins. JIMAR brings together research scientists from NOAA line offices, UH, and the global community to conduct research in the broad interests of NOAA. NOAA line offices collaborating in the JIMAR program include the Environmental Research Laboratories (especially the Pacific Marine Environmental Laboratory [PMEL], Atlantic Oceanic and Meteorological Laboratory [AOML], and the Earth System Research Laboratory [ESRL]), National Marine Fisheries Service (NMFS), National Weather Service (NWS), National Environmental Satellite and Data Information Service (NESDIS), and National Ocean Service (NOS). JIMAR



Thomas Schroeder, Director

also promotes student development, outreach, and supports special training programs. JIMAR intends to be the lead agent for all NOAA research in the Indo-Pacific region and to maintain standards of accomplishment expected of the School of Ocean and Earth Science and Technology (SOEST) at the UH. Included in this report are projects under award numbers NA17RJ1230, NA09OAR4320075, and NA08OAR4320910.

Our mission and vision statements are:

Mission: To conduct research that is necessary to properly understand and predict the changes in the Indo-Pacific environment and to conserve and manage coastal and marine resources in the U.S.-affiliated Pacific Islands with a special emphasis on the Hawaiian Islands, for purposes of meeting the Nation's economic, social, and environmental needs in these regions.

Vision: To support NOAA's operational and scientific move into the 21st century while recognizing the special character, vulnerabilities, and the role of the Pacific Islands in demonstrating the link between our planet's environment and the global and regional economies.

During FY 2010 JIMAR continued to expand its role in fisheries and coastal research related to the Northwestern Hawaiian Islands Marine National Monument. We continued to work with interdisciplinary groups addressing impacts of a changing climate on insular environments, especially in the area of water supply. We initiated an effort to downscale regional climate model outputs to individual island settings. Participants include NOAA, Dept. of Interior, and East-West Center.

We have become a significant contributor to the Hawaiian Regional Ocean Observing System, housed in SOEST. This includes support of observational platforms. The Director continues to advise the University of Hawai'i at Manoa (UHM) campus on emergency preparedness. The Homeland Security Center for first responders to natural disasters has been funded and is in its start-up phase. The JIMAR Director serves on the advisory committee and is a content source. Lastly, JIMAR supports a program with the UHM School of Hawaiian Knowledge to ascertain historic accounts of Hawaiian natural disasters from Hawaiian language media (primarily 19th century Hawaiian-language newspapers). To date 4,000 Hawaiian language articles have been identified and assembled in a database for researchers and educators.

The Director of JIMAR is a regular member of the University of Hawaii faculty and is appointed through joint decisions by leaders of the University and NOAA Research. The Director reports to an Administrative Board composed of University and NOAA officials. As both NOAA Research and University research ventures have grown, both agencies have delegated more responsibilities to the field. The Director of NOAA Research has delegated most decision-making authority to the Director of PMEL. The President of the University has delegated his responsibilities as Chair of the Administrative Board to the Chancellor of the Manoa campus. The Director manages day-to-day operations through the administrative staff (fully-supported by the Cooperative Agreement and returned indirect cost funds), Program Managers (Pelagic Fisheries Research Program [PFRP]), and faculty

PI/Directors (University of Hawaii Sea Level Center [UHSLC]). A Council, elected among the Fellows, advises the Director on major expenditures on visiting scientists and the selection of new and renewed Fellows. The list of current Fellows and Council members are provided. Although uncertainty continues over the future of JIMAR under the recompetition of the Cooperative/Joint Institutes, we have proceeded to expand the Fellows roster through the addition of scientists specializing in Ocean climate/chemistry. We renewed the appointments of all current Fellows so that all appointments are synchronized. Owing to the long-distance nature of the NOAA/JIMAR relationship, no single meeting of all Fellows is possible. Business of both the Fellows and the Council are done via e-mail and by visits of the Director to NOAA facilities and professional meetings.

JIMAR Senior Fellows from NOAA are Dr. Eddie Bernard (PMEL), Dr. Steven Bograd (PFEL), Dr. Richard Brill (NMFS), Dr. Richard Feely (PMEL), Dr. Ed Harrison (PMEL), Dr. Gregory Johnson (PMEL), Dr. William Kessler (PMEL), Dr. Frank Marks, Jr. (AOML), Dr. Michael McPhaden (PMEL), Dr. Dennis Moore (PMEL), Dr. Jeffrey Polovina (PIFSC), Dr. Samuel Pooley (PIFSC), Dr. Mark Powell (AOML), and Dr. Frank Schwing (PFEL).

JIMAR Senior Fellows from the University of Hawaii are Dr. Gary Barnes, Dr. Steven Businger, Dr. Eric DeCarlo, Dr. Eric Firing, Dr. Charles Fletcher, III, Dr. Kim Holland, Dr. Roger Lukas, Dr. Douglas Luther, Dr. Julian McCreary, Dr. Mark Merrifield, Dr. Thomas Schroeder, Dr. John Sibert, and Dr. Bin Wang. Visiting Senior Fellows are Dr. Gerald Meehl, Dr. Jagadish Shukla, Dr. Akimasa Sumi, and Dr. Michio Yanai.

JIMAR Council Members from NOAA are Dr. Michael McPhaden, Dr. Dennis Moore, and Dr. Jeffrey Polovina.

JIMAR Council Members from the University of Hawaii are Dr. Eric Firing, Dr. Julian McCreary, Dr. Thomas Schroeder, and Dr. Bin Wang.

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



Distribution of JIMAR's Task I NOAA Funding by Activity

JIMAR science encompasses several dozen subprograms. In the aftermath of the Boxing Day tsunami, JIMAR has continued to play a leadership role in the development of an Indian Ocean tsunami warning network. The UH Sea Level Center had developed tide gauges that are capable of delivering near-real time high temporal resolution information. The Pacific Tsunami Warning Center has used our Pacific gauges as part of their warning network. NOAA funds for this effort have been supplemented by grants from the Asia Disaster Preparedness Center and the United Nations.

Dr. Kevin Weng has been appointed program manager for the Pelagic Fisheries Research Program (PFRP). PFRP continues to be a vital program in support of fisheries management in the Western Pacific, both through internal research efforts and a unique international competitive funding program. After a period of uncertainty the prospects for PFRP seem again bright.



Accomplishments for Fiscal Year 2010

Equatorial Oceanography

JIMAR Senior Fellows are actively involved in equatorial oceanographic research. Current activities include current profiling, sea level monitoring, equatorial circulation studies, and dynamic modeling.

Penetration of Anthropogenic CO₂ in the Oceans Based on Analysis of Recent WOCE/ JGOFS/OACES Carbon Data Using the Remineralization Ratios Obtained by the New Three-End-Member Mixing Model

P.I.: Yuan-Hui Li

NOAA Office (of the primary technical contact): Atlantic Oceanographic and Meteorological Laboratory

NOAA Goal(s)

- · To understand climate variability and change to enhance society's ability to plan and respond
- · To serve society's needs for weather and water information

Purpose of the Project

The purpose of this project is two-fold. First, to use the three-end-member mixing model on the complete set of newly synthesized and quality assured WOCE/JGOFS and NOAA global CO_2 survey data to re-evaluate the remineralization ratios throughout the whole ocean basin. The objective of this task is to obtain new values of remineralization ratios for the global oceans and to verify that these ratios do vary systematically among ocean basins as the project's preliminary results have indicated (Li and Peng, 2002). Second, to develop a new method for estimating the penetration of anthropogenic CO_2 in the ocean. The objective of this task is to include the variable remineralization ratios for estimating the anthropogenic CO_2 inventory in the ocean and to provide information from an alternative method for comparison with that derived from the popular ΔC^* method.

Progress during FY 2010

The project found that remineralization ratios change as functions of both latitude and depth, so it is harder to apply our model to evaluate the anthropogenic CO_2 inventory in the oceans. However, we found that the major cause for the change in remineralization ratios is partial conversion of organic nitrogen into N₂, N₂O, and NO by yet unidentified bacteria during oxidation of organic matter in oxycline (the so-called partial nitrification hypothesis).

University of Hawaii Sea Level Center

P.I.: Mark A. Merrifield

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

NOAA Goal(s)

- · To understand climate variability and change to enhance society's ability to plan and respond
- · To serve society's needs for weather and water information

Purpose of the Project

The University of Hawaii Sea Level Center (UHSLC) collects, processes, analyses, and distributes tide gauge data from around the world in support of climate and oceanographic research. The UHSLC focuses on the collection of high frequency measurements that are available in near-real time, usually via the Global Telecommunications System (GTS). Nearly 200 stations are quality assessed on a daily basis. The center complements the Permanent Service for Mean Sea Level (PSMSL), which is the primary archive for historic monthly-averaged time series of sea level. Data are provided to the UHSLC from \sim 450 stations maintained by 65 international agencies. In addition, the UHSLC directly assists host countries in the maintenance and operation of 70 stations. The UHSLC

is an active contributor to the Intergovernmental Oceanographic Commission Global Sea Level Observing System (GLOSS), and participates in operational and scientific oversight through the GLOSS Group of Experts. The UHSLC is primarily concerned with the implementation of the Global Climate Observing System (GCOS) sea level network, a subset of GLOSS designated as being of high importance for climate research.

Progress during FY 2010

UHSLC researchers completed a study of spatial variations in sea level rise rates in the Pacific. High rates of sea level rise in the western equatorial Pacific and low rates along the eastern boundary of the Pacific are linked to an increase in trade wind strength across the equatorial band since the early 1990s. The increase in trade wind strength and the associated wind-driven sea level response are believed to be expressions of an intensifying Hadley circulation in the Pacific, perhaps related to recent warming trends.

Extreme value statistics have been compiled for tide gauge records around the globe. A product set based on these analyses is near completion. Trends in these statistics are under investigation, particularly the relationship between extreme events and the changes in the trade wind circulation noted above. UHSLC contributes to the annual assessment of sea level variability as part of the annual State of the Climate report in the Bulletin of American Meteorology.

Maintenance and operation of stations in the global tide gauge network have been the primary operational focus of the UHSLC during 2010. UHSLC technicians performed on-site maintenance at 25 stations in the Pacific, Atlantic, and Indian Oceans and provided remote technical support for 15 additional stations. The UHSLC maintains the GLOSS Fast Delivery Data Center, which is the main provider of tide gauge data for ongoing satellite altimeter cal/val operations. 267 stations are included in the Fast Delivery database. UHSLC is committed to implementing GCOS sea level network. Steady progress over the past several years has resulted in the acquisition of data from 153 of the 170 GCOS stations. Two new GCOS stations were installed during FY 2010 (Puerto Deseado and Puerto Madryn, Argentina) by UHSLC technicians. The project's goal for the end of 2010 was to complete the implementation of the 170 stations in the GCOS network. While the project has made great strides toward improving the real-time reporting of data from the GCOS stations (currently 143 of the 170 stations report in near real-time or fast delivery mode), and the project has seen steady improvement in the GPS coverage at the GCOS tide gauges (113 out of 170), the project is approaching a stage where the remaining stations that are not yet in operation are beyond the project's direct influence. Of the 27 stations that are not reporting data regularly, 14 are from China, India, and Russia. The project expects one of the Chinese stations to begin near-real time transmissions this year as a result of diplomatic negotiations, but there is no solution imminent for the remaining stations. In addition, five stations in Cuba, Venezuela, and the Republic of Korea require more than just the offer of supplies and/or a technical visit from a UHSLC technician.

Tsunami Research

JIMAR originated from the Joint Tsunami Research Effort and has maintained a long collaboration with the Pacific Marine Environmental Laboratory (PMEL) in tsunami research. JIMAR scientists are heavily involved in tsunami hazard mapping and preparedness throughout the Pacific basin with special emphasis on Hawaii. JIMAR scientists have collaborated with PMEL, the Pacific Disaster Center, and Hawaii State Civil Defense.

Archive of Rapidly Sampled Hawaiian Sea Level

P.I.: Douglas S. Luther

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

NOAA Goal(s)

· To serve society's needs for weather and water information

Purpose of the Project

The purpose of the Archive of Rapidly Sampled Hawaiian Sea Level (ARSHSL) is to provide an electronically accessible database of rapidly sampled ($\Delta t \leq 6$ minutes) sea level observations from existing Hawaiian coastal sea level gauges maintained by NOAA agencies (NOS and Pacific Tsunami Warning Center [PTWC]). This sea level dataset is publicly available, via the Internet, for both practical applications and research. The archive was originally established with NOAA funding in 1997 to ensure a consistent repository of rapidly sampled sea level in the Hawaiian Islands for the study of weak tsunamis and related infra-gravity wave signals (including edge waves and harbor resonances) at periods of 1-40 minutes. The archive is maintained with funding by JIMAR. Beyond studies of the 1-40 minute gravity waves that impact commercial and private boating activities, the ARSHSL data is used by the NOAA-funded Hawaii Ocean Observing System (HiOOS), and investigators studying the dynamics of ocean phenomena such as internal and external tides (0.5 to 1 day periods), coastal trapped internal waves (1.5 to 5 day period), wind-forced mesoscale variability (3-60 day period), mesoscale eddies (60 to 180 day period), and interannual variability around the Hawaiian Islands. Sea level data from two-thirds of the gauges accessed would otherwise be lost without this archiving activity; that is, the data is not saved by the agency (PTWC) responsible for maintaining the gauges because data archiving is not a mission of that agency. Therefore, this data rescue activity provides 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.

Progress during FY 2010

Per the plans for this past year, the ARSHSL was maintained on the World Wide Web (http://www.soest.hawaii. edu/oceanography/dluther/arshsl.html) by M. Luther and D. Luther, in collaboration with the NOAA-funded University of Hawaii (UH) Sea Level Center (M. Merrifield, Director). One-minute and 6-minute data from six NOS gauges are retrieved from NOAA's Tides and Currents web site (http://tidesandcurrents.noaa.gov/) rather than through special communication pathways previously established for ARSHSL. PTWC sea level gauge data (1-second or 2-minute samples, depending on the gauge) are automatically or, if necessary, manually downloaded daily via Internet and telephone links from up to 15 PTWC gauges (in 13 harbors). All the sea level data, as originally sampled from a total of 17 harbors (two harbors have both NOS and PTWC gauges) dispersed around the five main islands of Hawaii, are stored on the ARSHSL web site, usually after both a low-level quality control check and elimination of extreme outliers. Access to the web site is unrestricted, with past users ranging from UH graduate students to government civil engineers, and even PTWC. The applications have ranged from hydrogeology to gravity wave studies to dock design. Predominant users in the past year focused on water table fluctuations on the Big Island (USGS) and on harbor seiches in support of the development of "harbor conditions" nowcasts and forecasts for the HiOOS. JIMAR is supporting a graduate student, Assaf Azouri, who is analyzing the 12 years of PTWC sea level data from Haleiwa Harbor in ARSHSL to determine the relationship between Haleiwa's suite of infragravity wave fluctuations and their many forcing pathways (e.g., wind-generated swell to harbor infragravity wave and swell to coastal infragravity wave to harbor infragravity wave). It is anticipated that during the next year Azouri will finish his analyses and create a product for HiOOS that will predict the occurrence of potentially damaging infragravity wave currents in Haleiwa Harbor up to a few days into the future.

A technical report on the ARSHSL was prepared in January 1998, and is periodically updated on the web site. Logs of all data holdings and processing activity are being maintained on the web site for each station. As expected, archiving activities required most of the budgeted effort this past year. Per the plans stated in last year's report, additional "value added" enhancement activities accomplished this past year include: (i) updating the editing and quality-control procedures in light of gauge enhancements by NOS and PTWC; and (ii) updating files of concatenated, quality-controlled, hourly-averaged sea level data for studies of low-frequency phenomena, especially to aid modeling and prediction of sea level inundation hazards around Oahu for NOAA's HiOOS. Gauge maintenance remains a concern because this project is dependent upon other NOAA agencies for this activity. The six NOS sites were always brought back on-line after only brief (order of days) interruptions caused by occasional equipment malfunctions. Of the 15 PTWC gauges, six are currently inoperative (the same as last year at this time); sea level gauge operation and maintenance is necessarily an ancillary activity for PTWC.

Three-dimensional Model of Tsunami Generation and Near-field Characteristics

P.I.: Thomas A. Schroeder [Kwok Fai Cheung]

NOAA Office (Of the primary technical contact): Office of Oceanic and Atmospheric Research

NOAA Goal(s)

• To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

The objectives of the research include: implementing a continuum mechanics model and developing a nonhydrostatic model to describe seafloor deformation and tsunami generation in three dimensions; implementing the non-hydrostatic model for near-field tsunami modeling and determining the applicable range of the conventional hydrostatic approach; and applying the proposed model package to reconstruct and analyze the 2009 American Samoa Tsunami.



NEOWAVE results for wave transformation over a complex reef system in the 2009 Benchmark Challenge at the ISEC Community Workshop

Progress during FY 2010

A three-dimensional finite element model of continuum mechanics can provide realistic descriptions of fault slippage and the resulting earth surface deformation. In particular, the Research Organization for Information Science and Technology in Japan developed the finite element model, GeoFEM, to describe tectonic dynamics as part of the Earth Simulator Project. The project has adapted GeoFEM to provide time-dependent seafloor deformation based on user-specified fault parameters consisting of the focal depth, dimensions, orientation, and slip. The implementation of GeoFEM has been verified by the analytical solution for homogeneous and isotropic earth materials and a flat seafloor. GeoFEM can include earth surface relief to produce more realistic deformation over steep trenches or volcanic island slopes for tsunami modeling.

Near-field or local tsunamis are not fully developed in terms of wave dynamics and exhibit distinct characteristics specific to the seismic source and local bathymetry that are not amenable to conventional hydrostatic models. The project has developed a non-hydrostatic model for tsunami generation, propagation, and runup and published a paper describing the results. Instead of solving the complete three-dimensional problem, the project introduces a non-hydrostatic term into the nonlinear shallow-water equations to account for the variation of flow kinematics over the water column. The resulting model remains depth-integrated, but includes an approximate solution in the vertical direction. This computationally efficient approach accounts for the kinetic energy transferred from the seafloor deformation and simulates near-field tsunami characteristics as well as frequency dispersion in far-field propagation.

University of Hawaii Sea Level Center—Tsunami Research

P.I.: Mark A. Merrifield

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

NOAA Goal(s)

· To serve society's needs for weather and water information

Purpose of the Project

The UHSLC plays an active role in the development of tsunami and operational water level networks. The purpose of this activity is to encourage practices and standards that ensure that tide gauge data satisfy the needs of the climate research as well as the tsunami warning communities. This strategy has led to the expansion of high quality tide gauge stations in tsunami risk regions (e.g., Southeast Asia, Africa, the Indian Ocean, South America). The UHSLC maintains approximately 70 tide gauge stations in the Indian, Pacific, and Atlantic Oceans. This project has completed the upgrade of nearly all of these stations to comply with tsunami monitoring requirements. The few remaining stations that have not been upgraded are in remote locations that will be serviced as soon as the project can arrange transportation to the sites.

Progress during FY 2010

This project has completed the first year of a three-year project to upgrade or install 12 tsunami stations in the Pacific, and 5 to 10 in the Caribbean in coordination with the Pacific Tsunami Warning Center (PTWC) and the West Coast and Alaska Tsunami Warning Center (WCATWC). During FY 2010, the UHSLC installed stations in Quepos, Costa Rica, and Legaspi, Philippines in the Pacific, and Punta Cana and Puerto Plata, Dominican Republic, and Limon, Costa Rica.

Climate Research

JIMAR's climate theme evolved in concert with the equatorial oceanography theme. The focus was the El-Niño Southern Oscillation (ENSO) phenomenon in all its oceanic and atmospheric aspects. JIMAR scientists continue to study fundamental aspects of climate and climate variability. The UH Sea Level Center is a major contributor to NOAA's climate program. The project's Pacific ENSO Applications Center (PEAC) has continued the JIMAR tradition by developing interdisciplinary approaches to the study of climate impacts and development of experimental forecasts. Partners in PEAC include the NWS Pacific Region, University of Guam, Pacific Basin Development Council, and NOAA Research through its Climate Program Office.

Changes in the Tropical Pacific Climate Variability During the Last Millennium: External Forcing Versus Internal Variability

P.I.: Axel Timmermann

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

NOAA Goal(s)

• To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

Separating externally forced signals in tropical Pacific climate reconstructions and model simulations from the ones that are generated by internal instabilities is a fundamental problem. Using several existing climate model simulations of the last 500-1000 years and combining different paleo-proxy records for ENSO, the project will elucidate the physical mechanisms responsible for long-term changes in the tropical Pacific climate during the last millennium. Questions to be addressed specifically are as follows.

- What is the degree of consistency between different paleo-ENSO reconstructions during the last millennium?
- What is the range of internally generated ENSO variability on decadal and centennial timescales in comparison with the externally induced low-frequency modulation of ENSO?
- What are the mechanisms of internally generated and externally induced long-term changes of ENSO?

These questions will be addressed by a careful statistical analysis of existing paleo-proxy data for ENSO and using coupled-atmosphere ocean general circulation model simulations for the last 500-1000 years. The project's proposed research will reassess existing paleo-proxy data, provide rigorous uncertainty estimates, and might eventually contribute to a better understanding of ENSO's sensitivity to climate change, with important implications for society.

Progress during FY 2010

In this fiscal period the project examined the response of the El Niño-Southern Oscillation (ENSO) to massive volcanic eruptions in a suite of Coupled General Circulation Model (CGCM) simulations utilizing the Community Climate System Model, version 3 (CCSM3). The project found that the radiative forcing due to volcanic aerosols injected into the stratosphere induces a climate response that projects onto the ENSO mode and initially creates a La Niña event, which peaks around the time the volcanic forcing peaks. The curl of the wind stress changes, which accompany the volcanically forced equatorial region cooling, and acts to recharge the equatorial region heat. For weaker volcanic eruptions this recharging results in an El Niño event about two seasons after the peak of the volcanic forcing.

The results of the project's CCSM3 volcanic forcing experiments (see figure) leads us to propose that the initial tropical Pacific Ocean response to volcanic forcing is determined by four different mechanisms. One is the dynamical thermostat mechanism (the mean upwelling of anomalous temperature) and the other processes are related to the zonal equatorial gradients of the mean cloud albedo, Newtonian cooling, and mixed layer depth. The project finds that in CCSM3 the zonal gradient set by both mixed layer depth and Newtonian cooling terms oppose the zonal SSTA gradient produced by the dynamical thermostat and initially dominate the mixed layer equation using observed estimates of the spatially varying variables the project again finds that the mixed layer depth and Newtonian cooling terms oppose and dominate the zonal SSTA gradient produced by the dynamical thermostat mechanically forced mixed layer equation using observed estimates of the spatially varying variables the project again finds that the mixed layer depth and Newtonian cooling terms oppose and dominate the zonal SSTA gradient produced by the dynamical set by both project again finds that the mixed layer equation using observed estimates of the spatially varying variables the project again finds that the mixed layer depth and Newtonian cooling terms oppose and dominate the zonal SSTA gradient produced by the dynamical set by the dyn



a) Time series and magnitude of the radiative affects of the volcanic forcing used. b) Longitude-time plot of ensemble mean equatorial SSTA with overlying SSTA contours generated from the simple mixed-layer model. c) Longitude-time plot of 20_ isotherm depth anomalies with anomalous zonal wind vectors overlaying. The subscripts s, m and l, represent the small, moderate, and large volcanic forcing experiment ensembles, respectively.

thermostat. This implies that the observed initial response to volcanic forcing should be La Niña-like, whereas the subsequent stages of the equatorial response are dominated by the recharging of the equatorial thermocline and the increased chance to generate an El Niño event.

Development of an Extended and Long-range Precipitation Prediction System Over the Pacific Islands

P.I.: Hariharasubramanian Annamalai

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

NOAA Goal(s)

• To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

The project's goal is to develop and transition a dynamical precipitation prediction system for all U.S. Affiliated Pacific Islands (USAPI) based on the Climate Forecast System (CFS). For the target regions over the USAPI,



Figure 1. (a-c) Temporal evolution of December through February average (DJF) SST anomalies (°C) hindcast by CFS at lead 0-month. Ensemble mean (blue), all 15 individual members (different colors) and observations (red) are shown for three regions: (a) Niño3.4 (5°S-5°N, 190°E-240°E); (b) Warm pool El Niño (WP_EN; 5°S-5°N, 160°E-210°E); (c) Cold Tongue El Niño (CT_EN; 5°S-5°N, 210°E-270°E); (d) same as (a) but for equatorial Pacific rainfall anomalies (mm/day) averaged over (10°S-5°N, 170°E-250°E).

the current operational seasonal precipitation prediction system is based on empirical methods (e.g., Canonical Correlation Analysis or CCA). In CCA prediction, sea surface temperature (SST) provides the most reliable predictive information and higher prediction skill for ENSO winters. For non-ENSO years and also for weak to moderate ENSO events, although significant seasonal rainfall anomalies are observed over the USAPI, precipitation forecast skill by the empirical model is low. There are several possible reasons for this including: a) nonlinear relationship between ENSO SST and precipitation is not incorporated; b) details in the space-time evolution of SST during different flavors of ENSO are not properly accounted for; and c) SST anomalies other than ENSO may be responsible for rainfall variations. A prediction system based on a fully coupled dynamical model may overcome some of the above limitations.

Progress during FY 2010

The 15-member ensemble retrospective forecasts (hindcasts) performed with the NCEP CFS for the period 1982-2005 were assessed for seasonal prediction skills over the tropics, both from a deterministic (anomaly correlation, ACC) and probabilistic (Heidke Skill Score [HSS] and Rank Probability Skill score [RPSS]) perspectives. The skill measures were computed for all four seasons and leads ranging from 0 to 6 months. Diagnostics such as persistence correlation, root-mean-square-error, signal to noise ratio, and composites were also analyzed. The project repeated the diagnostics to verify the real-time forecast performed by CFS for the period 2006-09. The suite of verification methods employed also provided uncertainty measures (error) associated with the hindcast and forecast skills.

CFS has ACC values higher than 0.8 (up to 7 months lead) in predicting tropical central to eastern Pacific SST anomalies, and for all seasons except boreal summer (Sooraj et al., 2010). CFS's skill in hindcasting three Niño indices, representing Niño 3.4 (5°S-5°N, 190°E-240°E), Niño 4 (warm pool [WP] El Niño events, SST averaged over 5°S-5°N, 160°E-210°E), and Niño 3 (cold tongue [CT] El Niño events, SST averaged over 5°S-5°N, 210°E-270°E) are shown in Figs. 1a-c. While the mechanisms responsible for the different flavors of El Niño may be different and complex, and their regional and global impact may differ, CFS demonstrates high skill in capturing phase and amplitude of SST anomalies associated with all the Niño indices. For example, at 0 month lead time, the warming associated with WP events (1990-91, 1994-95, 2002-03, and 2004-05) is aptly hindcast with minimum spread among the ensemble members (Fig. 1b) with an overall ACC of 0.95 and signal to noise ratio

greater 5.0. At 7 months lead time the ACC drops to 0.77 for WP events but remains high at 0.9 for CT events (not shown in figure). An examination of winter (DJF) spatial distribution of SST anomalies during individual WP events indicates that the model is successful in capturing the local maxima around the dateline (Sooraj et al., 2010).

Over the equatorial Pacific, skill for the precipitation anomaly is higher during boreal winter (Fig. 1d), and following spring, and is marginal for other seasons (Sooraj et al., 2010). The model's ability is hindcasting equatorial Pacific heating anomalies is also reflected in its high skill in hindcasting SST and precipitation anomalies over southwest Indian Ocean, and subsequently, rainfall anomalies over the USAPI. The model shows skill (up to about 6 months lead) in hindcasting seasonal precipitation anomalies over south and west Pacific Island regions, however, the skill over the Hawaiian Islands is high only during very strong ENSO episodes and is limited to 1-2 month lead time (Sooraj et al., 2010).

Figure 2 summarizes the over-all skill (both deterministic and probabilistic) of CFS in hindcasting seasonal rainfall anomalies over the USAPI. The left panels (Figs. 2a-c) are scatter diagrams between ACC and HSS, and the right panels (Figs. 2d-f) are between ACC and RPSS, respectively. Over the west Pacific region, the rainfall hindcast for the boreal fall season has a negative ACC and RPSS, and low HSS values and thus does not seem useful. However, hindcasting winter rainfall variations have the highest skill,



Figure 2. (left panels) Scatter plots between anomaly correlation coefficient (ACC) and Heidke skill scores (HSS), and (right panels) scatter plots between ACC and Rank Probability skill score (RPSS) over three regions of the USAPI. The results are four standard seasons, and for all lead time forecast (0–6 months) shown in different colors.

followed by spring and summer. For the south Pacific region, for 0 to 4 months lead time hindcasting winter and spring rainfall variations for which all scores converge have higher confidence. Here too, hindcasting the summer precipitation anomalies are less skilful. For the Hawaiian region, at shorter leads and for all seasons except fall, rainfall hindcast is skilful and probably useful too. Encouraged by the hindcast performance, the project is examining the skill for the real-time forecast for the period 2006-2009. The results from these comprehensive diagnostics performed are available in Sooraj et al. (2010) (manuscript submitted for publication).

Dynamics of Pacific Decadal Climate Variability and ENSO Modulation

P.I.: Fei-Fei Jin

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

NOAA Goal(s)

• To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

Significant decadal variations in the Pacific have been identified together with evidence of the strong decadal modulations of the frequency, amplitude, and predictability of the El Niño-Southern Oscillations (ENSO). The project's understanding of the decadal variability is still limited. The aim of this proposed research focuses on the roles of the tropical ocean-atmosphere interaction in the decadal climate variations of the tropical Pacific and decadal modulations of ENSO. The project will examine the relevance of the decadal modes (recently found as analytical solutions of a reduced-gravity model by the PI) of tropical ocean dynamics to the decadal climate variability of the tropic Pacific. This project will investigate the coupled mechanisms that modify the decadal modes of the tropical ocean into coupled modes. The project will study the interaction of the coupled decadal modes with ENSO and explore nonlinear scenarios that allow large amplitude modulations of ENSO. The project will also explore the implications of these deterministic processes to the regime predictability of the ENSO activity

Progress during FY 2010

This project studied different types of El Niños and their response to global warming.

The Effects of the Stratospheric Quasi-biennial Oscillation on Seasonal Predictability of Tropospheric Circulation in the Northern Hemisphere Extratropics

P.I.: Kevin P. Hamilton

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

NOAA Goal(s)

• To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

This purpose of this project is to investigate the role of the stratosphere, including the tropical stratospheric Quasibiennial Oscillation (QBO), in the circulation of the troposphere with a view to developing practical enhancements to current seasonal and other extended range forecasting systems.

Progress during FY 2010

The predictability associated with persistent anomalies in the tropical stratosphere and the winter stratospheric vortex was examined in the context of model reforecasts. By also quantifying sources of predictability associated with tropospheric anomalies, the unique contribution of the stratosphere in this regard was confirmed.

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

P.I.: Kevin Hamilton [Peter Hacker, James Potemra]

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

NOAA Goal(s)

- To understand climate variability and change to enhance society's ability to plan and respond
- To serve society's needs for weather and water information

Purpose of the Project

This project enhances activities at the Asia-Pacific Data-Research Center (APDRC) as well as climate research within the International Pacific Research Center (IPRC) at the University of Hawaii. The project's overall goals are: (i) to meet critical regional needs for ocean, climate and ecosystem information; (ii) to enhance activities in support of the Global Earth Observation System of Systems (GEOSS) and the NOAA Integrated Data and Environmental Applications (IDEA) Center; (iii) to provide infrastructure in support of follow-on activities to the Global Ocean Data Assimilation Experiment (78); and (iv) to conduct research to enhance understanding of climate variability and change in the Asia-Pacific region. The vision of the APDRC is to link data management and preparation activities to local researchers and collaborators, the national climate research community, and the public. The APDRC is organized around three main goals: providing integrated data server and management systems for climate data and products; developing and serving new climate-related products for research and applications users; and conducting climate research in support of the IPRC and NOAA research goals

Progress during FY 2010

The APDRC addresses the first goal of the project through the following objectives: operate and maintain multiple, integrated web-based servers; continue server upgrade and development; partner with other data sites



Figure 1. Streamlines and magnitudes (colors) of mean SCUD model (top) and drifter (bottom) velocities (cm/s). The SCUD product is available for the period 1999-2009 at ¼ degree and daily resolution. Input data are: NOAA/AOML drifter trajectories; QuikSCAT wind; AVISO gridded sea level anomaly; and mean dynamic ocean topography. (Maximenko et al., 2010)



Figure 2. Simulation of marine surface "debris" density evolution assuming and initially uniform distribution. Calculation uses the SCUD product. (Maximenko et al., 2010)

on data-server interoperability; acquire, prepare, and document data and products for the local archive; and link to remote products and necessary metadata. Progress during the past year has focused on: providing dual server systems for internal and external users and seamless backup in case of problems; upgrading the Live Access Server options to provide new capabilities; increasing the data storage of the system to provide greater access to high-resolution model products; and upgrades to the web pages to provide better access to project pages and products. The second goal has the following objectives: develop integrated data products for ocean state estimates; and develop model- and observation-based analyses and indices to improve prediction studies for atmospheric processes. Progress during the past year has focused on: improving the suite of Argo-based analyses; development and serving of the new Surface CUrrents from Diagnostic Model (SCUD) product to support studies of marine debris; and continuing development of prototype seasonal rainfall forecast systems to be used by U.S. Pacific Islands communities for water management guidance. The third goal addresses basic and applied climate research and has resulted in several publications addressing the broad scope of IPRC climate research. Examples of topics include: the potential impact of the tropical Indian Ocean-Indonesian Seas on El Niño characteristics; the inflow pathways of the Indonesian throughflow; the role of stratiform rainfall in sustaining the Madden-Julian Oscillation; the impacts of initial conditions on intraseasonal monsoon forecasting; the dynamics of the northern Tsuchiya Jet; intra-seasonal variation of the Kuroshio southeast of Taiwan and its possible forcing mechanism; mesoscale eddies in the lee of the Hawaiian Islands; observational evidence for propagation of decadal spiciness anomalies in the North Pacific; and contrasts of the rainfall-SST relationships in the western North Pacific between the ENSO developing and decaying summers.

Impacts of Warm Pool and Extratropical Processes on ENSO

P.I.: Bin Wang

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

NOAA Goal(s)

• To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

In general, the purpose of the project is to study how ENSO interacts with warm pool and extratropical processes. This project will address how the mid-latitude atmospheric variability influences the tropical Pacific and what roles the Indo-Pacific warm pool processes play in generating ENSO irregularity and biennial variability.

Progress During FY 2010

The project studied how ENSO regulates teleconnections associated with Madden-Julian Oscillation (MJO). The joint tropical-extratropical intraseasonal variations are shown to have an action center in the North Pacific where the pressure anomalies have opposite polarities between Phase 3 (Indian Ocean) and Phase 7 (western Pacific) of the MJO. The MJO teleconnection is stronger in La Niña than in El Niño years. The teleconnection in the same phase of MJO may induce opposite anomalies over East Asia and North America between El Niño and La Niña years. During MJO Phase 3, a gigantic North Pacific anticyclonic anomaly occurs during La Niña, making coastal northeast Asia warmer/wetter than normal, but the western U.S. colder/drier. During El Niño the anticyclonic anomaly is confined to the central North Pacific, hence the northwest U.S. experiences warmer/wetter than normal weather under influence of a downstream cyclonic anomaly. During Phase 7, an extratropical cyclonic anomaly forms over the northwest Pacific during La Niña due to convective enhancement over the Philippine Sea, causing bitter winter monsoon over Japan. During El Niño, the corresponding cyclonic anomaly shifts to the northeast Pacific due to enhanced convection over the equatorial central Pacific, which causes



Schematic diagrams illustrating typical patterns of MJO-teleconnection at Phase 3 (convection enhanced over the Indian Ocean) during (a) El Niño and (b) La Niña years. Black thin contour displays composite anomalies of seasonal mean rotational wind at 300 hPa. Blue and red thick contours display MJO rotational wind at 300 hPa. Letter A (C) depicts the anticyclonic (cyclonic) circulation anomaly. The winter mean SST anomaly during El Niño and La Niña is shaded in red ($T \ge 0.5^{\circ}$ C) and blue ($T \le -0.5^{\circ}$ C), respectively. The dotted blue (red) arrow denotes cold (warm) advection. Green cloud shapes represent convection associated with MJO and orange cloud shapes denote the subsidence at Phase 3. The thick green line indicates the succession path of cyclonic and anticyclonic anomalies departed from the convection.

warm and wet conditions along the west coast of U.S. and Canada. Furthermore, the impacts of MJO teleconnection on the northeastern Pacific and North America are found to be stronger during El Niño than during La Niña.

Investigating the Transport and Transformation Mechanisms of Atmospheric Mercury in the Remote Central North Pacific Marine Free Troposphere

P.I.: Thomas A. Schroeder [Darryl T. Kuniyuki]

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

NOAA Goal(s)

• To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

The purpose of the project is to collect atmospheric mercury speciation data. The project will undertake the collection and analysis of semi-continuous high altitude (11,400 feet) measurements of Hg⁰, RGM, and Hg^P at MLO,



(left) Poai Suganuma in front of the Dichotomous partisol. (right) Poai holds a denuder that captures the mercury gas.

Hawaii. The objectives of this task will be to accumulate a long-term record of ambient Hg⁰, RGM, and Hg^P chemistry to (i) support atmospheric mercury chemistry research, (ii) establish a baseline mercury measurement station, and (iii) investigate the long range transport of mercury from South East Asia across the Pacific. In addition to this primary task, other data is measured and collected that may affect the transport and transformation mechanisms of atmospheric mercury. This data includes the following: aerosol particulate measurements, collection and analysis, gas and particulate phase halide sample collection and analysis, semi-continuous gas

and particulate phase halide collection and analysis, semi-continuous ozone, sulfur dioxide, elemental carbon, and meteorology measurements. All of the data are to be organized and archived in a database. Some data and theories will be placed on the MLO web site and other types of media for outreach purposes.

Progress during FY 2010

In 2009 the Dichotomous partisol sampler broke down and due to funding cuts was not repaired. The instrument was sent back to EPA. Tom Davis left MLO and was replaced by Poai Suganuma, who is now assigned to run the mercury project. Mercury instruments, Ambient Ion Monitor (AIM), aethalometer, surface ozone and sulphur dioxide analyzers were running normally throughout the year.

Local and Indigenous Climate Knowledge Network

P.I.: Cheryl Anderson

NOAA Office (of the primary technical contact): Climate Program Office Regional Integrated Science and Assessment Program

NOAA Goal(s)

- · To understand climate variability and change to enhance society's ability to plan and respond
- To serve society's needs for weather and water information

Purpose of the Project

The objective of this collaborative project with the Pacific, South West and Alaska Regional Integrated Science and Assessment Programs is to build a process for coping with drought by blending knowledge among indigenous resource managers and populations of these typically underserved peoples. By using telecommunications technologies for video-teleconferencing, the project engages in dialogue and information exchange among indigenous communities to share information, facilitate relationships among communities, and to better assess needs for climate services.

Progress during FY 2010

The objectives for the project were to: 1) build cross-RISA strength in local knowledge and indigenous approaches to drought and climate change adaptation; 2) document local and indigenous coping strategies and information needs related to drought, water availability, and water quality; 3) assess information needs of underserved populations by strengthening communication in a shared learning environment; and 4) provide introduction and training to build capacity for indigenous resource managers to use NOAA and NWS products in decision-making. The intent was to accomplish these objectives through three trial video-teleconference sessions.

During this period, the intent was to document the process and develop publications that described the process for engaging native resource managers thinking about water issues. The article is under development, however, because it is a collaboration of several PIs the focus of the article has yet to be determined.

Pacific ENSO Applications Center

P.I.: Thomas A. Schroeder

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

NOAA Goal(s)

- · To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management
- To understand climate variability and change to enhance society's ability to plan and respond
- · To serve society's needs for weather and water information

Purpose of the Project

The purpose of the project is to conduct develop research and information products specific to the U.S.-Affiliated Pacific Islands (USAPI) on the El Niño Southern Oscillation (ENSO) climate cycle. The project will also study the historical impact of ENSO on rainfall, sea level variability and change, and tropical cyclones in support of planning and management activities in such climatesensitive sectors as water resource management, fisheries. agriculture. civil defense, public utilities, coastal zone management, and other important economic and environmental sectors of the USAPI

Progress during FY 2010

Based on the project's initial findings on higher sea-level in the most recent La Niña year (in 2007-08), which maintained a close correspondence with the faster rate of predicted average global sea-level rise, it is unclear whether the rise is a reflection of recent decadal variability or an actual increase in the rate of the longer-term trend. This finding pointed us towards future research to confirm more objectively the physical causes and possible future scenarios of sea levels in the USAPI. However, to accomplish this a more formal modeling effort was needed.



Seasonal sea-level deviations for three 2-year periods of ENSO cycle. Primary y-axis, sea-level deviations in millimeter, and secondary y-axis, Oceanic Niño Index (ONI).

The project has, therefore, attempted to downscale the results of the IPCC-AR4 model output to target the USAPI region statistically and with the use of regional dynamical models, which have already provided some preliminary understanding and greater confidence in why this pattern of recent increases in sea level is taking place. To examine the effect of global warming, the project has used different sets of projected global warming of the twentieth century and sea level rise scenarios as produced in most recent report of the IPCC (IPCC, 2007a-c: Working Groups I, II, and III).

Pacific RISA Integrated Climate Program Support

P.I.: Cheryl L Anderson

NOAA Office (of the primary technical contact): Environmental Research Laboratory/Forecast Systems Laboratory

NOAA Goal(s)

· To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

The focus of this overall project is to provide ongoing support and collaboration for a Pacific Regional Integrated Climate and Assessment (RISA) climate program that responds to regional stakeholder climate needs, specifically related to issues in coping with drought and extreme climate impacts. This scope of work involves three sets of activities, two of which require collaboration with other RISA programs. The goal of this project will be to engage with stakeholders directly to meet their needs in better accessing and understanding information related to climate, hazards, and drought.

Progress during FY 2010

There were three activities conducted by this project. The first activity was to build capacity in the development, analysis, and delivery of climate information tailored to the needs of disaster management communities. The project will use the Climate Information Delivery and Decision Support System (CLIDDSS) as the technical platform for data portfolio management to support the distribution of information through newsletter formats to multi-sector disaster managers about their climate-related risks. The focus for the first year was on laying groundwork by identifying key data sets and by working with the hazards community to better understand the use of climate information. Work with the hazards community has been stalled because of the hazard mitigation planning process that requires all of the counties and the state to meet specific planning deadlines this year. The second activity examined user needs for drought decision making and the potential of climate and drought information. Dr. Finucane, East-West Center, helped in the design of a survey instrument used by colleagues in another RISA program in Washington to understand their stakeholder needs related to drought. The third activity was to continue to build stakeholder involvement in the Pacific region, especially through maintenance and postings on the Pacific RISA web site. This is an ongoing activity that was maintained during the past year, www.pacificrisa.org.

Profiling CTD Float Array Implementation and Ocean Climate Research

P.I.: Thomas A. Schroeder [Gregory C. Johnson]

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

NOAA Goal(s)

· To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

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

Progress during FY 2010

E. Steffen and the PMEL float lab took delivery of 66 Argo floats this year. She successfully overcame logistical pressures in dealing with a recall of CTD pressure sensors in the entire inventory of floats in the laboratory. She installed Lithium batteries in all the floats, tested all the floats (troubleshooting and coordinating repairs of many problems), and arranged for float deployments. She traveled to load floats on various ships and train deployers, and participated in the annual U.S. Argo Panel meeting. This year she also worked with others in the lab to implement many system changes to accommodate the Iridium telemetry floats now used by PMEL in equatorial regions. Stated goals were met.



Figure 1. Locations (filled circles) of Argo floats prepared by JIMAR float research Analyst E. Steffen as of 20 July 2010. Grey indicates floats that have not reported for the last 20 days or more, colors more recently reporting floats.



Figure 2. Upper Ocean (0-750 dbar) Ocean Heat Content Anomaly [10⁹ J m²] for 2009 relative to 1993-2009 estimated using in situ (mostly from Argo in recent years) temperature data and satellite altimeter sea surface height data (in colors, with red being warm and blue cold).

J. Lyman produced and analyzed (with JIMAR Senior Fellow Dr. Gregory Johnson) yearly maps of global upper ocean heat content from 1993 through 2009 (Fig. 1) combining in situ thermal data and satellite altimetry data, as well as yearly maps of sea surface salinity from 2005 through 2009. They also worked on estimating uncertainties in global ocean heat content anomalies and their trends (published in *Nature* with considerable press coverage). This year Lyman was first author of one published manuscript, and co-author of two published reports. Stated goals were met.

Remote Versus Local Forcing of Intraseasonal Variability in the IAS Region: Consequences for Prediction

P.I.: Shang-Ping Xie

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

NOAA Goal(s)

• To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

The purpose of the project is to investigate the dynamics of intraseasonal variability in the summer Inter-American Seas (IAS), a warm ocean region including the tropical Northeast Pacific and Northwest Atlantic. The scope of the project's study includes the connection with the better-known intraseasonal oscillation in the Indo-Western Pacific, local feedback in the IAS, and intraseasonal modulation of tropical cyclones.

Progress during FY 2010

A regional ocean-atmospheric model (ROAM) shows excellent skills in simulating the structure and phase of the intraseasonal oscillation (ISO) over the IAS. The skills originate from the lateral boundary conditions imposed from an atmospheric reanalysis. Nevertheless, the project's results establish that ROAM is a useful tool to study ISO, its east-west propagation, and local feedback mechanisms. Specifically, the project showed that local ocean-atmosphere interaction is secondary in importance to wave propagation from the western Pacific.

Subseasonal variability in sea surface height (SSH) over the eastern Pacific warm pool off Central America was investigated using satellite observations and an eddy-resolving ocean general circulation model. SSH variability



(above) Figure 1. Hovmoller plots of outgoing longwave radiation (OLR color, Wm²) and 850hPa zonal wind (U850, contoured at 0.5ms⁻¹ intervals, negative dashed and zero omitted), both filtered. OLR is averaged between 10°N and 20°N, while U850 is averaged between 10°S and 10°N. Note these plots cover the complete longitude domain of IROAM from 150W to 30W, allowing inspection of boundary conditions. a) OLR from NOAA and U850 from reanalysis for 2002, as a function of pentad number (pentads 30 to 53 span the June to September period). b) Corresponding fields from IROAM. (right) Figure 2. Skills of IROAM simulation of ISO phase as measured by lag correlations of IROAM zonal wind at 850hPa onto the observed counterpart, both averaged in the box 10°N to 15°N, 130°W to 100°W. Data is taken from 1998-2003, all seasons.



is organized into two southwest-tilted bands, on the northwest flank of the Tehuantepec and Papagayo wind jets and collocated with the thermocline troughs. Wind fluctuations are important for eddy formation in the Gulf of Tehuantepec. When forced by satellite wind observations, the model reproduces the high-variance bands as well as the phase and offshore propagation of eddies off Tehuantepec. The Papagayo wind jet is significantly correlated with the global Madden-Julian Oscillation (MJO) while the MJO correlation is marginal for the Tehuantepec jet.

Roles of Ocean-Atmosphere-Land Interaction in Shaping Tropical Atlantic Variability and Toward Reducing Climate Model Biases in the Equatorial Atlantic and Adjacent Continents

P.I.: Shang-Ping Xie

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

NOAA Goal(s)

• To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

Tropical Atlantic variability affects the climate for the surrounding continents but its mechanisms remain unclear. The purpose of this project is to better understand the interaction of the ocean, atmosphere and land and its role in tropical Atlantic variability. The project will also identify the sources of and reduce errors in simulating tropical Atlantic climate.

Progress during FY 2010

Diagnosis of GFDL CM2.1 simulations confirmed the project's previous result based on multi-model analysis that the atmospheric model features large westerly biases in equatorial wind and that these wind biases lead to a



Figure 1. SST (shading), surface winds (vectors; m/s), and precipitation (contours; interval 1 mm/day) for (a) observations (ICOADS SST and surface winds, CMAP precipitation), (b) the difference between Control and the observations, (c) the difference between Control and an experiment in which equatorial surface wind stress is prescribed from climatology during MAM, and (d) the difference between Control and an experiment in which climatological surface wind stress is prescribed over the entire tropical Atlantic throughout the year (Richter et al., 2011).



Figure 2. Annual mean precipitation change (green/gray shade and white contours mm/month): (a) CM2.1 A1B ensemble mean along with SST change (color contours in °C), and (b) AM2.1 Cess+2K run along with mean precipitation (black contours at 100, 200, and 300 mm/month). Contour intervals for precipitation are 10 mm/month in (a), and 20 mm/month in (b). A wet-get-wetter pattern dominates with uniform SST warming (b) but precipitation change follows SST patterns when ocean and atmosphere are fully interactive (a).

development of the equatorial cold tongue in the following season that is too weak. Overriding experiments in collaboration with GFDL confirm this result (Richter et al., 2011).

Diagnosis of observations and a simulation with a realistic ocean GCM showed that a Benguela Niño off the southern African coast tends to precede the development of the Atlantic Niño, which is a warm event centered on the equator. Both events are related to the variability in the South Atlantic subtropical high and to their distinct seasonality.

Investigated the Gulf Stream's atmospheric effects with observations and an atmospheric GCM. The warm current's effect is most pronounced in convective precipitation (Kuwano-Yoshida et al., 2010), and is deeper in the vertical extent in summer than winter (Minobe et al., 2010).

Studied high correlation of spatial patterns between SST and precipitation changes. To first order, tropical rainfall increases where SST warming is above the tropical mean, and vice versa (Xie et al., 2010). In the subtropical North Atlantic, southwest-slanted banded structures dominate, associated with changes in the ventilation of spuriously strong mode water in the model. The spurious ventilation can be traced back to the biases in the simulation of the Gulf Stream and its northeastward extension, a common problem for ocean and coupled GCMs.

Tropical Meteorology

The JIMAR tropical meteorology theme developed in response to the move of the National Weather Service (NWS) Honolulu Forecast Office to the UH Campus. The move was associated with the modernization of the NWS and was motivated in part by the long history of interaction between the Honolulu Forecast Office and the UH Department of Meteorology. Interactions among faculty, students, and NWS staff have been excellent. NWS supports student research through the NWS Education Fund (supported by in-lieu-of-rent monies) and the NWS Pacific Region Fellowship Program. Interactions with the Pacific Region extend to climate service (see ENSO Applications discussion under the climate theme) and establishment of the Pacific Training Desk.

Development of Real-Time Precipitable Water Capability Using the Global Positioning System

P.I.: James H. Foster

NOAA Office (of the primary technical contact): Environmental Research Laboratory/Forecast Systems Laboratory

NOAA Goal(s)

· To serve society's needs for weather and water information

Purpose of the Project

The project objective is to maximize earth-based GPS resources and it has two primary tasks. The first is to develop, operate, and maintain the SkyNet network of GPS meteorology stations in Hawaii, upgrading equipment and processing approach as necessary. The second strand is to undertake research that can be applied to maximize the utility of GPS derived integrated precipitable water vapor data to the operational meteorological and climatological community.

Progress during FY 2010

The SkyNet network operated continuously during FY2010, with only minor outages, except for Oahu sites HWWJ and HWCC where long-standing problems have hampered operations. GPS processing software has been upgraded to the latest version and has successfully migrated to a new processing array in order to speed up the production of solutions. A new near-real-time processing approach has been implemented and is currently producing estimates of atmospheric delay every 15 minutes for 50+ GPS sites throughout Hawaii.



Time series of zenith neutral delay (ZND) from the twin geodetic GPS receivers newly installed on the University of Hawaii research vessel Kilo Moana from a segment of a 2010 cruise. The baseline distance to the reference station was >600 km, demonstrating greatly extended processing range capability.

The key reference site HILO located at the National Weather Service office in Hilo, collocated with their ASOS and radiosonde launch sites, has been decommissioned due to airport expansion. A replacement site HILR was constructed within the NWS compound and is now fully operational.

The GPS system on the University of Hawaii research vessel *Kilo Moana* has been upgraded to geodetic grade receivers. A sample of data was collected during a 2010 cruise and was successfully processed using kinematic processing techniques to demonstrate the possibility of obtaining near-real-time GPS meteorological solutions from the *Kilo Moana*.

National Weather Service Fellows

P.I.: Thomas A. Schroeder

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

NOAA Goal(s)

• To serve society's needs for weather and water information.

Purpose of the Project

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

Progress during FY 2010

Jessica Garza has refined her M.S. thesis topic and is progressing towards completion of her thesis this coming year. She is working with Professor Pao-Shin Chu of the Department of Meteorology.

National Weather Service International Pacific Training Desk

P.I.: Thomas A. Schroeder

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

NOAA Goal(s)

- To understand climate variability and change to enhance society's ability to plan and respond
- To serve society's needs for weather and water information

Purpose of the Project

The International Pacific Training Desk provides training in modern operational meteorology to interns selected from the Weather Services of nations with World Meteorological Organization Regional Association 5. The Honolulu National Weather Service Forecast Office hosts the interns. They attend various functions at the University of Hawaii Department of Meteorology, and are introduced to climate services provided by the JIMAR Pacific ENSO Applications Center. It is hoped that the training provided at the Pacific Desk will enable the participating countries to begin to issue their own forecast products, if they are not already doing so, and for others to upgrade their capabilities

Progress during FY 2010

Seven students have attended training at the Pacific International Desk in FY 2010 with four more to participate before end of the Fiscal Year. Procedures have changed so that now two students from one country are hosted at the same time. All students spend six weeks at the Honolulu National Weather Service Forecast Office, which is also the Central Pacific Hurricane Center and a Regional Specialized Meteorological Center (RSMC). At the end of FY 2010 the Pacific International Desk will have hosted 59 participants from 17 nations in the South Pacific and Southeast Asia since 2001.

Fisheries Oceanography

Fisheries oceanography has become the largest component of JIMAR. The program has three components: collaborative research with the Pacific Islands Fisheries Science Center (PIFSC) of the National Marine Fisheries Service (NMFS); collaborative research with the Pacific Environmental Group in Monterey, CA; and the Pelagic Fisheries Research Program (PFRP), managed by JIMAR in cooperation with the NMFS Southwest Fisheries Laboratory, La Jolla, CA and the Western Pacific Regional Fishery Management Council.

Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations

P.I.: Thomas A. Schroeder [Franklin B. Schwing]

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

NOAA Goal(s)

- To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management
- To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

The project's goals are (1) to describe the characteristic modes of variability in the North Pacific Ocean over interannual to decadal time scales. from analysis of historical data and numerical ocean model output, and to conduct research related to the application of *in situ* and satellite remote sensing data products for marine fisheries and other ocean users' requirements; and (2) to conduct research and provide satellite data in support of the emerging west coast regional associations (RAs) of the Integrated Ocean Observing System (IOOS). These research efforts are being undertaken to: a) improve understanding of marine environmental variability and its impacts on living marine resources; b) develop improved living marine resource assessment models; and c) apply satellite remote sensing technology to improve the management of economically and ecologically important marine resources

Progress during FY 2010

In addition to maintaining the existing data services, this project made progress in several areas during FY 2010.

• High Resolution Satellite Data Web Sites for Coastal Applications

As marine scientists increasingly focus on coastal issues, data providers are called upon to produce and distribute data sets capable of resolving the faster/smaller scales typical of the near-shore marine environment. In order to meet these needs, CoastWatch



Figure 1. Time vs. latitude diagrams for (a) spring transition index (Julian day), (b) length of upwelling season index (days), and (c) total upwelling magnitude index ($m^3 s^{-1} 100 m^{-1}$). Periods of strong El Niños (defined by multivariate ENSO index > 1.0) are marked (Bograd et al., 2009).

has developed a number of high-resolution, near-real-time data sets. These were enabled in time to address a number of harmful algal blooms events in the Pacific Northwest.

• An improved Cloudmask for Regional Sea Surface Temperature Retrievals

The project has entered the third stage in a collaborative attempt to generate high-quality sea surface temperature data for coastal applications. This included the development and testing of blended SST products that provide increased coverage and thus improved descriptions of the environment. Partners include the NOAA National Oceanographic Data Center and NASA's Jet Propulsion Laboratory.

• Improved web site for historical California fishery landings data

The project has re-designed and implemented significant improvements to a web site that enables access to location-specific landings data from California trawl fishery logbooks, while preserving the confidentiality of individual fisher's location and harvest. Queries for a region can be made by species or total landings. Once a query is made, the results are aggregated on the fly into monthly time series or yearly totals and only aggregations that follow the privacy policy are returned to the user.

• Climate variability in the California Current

The project continued to analyze the historical *in situ* atmospheric and oceanographic data, with the goal of describing and understanding variability in physical forcing in the California Current and relating this variability to observed ecosystem fluctuations. This work has focused on several projects: (a) an analysis of long-term trends in water properties (dissolved oxygen, inorganic nutrients) in the southern California Current, and implications for ecosystem structure; (b) a quantification of variability in the transport and properties of source waters to the California Current; (c) an analysis of variability in deep flushing of the Santa Barbara Basin; (d) an investigation of the magnitude and variability of cross-shelf property transports in the California Current using passive tracers in a high-resolution Regional Ocean Modeling System (ROMS) model; and (e) understanding variability in the amplitude and phasing of coastal upwelling in the California Current and its impacts on trophic match-mismatch dynamics (Fig. 1).



Figure 2. Top: two environmental predictors of blue whale movement behavior in the eastern North Pacific, distance from the coast (left) and remotely sensed sea-surface temperature (right), and NPMR model response to these two variables indicating a higher probability of 'area restricted search' behavior (an indicator of foraging) in areas with cool sea-surface temperatures (SST ~15°C) and small to intermediate distances from the continental shelf. From Palacios et al. (in prep).

• Blue whale movements and behavior in the eastern North Pacific

The project continued it's collaboration with Bruce Mate (Oregon State University) to conduct analyses of satellite-tracked blue whales in the eastern North Pacific. The project's focus has been on developing habitat models to predict whale movement behavior throughout their migration based on environmental variables obtained from remote sensing. The project used generalized additive models (GAMMs) as well as nonparametric multiplicative regression (NPMR) as the project's main modeling tools. The project's preliminary results indicate that blue whales increase their 'area restricted search' behavior (an indicator of foraging) in areas with cool seasurface temperatures (SST $\sim 15^{\circ}$ C) and at small distances from the continental shelf (Fig. 2). This ongoing effort will help us characterize the ecological niche of the endangered eastern North Pacific blue whale population.

Contribution, Linkages and Impacts of the Fisheries Sector to the Economies of Hawaii and Other U.S.-Affiliated Pacific Islands: An Extended Input-Output Analysis

P.I.: PingSun Leung and Minling Pan

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The goal of this research program is to assess the contribution, linkages, and impacts of the fisheries sector to the State of Hawaii and other U.S.-Affiliated Pacific Islands. The study will provide much needed up-to-date information on the economic importance and value of the various fisheries in Hawaii and other Pacific islands. For the first fiscal year, the following two specific objectives were sought.

- Update the economic Input-Output (I-O) analysis on Hawaii's fisheries based on the 2005 I-O model of the State economy and recent cost-earnings information.
- Extend the I-O analysis to a social accounting matrix framework to assess fisheries' economic impacts and their social impacts on fishing and other communities.

Progress during FY 2010

• Objective 1: Updating the 2005 Fishery I-O model

Approach Implemented: The fishery model was updated by extending the 2005 Hawaii State I-O table (prepared by DBEDT (2008)) with six decomposed fishery sub-sectors—tuna longline, swordfish/tuna longline, small commercial boat pelagic, small commercial boat non-pelagic, recreational, and charter fishery sectors. Each of these sectors was incorporated into the I-O table by making use of the best data available.

Tasks Completed: Appropriate sources of data were procured for each of the six fishery subsectors and were successfully integrated into the State's I-O.

• Objective 2: Extend the I-O analysis to a social accounting matrix (SAM) framework

Approach Implemented: The project extended the I-O analysis into a Fishery SAM model by integrating different socio-economic information into a unified and linked database. First, and most importantly, the 2005 Hawaii State I-O Model was used to provide information on the production activities, factor payments, and final demand aggregate accounts. The State I-O table served as the primary foundation of the SAM, in which all other accounts and information were linked and made to be consistent with this table. The State I-O includes production activity information for 68 accounts. One of these sectors is the commercial fishery sector that the project has decomposed into the six fishery sub-sectors. Second, data for the additional SAM accounts—value added and institution accounts—were retrieved from the 2006 IMPLAN data. This data yields the incomes of the various socioeconomic groups relying on household income and expenditure surveys. The 528 IMPLAN industry sectors were aggregated into the 68 industry sectors from the Hawaii State I-O model. To adjust the accounts to be consistent with 2005 Hawaii State I-O model accounts, the project relied on the purchase coefficients to relate it to the I-O output accounts. Third, to complete the income distribution mapping from the industry sector to the household sector the project made use of the 2006 Hawaii State Industry Occupational Matrix. The fully articulated SAM will consist of 97 separate accounts: 6 fishery subsectors; 67 non-fishery production sectors; 12

value added sectors; 4 endogenous household sectors; and 8 exogenous accounts (government, investment, and current/capital accounts).

Tasks Completed: The different socioeconomic databases have been assembled and successfully integrated and linked. A test balance of the SAM has been successfully implemented.

Pending Work: The project is currently reviewing the various databases for any possible further revisions that may be needed. After this is completed, the model will be used to conduct a comprehensive socio-economic examination of fisheries sectors' linkages and impacts in Hawaii. It should be noted that the project did not get underway until mid-September of 2009 when the project's project economist, Mr. Shawn Arita, was officially on board. In addition, there were unforeseen data problems with the cost-earning information of the longline fleet, which caused a slight delay in overall implementation of this objective.

Data Administration of Pelagic Fisheries Data

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Karen Sender]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

This project provides continued data administration support for PIFSC and PIRO scientists and data managers. The Hawaii Longline Observer Data System (LODS) is a complete suite of tools designed to collect, process, and manage quality fisheries data and information. Guided by the principles of the NOAA Data Quality Act, LODS is the result of the collaboration and cooperation of scientists, data collectors, and information management experts across the NOAA Fisheries Pacific Islands Region. This project also supports the development of the Hawaii Longline Logbook Data System (LLDS) leveraging tools and software modules designed and built for the LODS. On-going data administration support of LODS and the development of LLDS ensure efficient response to changing data collection requirements, consistent and documented data processing and data management, and secure and high quality data that is accessible to fisheries scientists and managers.

Progress during FY 2010

LODS was successfully upgraded in FY2010. The project team worked closely with the LODS data manager and steering committee to identify new system requirements. The major enhancement for this release was the ability to support an additional species code list. Additional work enabled required data translation and migration. The project team adopted the NMFS JIRA issues management (trouble ticket) tool to track all system defects and enhancement requests and to ensure rigorous development, testing, and migration to production requirements. Database and application server upgrades and patching were supported to meet security and maintenance requirements.

In FY2010, the project worked on the integrated LLDS enabled integration of Logbook, Observer (LODS), and catch landings data. Enhancements to the LLDS database structure and the design of a Logbook Permit History database have met new and critical reporting capabilities to support fisheries management. Data migration routines were developed to migrate data into LLDS. Development of a direct data entry application is, as yet, incomplete. Data management modules from LODS are completed and will be integrated into that application.
Fisheries Oceanography: Analysis on Bycatch by U.S. Pacific Islands Fisheries

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Christofer Boggs, Marti McCracken]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of this project is to estimate the bycatch in the NOAA Fisheries Service Pacific Islands Region. The project will compile existing estimates (mostly for protected species) and make rigorous new estimates of fish bycatch based on observer data for the fisheries that have an observer program. For other fisheries where data is less available, estimates will be based on any available sources including surveys, research fishing using similar gear types, and descriptive reports on these or similar fisheries. Extrapolations from limited observations or reports will be made using effort reported by the fisheries or estimated from monitoring of commercial landings. The adequacy of estimates and the type of data improvements required for reliable bycatch estimation will be evaluated and discussed in related reports.

Progress during FY 2010

The project produced sea turtle and seabird bycatch estimates for year 2009 and marine mammal bycatch estimates for years 2004-2008.

Fisheries Oceanography: Ecosystems Observation Research Program

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Michael P. Seki]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

This project monitors and conducts research on ecosystems that involve marine species and resources of concern to the Pacific Islands Region. The project activities enable scientists to provide scientific 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 specific activities include support for data management of the various ocean observing system inputs, biological and ecological sampling of species for use in studies to advance population assessment efforts, and support for advancing public awareness of marine ecosystems observations

Progress during FY 2010

Activities highlighting the project during FY 2010 include the following.

• Continued to conduct biological studies aimed at improving knowledge of life history parameters (e.g., age and growth, reproduction, etc.) with specific intentions to complement and improve ongoing population assessments of fishery resources. To this end, two biological technicians are supported to collect life history information of commercially important bottomfish species and biological samples for age and growth and reproduction studies. Routine sampling at the commercial fish auction has been conducted to support the size- and age-based monitoring of the landed catches. This year's efforts also took the project to Guam and Saipan where they participated in a workshop to train local staff techniques on proper techniques and procedures for recording fish measures and the extraction of otoliths and gonads for life history studies.

• Supported the PIFSC geographic information systems (GIS) capabilities through the development and implementation of procedures, programs, models, and interfaces to manage, catalogue, document, access, and distribute geo-referenced data products generated by PIFSC. Customized web-based applications using ArcGIS for the display and distribution of the spatial information repository to support project managers and scientists were developed. Built up the Hawaii bottomfish geo-database for spatial resource management and critical habitat assessments.

• Supported graduate student's analysis of geographic trends in catch versus value of the Hawaii bigeye tuna longline fishery. A spatial (GIS) application was employed to look at catch and catch per unit of effort (CPUE) of bigeye tuna from logbooks; and weight, economic value, and size frequency distributions from dealer reports. The analysis revealed an increase in the spatial distribution of effort and catch with a corresponding distribution of weight and value of bigeye tuna. The vast majority of effort, catch, weight, and value is concentrated around the main Hawaiian Islands, but that has declined throughout the years as fishers have been willing to travel further away to fish.

Fisheries Oceanography: Methods Aimed to Reduce Sea Turtle-Longline Interactions: Tests of Modified Baits and Fishing Gear

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Yonat Swimmer]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of the project is to conduct research in the area of sea turtle bycatch reduction through experimental longline field trials. Specifically, this work aims to provide the logistical, scientific, and/or the financial support to collaborators to conduct at-sea trials of experimental longline fishing gear to test capture rates of both target (fish) species and incidentally caught bycatch species such as sea turtles.

Progress during FY 2010

To date, the project's field trials have compared over 1 million traditional vs. experimental hooks in Italy, Brazil, Uruguay, Costa Rica, Spain, Vietnam and Indonesia. In each location, the project's work has shown that



use of relatively large circle hooks reduces (by varying degrees) the incidental capture of sea turtles in fisheries. Furthermore, their use has also been shown to significantly increase capture rates of tuna (Thunnus spp.). Capture of billfish, primarily swordfish, has been shown to be slightly reduced on circle hooks compared to traditional hooks, and this may reduce the economic viability of this hook in certain fisheries. The data also suggest that the capture of pelagic rays is also greatly diminished by the use of circle hooks in relation to traditional J hooks, which has been instrumental in encouraging local fishers to adopt use of circle hooks in the fisheries. There is some concern, however, that use of circle hooks results in higher capture rate of sharks, and this is a concern that will be addressed in the near future. In the past year, the project initiated field trials of circle hooks in Vietnam. Additionally, the project began trials of a "release" hook in Costa Rica, and the project looks forward to evaluating these data in the near future to determine their potential use to promote safe release of turtles in longline gear.

Figure 1. Swordfish captured in a Spanish longline fishery during experimental field trials with circle hooks. Photo credit: Y. Swimmer

The work involved contracting a statistician to help with a metadata analysis that will allow for robust sample size enabling researchers to differentiate the relative influences of variables such as hook shape and size on rates of capture of sea turtles, sharks, as well as target species. All of the data has been entered into an Access Database that is publicly available and posted on the NOAA bycatch web site.

Figure 2. Loggerhead sea turtle caught in longline fishing gear in Spain. Photo credit: Y. Swimmer



Fisheries Oceanography: Protected Species Research Program

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Frank Parrish, Charles Littnan, Erin Oleson]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of the Protected Species Research Program is to study the relationship between environmental/ oceanographic parameters and population biology of the Hawaiian monk seal and all cetacean species in the Pacific Islands region, develop strategies to mitigate causes of mortality to enhance the recovery of the monk seal, identify and determine status and trends of cetacean stocks, and develop strategies to reduce fisheries bycatch.

Progress during FY 2010

• Hawaiian Monk Seal Research Program (HMSRP):

Activities undertaken by the HMSRP included population monitoring and assessment, characterization of foraging ecology, and evaluation of health and disease. In 2010, the project's program is partway through conducting annual

field camps in the Northwestern Hawaiian Islands (NWHI). Researchers are collecting valuable population information, tagging seals for long-term identification, assisting in marine debris collection, documenting and mitigating mortality by aggressive males, and mitigating shark predation on pre-weaned pups. Additional activities in 2010 included the completion of an over-winter camp at Laysan Island, where a trial study to determine the benefits of treating young seals for parasitic worms was conducted. All seals age 0 to 3 yr old were randomly assigned to either treatment or control groups. The survival, parasite load and body mass changes of treated and control

Figure 1. 2010 Monk Seal observation in the NWHI.



animals were measured and results are currently being analyzed. During the Laysan camp, standard population monitoring was conducted as well. In 2008 and 2009, 12 weaned monk seals were translocated from French Frigate Shoals to Nihoa Island. The subsequent survival of these translocated seals as well as natives of Nihoa was evaluated through visual observations.

Monk seal assessment, foraging and habitat use studies in the Main Hawaiian Islands (MHI) continued in FY 2010 through the efforts of a full time sightings coordinator, seasonal field technicians and a cadre of responders collecting data whenever seals were reported in the MHI. In FY 2010 a focused field effort in the MHI was completed with two researchers searching shorelines of the most accessible MHI. In addition, surveys of Lehua Rock and Kahoolawe were also conducted in collaboration with State institutions. Diet and movement patterns of seals in the MHI were advanced through identification of hard parts, analysis of past seal telemetry records, and deployment of state-of-the-art GPS cell phone tags in the MHI. The HMSRP is using these data to support critical habitat re-designation for the monk seal under ESA. The Health and Disease program continued to train field technicians in sample collection and managed the disposition of a large number of biomedical samples accumulated through regular field camps, the de-worming study, and MHI epidemiological sampling.

• Cetacean Research Program (CRP)

During the FY 2010 the Cetacean Research Program conducted both small boat and large ship surveys to collect photo, biopsy, and acoustic data from cetaceans within Hawaii and the Pacific Islands region for ongoing population studies. In October 2009, the CRP conducted small boat surveys off the coast of O'ahu. Over 1900 km were surveyed over 15 days (Fig. 2). Approximately 29,000 photos and 30 biopsy samples were collected during 46 encounters with 11 cetacean species. In addition, five satellite tags were deployed on false killer whales to investigate the large-scale movements of individuals within the insular population. In February and March of 2010, the CRP conducted small boat surveys in the nearshore waters of Guam and Saipan. During 16 days of surveys, the CRP covered 384 km of trackline and encountered 18 groups of four cetacean species. Approximately 4000 photos and 15 biopsy samples were collected.

In the early months of 2010 (January-May), the CRP conducted three large ship surveys aboard the R/V *Oscar Elton Sette*. The first survey was conducted during the *Sette*'s transit from Oahu to Guam (January 26-February 8).



Figure 2. In 2009, CRP surveyed over 1900 km over 15 days by small boat survey off the coast of O'ahu.

The second was conducted during an Ecosystem Observation Division cruise in the waters of the Commonwealth of the Northern Mariana Islands (March 20-April 11). The third was conducted during the *Sette*'s return transit from Guam to Oahu. During a total of 50 days of effort the projects of visual observers searched for cetaceans using "big-eye" 25-power binoculars covering a total of 1914 km. The projects recorded 54 sightings of 14 species and obtained photo-identification and biopsy samples for investigation into the stock structure of local cetaceans. During the two transit legs, a towed hydrophone array was monitored for acoustic detections of vocal cetacean groups for future comparison of vocalization types by species and for eventual calibration of visual versus acoustic detection rates. In addition, a High-Frequency Acoustic Recording Packages (HARP) was deployed off Wake Island during the first transit leg and was recovered during the second transit leg. Another HARP was then deployed at an adjacent location during the second transit leg. It will remain there until 2011 for long-term continuous recording of cetacean occurrence at Wake Island.

The CRP has also maintained HARPs for long-term continuous recording of cetacean occurrence off the Kona coast of the Island of Hawaii, Kauai, Palmyra Atoll, and Pearl and Hermes Reef in the Northwest Hawaiian Islands. Results of these monitoring efforts will provide detailed accounts of the seasonal and diel behavior of cetaceans in these locations.

A fine-scale integrated visual and acoustic study of beaked whales and other deep-diving odontocetes off the Kona coast of the Island of Hawaii in coordination with Scripps Floating Instrument Platform (FLIP) was planned for October 2009. However, a change in the transportation schedule of the FLIP prevented the execution of the study.

Marine Resource Dynamics and Assessment Program (MARDAP): Cooperative Research

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Michael K. Musyl, Christofer H. Boggs]

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

NOAA Goal(s)

 To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The project was originally funded to instigate and coordinate cooperative research between NOAA Fisheries Service scientists and the fishing industry, fishery managers, and academic researchers by encouraging collaboration, improving communication, and using the fishermen's expertise and

Figure 1. Fishing depth and habitat depth of the blue shark in the Central Pacific. Percentage time at depth for free ranging blue sharks during daytime (upper panel) and nighttime (lower panel) excursions (identified by pop-up satellite archival tags [PSATs] that are depicted by horizontal bars) correlated with nominal catch-perunit-effort (CPUE) (data from the Pacific Islands Regional Observer Program) for the Hawaii-based commercial longline fishery. Catch was standardized as number of blue sharks caught per 1000 hooks. Nominal CPUE was calculated for 20 m depth bins by using temperature-



depth recorders (TDRs) attached to monitored longline sets in the nadir (deepest) position on "baskets" (i.e., hooks between suspended floats comprise a basket or section of the longline). The first and last 30 min of TDR data were truncated to allow for settling and retrieval of the baskets. Deep daytime sets (140 sets, n = 908 blue sharks captured) targeted bigeye and yellowfin tuna (Thunnus obesus and T. albacares) and shallow nighttime sets (178 sets, n = 5,589 blue sharks captured) targeted swordfish, Xiphias gladius. Correlation of daytime and nighttime depth distribution patterns with CPUE were highly significant (daytime, r = 0.61, P << 0.001; nighttime, r = 0.62, P << 0.001) (Musyl et al., in prep).



Figure 2. Box and whisker plots showing daytime and nighttime depth and temperature preferences among pelagic species in the Central Pacific as identified by pop-up satellite archival tags (PSATs). The "box" represents the inter-quartile range where the position of the mean (bold, horizontal line) and median (thin, horizontal line) are provided; "whiskers" represent the $10-90^{th}$ deciles. M=male and F=female (Musyl et al., in prep).

vessels to answer scientific questions of immediate importance to industry and managers. In 2004 funds were added specifically to research marlin bycatch reduction in the Hawaii tuna longline fishery with funding provided by the Reducing Bycatch Program of NOAA.

Current commercial tuna longline setting techniques were altered to test a method developed by the South Pacific Commission (SPC) to eliminate all shallow set hooks (less than 100 m depth) from tuna longline sets. By eliminating all shallow set hooks, researchers hoped to maximize target catch of deeper dwelling species such as bigeye tuna, reduce the bycatch of turtles and other protected species, and reduce the incidental catch of many other non-target but marketable species (e.g., billfish and sharks).

Progress during FY 2010

The general overall results of the project were published in the peer-reviewed literature (Beverly et al., 2009).

Marine Resource Dynamics and Assessment Program (MARDAP): Economics of Fisheries Initiative

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Minling Pan]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

This research project, initiated in July 2000, focuses on economic assessments of commercial and recreational fisheries in Pacific Island areas.

Progress during FY 2010

This well-established project continued to successfully assess and monitor changes in key economic indicators in the Hawaii-based and America Samoa longline fisheries. In addition, in FY 2010, the project successfully launched two new research projects: 1) the Main Hawaiian Islands (MHI) bottomfish fisheries economic study; and 2) the seafood preference study on wild caught versus aquaculture/farmed

products. economic study achieved a response rate of one of the survey sites 45.6% (223 out of 489) by active fishermen.



The MHI bottomfish fisheries A seafood preferences survey was conducted in front of Times Supermarket,

The seafood preference study has collected 176 samples. These data provided a sufficient sample size for the project to conduct further economic analysis on these subjects.

Marine Resource Dynamics and Assessment Program (MARDAP): Research Support

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Susan Kamei]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

This project supports the continuation of administrative and facilities support for research activities as part of the ongoing research under the Marine Resource Dynamics and Assessment Program (MARDAP). Project funds support on-going research operations conducted at the Pacific Islands Fisheries Science Center on the University of Hawaii campus, the Aiea Heights research facility, and the Kewalo Research Facility.

Progress during FY 2010

The maintenance assistant continued to provide facilities and maintenance support including basic carpentry, plumbing, and general upkeep of facilities. In addition, the maintenance assistant coordinated the office moves for various programs. Work plans were executed as originally programmed for the maintenance assistant.

The administrative specialist supported by this award continued to perform a wide array of duties in support of research staff including travel coordination and administration, property administration, procurement, personnel tracking and security in-processing, and general correspondence and office administration. The incumbent left JIMAR employment as of October 2009 to pursue a federal career path. A backfill for this position was not requested as it was determined that workload could be sustained using existing administrative staff. Unused funds originally programmed for this position were used to offset the FY 2010 budget request for research support activities.

Marine Resource Dynamics and Assessment Program (MARDAP): Research Support— Fisheries Data Monitoring

P.I.: Thomas A. Schroeder [David Hamm]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of this project is to provide the Pacific Islands Fishery Science Center with fishery data monitoring and technical assistance in support of research operations. The project provides current data and information on the Hawaii Federal Fishery Management Plan (FMP). It also provides the fishing industry with a point of contact for feedback and information exchange with fishery scientists and managers.

Progress during FY 2010

Dr. William A. Walsh, with funding from the Pelagic Fisheries Research Program (PFRP), provided significant research support to the Fishery Monitoring and Analysis Program during FY 2009. He completed a quantitative description of the entire shark catch as reported by fisheries observers. The results have been published in *Marine and Coastal Fisheries*, an online, peer-reviewed journal of the American Fisheries Society. The most important conclusion was that the Hawaii-based pelagic longline fishery has made substantial progress in reducing shark mortality. The results are noteworthy because in contrast to previously described significant decrease in nominal CPUE these models indicate that there has been no significant decrease in standardized CPUE during the last 15 years (1995-2009) in the deep set fishery, suggesting that the decrease in nominal CPUE was primarily attributable to changes in fishing locales and probably did not reflect diminished stock size such as might have resulted from localized depletion.

Shark species management is now and will continue to be a focus at the state, federal, and international levels. The published paper provides a basis for the presentation to the International Scientific Committee (ISC) for Tuna and Tuna-like Species in the North Pacific Ocean, which will be planning stock assessments for Pacific sharks.

An additional series of analyses on standardizations of CPUE is on course to be completed during FY 2011. The standardization of blue shark CPUE and the standardized catch rates for the five common shark species (i.e., those that comprised at least 1% of the shark catch) in the deep set fishery will cover 95% of the shark bycatch in this fishery.

JIMAR Fisheries Specialist Walter Machado continues to provide a high level of support to fishery monitoring activities by ensuring that timely, high quality data are available to JIMAR, NMFS, and non-agency researchers. He also assists with information exchange between the fishing industry and Federal and State management agencies and individuals. In addition to conducting daily rounds to local docks to collect log books, Machado assisted with the installation of a Federal longline logbook drop box located within the United Fishing Agency facility to enhance the fishermen's ability to submit logbooks in a timely manner. He also helps fast-track appropriate logbooks and completes a detailed compliance review with reporting protocols for each logbook received. This logistical support for fast-tracking, monitoring, and reporting helps NOAA and the Dept. of Commerce fulfill international obligations of the U.S. and effectively manage the fishery.

JIMAR Bigeye Tuna DB Assistant Michael Abundo provides much needed additional real time monitoring support to successfully complete the requirement of monitoring the catches of pelagic tuna species to fulfill the U.S. obligations to international management initiatives. Abundo has positively contributed to this effort through providing the major effort in the fast tracking of the collected longline logbook information. Additionally he participates in the collection and compliance review of the logbooks as well as creating and maintaining a photographic database of permitted Hawaii longline vessels.

Logbook collection for the Pacific Remote Island Area (PRIA) has also become increasingly important because the Regional Office has issued additional federal permits for those areas. Recent establishment of larger Marine

National Monument boundaries around each PRIA and increased permit issuance could mean increased long distance logbook collection activity as well.

The scanning and archiving project seeks to preserve the longline logbook data and allow more efficient access to historical logbook pages by managers and researchers. The assistance of Nao Abe, Heather Omori, and Joanie Wong, halftime scanners hired via JIMAR, has allowed the project to complete eight years of archival longline logbook scanning. Online logbook viewing capability will be a key aspect of data quality control and will enhance fast-tracking efficiency. Machado is tasked with the day-to-day supervision of this work.

Increased international management (Inter-American Tropical Tuna Commission and Western and Central Pacific Fisheries Commission) of highly migratory tuna species has made timely reporting even more vital to research and management, as well as industry compliance. Support via this project helps enable the best possible catch monitoring, forecasting, and quota management activity, which provides real-time data to support forecasting of existing catch limits and also helps modeling and research to more accurately reflect the dynamics of the fishery.

Marine Resource Dynamics and Assessment Program (MARDAP): Research Support SIS

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Jerry Wetherall]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

Provide technical web services, scientific editorial services, and scientific information services to research staff at the Pacific Islands Fisheries Science Center (PIFSC).

Progress during FY 2010

• Web Services: The new webmaster maintained and improved both functionality and contents of the web site, including presentation of research contributions by JIMAR scientists in the Center's research divisions. Web applications were developed to support interaction with Web visitors; these will be implemented on the new web server later in 2010. The online Quarterly Research Bulletin was enhanced. A web site overhaul was begun, and design templates were created that improve Web site navigation and delivery of key content. The webmaster continued to ensure compliance with NOAA web standards. To enhance the value of the web site for education and outreach, particular attention was given to presenting technical material in plain English to make it more accessible to lay readers.

Scientific Editing: The scientific editor continued to provide comprehensive professional editing services to scientific staff enabling timely submission of manuscripts by JIMAR scientists to peer-reviewed journals and production of in-house technical reports. She continued to work with the JIMAR scientific editor in the Coral Reef Ecosystem Division to ensure the continued development of best practices on scientific style for their publications. She improved the quality and appearance of the Technical Memoranda. She provided key design and editing expertise to JIMAR staff on a marine debris publication for Hawaii public education and outreach. She created the 2009 Annual Report using Adobe InDesign. Adoption of an online manuscript processing system was canceled, as development of the Ruby-on-Rails software was halted when the previous webmaster resigned.
Scientific Information: The scientific information specialist continued to provide technical support to the Scientific Information Services group on various aspects of data services, including support of PIFSC-affiliated JIMAR scientists. He recruited, trained, and guided UH student staff that review, enter, and verify confidential commercial fishery statistics for input to an Oracle database. He procured a software security dongle to ensure continued availability of the legacy Rode-PC data entry software used by the group. He took online training to develop skills in Drupal and other software tools to enhance management of metadata for research data collections,

including those of JIMAR.

Marine Resource Dynamics and Assessment Program (MARDAP): Sociocultural Profile of Pacific Islands Region Fishing Ports

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Stewart Allen]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of this project is to develop sociocultural fishing community profiles at the island scale for the Pacific Islands Region. These profiles have identified a number of social science information needs at finer scales, such as the village or community scale. Collecting and applying socioeconomic information at these scales will be increasingly important as the Western Pacific Regional Fishery Management Council adopts an ecosystem-based approach to managing fisheries in the region; a key aspect of this approach is an increasing reliance on management by or in collaboration with communities. This project provides communities and others with the capability to identify and meet their own social science information needs by developing a core set of training materials on how to identify socioeconomic information needs, collect information, and apply it to local and regional decisions regarding fishing and management of coastal and marine ecosystems. The materials are designed to be flexible enough to be applied in a variety of community settings and for a variety of projects, yet retain a systematic approach to ensure that the results are valid, reliable, and useful.

Progress during FY 2010

An outline for the project identified 11 modules to be developed. The modules are: why do socioeconomic assessment and monitoring; preparing for socioeconomic assessment and monitoring; defining assessment objectives; site selection; stakeholder consultation; determining appropriate indicators; data collection methods and considerations (surveys, key informant interviews, focus group, participant observation, secondary data collection, ethical issues); sampling; data analysis; communication of results; and using results for adaptive management. Each module consists of a Powerpoint presentation template and an associated notes page to guide the trainer through the training process. Some of the modules incorporate one or more worksheets to be completed by training participants. To date, three training modules have been completed and an annotated outline has been completed for the remaining eight.

Marine Resource Dynamics and Assessment Program (MARDAP): Stock Assessment Research Program

P.I: Thomas A. Schroeder [Samuel G. Pooley, Gerard DiNardo]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The goals of this program are to: (1) assess the status of pelagic stocks in the Pacific Ocean; (2) assess the status of insular resources in the Pacific Islands Region (e.g., bottomfish); and (3) assess the impact of fishing on these stocks. During technical reviews of Northwestern Hawaiian Island (NWHI) insular resource assessment procedures, it was recommended that collaborative research programs between the industry, the PIFSC, and the University of Hawaii (UH) be developed. These programs will provide independent estimates of population size, generate updated estimates of population dynamics, further the project's understanding of the ecological role of insular resources in NWHI ecosystem, and advance insular stock assessment methodologies in the Pacific Islands Region (PIR). Technical reviews of pelagic stock assessment procedures resulted in similar recommendations,



Participants at the April 2010 ISC Billfish Working Group Workshop, ISC Billfish Working Group: (left to right) Shino Kitamura, Gary Sakagawa, Lyn Wagatsuma, Gakushi Ishimura, Minoru Kanaiwa, Jon Brodziak, Kotaro Yokawa, Saori Matsuda, Dean Courtney, Su-Zan Yeh, Kevin Piner, Chi-Lu Sun, Ai Kimoto, Michael Hinton, Yutaka Watanuki, Ikuko Kobayashi, Gerard DiNardo, Eri Ooka, and Natsumi Kamatani.

with an eye on broadening potential collaborators to address Pacific-wide issues. Currently, PIFSC conducts assessments of pelagic fish stocks in the Pacific Ocean collaboratively with scientists from Japan, Taiwan, Korea, China, Mexico, and the Inter-American-Tropical-Tuna-Commission (IATTC) under the auspices of the International Scientific Committee (ISC). Priority is given to billfish and oceanic shark species in the Pacific Ocean, including marlins and swordfish, as well as blue, oceanic whitetip, silky, and thresher sharks.

Progress during FY 2010

The JIMAR FY 2009 annual report outlined four goals for FY 2010, including: (1) implementation of a fisheryindependent pilot survey that combines biological data collection and tagging programs for bottomfish in the Main Hawaiian Islands (MHI); (2) conducting the NWHI lobster resource survey in June 2010 with the collection of bottomfish samples to re-estimate biological parameters (e.g., growth); (3) planning and participation in three ISC Billfish Working Group workshops; and (4) advancing stock assessment methodologies for pelagic species in the North Pacific ocean and insular species in the PIR.

Of the goals articulated, the following were accomplished.

• Implementation of a fishery-independent pilot survey for bottomfish stocks in the Main Hawaiian Islands. The development of a PIR fishery-independent survey for bottomfish is recognized as a high priority among regional fishery managers and scientists. This is a multiyear project. Data from the survey will be used to determine optimal gear, sample sizes, and number of vessels needed to implement fishery-independent surveys in the Hawaiian Archipelago, Guam, CNMI, and American Samoa. Data from the tagging study will provide growth and movement data to advance the development of species-specific models. The collected biological samples will allow for the estimation of contemporary age and growth parameters. A local vendor was successfully contracted to implement all aspects of the cooperative research with significant support from JIMAR staff. Results to date include the completion of eight fishing trips aboard local fishing vessels to collect requisite data for assessing the feasibility of a fishery independent bottomfish survey, collection of 50 biological samples to advance bottomfish age and growth research, and completion of three outreach sessions with local constituents. In addition, seven fishermen were contracted to conduct tagging operations in the Main Hawaiian Islands and 1300 bottomfish (snappers) were tagged and released; a total of 18 fish were recaptured. A final report describing the results of year 1 will be completed by September 2010.

• Planning and participation in three ISC Billfish Working Group workshops. Three ISC Billfish Working group workshops were convened in FY 2010 with significant support from JIMAR staff. The main goal of the

November 30-December 4, 2010 workshop was to develop plausible stock structure scenarios for striped marlin in the North Pacific for use in stock assessments. Other goals include reviewing the status of the North Pacific swordfish assessment using Stock Synthesis 3 (SS3), attending the blue marlin symposium, and conducting billfish economic research. At the April 15-22, 2010 workshop the goals were to: (1) finalize reviews of the North Pacific swordfish stock assessment using SS3 and Bayesian production models; (2) delineate striped marlin stock boundaries; and (3) identify potential billfish biological reference points (BRP). At the July 12-13, 2010 workshop potential billfish BRP will be finalized. Workshop reports have been finalized and submitted to the ISC Plenary for review and adoption.

• Advancing stock assessment methodologies for pelagic species in the North Pacific Ocean and insular species in the PIR. Numerous stock assessments were completed with assistance from JIMAR staff, and significant progress on population model development also occurred in FY 2009. A spatially explicit population model was developed for swordfish stocks in the North Pacific Ocean in collaboration with scientists from Japan, Korea, Mexico, Taiwan, China, and PIFSC. Eric Fletcher and Lyn Wagatsuma provided analytical support (i.e., data manipulation, computer programming, and graphical analyses) for the swordfish assessment. An improved spatially structured population model was developed for deep-slope bottomfish stocks in the Hawaiian archipelago and an updated stock assessment conducted by Fletcher and Wagatsuma also provided analytical support for the bottomfish assessment. In addition, Dr. Shelley Clarke (formerly with JIMAR) along with scientists from PIFSC, Imperial College London, and Japan completed a North Pacific blue shark stock assessment.

• *NWHI lobster resource survey*. The NWHI lobster resource survey was not conducted in FY 2010 due to scheduling conflicts with the *R/V Oscar Elton Sette*.

Marine Resource Dynamics and Assessment Program (MARDAP): Western Pacific Stock Assessment Review Process

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Gerard DiNardo]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The Western Pacific Stock Assessment Review (WPSAR) process is intended to improve the quality and reliability of stock assessments conducted by NMFS Pacific Islands Fisheries Science Center (PIFSC) scientists, by ensuring rigorous and independent scientific review of completed assessments. WPSAR is a collaborative program between the NMFS PIFSC and Pacific Islands Regional Office (PIRO), the Western Pacific Regional Fisheries Management Council (WPRFMC), and JIMAR.

Progress during FY 2010

In July 2009, the utility and scientific advice of the recent Hawaiian Archipelago bottomfish stock assessment (Brodziak et al., 2009) was assessed using the WPSAR process. The results of the review were presented at the October 2009 meeting of the WPRFMC in Honolulu, Hawaii.

Marine Turtle Conservation and Management Initiative

P.I.: Thomas A. Schroeder [Charles Karnella]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

In many coastal and island communities in the Pacific marine turtles have long been used as a food source and play important cultural roles in the lives of the inhabitants. Six marine turtles species—green, hawksbill, olive ridley, leatherback, loggerhead, and flatback turtles—inhabit the Pacific, especially the marine areas of Melanesia. This is an area of growing commercial fishing fleets, specifically using longline and purse seine gear types. The purpose of this project is to introduce fishermen, fishery administrators, policy makers, and other relevant stakeholders to information and materials designed to increase the opportunities for survival by marine turtles that might be captured during the course of pelagic fishing operations in the exclusive economic zones of New Caledonia (this action will augment NOAA Fisheries supported marine turtle conservation activities already underway in Papua New Guinea, Indonesia, and future activities possibly in Solomon Islands).

Progress during FY 2010

New Caledonia Sea Turtle-Fisheries Interaction Outreach Education Project

The extension agent continued education-outreach activities to provide information to the public about the three species of sea turtles occurring in New Caledonia. Outreach efforts continued at the Aquarium de Nouméa, and Aquarium staff continued to visit and provide outreach at village sponsored fairs. Awareness and outreach activities developed at the Aquarium de Nouméa include a public sea turtle oral presentation and quiz, with additional activities for school groups. Approximately 611 students participated in these activities this fiscal year. A sea turtle exhibition was created that includes 16 tarps, 8 screens with videos and interactive games. The exhibition was inaugurated in early January 2010 and ran through April 2010. A WWF film regarding marine turtles in New Caledonia, followed by a quiz, is presented every open day at the Aquarium. A turtle feeding session occurs on Wednesdays at 3 p.m. and a general announcement goes over the loudspeaker for Aquarium visitors to gather and be guided to outdoor turtle tanks where they are educated on turtle biology and answer questions while the turtles are being fed. Outreach materials (poster boards and panels) depicting sea turtle life cycle, habitats, and threats were developed. Aquarium staff use these materials to visit and provide outreach at 12 village sponsored fairs, which were attended by over 1070 people. These public education and outreach items are of a high quality that attracts the public and are easy to understand. At these fairs, children also learn about turtles by coloring turtle pictures that are then proudly displayed. A turtle conservation workshop was convened under Northern Province authority from March 26-27. Topics covered included the significance of turtles in the Melanesian culture, including their role in traditional ceremonies, because all conservation messages have to be channeled through customary chiefs if community participation is desired. All presentations and discussions were filmed and a DVD will be released shortly.

Mesophotic Reef Ecosystems of Hawaii's Au'au Channel

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Jeffrey J. Polovina, Frank Parrish]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of PIFSC three-year mesophotic coral study is to characterize the poorly known coral ecosystems that occur at the deep edge of photosynthesis. This work is part of a three-year-long collaboration with the Bishop Museum, University of Hawaii, and Hawaii Department of Land and Natural Resources funded by NOAA's Coral Reef Ecosystem Studies Program. This work involves surveying the seafloor between depths of 50 and 150 meters to identify the location and the nature of patches of *Leptoseris* coral spp. in the Auau Channel. Of special interest are the distribution of the coral, nature of the bottom habitat, environmental conditions, and fish associations. The data will be collected on a number of research cruises using equipment such as remote cameras, submersibles, and hydroacoustics.



Figure 1. Launch of the Hawaii Undersea Research Laboratory's Pisces IV submersible from the University of Hawaii vessel RV Kaimikai-o-Kanaloa.



Figure 2. A Leptoseris spp. coral colony that was mark for growth studies.

Progress during FY 2010

• June 11-18, 2009 small craft work off the island of Kauai

Collaborated with the Division of Aquatic Resources on a weeklong mixed-gas diving operation to study the mesophotic reefs of Kauai. Surveys were conducted and data loggers placed in the patches of *Leptoseris* spp. discovered a year earlier during one of the submersible dives.

• July 24-August 2, 2009 Cruise to Auau Channel

A ten-day research cruise (7/24/09-8/2/09) on the NOAA ship *Hi'ialakai* was conducted to continue studies of the mesophotic reefs of the Auau Channel. This cruise was originally planned for the NOAA vessel *Oscar Elton Sette* but mechanical problems prevented its use. Participants included researchers from NOAA Fisheries and the University of Hawaii. The emphasis of this cruise was as follows.

- 1) To recover and redeploy instruments originally deployed in 2008.
- 2) To make mixed gas dives to survey different mesophotic coral and fish assemblages.
- 3) To conduct remote camera surveys to document the mesophotic reef complex.
- 4) To perform conductivity, temperature, and depth casts in the solution basin adjacent to mesophotic coral site.
- 5) To deploy archival video drop-cameras to survey fish assemblages.

There had been plans to use hydroacoustic transects to tow nets through the scattering layer but the *Hi'ialakai* had no fishery acoustic system to survey with and the data from the previous years acoustic survey on the *Sette* had failed to identify a scattering layer during the day or night so this project was discontinued.

• January 11-17, 2010 Cruise to Auau Channel

A seven day research cruise using the University of Hawaii's *Kaimikai-o-Kanaloa* (*K-o-K*) with the Hawaii Undersea Research Laboratory *Pisces* submersible was conducted in the Auau Channel from January 11-17, 2010. Participants included scientists from University of Hawaii, State Division of Aquatic Resources, and NOAA Fisheries. These dives provided additional benthic transect data to be analyzed along with the data from previous cruises. Many samples were collected for analysis including corals, algae, benthic invertebrates, and fish. The samples were shared among investigators for identification, isotopic analysis, genetic studies, and life history observations. One of the more notable samples was the collection of the *Leptoseris* spp. colony that had been marked with tetracycline in April 2008 to measure its growth rate.

In addition to the submersible dives, remotely operated vehicle (ROV) dives were made to better understand the spatial distribution of benthic communities. These transects using the ROV's high resolution camera improves taxonomic identifications and compliments the remote camera surveys conducted from the NOAA vessels, which cover a greater area because of more days at sea.

Pacific Islands Monitoring and Sampling Program

P.I.: Thomas A. Schroeder [David Hamm]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The project is a series of pilot Commercial Fisheries Biosampling (CFBS) studies at three island areas in the Pacific Region including Guam, the Commonwealth of the Northern Marianas Islands (CNMI), and American Samoa. Generalized methodology is being developed and adapted to the unique characteristics of each area's fisheries with the goal of eventually forming an integrated program for the Pacific Region. While ensuring standardization of laboratory techniques and analysis for the region, field logistics must be tailored to the features of each area's fisheries (i.e., differences in demographics, transportation, customs and existing or developing infrastructure, existence/nonexistence of centralized markets, etc.).

Program objectives are to provide the necessary stock identity, age, growth, spawning, life history and lengthat-age, and length-frequency data needed for sustainable management of key commercial fish stocks in Pacific Islands Areas through a systematic sampling of whole catches from key fisheries. The Reauthorized Magnuson-Stevens Act points towards increasing data requirements to understand geographic and genetic boundaries of stocks and support assessment of Allowable Catch Limits (ACLs). The intent of the CFBS is to develop field and laboratory techniques for sampling life history information, determining stock structure, and documenting and verifying taxonomic and genetic characteristics with regional logistics and methods that can be implemented on a larger scale.

Progress during FY 2010

Significant progress has been made in Guam, where a full-time JIMAR CFBS biologist has been hired (October 2009) and living on Guam (since November 2009). Eric Cruz is well established and has been able to sample length-weight data consistently (3-5 days a week) at the central fish processing center, the Guam Fishermen's Co-op (the "Coop"). An excellent working relationship has been formed and the Coop provides space and allows Cruz to sample catches as they arrive. Length and weight data are routinely collected there on variable numbers of up to 100 commercial species, depending upon the composition of incoming catches.

Gonads and otoliths have been removed from a few specimens opportunistically, but these have been limited to deep snappers and Napoleon wrasses, because they are not sold whole. Work is ongoing to improve techniques for removing otoliths with the least damage to fish, so they remain marketable. The ease of doing so varies with species. Priority species for length-and-weight frequency, and eventually length-at-age and growth analysis, will be determined in collaboration with PIFSC scientists based on their consistency and frequency in catches and the need for research. Obstacles encountered are being overcome gradually and include the challenges of developing non-invasive sampling techniques, difficulty in anticipating the costs and amounts of fish that must be purchased (and surveyor reimbursed) when damaged through sampling, and constraints on sampling smaller reef fish that are marketed whole. The project is overcoming these obstacles by working closely with the Coop, finding ways to "clean your fish for a reduced price with the benefit of helping fishery science" (a win-win in terms of sampling and outreach), and training with experienced contractors to develop and perfect sampling protocols to reduce "fish downtime" and tissue damage.

Pacific Islands Regional Observer Program

P.I.: Thomas A. Schroeder [Kevin Busscher]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The Pacific Islands Regional Observer Program is managed through a Fishery Management Plan developed by the Western Pacific Regional Fishery Management Council and approved by the National Marine Fisheries Service with the authority of the Magnuson-Stevens Fishery Conservation and Management Act, and the Endangered Species Act. The observer program provides high quality data on protected species interactions (sea turtles, marine mammals, and sea birds), catch composition, fishing effort, and selected fisheries research projects from commercial longline vessels based in Hawaii and American Samoa. The data are collected at sea by fisheries observers. The debriefers/data surveyors' primary purpose is to train observers and ensure the quality and integrity of data collected by the observers through debriefing observers and data editing.

Progress during FY 2010

From July 2009 through June 2010, 369 observer trips were debriefed. Of the 369 observed trips, 294 were completed through the final data editing stage. In addition, the program has completed the final data editing for 100 trips from the previous year. This puts the observer program approximately 75 trips behind in the final data editing stage for observer data. Having a deficit of 75 trips is normal due to lag time of data entry.

From March 2010 through June 2010, three research cruises were completed onboard commercial longline fishing vessels to test marine mammal take reduction devices used during longline operations for the Hawaii longline fleet. More research is needed before the devices can become fully operational. From February 2010 through March 2010, observer training and technical assistance was provided for observers and observer trainers in Marjuro and Kiribati in order to develop and enhance at sea fisheries monitoring programs in the Forum Fisheries Agency. A full debriefing staff has enabled the program to meet the project's objectives this year.

Pelagic Fisheries Research Program (PFRP): Program Management

P.I: John R. Sibert and Kevin Weng

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

Manage the activities of the PFRP, solicit and implement new research proposals, and promote science-based management of fisheries for highly migratory fisheries in the western Pacific Ocean.

Progress during FY 2010

• *Request For Proposals (RFP)*. Program manager met with WPRFMC and PIFSC to discuss important topics, and wrote a request for proposals (RFP) to reflect these priorities. An RFP was published and announced in February 2010. Of the 35 letters of interest received, 13 were invited to submit proposals (of which 2 letters of interest were requested to combine their research into one proposal). External peer reviews of all proposals were obtained, and a science review panel meeting was conducted. Of these, 8 proposals were approved for funding by the steering committee.

• *International collaboration in research on pelagic fisheries*. The SPC's Pacific Tuna Tagging Program (PTTP) has received many tag returns, providing a great deal of new data on tuna movements. A collaborating project in Hawaii, the Hawaii Tuna Tagging Project 2, has begun releasing tagged fish. The PFRP is supporting this program.

• Assumed leadership role in the ADMB Project. This project is an international effort to ensure that the AD Model Builder software will be maintained in the future. (This software is used in over 200 fisheries management agencies for statistical modeling and assessment of fish population around the world; see http://admb-project.org/.)

PFRP: Analyses of Catch Data for Mahimahi (*Coryphaena hippurus*) and Wahoo (*Acanthocybium solandri*) from the Hawaii-based Longline Fishery and Other Pacific Fisheries

P.I.: Kevin Weng [William A. Walsh]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of this project is to conduct detailed analyses of catch data for wahoo and mahimahi, two widely distributed, economically, ecologically, and recreationally important mid-sized pelagic predaceous fishes from several Pacific fisheries. The first objective is to develop statistical models of catch rates from the Pacific Islands Regional Observer Program database and then apply the model coefficients to the logbook data from the Hawaii-based longline fishery in order to characterize and quantify reporting biases. This will increase the number and types of species with corrected, well-documented catch histories in the data archives of the Pacific Islands Fisheries Science Center. The second objective is to determine whether, and if so to what extent, intraspecific CPUEs for these species are correlated in various regions of the Pacific Ocean. Likely data sources, in addition to the Hawaii-based longline fishery, include troll data from the Hawaii Division of Aquatic Resources, offshore creel survey records from the Guam Division of Aquatic and Wildlife Resources, observer and longline logbook records from American Samoa, and offshore creel records from American Samoa. The third objective is to use the corrected CPUE trends from the Hawaii-based longline fishery to test predictions from ecosystem models for the North Pacific Ocean, which suggest that fishes at lower trophic levels (e.g., mahimahi, wahoo) would

exhibit compensatory responses to declines in higher trophic level predators (e.g., blue marlin, yellowfin tuna, blue shark). A recent paper (Polovina et al., 2009, "Increases in the relative abundance of mid-trophic level fishes concurrent with declines in apex predators in the subtropical North Pacific, 1996–2006", *Fishery Bulletin*, 523–531) presented evidence in support of these concepts. It remains to be seen, however, if such patterns would be observed in temperate regions or across a greater spatial scale(s). The fourth objective is to identify and estimate patterns in the sizes of these fishes. In the case of the Hawaii-based longline and commercial troll fisheries, individual weights of each fish sold at the United Fishing Agency public fish auction since January 1, 2000 will be available. The reason for this work is that previous research suggested that wahoo exhibits a two-year cycle in body size that may be related to some life history trait.

Progress during FY 2010

This project is in the early analytical stages, and none of the objectives have been met. The project devoted most of the efforts in FY 2010 to analyses of shark bycatch data (see PFRP Project 657157). Work to date on this project has consisted of data preparation, quality control checks, and exploratory analyses.

The budget allocation for this project has been spent in full. No further expenditures or requests for additional funding are planned. Report(s) will be submitted annually until the publication process has been completed.

PFRP: Assimilating *in situ* Bioacoustic Data in a Mid-trophic Level Model and Its Impact on Predicted Albacore Feeding Habitat in the American Samoa Waters

P.I.: Kevin Weng [Réka Domokos, Patrick Lehodey]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

Pacific tuna stocks are facing increasing fishing pressure while they are also under the influence of natural variability and climate change. Nevertheless, the management of these species is still based on annual statistical stock assessment analyses and ignore environmental and climate variability. There is a need for new complementary approaches to management that relies on the development of ecosystem end-to-end models integrating both natural and anthropological effects. Such models, which describe the spatial population dynamics of tuna in relation to their bio-physical environment (e.g., SEAPODYM, a basin-scale ocean model), require key information and parameterization of the forage for tuna, the Mid-Trophic Level (MTL) micronekton, which is one of the less known components of the ocean ecosystem. To optimize the parameters of the basin-scale SEAPODYM MTL sub-model, *in situ* micronekton biomass should be incorporated at all representative regions within an ocean basin. The purpose of this project is to incorporate *in situ* multi-frequency bioacoustic data from four different regions of the Pacific Ocean into SEAPODYM-MTL with a rigorous mathematical method of data assimilation. The incorporation of data from these first four regions is instrumental in the development of SEAPODYM and will lead to massive improvements of the model in the future. Further, the impact of this new parameterization will be tested using the feeding habitat and population dynamics of south Pacific albacore tuna in the Samoa region by comparing the model results to *in situ* data.

Progress during FY 2010

• Shipboard surveys were conducted around the Commonwealth of the Northern Mariana Islands (CNMI) and Guam. The surveys were conducted along three meridional and two zonal transects between March 20 and April 12, 2010. Bioacoustic and current data (from an acoustic Doppler current profiler [ADCP]) were collected continuously down to 1200 and 800 m, respectively, along with data from Conductivity-Temperature-Depth (CTD) casts down to 1000 m depth, spaced at every 0.25°.

• Processing of acoustic, ADCP, and CTD data, collected during FY 2009 in the north central Pacific and during FY 2010 at CNMI and Guam, has been completed along with satellite altimetry and sea surface chlorophyll from the corresponding time periods. Results indicate an uncoupling of the physical and biological fronts between the



Figure 1. From top to bottom: Upper 1000 m bioacoustic backscatter, and upper 300 m temperature, salinity, dissolved oxygen, and chloropigments along 158°W. Data was collected in March 2009.

Transition Zone (TZ), the boundary between the subtropical and subarctic gyres, and the Chlorophyll Front (CF), which is the front between oligotrophic and mesotrophic regions associated with waters south and north of the TZ, respectively. During the north central Pacific survey ($22^{\circ}30'-36^{\circ}00'N$, $158^{\circ}00'W$), the TZ was observed at ~31°N, while the CF further north, at ~ $35^{\circ}N$ (Fig. 1). Changes in the bioacoustic scattering layers, composed of micronekton (forage for higher trophic level organisms), were associated with the TZ as opposed to the CF (Fig. 1). At CNMI and Guam, prominent meridional differences were observed in both physical and biological variables, including acoustic backscatter, presumably due to characteristics of the North Equatorial Current (south) and waters within the subtropical gyre. Zonal differences were observed only in the bioacoustics data, most likely due to island effects. Micronekton biomass from the acoustics data at the central and western north Pacific is being currently calculated for data assimilation into the model.

• The definition of vertical layers is a critical step for the MTL modeling in SEAPODYM because all the dynamics are then based on the average fields of temperature and currents within these layers. In the current version the epipelagic layer is defined by the euphotic depth (Z_{eu}) ; the mesopelagic is between one and $3xZ_{eu}$ and the bathypelagic layer is between $3xZ_{eu}$ and 1000 m. The project used satellite derived primary production computed according to the VGPM model (Behrenfeld and Falkowski, 1997), in which the euphotic depth follows the definition of Morel and Berthon (1989) based on surface chlorophyll-a concentration. The Ocean Productivity Team recently undertook a major reprocessing of all sea color satellite data (http://oceancolor.gsfc.nasa.gov/REPROCESSING/R2009) and also had to restart modeling work from this new updated dataset. The new profile carried out along the longitude 158°W between 23 and 36°N collected in situ data, especially chloropigments that are a useful indicator of the euphotic depth. Based on these data the predicted euphotic depth would be underestimated by ~50% and thus the project would need to account for a corrective factor (Fig. 2). However a new parameterization proposed by Morel (2001, 2006) may reduce this error. The project plans to test this updated parameterization and then check the result with several other acoustic profiles.

• The approach for acoustic data assimilation is currently being developed. The adjoint code for the transport model has been already developed for the tuna model (Senina et al., 2008). The optimization of the relative energy transfer coefficients (E'_n) will be achieved using a cost function that is based on the comparison of relative ratio in the three vertical layers during day or night of observed acoustic signal and predicted MTL biomass. Optimization experiments will start soon after the vertical layers are selected and acoustic data processed in the appropriate format.



Figure 2. Vertical layer boundaries. Top: Euphotic depth (Z_{ev}) predicted with Morel's definition (1989) superimposed on the chloropigment profiles of the transect sampled during FY09 (central north Pacific). The predicted depth is underestimated by 40-50%. Bottom: predicted layer boundaries after correction by a factor 1.5: $1x Z_{ev}$; $3x Z_{ev}$ (mesopelagic) and $6x Z_{ev}$ (bathypelagic), superimposed on the 38 kHz backscatter along the same transect.

• Run first assimilation experiments. To have the most realistic predicted environment, the project uses a model configuration that allows for mesoscale activity (resolution 1/4 deg x 6 day), and is based on satellite-derived primary production (e.g., Behrenfeld and Falkowski, 1997) and physical variables (temperature and currents) from a physical ocean reanalysis with data assimilation (GLORYS provided by MERCATOR-OCEAN). The project reprocessed the whole dataset after the revision of primary production data set and ran an initial reference simulation from which the project will compare the predicted biomass in each layer to relative strength of acoustic signal.

PFRP: Biology and Habitat Use of Monchong (*Eumegistis illustris*) at Cross Seamount, Hawaii

P.I: Kevin Weng

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

Monchong is a generic local name given to two deep-water pomfret species—the sickle pomfret, *Taractichthys steindachneri*, and the lustrous pomfret, *Eumegistis illustris*. The sickle pomfret is a common incidental catch in pelagic longline fisheries throughout the North Pacific. The lustrous pomfret exhibits fidelity towards deep

slope or seamount habitats and are generally caught by short-line or handline. Both monchong species are valued by Hawaii seafood wholesale and processing firms who have successfully promoted it in the fresh market and restaurant trade. These species have become an increasingly important component of local Hawaii fisheries in terms of commercial fishery landings and sales in recent years. In the case of the lustrous pomfret, most of the catch occurs at Cross Seamount, a smallish seamount 8 km in diameter at the summit located 290 km south of Honolulu. Concerns over the sustainability of current pomfret removal rates with respect to recruitment from this limiting habitat have prompted the Western Pacific Regional Fishery Management Council, in coordination with PIFSC, to launch an investigation into expanding knowledge of pomfret life history and ecology. This monchong study will occur in conjunction with the Hawaii Tuna Tagging Project 2, a PFRP-funded project that is an integrated component of a Pacific Tuna Tagging Project (PTTP). Tagging programs are widely recognized as important tools for understanding the population dynamics, dispersal patterns, and fisheries interactions of fish populations and produce additional data inputs necessary to improve stock assessments and predictive models.

Progress during FY 2010

The project has conducted two cruises to Cross Seamount. During the April 2010 trip to the Cross Seamount the acoustic monitoring array was placed on the summit of the seamount. The project also tagged 11 total monchong, seven of which were tagged with V13P tags. Several monchong were dissected and gonads taken, as well as stomach and muscle samples for a study of pelagic ecosystems being conducted by a collaborator. During the second cruise in late May 2010, three monchong were detected with a VR2 hung over the side while drifting at night over Cross, with depth readings indicating that the tags were up in the water column and moving.

PFRP: Climate and Fishing Impacts on the Spatial Population Dynamics of Tunas

P.I.: Kevin Weng [Patrick Lehodey, Olivier Maury]

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

NOAA Goal(s)

- · To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management
- To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

A high priority for effective management of large pelagic fishes is the capability to discriminate between the effects of exploitation and climate dynamics on the sustainability of tuna populations. Climate related changes are believed to strongly influence the pelagic habitats of tuna, and thus movement and migration patterns. But not all tuna respond the same way to climate cycles, thus there should be demonstrable differences in survivorship during recruitment and responses to exploitation patterns. Empirical and analytical evidence are needed to explain the relative importance of environmental and fishing variability in structuring pelagic ecosystems. There is a need to determine the mechanisms involved in observed variability across species and oceanic regions. This project proposes to run two spatial bio-physical models for several tuna species concurrently with different long-term (up to 50 years) climate regime datasets. It is anticipated that the models will enable researchers to evaluate potential alternative system states due to physical and anthropogenic forcing and help determine if the impacts of natural climate variability could be anticipated in such a way as to help establish a management regime that accommodates exploitation pressures and natural variability to build sustainable tuna fisheries.

Progress during FY 2010

The project has been extended until mid-2010. For FY 2010 (Jul-2009-Jul 2010), planned activities are listed below. A final report of the project will be provided separately.

The CCSM physical-biogeochemical reanalysis has a variable horizontal and vertical resolution requiring interpolation on a regular grid. The project had to compute euphotic depth, which was not included in the dataset. To get this variable the project first needed to obtain the PAR(0) (Photosynthetically Active Radiation at surface). The project tried to reconstruct this variable from the equation provided in Moore et al. (2002) using the PAR at



Figure 1. SEAPODYM application to skipjack in the Indian Ocean (with Pacific 0. parameterization). Circles are proportional to catch (black circles are predicted catch, grey circles are observed catch).

mixed layer depth that was provided with the reanalysis. However the result was not good, due to the discretization by vertical levels in the model. After discussion with NCAR, it appeared that PAR(0) can be deduced from a variable (qsw) that was missing in the records. This variable was finally provided by NCAR and the project has reprocessed the dataset. The range of variability of the euphotic depth from this reanalysis appears very small compared to other datasets. Unfortunately this reanalysis was not ready in time for optimization experiments. However, it will be used in further optimization experiments to finalize coming publications.

One of the goals of the project was the setting up of a global database including fishery data (catches, fishing efforts, and size-frequencies) for the tropical tunas in the three oceans over their whole historical period with an appropriate resolution and fleet stratification. Thanks to the important involvement of IRD staff and to the availability of complementary funds, the work has gone far beyond the initial objectives because the database has been completed and extended to include a total of 14 exploited species including tropical tunas in the three oceans. Furthermore, it has been linked to the CLIOTOP MDST (Model and Data Sharing Tool), which provides a user



Figure 2. APECOSM-E application to skipjack in the Indian Ocean. Distribution of vertically-integrated simulated biomass (1st line), observed catches (2nd line) and simulated vertical distribution of biomass on an equatorial East-West transect at 0°N (3rd line): non-ENSO year (February 1996, left) vs. ENSO year (January 1998, right). The simulation presented has been optimized over the 1984-1989 period. It however matches quite well the distribution of catches in other years such as 1996 or the anomalous 1998. This provides a validation of the model over data, which have not been used for its optimization.

friendly web base interface to access, visualize and extract the data. The web site has been temporarily deployed on a server at http://vmmdst-dev.mpl.ird.fr:8080/MDST/ for debugging and beta testing. However, while detailed fishing datasets of catch effort and size frequencies of catch are publicly available in IOTC and ICCAT, the project did not get an official agreement to release similar public domain data sets for Pacific Ocean despite a formal request sent to the directors of both tuna commissions for the Pacific Ocean (Guillermo Campéon, IATTC, and Andrew Wright, WCPFC). Access to those data will remain restricted pending an agreement by IATTC and WCPFC to release the data.

Optimization experiments have been conducted with SEAPODYM for skipjack, yellowfin and bigeye with three reanalyses: ESSIC; NCEP; and ERA40 in the Pacific. As noted previously, the project was not able to use the CCSM reanalysis. However, additional simulations were conducted using a climate model simulation (IPSL) to investigate the impact of climate change under the IPCC A2 scenario, which will be detailed in the project's final report and publications.

The optimal parameterization obtained in the Pacific for skipjack has been used to run a simulation in the Indian Ocean (Fig. 1). Results are very encouraging because without any change in the parameterization except for the fishing parameters (selectivity and catchability) the simulation provided a very good fit to the fishing data (catch and effort and size frequency) and was able to predict the changes associated to the ENSO event of 1997-98 (see final report).

Optimization experiments were run using APECOSM-E, a simplified version of APECOSM devoted to parameter estimation, for skipjack in the Indian Ocean using the ERA40 reanalysis. These optimization experiments have been undertaken over various time periods ranging from 2-18 years (1984-2001) for testing the sensitivity of the optimization procedure (see final report).

The optimization work with APECOSM has been delayed due to the unexpected departure (still not replaced) of Blaise Faugeras, the engineer in charge of running APECOSM-E, from IRD in August 2007 and the difficulty of recruiting a qualified postdoc (cf. previous reports). Finally, Dr. Sybille Dueri was recruited in IRD on February 1, 2009, for 12 months, to conduct the optimization experiments. While initial results obtained for skipjack in the Indian Ocean were encouraging, it was not possible to test the approach in the Pacific Ocean as initially proposed. Applying APECOSM in the Pacific Ocean would require that the same fishing data available for running SEAPODYM in the Pacific Ocean be made available for running APECOSM. The complete longline fishing dataset cannot be obtained from WCPCF outside of agreed tasks listed by WCPCF. This was the case for SEAPODYM due to historical links with SPC and WCPFC, but not for APECOSM.

P. Lehodey attended the PFRP-PI meeting in Nov. 2009 and the Scientific Committee meeting of the Western Central Pacific Fisheries Commission. Lehodey was also invited to provide a presentation at the Ecosystem meeting of the International Whaling Commission (Morocco, June 2010).

PFRP: Descriptive Assessment of Traditional and Small-Scale Fisheries in the Western Pacific

P.I.: Edward W. Glazier and Kevin Weng

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

NOAA Goal(s)

To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

This project involves the collection, compilation, synthesis, analysis, and reporting of existing and new information regarding small-scale and traditional fishing fleets and activities across Hawaii, the Commonwealth of the Northern Marianas, Guam, and American Samoa. The end product will be an empirically based descriptive assessment of those small-scale fisheries in the study region that are not clearly or entirely commercial or recreational in nature. The ultimate intent of the work is to improve the quality and quantity of data available for purposes of fishery management and as potentially needed for determination of equitable ACLs across the region.

Progress during FY 2010

Fieldwork and preliminary data analysis were initiated early in 2010. These activities will be ongoing through FY 2010.

PFRP: Development of Business Card Tags: Inter-Individual Data Transfer

P.I.: Kevin Weng [Laurent Dagorn, Kim N. Holland]

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

NOAA Goal(s)

To protect, restore, and manage the use of coastal and ocean resources through ecosystem-base management

Purpose of the Project

The purpose of the project is to develop and field test acoustic transceivers that will allow communication between tagged animals when they come within range during their normal movements in the open ocean.

Progress during FY 2010

Primary activities in 2010 consisted of continued analysis of data collected in the first phase of field testing and planning for second round of deployments. To this end, the PIs met with potential collaborators in Hawaii and in the Azores to discuss experimental design.

PFRP: Describing the Vertical Habitat of Bigeye and Albacore Tunas and Post Release Survival for Marlins in the Central Pacific Longline Fisheries with Pop-up Archival Transmitting Tags

P.I.: Kevin Weng [Jeffrey J. Polovina, Michael P. Seki]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystembase management

Purpose of the Project

The purpose of this project is to describe the vertical habitat and horizontal movements of bigeye and albacore tunas and other pelagic fishes in the central Pacific. These tunas are target species in longline fisheries in both Hawaii and American Samoa and an understanding of the habitats and movements of these species is needed as a background to fisheries management.



The model predicted percent of days during which bigeye tuna are potentially vulnerable to long-line gear pooled by the quarter of the year and 2° latitude bins based on the geolocation estimates.

Progress during FY 2010

During 2010, the project focused on using its tagging data to build a spatial ecosystem model for the central North Pacific to better understand the movements of swordfish and loggerhead sea turtles. This ecosystem model is being developed as a PhD thesis by Ms. Melanie Abecassis, who is being supported by the project. The ecosystem model uses an ocean circulation model and a food web model to propagate energy through the ecosystem and describes the spatial movement of species at the top of the food web based on changes in their habitat that combines physiological characteristics with available forage. Continued progress has been made towards the building of a loggerhead sea turtle movement model. Dr. Patrick Lehodey of CLS and the University of Toulouse is a co-advisor on Ms. Abecassis' thesis along with Dr. Jeffrey Polovina.

Second, a manuscript describing the spatial and temporal variation in bigeye tuna habitat was written, accepted for publication in 2009, and published in *Progress in Oceanography* in 2010.

PFRP: Distribution and Use of Seafood in the Context of the Community: A Case Study of the Main Hawaiian Islands

P.I.: Kevin Weng [Edward W. Glazier, Stewart Allen]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The goal of the Oahu seafood distribution project is to provide fishery managers with empirically based description and analysis of market and non-market distribution of pelagic seafood in the Main Hawaiian Islands. The project uses a case study approach to examine cultural and community dynamics associated with the pursuit, capture, sharing, reciprocal exchange, and sale of pelagic fish by small boat fleets at Waianae on the Leeward Coast of Oahu and at Haleiwa on the North Shore of Oahu. The analysis is configured so that project results can be used to improve understanding of seafood distribution elsewhere in the Hawaiian Islands.

Progress during FY 2010

Fieldwork and preliminary analysis for this project were completed in 2008 and final project report is in review.

PFRP: Economic Fieldwork on Pelagic Fisheries in Hawaii

P.I.: Kevin Weng [Minling Pan]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The main objective of the research has been to investigate possible potential long-term pricing relationships among the major landings of the Hawaii tuna longline fishery (for bigeye, yellowfin, skipjack, and albacore). In FY 2010, the project conducted statistical analysis by using the multivariate Markov-switching error-correction model to study the tuna price responses to changes in the quantity of landings, market structure, and ecosystem conditions in the Hawaii market.

Progress during FY 2010

This project was completed in 2010. The results from the study were presented at two international conferences and one workshop (see list of presentations). A draft report titled "Tuna Price in Response to Changes of Market Structure and Ecosystem Conditions—Price Linkage between Hawaii and Japanese Tuna Sashimi Markets" was completed and is under revision.

PFRP: Fishery Dynamics in the Samoan Archipelago

P.I.: Kevin Weng [Keith A. Bigelow, Adam Langley, John Hampton]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of the project is to improve understanding of the dynamics of south Pacific albacore. Major objectives include: 1) to analyze the spatial and temporal dynamics and fishery interaction of longline fisheries within and around the American Samoa EEZ; 2) to compare albacore fishery dynamics in other Pacific Island Countries and Territories (PICTs) longline fisheries; and 3) to improve the regional albacore stock assessment.

Progress during FY 2010

• *Objectives 1 and 2*. Little progress was made in FY 2010 on objectives 1 and 2 as research in previous years concentrated on these objectives.

• *Objective 3.* A full south Pacific albacore stock assessment was conducted in 2008 and a comparative assessment was conducted in 2009. South Pacific albacore is the only WCPFC species that is assessed with standardized CPUE indices constructed with operational data. The 2009 CPUE standardization using operational level data represented an improvement in constructing relative abundance indices for south Pacific albacore, although there was concern that some Taiwan vessels had changed from targeting albacore to bigeye tuna since the late 1990's. Results indicate that overfishing is not occurring and that the stock is not in an overfished state. There is no indication that current levels of catch are not sustainable with regard to recruitment overfishing. However, current levels of fishing mortality may be affecting longline catch rates on adult albacore within domestic Pacific Island longline fisheries.

PFRP: Hawaii Tuna Tagging Project II

P.I.: Kevin Weng [Kim N. Holland, David Itano]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of the project is to determine the population dynamics and distribution characteristics of coastal tunas supporting the coastal fisheries of the Hawaii region.

Progress during FY 2010

A large proportion of activity consisted of further discussion of the legal constraints concerning the use of non-UH vessels for tagging activities. Finally, agreement was reached between the University and its insurers and the private operators of fishing vessels regarding the terms of use of the vessels. Following this resolution, a successful cruise was conducted to the Cross Seamount to deploy receivers and tag fish. Tagging activities close to the main Hawaiian Islands were hampered due to mechanical problems on the fishing vessel that will be used for most tagging activities. However, these have now been resolved and a custom-designed tagging cradle has been constructed to service upcoming tagging operations.

PFRP: Impacts of Fishing on Vulnerable Non-target Species at Seamount

P.I.: Kevin Weng

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

Seamounts have extraordinary levels of endemism and exert a powerful aggregating effect on species, attracting fishes, cetaceans, seabirds and turtles. Only a few of the world's 100,000 seamounts have been explored, leaving

us with a minimal understanding of the biology of seamount organisms. Despite this, seamounts experience intensive fisheries and interviews with commercial fishermen in Hawaii reveal frequent catches of benthopelagic sharks. As a result the Western Pacific Fishery Management Council and NOAA are responsible for the management of species that are potentially endemic, highly vulnerable to fishing, and so poorly understood that they cannot be assessed and for which no definition of essential fish habitat (EFH) exist. While seamounts have been hypothesized as stepping-stones, the project does not know if seamount sharks are isolated populations or if they move between seamounts and landmasses. Deep set longline fishing will be conducted at Cross Seamount to characterize the elasmobranch community. Detailed studies will be conducted for the three highest trophic level bentho-pelagic elasmobranchs, the Cooke shark (*Echinorhinus cookei*), the six gill shark (*Hexanchus griseus*), and the sleeper shark (*Somniosus pacificus*). A combination of acoustic, satellite, and accelerometry technologies will be used to characterize their behavior, habitat use, and connectivity with other seamounts and islands. The resulting data will allow definitions of EFH and determination of appropriate management units. The proposal includes a low risk-high reward component, which uses established methods on new species, and a high risk-high reward component, which aims to develop a novel method to study these deep-water animals.

Progress during FY 2010

The individual objectives of the project and progress made for each are as follows.

• *Characterization of bentho-pelagic elasmobranchs.* The project conducted two cruises to Cross Seamount. Due to limited time the project only conducted a few sets near the bottom to target demersal/bentho-pelagic sharks. The project conducted a series of mid-water sets that captured teleost fishes, but not elasmobranchs.

• *Determination of fine-scale habitat use.* During 2010 the acoustic monitoring array was placed on the summit of Cross Seamount. Due to limited time on the cruise the project was not able to capture and tag sharks. The project will return and tag sharks on a future cruise to the seamount.

• Determination of connectivity and long-range movements. VR2 listening arrays on the Main Hawaii Islands and North West Hawaiian Islands continue to be maintained by University of Hawaii researchers in order to detect inter-island movements. Satellite tagging has not yet occurred but the equipment has been ordered.

• *Studying foraging behavior to reduce by-catch*. The Daily Diary accelerometer was to have been housed for use in deep water by the developers at Swansea University, UK. However, they have experienced some delays and the project is in contact with them about assisting them with this development via pressure testing of their tag. In addition, the PI has been in touch with the developer of the Little Leonardo tag in Japan and plans to conduct tests using their device near Oahu later this year.

PFRP: Improved Effectiveness of WCPFC Through Better Informed Fishery Decision Maker

P.I.: Kevin Weng [Simon Hoyle]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

To develop a tool that will allow WCPFC decision makers to interact directly with stock assessments, and observe how alternative management strategies may affect both them and other interested parties. This application will: a) help decision makers become familiar and comfortable with the stock assessment's predictions; b) allow decisionmakers to explore a greater range of management options than they can at present, including those they see as more relevant to them; c) allow decision makers to discuss potential outcomes and compare alternative strategies with their industry representatives; and d) allow each group to see how the various options they are considering may affect them and the parties they negotiate with by providing a greater and more relevant range of outputs.

Progress during FY 2010

Work on this project began in January 2010. Objectives for calendar year 2010 were: a) design the preliminary application; b) liaise with fishery decision-makers, fishery stakeholders, management experts, and scientists,



Figure 1. Screen shot of the initial screen of the management options software package Tuna Management Simulator (TUMAS).



Figure 2. A screen shot of predicted biomass plots produced by the management options software package TUMAS.

to identify the stock assessment information that would be most useful to support negotiation and decisionmaking; c) decide on software platform; d) set up a system for managing software development; e) develop a simple application for bigeye tuna that allows the user to save the graphs and tables that are created; f) modify MULTIFAN-CL to work with the management options application; g) identify outputs to be provided by the management application; h) demonstrate an initial prototype at stock assessment training workshops in July 2010; and i) train and support participants (to extent possible), and obtain feedback from the SPC-GEF stock assessment training workshops, December 2010 WCPFC Commission meeting, FFA management options workshops, training workshop in Hawaii, and August 2011 SC7.

Some objectives for the calendar year 2010 have been met so far, and all others are on track to be met this year. The preliminary application, the Tuna Management Simulator (TUMAS), has been designed and the JavaFX software platform selected. The project has liaised with stakeholders and obtained preliminary advice on outputs to be provided by demonstrating and seeking feedback on preliminary versions of the application at the SPC

pre-assessment workshop in April and at an SPC stock assessment training workshop in June. Software development is making good progress and managed using the SVN versioning system and a Gforge project management interface. The application creates graphs, which the user can save, and has been applied to assess bigeye tuna. The project has also made changes to allow MULTIFAN-CL to work with the management options tool and others (additional functions) are under way.

PFRP: Integrative Modeling in Support of the Pelagic Fisheries Research Program: Spatially Disaggregated Population Dynamics Models for Pelagic Fisheries

P.I.: John R. Sibert and Kevin Weng

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

NOAA Goal(s)

· To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

The general objective of this research is to integrate the results of different components of the Pelagic Fisheries Research Program into a consistent framework that integrates knowledge of fish movement and population dynamics, the fishing process, economics, and oceanography. The primary focus is the development of spatial models of pelagic fish population dynamics that explicitly include movement, mortality, and fisheries. The work emphasizes collaboration with other PFRP projects. The specific objectives were to continue, improve, and maintain the movemod diffusion and advection modeling software and run the movemod model with new and existing data sets.

Progress during FY 2010

A postdoctoral researcher, Dr. Timothy Sippel, was hired. He completed his PhD at the University of Auckland, where he developed movement models for striped marlin and other species.

Dr. John Sibert worked with Dr. Inna Senina and Dr. Patrick Lehodey (CLS, France) to integrate models of individual movement into the SEAPODYM model of population movement. PFRP graduate student Eun Jung Kim (University of Hawaii, Dept. of Oceanography) is adding a feature to the movemod software for her thesis research to make population movement explicitly dependent on the density of FADs. Visiting intern Robert Bauer (University of Rostock, Germany) used the movemod software as part of his research using NOAA Hawaii longline data. Dr. Sibert used the movemod model on new skipjack, yellowfin, and bigeye tagging data from the Secretariat of the Pacific Community (SPC). Maintenance of the movemod software included resolving issues and defects in the source code. All of the movement software has been updated and ported to newer compilers. The software usage has also been streamlined to make it easier to use. Planning is underway to create an open source project for the movemod model source code, which will make the software freely available to anyone to use and modify.

PFRP: Intra-guild Predation and Cannibalism in Pelagic Predators: Implications for the Dynamics, Assessment and Management of Pacific Tuna Populations

P.I.: Kevin Weng [Tim Essington, Mark Maunder, Robert Olson]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

This project seeks to: (1) construct a comprehensive database of the feeding habits of pelagic apex predators; (2) use those data to identify the life history stages, locations, and time periods when predation on commercially-

valuable tuna is most pronounced; and (3) develop simple population models to gauge the impacts of predation on fisheries reference points.

Progress during FY 2010

The project completed the database and analysis of feeding habits data and is finalizing manuscripts for publication. An important component of the database is the inclusion of historical data from the 1950's and 1970's, not as data summaries but as raw data. This has dramatically increased the project's power to describe important predators on tunas, the sizes of tunas being consumed, and evaluate the implications of changing predator fields on the productivity of tunas.

This project has two main products to date. The first is a draft manuscript that describes the main predators on skipjack, yellowfin and bigeye (rare) tunas, and used simple measures of reproductive value to identify groups of predators likely to have the greatest effect on population dynamics. This analysis revealed that large fish (i.e., marlins, sharks, larger tunas) rarely consume bigeye tuna but that yellowfin and, especially, skipjack tuna comprise a significant component of the feeding habits of large bodied pelagic predators. Moreover, consumption is directed at body sizes that are near or exceed the size at recruitment, indicating that these predators may directly impact the productivity of these species. For yellowfin tuna, the most important predators are the *Carcharhinus* sharks and for skipjack tuna the most important predators are sharks and marlins. Another notable observation is that the frequency of occurrence of both species in predator diets is highest in samples collected via purse seine sets on floating objects (likely a consequence of the aggregating effect of these objects on juvenile fishes). This suggests that fishing practices may be inadvertently changing predator-prey interactions by altering the spatio-temporal overlap of juvenile tunas with their predators

The second product used these data to assess changes in the prey fields of tunas and other predators, using the fish as "biological samplers" that can provide an indicator of changes in prey communities. This work provided the first documented evidence for increasing cephalopod abundance over the four decades of data. Moreover, the project finds even recent increases in cephalopod abundance are attributable mostly to *Dosidicus gigas* (Humboldt squid). This finding is noteworthy because while poleward range expansion of this species is well known, the project's data are collected in the core of their range and therefore provides the first indication of possible population growth independent of range expansion.

PFRP: Investigation of Shark Bycatch in the Hawaii-based Longline Fishery, and an Extension of Analyses of Catch Data from Widely Separated Areas in the Pacific Ocean

P.I.: Kevin Weng [William A. Walsh, Keith A. Bigelow]

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

NOAA Goal(s)

To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

This project is intended to provide a sound scientific basis for shark management in this fishery. Thus, a paper published in FY 2010 (see publication list) presented a quantitative description of the entire shark catch as reported by fishery observers including species composition, minimum mortality estimates, mean sizes, sex ratios, and associations with target species. The remaining work is intended to yield two additional papers that will focus on standardizations of catches-per-unit effort (CPUE). The first will address blue shark (*Prionace glauca*) CPUE because it is the predominant bycatch species in this longline fishery and many others worldwide. The second paper will present standardized CPUE trends for the other five common shark species taken by this fishery. Both of these papers will concentrate on the deep-set sector of this fishery because it has remained open since the establishment of the Pacific Islands Regional Observer Program in March 1994. If these papers are completed and published as envisioned, it will represent a body of scientific information in the primary scientific literature that will cover approximately 95% of the shark bycatch in this fishery.

Progress during FY 2010

Progress in FY 2010 (in addition to the aforementioned publication) has consisted of blue shark CPUE standardizations with two statistical models (a generalized additive model and a generalized linear model) fitted to



Catch per unit effort (CPUE; number of sharks/1,000 hooks) plotted on a logarithmic scale for common shark species caught in the (A) shallow-set sector and (B) deep-set sector of the Hawaii-based longline fishery. Solid bars represent mean CPUE values from the period 1995–2000; cross-hatched bars represent mean CPUE values from the period 2004–2006. The percentages represent the changes in CPUE between the two periods.

fishery observer catch and operational data. The results appear noteworthy because, in contrast to the previously described significant decline in nominal CPUE, these models indicate that there has been no significant decrease in standardized CPUE during the last 15 years (1995-2009) in the deep-set sector of this fishery. This suggests that the decrease in nominal catch rates was primarily attributable to changes in fishing locales and probably did not reflect diminished stock size such as might have resulted from a localized depletion. The current intention is to fit one more statistical model (a generalized linear mixed model) to evaluate the consistency of results and inferences.

This work should prove useful because sharks are now and will continue to be a focus of management activity in this fishery due to concerns at the state, national, and international levels (P. Dalzell, Senior Scientist, Western Pacific Regional Fishery Management Council, personal communication). In addition, the

published paper will be used as the basis for a presentation to the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean, which will meet in Victoria, British Columbia, Canada, in July 2010 to plan stock assessments for Pacific sharks (D. Courtney, Research Fishery Biologist, NOAA Fisheries, personal communication).

The budget allocation for this project has been spent in full. No further expenditures or requests for additional funding are planned. Report(s) will be submitted annually until the publication process has been completed.

PFRP: Modeling the Eco-physiology of Pelagic Fishes and Sharks with Archival and Popup Satellite Archival Tags (PSATs)

P.I.: Kevin Weng [Michael K. Musyl, Christina Larsen, Hans Malte, Richard C. Brill]

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

NOAA Goal(s)

- To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management
- To serve society's needs for weather and water information

Purpose of the Project

The project was designed to benefit by using available data from archival and PSAT tags to develop individual based models (IBMs) to describe the eco-physiology of different species of large pelagic fishes and sharks. This



Figure 1. Niche partitioning in the pelagic environment. Unweighted pair-group method using arithmetic averages (UPGMA) clustering using distributions of daytime temperature preference readings from PSATs. The greatest vertical distance between cumulative distribution functions among tags from two-sample Kolmogorov-Smirnov tests was formatted into a distance matrix as input for UPGMA clustering. Electronic tag data from other large pelagic species (bigeye tuna, swordfish, black marlin, blue marlin) were used as outgroups to help clarify and define relationships. B=blue shark (Prionace glauca), SF=shortfin mako (Isurus oxyrinchus), T=bigeye thresher (Alopias superciliosus), E=bigeye tuna (Thunnus obsesus), R=swordfish (Xiphias gladius), S=silky shark Carcharhinus falciformes), O=oceanic whitetip shark (C. longimanus), K=black marlin (Makaira mazara), L=blue marlin (M. nigricans), M=male, and F=female. Total length (TL, in cm) and pop-up latitude are given for each tagged subject (na = not available). The cophenetic correlation (0.86) (measure of goodness-of-fit between the matrix and resultant clustering dendrogram) indicated "good" fit. For the most part, the topology of pelagic shark clusters did not appear to correlate with phylogeny, life history characteristics, neural anatomy, relative eye size, physiology or endothermy; indicating other factors (e.g., ontogeny, latitude, locomotion, diet, and dimensionality of the environment) probably influence the structure as well as the spatial and temporal stability of thermal niche partitions (Musyl et al., in prep).

project will complement data already collected on a number of pelagic species and will be linked to existing PFRP projects by Musyl, Brill, and Moyes. Thus, the study will be a collaborative effort between many institutions and agencies including the University of Hawaii/JIMAR/PFRP, VIMS/National Marine Fisheries Service, and the Dept. of Zoophysiology, University of Aarhus, Denmark. The project's ultimate goal is to develop model(s) that will be applicable to many different species of pelagic fish and shark. Using these models it was anticipated that researchers could evaluate the importance of specific oceanographic parameters in an unbiased fashion, which would allow for intra- and inter-species comparison. A second purpose of this study is to explore failure (or conversely success) scenarios in PSATs attached to pelagic fish, sharks, and turtles. Specifically, this aspect



Figure 2. Depth and temperature preferences of silky shark as identified by PSATs [n = 10 PSATs], median days-at-liberty = 73 (733 total days-at-liberty, range 12–194 days). Silky shark spend ~95% of the time within 2 degrees of sea surface temperature (SST) and are confined to the surface mixed-layer. (a) Representative vertical movement behaviors. (b) Temperature-depth profiles using the data from all sharks. The perpendicular nature of the profile indicates residency in the surface mixed-layer. (c) Exploded section from panel (a) with horizontal black bars representing nighttime. (d) Most probable tracks estimated from the Kalman Filter-SST model (Neilsen et al., 2006). (e) Average hourly depth (\pm SD) readings calculated for all samples. (f) Percentage time occupied in depth strata (\pm SD) for daytime and nighttime diving activities. Note that the population of silky sharks (all immature, n = 4) south of ~10°N corresponds to the 'Epipelagic C' cluster in the above figure (samples tagged in 2005).

of the study is designed to look for explanatory variables in the context of PSAT retention rates, percentage retrieved satellite data (i.e., depth, temperature, geolocations), and tag failure. By examining several factors and information about PSATs attached to vastly different pelagic species, it is anticipated that certain patterns/ commonalties may emerge to help improve the project's understanding of attachment methodologies, selection of target species, and experimental design. Lastly, information derived from this study will allow an unprecedented and critical appraisal of the overall efficacy of the technology.

Progress during FY 2010

Although the project was unavoidably delayed due to major knee surgery for PI Musyl in FY 2007 and in FY 2008 (and medical problems with other personnel), several manuscripts have been published and submitted by project personnel (see publications list) including a major review manuscript on PSAT performance and reliability (Musyl et al., in prep.), a major review on pelagic species in relation to physiology and movement (Bernal et al., 2009), an article on thermal biology in tuna (Boye et al., 2009) as well as a paper in the journal *Nature* by Humphries et al. (2010) detailing search patterns of pelagic species, which has important ramifications in learning how animals disperse. Project personnel have also completed major analyses to correlate movement patterns of PSAT tagged blue sharks, silky sharks, oceanic white-tips, bigeye threshers, and short-fin mako sharks with various oceanographic parameters. Another manuscript detailing the post-release survival of pelagic sharks from longline gear will be submitted soon.

PFRP: Nursery Origin of Yellowfin Tuna (Thunnus Albacares) in the Hawaiian Islands

P.I.: Kevin Weng [Jay R. Rooker, David Itano]

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

NOAA Goal(s)

To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of this study is to provide information on the source(s) of bigeye and yellowfin tuna recruits (age-1 and age-2) to Hawaii-based surface fisheries using natural tracers (stable isotopes and trace elements) in otoliths. The project's first step was to develop a baseline that described the chemical signatures in the otoliths of age-0 tuna from putative spawning and/or nursery areas in Hawaii and the broader western and central Pacific Ocean (WCPO). This initial baseline was then used to test whether ambient chemical conditions in regional nurseries were sufficient to impart unique signatures in the otoliths of age-0 tuna. After establishing a baseline, the project targeted age-1 and age-2 (sub-adult to young adult) tuna from Hawaiian Island fisheries to determine their source (natal origin). The goal of this work was to determine whether residents (versus transients) constitute the primary source of recruits to the Hawaii-based fisheries.

Progress during FY 2010

The project completed the collection of remaining age-0 individuals for the second year (2009) of the twoyear project. In addition, the project completed collections of age-1 and age-2 samples from the Hawaii- and Equatorial-based fisheries to determine natal origin of both species. The project's primary aim during the current fiscal year was to determine the origin of unknown bigeye and yellowfin tuna (age-1 and age-2) using a mixstock procedure (HISEA) that is based on using the project's age-0 signatures as baseline data. Results were very promising and the baseline was used successfully to classify adolescent yellowfin and bigeye tuna collected in Hawaii- and Equatorial-based fisheries.

For yellowfin tuna, significant differences existed in otolith core δ^{13} C and δ^{18} O of age-0 fish collected among nursery areas for each year of the two-year study period (2008-2009). Samples from the nearshore Hawaiian Islands were the most enriched in δ^{18} O, while samples obtained from the Philippines were most depleted in both δ^{13} C and δ^{18} O relative to other nurseries. Inter-annual variability in otolith core chemistry was significant for individuals from the Line Islands and Philippines, demonstrating the importance of age-class matching when attempting to predict natal origin of older fish. Overall cross-validated classification success to the Hawaiian Islands and Line Islands was 100%. Mixed-stock analysis indicated 95% of sub-adult yellowfin tuna collected from the nearshore Hawaiian Islands originated from this same nursery area. Similarly, the majority of subadult yellowfin tuna in equatorial areas around the Marshall Islands originated from the same region (91%), highlighting the importance of locally spawned yellowfin tuna to fisheries in both regions.

Discrimination of age-0 bigeye was moderate among nursery areas, with no significant distinction among nurseries in the central Pacific samples (Hawaii, Cross Seamount, and Line Island). Nevertheless, signatures were distinct between equatorial and central Pacific regions, and mixed-stock analysis indicated that over 99% of sub-adult bigeye tuna in the Marshall Islands originated from the nurseries in the equatorial Pacific. Determining the origin of sub-adult bigeye in Hawaiian waters was more problematic because signatures of individuals from different nurseries in the central Pacific were similar. The project hopes that the addition of trace elements to the project's baseline will enhance its resolving power in the central Pacific, particularly the Hawaiian Islands. However, the project is still awaiting data from Woods Hole Oceanographic Institute to fully explore the value of adding trace elements to the project's models.

PFRP: Performance of Longline Catchability Models in Assessments of Pacific Highly Migratory Species

P.I.: Kevin Weng [Keith A. Bigelow, Mark Maunder, Adam Langley, Pascal Bach]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of the project is to provide improved models of tuna and billfish resource abundance to the regional fisheries agencies (IATTC, NOAA Fisheries, NRIFSF, SPC) or committees providing scientific advice to management bodies (ISC, Scientific Committee of the WCPFC). Standardized longline CPUE trends are highly influential in Pacific HMS assessments because the standardized trends represent the only indication of resource abundance in the absence of fishery independent indices. The removal of catchability and vulnerability effects will continue to be an important consideration in future Pacific HMS assessments. The project will also develop improved longline catchability models for use in population assessments.

Progress during FY 2010

The project worked with the IATTC and the Shanghai Ocean University on an evaluation of detailed information from experimental longline fishing to investigate the main factors that degrade the performance of habitatbased CPUE standardization approaches. Analysis of bigeye tuna catch rates from longline sets with depth and temperature recorders suggested that habitat based indices of abundance from statistical analysis of longline data are not influenced by the assumptions about the methods used to calculate fishing depth of hooks, source of environmental data, or use of appropriate archival tag data. However, the estimated temperature preference of bigeye tuna from the catch rate data are substantially different from those estimated from archival tag information. The temperature preference from archival tag data provide a substantially worse fit to the catch rate data. These results add additional support to the suggestion that habitat preferences estimated from archival tags are not appropriate for standardizing catch rates for bigeye tuna and, probably, other species. A draft manuscript was produced based on the study.

The project continued collaboration with Dr. Phil Goodyear to simulate fish populations given specific habitat preferences, generate spatial and temporal strata with fish vertically distributed by habitat, and apply catch rate standardization analyses to ascertain if "true" population trends can be recovered. Simulations were conducted for Atlantic bigeye tuna and blue marlin. Catch rate standardization analyses of the simulated data were not completed due to time constraints for researcher K. Bigelow.

PFRP: Rescue, Compilation, and Statistical Characterization of Historic Longline Data, Pacific Oceanic Fisheries Investigation 1951-73.

P.I.: Kevin Weng [Bert Kikkawa]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

This report describes work performed as a continuation of "Rescue, Compilation, and Statistical Characterization of Historic Longline Data, Pacific Oceanic Fisheries Investigation, 1951-1973" (PFRP Project 657356). This portion of the project involved careful examination of "rescued" data (i.e., data quality control) from three large foreign fleets, followed by preparation and formatting of the data into a Geographical Information Systems (GIS) database. The GIS will be used to characterize and visualize the data in the form of maps that depict spatiotemporal
patterns in the distributions and relative abundances of the major tunas, billfishes, and sharks caught by pelagic Pacific longline fisheries. The corrected catch data will be archived by the Scientific Information Services group at the PIFSC.

Progress during FY 2010

During FY 2010, the Samoa Cannery Tuna Catch Data (logbooks), referred to henceforth (and at the PIFSC) as FC003, were carefully evaluated for accuracy, organized, and then depicted in several ways. A text file FC003 contains catch (counts, as catches per set) and operational information from Japanese, Taiwanese, and Korean fleets (Japanese 1963-1972; Taiwanese 1964-2000; Korean 1964-1992). These dates differ from those in the project title because additional records from years after 1973 became available after the original project approval, whereas data from the 1950s data were not available.

The project prepared text file FC003 by importing the original data into an Excel spreadsheet and then formatting it into headers and catch and effort information as specified by a key created earlier in this project. The data from FC003 were checked for various problems (e.g., missing values, duplicate records, typographical errors, etc.) and corrected as necessary. These exploratory analyses indicated that there were insufficient numbers of measurements for most species to detect and estimate trends in sizes. There were, however, sufficient size data for albacore (*Thunnus alalunga*) so this became the species of primary interest regarding sizes of fish caught at various times and places.

FC003 was next entered into a GIS database. This involved opening the Excel table in ArcGIS, and converting the coordinate information in the table to an XY format. In order to center the dataset onto the Pacific Ocean, the projection was set at PDC Mercator, WGS 84, meridian -150. The points were then examined for their distributions. All outlier points were either deleted or corrected for location based on octant code and other relevant information available in the dataset. The ArcGIS database (FC003 Historical Longline Fishery.dbf) is comprised of multiple point feature class files, raster files, Dbase tables, and metadata files written in conformity with NOAA Fisheries and spatial metadata standards.

The data were next subdivided further by fleet and set year, and whenever possible, by quarter. Point feature class files were created to show the geographic distribution of these subsets. Descriptive statistics (e.g., CPUE)



Figure 1. Distribution of Japanese longline effort throughout 1964.



Figure 2. Albacore Thunnus alalunga CPUE density plot throughout 1964.



Figure 3. Distribution of Japanese longline effort during the first quarter of 1964.

were added to the associated database tables. Graphs, histograms, and density maps were created using GIS tools to summarize the findings.

The only major project objective not attained was preparation of a PowerPoint presentation suitable for viewing by fishery scientists and managers. This aspect of the intended work was not performed because Mr. Kikkawa has been ill. In lieu of the PowerPoint presentation, animations were prepared to depict changes in the locations and levels of fishing activity by major foreign fleets over several decades. This departure from the original work plan was discussed with and approved by Mr. Kikkawa.

PFRP: Scaling Up: Linking FAD-Associated Local Behavior of Tuna to Regional Scale Movements and Distribution

P.I.: Kim N. Holland [Laurent Dagorn, David Itano]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of the project is to determine the geographical dimensions (size) of the ecosystem that underpins the coastal fisheries of the Hawaiian Islands—particularly the FAD fishery.

Progress during FY 2010

Tagging activities continued using a combination of acoustic and archival tags. Additionally, considerable effort was directed at analysis of the results of tagged fish that have already been recaptured. The emerging data set is of particular interest because the "fixes" obtained when acoustic tags are detected at FADs can be used to improve methods of modeling larger-scale movements based on light-based geolocation.

To date, 39 yellowfin tuna have been double tagged of which 13 have been recaptured after varying periods of time at liberty. Of these thirteen, 8 fish displayed significant off-FAD movements prior to recapture and these tracks are being used in the modeling analysis described above. To date, the results indicate that movements of FAD-associated yellowfin do not move beyond approximately 200 miles from shore.

PFRP: Sociological Baseline of Hawaii's Longline Industry

P.I.: Kevin Weng [Stewart Allen]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

This project extended the time frame and expanded the scope of an existing JIMAR project, "Sociological Baseline of Hawaii's Longline Fishery." The purpose of that project is to compile a comprehensive sociocultural profile of the longline fishing industry of Hawaii and provide information to decision-makers on regulatory impacts and implementation strategies. The additional funds were used to expand the sample of the original study and extend the scope to cover seafood distribution channels of longline-caught fish in Hawaii.

Progress during FY 2010

The sociocultural profile of the longline industry was completed and documented in a number of publications in 2007, already provided to PFRP. One additional publication, which will take the form of a NOAA Technical Memorandum, is in progress with a peer review completed in 2009. That publication combines the extended results with the five case studies of bycatch reduction in the longline fleet, a study undertaken using Fisheries Disaster funds. The second portion of the project, dealing with distribution of longline-caught fish, was initiated in combination with another PFRP project, "Distribution and Use of Seafood in the Context of the Community: A Case Study of the Main Hawaiian Islands" (Ed Glazier and Stewart Allen, PIs). That report described distribution channels of fish landed in Haleiwa and Waianae, and also included a case study of longline-caught fish from one vessel.

PFRP: Synchronous Assessment of Bigeye Tuna (*Thunnus obesus*) and Micronekton Biomass, Distribution, and Movement Patterns at Cross Seamount, and the Effects of the Seamount Environment

P.I.: Kevin Weng [Réka Domokos, Kim N. Holland, Jeffrey J. Polovina]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

Globally, seamounts play an important role in shaping the distribution of pelagic species, such as tunas and sharks. In the Hawaiian archipelago Cross Seamount, which is a seamount with a 5 nmi diameter 400 m deep plateau rising from a 5000 m seafloor and lying in the path of the North Equatorial Current (NEC) and internal tides generated at the Main Hawaiian Islands chain, is known to aggregate economically important fish such as juvenile and sub-adult bigeye tuna, a population that is heavily targeted by the local fishery. Reported moderate exploitation rates have recently raised concerns that the local fishery removes too many juveniles that could otherwise recruit to adult grounds and help maintain Pacific stocks. Because adult bigeye tuna are an important target species of both local and international fisheries, reducing recruitment into adult populations of bigeye could have wide ranging negative effects. These concerns call for closely monitoring the biomass of bigeye tuna aggregated at Cross Seamount. Because stock assessment methods that depend on conventional fisheries are known to be inaccurate and biased, the current research undertakes the development of a fisheries independent method of bigeye tuna biomass estimation using active acoustics. Further, because populations of bigeye tuna depend on the biological and physical environment, the distribution, composition, and movement patterns of bigeye tuna forage, micronekton, as well as the effects of the unique environment at Cross Seamount on both bigeye and micronekton, are investigated.

Progress during FY 2010

All data analyses for the effects of abrupt topography on ambient currents and on primary productivity, as well as the characterization of the effects of seamount environment on the spatiotemporal distribution and composition of micronekton were completed during FY 2009. A manuscript was prepared for publication in a peer-reviewed journal on this part of the project. During FY 2010, the manuscript was completed and submitted for publication.



Figure 1. Kernel Densities of TS values from bigeye tracks with -45°, 0°, and +45° degrees from the horizontal ($\pm 22.5^{\circ}$) from data collected in 2007 (left) and 2008 (right). TS values are significantly different from each other between angles but not between years.

Data analyses during FY 2010 were focused on the characterization of the movement patterns and spatiotemporal distribution of bigeye tuna associated with Cross Seamount using quantitative analyses. These analyses confirmed that tracks that were detected using settings to eliminate fish tracks of other large fish, such as yellowfin and skipjack tunas, mahi-mahi, and ono were successful. Mean acoustic target strengths (TS) for bigeye tracks during the FY 2007 and FY 2008 surveys were -30.16 and -30.61 dB, not significantly different from each other. These TS values correspond to 59.75 and 57.26 cm FL bigeye, corresponding to the mean size expected for the population associated with Cross Seamount. These same TS values would correspond to 99.42 and 95.42 cm FL yellowfin and a much larger skipjack, much larger than the expected mean sizes of yellowfin and skipjack found at the Seamount. Further, TS from tracks of fish swimming upward and downward showed a significantly lower and higher mean TS than fish swimming horizontally (Fig. 1). These results correspond to TS measurements of bigeye that were previously published in the literature by researchers at Institute de Recherche pour le Développement (IRD), France.

To quantitatively describe the spatiotemporal distribution of bigeye, tracks were summed over 0.2 x 0.2 minute boxes for each hour over the entire survey area. The number of tracks for each bin was normalized by 1 km traveled by the ship. These maps reveal that overall, the highest densities of tracks were observed at the upstream edges of the plateau (Fig. 2), although the highest number of tracks was observed typically in mid-day during both survey periods. TS from bigeye tracks showed increasing TS values with depth, indicating that larger fish occupy deeper regions over the plateau. These results correspond to results of previous studies using data from tags and experimental and commercial fishing records. Further, the total number of normalized tracks was 1.5 times higher during the FY 2007 than the FY 2008 survey. The results of this part of the project indicate that true biomass estimates of bigeye over Cross Seamount is possible given that the acoustic data can be collected at speeds so each survey can be completed in an appropriately short enough time frame, which requires the ability of collecting clean acoustic data at relatively higher speeds (6-8 knots). However, relative biomass of bigeye associated with Cross Seamount can be monitored using the existing data in combination with data collected during surveys in the future.

All data analyses is complete and a manuscript on the bigeye tuna part of the project is being prepared for publication in a peer-review journal.



Figure 2. Number of bigeye tracks summed over 0.2 x 0.2 minutes bins for the entire cruise periods in 2007 (left) and 2008 (right). The number of tracks is normalized by 1 km of ship track. Red arrows indicate the prevailing current directions during the two surveys. Contours indicate bathymetry at every 100 m, with the innermost contour at 400 m and the thick, white contour at 1000 m.

67

PFRP: Trophic Ecology and Structured-Associated Aggregation Behavior in Bigeye and Yellowfin Tuna in Hawaiian Waters

P.I.: Kim N. Holland [Laurent Dagorn, David G. Itano]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of the project is to understand the patterns of association of pelagic fishes (especially tuna) with floating objects (particularly FADs) and the impact of FADs on the feeding ecology and overall health of these species.

Progress during FY 2010

Much activity was focused on the analysis of data already in hand. Specifically, spectral analyses were conducted on the durations of residences and absences from FADs. Initial results show that these phenomena are not normally distributed but are comprised of two types—long and short term visitors and long and short-term absences and that residence times and absence times are not causally related. Electronic tag data acquired from fish recaptured at FADs were also analyzed to describe the changes in swimming depth that occur when fish become associated with FADs.

In line with investigating the impact of structures (FADs) on the trophic ecology of pelagic fish, we initiated a series of experiments looking at the Body Index Analysis (BIA) to investigate the condition of fishes caught at FADs. Simultaneously, we began studies with captive tuna to validate the BIA technique. In order to acquire quantitative synoptic measures of the biomass associated with FADs, a portable scientific echo sounder was acquired and field calibration of the unit was initiated.

Protected Resources Environmental Compliance Initiative

P.I.: Thomas A. Schroeder [Alecia VanAtta]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The Protected Species Environmental Compliance Initiative (PRECI), begun in FY 2003, seeks to enhance the conservation of protected resources throughout the U.S. Pacific Islands. The goal of the PRECI is to establish and maintain enhanced management and outreach and education, based on scientific research for protected resources within the jurisdiction of the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) Pacific Islands Regional Office (PIRO), Protected Resources Division (PRD). The PRECI directly supports the Joint Institute for Marine and Atmospheric Research (JIMAR) theme of achieving a sustainable balance between the forces of coastal development and conservation/preservation goals by conducting research and performing outreach and education. Research conducted during the course of the PRECI will be used to assist resource managers in decision making and directing further investigation in habitat and protected species, enhancing interagency cooperation, performing outreach and education, and protected species conservation and recovery.

Progress during FY 2010

The objectives established for this period included:

• sea turtle research and fisheries related mitigation activities, both domestic and foreign;

- preparation of scientific and policy documents;
- management of marine mammals in the Pacific Island Region (PIR);
- providing marine mammal biological expertise during the preparation and review of scientific and policy documents;
- coordinating and building capacity for Hawaiian monk seal and stranded cetacean response on Maui;
- coordinating and building capacity for Hawaiian monk seal and stranded cetacean response in the PIR;
- directing the ESA Section 4 effort to revise critical habitat for the Hawaiian monk seal;
- assisting in outreach and education missions by managing and developing outreach programs, materials and
 activities, and creating partnerships with other federal and state agencies and non-profit organizations
- JIMAR Sea Turtle Biologist Karen Frutchey continues to serve as the NOAA Fisheries Service International

Fisheries Program point of contact for western and central Pacific marine turtle research and management projects. Karen also acts as a liaison between marine turtle research and management project principal investigators (or relevant project staff internationally) and PIRO. Over this past year, as U.S. territory lead, Karen made technical

site visits to the CNMI, Guam, and American Samoa. Karen made an additional site visit to New Caledonia to review program progress, as well as attended a Secretariat of the Pacific Regional Environment Programme (SPREP) meeting in Auckland where she reviewed regional marine turtle research initiatives and promoted PIRO's marine turtle recovery program. Karen also attended the 30th Symposium on Sea Turtle Biology and Conservation, where she presented findings and met with numerous stakeholders and researchers from around the world. Karen continues to provide technical support for a marine turtle genetic sampling project in conjunction with NOAA's Southwest Fisheries Science Center; that project helps to determine western Pacific green turtle nesting stocks by assisting countries and territories with sample organization, analyzing green turtle skin samples, and obtaining mitochondrial DNA haplotypes. As part of this genetics project, Karen traveled to the Solomon Islands in May 2010 to attend a CITES workshop, where she gathered critical information regarding the international transport of



Figure 1. Karen Frutchey working with turtle program staff in CNMI to inventory a green turtle nest in order to assess hatchling success.

genetic samples. She then traveled to Vanuatu for a site visit, and provided training in the collection and transport of genetic samples to local researchers. Karen also drafted several NOAA marine turtle grant applications and reviewed ongoing grant progress and annual reports. In June 2010, Karen was deployed to Florida for the Gulf Oil Spill response to assist with the movement and management of sea turtles nests.

JIMAR Marine Mammal Biologist Michelle Yuen assisted with several marine mammal projects in the PIR over the past year. Michelle was instrumental in the preparation for the take reduction planning process for false killer whales that are incidentally caught in the Hawaii-based longline fishery. In October 2009, she represented PIRO at a national NMFS take reduction meeting in St. Petersburg, Florida. She provided species biological information, assisted with contracts and purchases, and coordinated with stakeholders in preparation for the four Take Reduction Team meetings held from February to July 2010. Michelle also regularly assisted with several projects for the recovery of the Hawaiian monk seal, particularly with the implementation of NMFS' Recovery Plan (2007) and the organization of the Hawaiian Monk Seal Recovery Team (HMSRT). Specific duties included: assisting with the coordination of the Semi-annual Hawaiian Monk Seal Counts; editing the quarterly Marine Mammal Response Network (MMRN)Newsletter; presenting species information to several schools, trainings, and organizations; mentoring college students for independent research projects; and assisting with the coordination of the PIR Marine Mammal Response Meeting. In addition, Michelle coordinated and organized the annual meeting in December 2009 for the HMSRT, which included developing agendas, materials, and assisting with logistics. Michelle also assisted with the completion of the 2010 Negligible Impact Determination for the Central North Pacific Stock of Humpback Whales, and the 2010 Amendment of Incidental Take Statements in the 2005 and 2008 Hawaii-based longline fisheries biological opinions, and 2010 Marine Mammal Protection Act List of Fisheries. In June 2010, Michelle resigned from her position with JIMAR in order to accept a new position in Australia.

JIMAR Sea Turtle Biologist Kim Maison worked with partners on various Hawksbill research and recovery projects including: organizing the 2010 Hawaii Hawksbill Recovery Group meeting; revising and finalizing an Action Plan for Research and Management of Hawksbills in Hawaii; and assisting the Hawaii Island Hawksbill Recovery Project in applying for NOAA grant funding. She also conducted an island-specific site visit, along with U.S. Fish and Wildlife Service, to discuss hawksbill issues on Maui (additional meetings planned for other islands). Kim reviewed four grant proposals and served as technical monitor for two grant funded projects including Hawaii hawksbill monitoring and conservation and research on sea turtles at Palmyra Atoll. She served as PIRO's representative on the working group for the implementation of the new ESA sea turtle observer rule



Figure 2. Kim Maison assisting in deployment of a satellite tag on an adult male green turtle at Palmyra Atoll.

and provided PIRO input to the ESA Observer Rule Annual Determination to NOAA headquarters. In addition, Kim led the turtle team in conducting a literature review and mapping project compiling all known information on green turtle nesting sites in the Pacific that is in the process of becoming a NOAA Technical Memorandum. Kim also continued to maintain a Sea Turtle Reference database for PRD and served as a supporting team member on ESA Section 7 consultations, providing technical assistance to the regulatory team on numerous projects and consultations. In particular, she drafted language for agency documents to incorporate the impacts of climate change into analyses that is currently in review and she is currently leading the completion of a biological opinion on new regulations for the American Samoa-based longline fishery. She attended and presented at two professional conferences (in Hawaii and India) on Green Turtle Nesting Sites in the Pacific. Finally, Kim repeated the long distance education project about sea turtles and Hawaii with a first grade class in Allamuchy, New Jersey that she began two years ago.

JIMAR Endangered Species Biologist Jean Higgins continued directing the ESA Section 4 effort to revise critical habitat for the Hawaiian monk seal. For this project, she has led efforts to form and facilitate a Critical Habitat Review Team (CHRT) with NOAA Fisheries regional management staff and the NOAA Fisheries science center staff. The CHRT is responsible

for determining areas appropriate for the critical habitat designation as well as determining any exemptions and exclusions that may be appropriate for consideration. As facilitator for the project, she has organized and facilitated CHRT meetings and collaborated with stakeholders to ascertain information regarding anticipated impacts from the areas under consideration for critical habitat. Collaboration included working with the Department of Defense, relevant Federal and State agencies, and contracted economic experts. In preparation for the proposed rule, Jean has begun drafting supporting documents including the biological report, appropriate maps, and the ESA Section 4(b)(2) report. In conjunction with the critical habitat designation, Jean has also participated in collaborative efforts with Navy staff to review Integrated Natural Resource Management Plans drafts as well as efforts to create partnerships with the Marine Corps base to provide future support for Hawaiian monk seal rehabilitation efforts. Jean has also provided additional support including draft reviews, mitigation advice to efforts in conjunction with ESA section 4 and section 7, and grant reviews for protected species issues. In May of 2010, Jean resigned from her position at JIMAR to accept a federal position with NOAA Fisheries, Protected Resources Division.

JIMAR Outreach and Education Specialist Jen Metz continued to provide assistance and guidance with the various outreach and education efforts for PRD. Jen continued to work closely with the PRD Marine Mammal Response Coordinator on various outreach efforts aimed at promoting awareness and conservation of the Hawaiian monk seal. These programs included working with partners and developing several new activities to use at outreach events focusing on various monk seal management issues. Jen drafted Statements of Work for a future Hawaiian monk seal learning module project and managed the Hawaiian monk seal Public Attitudes and Awareness survey project. Jen worked closely with her PRD colleagues to create more awareness about the False Killer Whale and the False Killer Whale Take Reduction Team (TRT). Outreach materials developed include a new false killer

whale TRT webpage and fact sheet. She also worked with the Sea Turtle Team Lead to organize an Outreach and Education Assessment for Hawaiian green sea turtles. This involved a one-day meeting with various Federal and State partners, culminating with a prioritized list of action items. Actions items that were completed include the development of Hawaiian Green Sea Turtle signs to be placed on green sea turtle feeding and basking beaches and the revision of a informational tackle box sticker for fishers about sea turtle. Jen continued to represent PRD interests at various outreach events including the Molokai Earth Day event, Honolulu Zoo Endangered Species Day, and at the North Shore Jr. Lifeguard program.

In January of 2009, Shelley Steele was hired as a JIMAR Outreach and Education Coordinator for NOAA Fisheries Service PIRO. Shelley has assisted with a variety of outreach and education projects and programs for both the PIRO and the Pacific Islands Fisheries Science Center. She purchased outreach equipment and hardware (i.e., easels, banner stands, button maker, etc.) and also designed and developed a number of outreach and educational activities. These include the Ocean Food Web activity, Ocean Trivia Game, Ocean Zones and Habitats activity, as well as a "Careers in Marine Science" presentation package. Working closely with the NOAA Fisheries Service communications officer and graphics specialist, Shelley and the project have developed a wide variety of new products, materials, and activities to promote and garner name recognition for NOAA Fisheries Service since January 2009. General tasks include maintaining the 2009 Outreach Calendar of Events, monthly outreach and education Organizational Chart and Strategic Plan, which includes goals such as the implementation of key messages to be used to guide education and outreach content for the region and increase internal and external collaboration with the development of an outreach team to address relevant issues.

In October of 2009, Nicole Davis was hired as the MMRN Specialist on Maui. As part of the PIR MMRN, Nicole manages the Maui Seal Sighting Hotline phone and coordinates marine mammal responses on Maui and within Maui County. This includes: responding to cetacean stranding events and monk seal haul-outs; managing seal pupping events; coordinating volunteer response; coordinating the Semi-annual Monk Seal Counts; contributing to the quarterly MMRN Newsletter; and presenting species information to schools, at trainings and community events, and with local organizations. Nicole recently presented at the Annual PIR Marine Mammal Response Meeting in Hilo. Nicole attended the Monk Seal Recovery Team and Marine Mammal Commission meetings on Oahu in December 2009, and the Aversive Conditioning Workshop in November. Nicole strengthened the response network in Maui County and worked to build capacity for marine mammal response throughout the island. To achieve this the project recruited and trained new volunteers, acquired response equipment, and worked with various agencies and organizations. This was also accomplished (between October 2009 and June 2010) by Nicole's success in receiving and documenting hundreds of monk seal sighting reports, as well as coordinating the responses to: regular haul-outs for 10 different identified seals; two hooked seals; one dead seal; one seal satellite tagging; one hooked dolphin; two dozen distressed humpback whale reports; one near-mass dolphin stranding event; a 50- day seal pupping event; two live dolphin/whale strandings; and two large dead whale strandings. This effort will continue as Nicole works to build capacity, expands the volunteer team island-wide, and strengthens the network of government agencies, community organizations, and residents on Maui.

In November of 2009, Dera Look was hired as the Assistant MMRN and Coordinator for the PRD. Dera works with the PIR MMRN to build and maintain efficient responses to monk seal and cetacean events. She provided onsite coverage for live and dead dolphin/whale strandings, and was involved in several large whale disentanglement responses. In June of 2010, Dera served as the onsite NOAA coordinator for the first live cetacean rehabilitation candidate at the newly opened Hawaii Cetacean Rehabilitation Facility in Hilo. Dera has also served as coordinator during monk seal pupping events, hookings, and dead seal responses. She has assisted with necropsies to collect valuable biological samples for various research projects of the PIFSC and Hawaii Pacific University. Dera is responsible for maintaining the national Marine Mammal Health and Stranding Response Program's PIR data, as well as drafting correspondence and reports related to the MMRN activities. She also performs administrative and logistical duties including purchasing response equipment and supplies, and maintaining property accountability logs. Dera has recently taken over the management of the state-wide Monk Seal Sighting Hotline, which involves fielding outer island monk seal sighting reports, recording Oahu sighting data, and disseminating volunteers to monk seal haul outs. She was responsible for the coordination of the annual MMRN meeting and has edited the past two issues of the quarterly *MMRN Newsletter*. She has been involved with outreach initiatives and is in the process of organizing basic protected resources training for the Honolulu Police Department.

Reducing Shark Bycatch with Electropositive Metals in Hawaii-based Fisheries

P.I.: Thomas A. Schroeder [Samuel G. Pooley, John Wang, Yonat Swimmer]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The incidental capture of sharks is estimated at over 300,000 metric tons annually and often comprises a large proportion of the total catch (Fig. 1). NOAA Fisheries has recognized shark bycatch as a management priority fisheries challenge and has indicated, "Management entities should invest in elasmobranch research, fishery monitoring, reduction of bycatch and bycatch mortality, minimization of waste, and enforcement". This project examines potential deterrents that may be useful in reducing shark interactions with fishing gear. Specifically, the project conducted at-sea field trials to compare catch rates of sharks caught on hooks with and without an electropositive metal, specifically Nd-Pr. This specific alloy has been identified to repel sharks from approaching baited gear, and therefore the project's research aims to identify the alloy's potential use as an effective bycatch mitigation method to reduce the unwanted capture of sharks in fishing gear.

Progress during FY 2010

• Highlights

- 1. Conducted inshore longline trials examining the effects of Nd/Pr alloys on scalloped hammerhead sharks.
- 2. Conducted longline trials examining the effects of Nd/Pr alloys on blue sharks and mako sharks.
- 3. Conducted pilot study in Ecuadorian longline fisheries examining effects on mixed shark species.
- 4. Currently conducting behavioral studies examining feeding behaviors of captive sharks to Nd/Pr alloys.
- Summaries

1. Conducted inshore longline trials examining the effects of Nd/Pr alloys on scalloped hammerhead sharks (Sphyrna lewini). In cooperation with University of Hawaii's Hawaii Institute of Marine Biology (HIMB), the project conducted fishing experiments in Kaneohe Bay with bottom-set longline gear targeting juvenile scalloped hammerhead sharks (*Sphyrna lewini*). Bottom longline gear contained branchlines that alternated with control 45g lead weight and 45g Nd-Pr weight. Results from 19 bottoms longlines yielded a total of 59 scalloped hammerhead sharks with 18 sharks caught on treatment hooks (CPUE= 0.008 sharks/hook-hour) vs. 41 sharks caught on



Figure 1. Sharks caught in artisanal fishery in Baja, Mexico.

control hooks (CPUE=0.019 sharks/hook-hour), suggesting a > 50% reduction on capture rates of sharks on hooks with Nd-Pr weights (Fig. 1).

2. Conducted longline trials examining the effects of Nd/Pr alloys on blue sharks and mako sharks. In collaboration with HIMB and NOAA Southwest Fisheries Science Center (SWFSC), the project conducted longline field trials off the coast of Southern California. Longlines were composed of 200 branchlines in which branchlines with lead weight alternated with branchlines with Nd/Pr metal weight for a total of 25 longlines set. The catch was composed of primarily mako sharks (*Isurus oxyrinchus*) (n=117) and blue sharks (*Prionace* glauca) (n=37). Initial analysis indicates no difference in the catch rates of mako sharks and blue sharks between control and treatment branchlines.

3. Conducted pilot study in Ecuadorian longline fisheries examining effects on mixed shark species. In collaboration with the Ecuadorian governmental and non-governmental agencies and NOAA Southwest Fisheries Regional Office (SFRO), the project initiated a pilot study in the Ecuadorian artisanal longline fisheries targeting tunas, billfish, and sharks. Longlines were composed of 300 branchlines and the project alternated branchlines with lead (control) vs. Nd/Pr



	Caught on Metal	Caught on Control	Total Caught
mako shark	61	56	117
blue shark	17	21	37
common thresher	0	1	1
dorado	0	1	1
hammerhead shark	1	0	1
mackerel	3	2	5
Mola mola	1	0	1
pelagic stingray	8	5	13
spiny dogfish	1	0	1

Figure 2. Comparisons of sharks caught on hooks with electropositive metal vs. controls.

Figure 3. Catch data from at-sea field trials testing catch rates of sharks on lines with and without electropositive metals.

(treatment) metal weights. Three sets were deployed over three days of fishing. Catch was low due to poor conditions and competition from other longline fishing boats in the area. Nonetheless, the project caught pelagic thresher sharks (*Alopias pelagicus*), silky sharks (*Carcharhinus falciformis*), and scalloped hammerhead sharks. The project was disappointed in the low catch rates and plans additional field trials to complete this work during summer 2010.

4. *Currently conducting behavioral studies examining feeding behaviors of captive sharks to Nd/Pr alloys.* In collaboration with HIMB the project is conducting a behavioral experiment with juvenile scalloped hammerhead sharks examining feeding and swim behavior in response to electropositive metals, electric fields generated by electrodes, hydrogen gas bubbles, and small amounts of Nd and Pr oxides. Protocols have been developed utilizing eight hammerhead pups in 114 feeding and swimming observations. Experiments are ongoing.

Satellite Remote Sensing Research Program

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Jeffrey J. Polovina]

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

NOAA Goal(s)

To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of this project is to: use satellite remotely sensed oceanographic data to describe ocean dynamics, particularly ocean features of importance to living marine resources; and use satellite remotely sensed data together with fishery data or tagging data to advance the project's understanding of aspects of the pelagic ecosystem including its spatial and temporal dynamics.

Progress during FY 2010

In FY 2010 the project completed an analysis of output from the NOAA Geophysical Research Laboratory's climate model to describe possible ecosystem changes in the North Pacific over the 21st Century. The results from this work were presented at the PICES/ICES Symposium on Climate Change Effects on Fish and Fisheries in Sendai, Japan, April 25-29, 2010 and submitted for publication. The project also completed a description of the oceanic habitat of melon-headed whales around Hawaii with electronic tracking data and satellite remotely sensed data. These results were submitted for publication.



Potential changes in depth-integrated primary production in the North Pacific based on NOAA's GRL climate and ecosystem model over the 21^{st} Century. Mean depth-integrated primary production, (a) 1998-2017, (b) 2080-2099, (c) time series of the area with primary production less than 0.3 gC/m²/d in the subtropical biome (red line) and the time series of the area with production equal to or greater than 1.2 gC/m²/d in the equatorial upwelling biome. Dashed white lines in (a) and (b) indicate the biome boundaries.

Sustainable Fisheries Initiative

P.I.: Thomas A. Schroeder [Alvin Katekaru]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of the Sustainable Fisheries Initiative is to foster sustained optimal use of marine fishery resources and to provide maximum protection for protected species in the Pacific Islands region. Project activities are authorized under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) and are consistent with the NOAA Fisheries Strategic Plan. The project uses the best scientific information available, collects/analyses data, and disseminates information, including socio-economic and regulatory information. It also evaluates biological, environmental, and economic issues of the impacts of such management actions on the human environment and protected species interaction with fishing gear. The desired outcome is to increase food supply, enhance the region's economy, maintain and foster island cultures, maximize commercial and noncommercial (recreational, subsistence, customary exchange) fishing opportunities while preventing overfishing and adverse impacts to protected resources.

Progress during FY 2010

Sustainable Fisheries Outreach and Education Projects. Generally, the project promoted western Pacific U.S. commercial and recreational fishermen's awareness of and knowledge about sustainable fisheries issues, proposed

fishery management actions, and new federal fishery regulations. During FY 2010, the following projects were completed.

- Main Hawaiian Islands Bottomfish Regulations Brochure
- CNMI Bottomfish Regulations Brochure
- CNMI Bottomfish Poster
- Seabird Mitigation Poster
- 2010 Bottomfish closure poster/flyer
- 2010 National Angler Registry handout flyer
- Hawaiian Spinner Dolphin brochure
- · Sea Turtle Signage
- · Western Pacific fisheries regulatory compliance guide updates
- Reorganized Sustainable Fisheries Division web site layout

Sustainable Fisheries Magnuson-Stevens Act and NOAA Fisheries Strategic Plan Mission Support Projects. The primary focus of these projects was to assist in the review, analyses, and revision of management actions recommended by the Western Pacific Fishery Management Council in compliance with requirements of the National Environmental Policy Act. During FY 2010, the following projects were completed.

- Establishment of American Samoa purse seine exclusion area.
- Gear modifications in the American Samoa longline fishery.
- Hancock seamount groundfish management measures.
- · Changes to Northwestern Hawaiian Islands bottomfish management areas boundaries.
- Fishery management measures for Pacific Islands' marine national monuments.
- Annual bigeye tuna quota management of the Hawaii-based deep-set tuna fishery.
- · American Samoa longline fishery limited entry permit program.
- · Longline and purse seine exclusion areas in the Northern Mariana Islands
- Purse seine fish aggregating device management in the western Pacific region.
- Total Allowable Catch Specs for main Hawaiian Islands bottomfish fishery 2010-11.
- Establishment of process for Western Pacific Community Development program.

Western Pacific Fisheries Information Network Project

P.I.: Thomas A. Schroeder [Michael M. Quach]

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

NOAA Goal(s)

· To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The Western Pacific Fisheries Information Network Project, funded through JIMAR (WPacFIN JIMAR), is an ongoing project that supports the primary functions of the Western Pacific Fisheries Information Network (WPacFIN) Program at the Pacific Islands Fisheries Science Center (PIFSC). WPacFIN JIMAR focuses on improving data collection in the Pacific Islands Region to address data needs to protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management. The project supports this goal at various levels, improving the quality of data input to fisheries modeling and research, as well as improving the accuracy of forecasting to help decision makers develop and ensure compliance with established catch limits.

The project's main clients are fisheries scientists, researchers, JIMAR and University of Hawaii institutions, the National Marine Fisheries Service, and the Western Pacific Regional Fisheries Management Council (WPFMC). The mission is to provide technical support to help participating fisheries agencies in American Samoa, Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI) develop and implement their fishery-dependent data collection programs; and provide the data needed to support these clients monitoring of established total allowable catch (TAC), quotas, data requests, Fisheries Ecosystem Management Plans and Reports.

Progress during FY 2010

WPacFIN JIMAR project continues to make significant progress in developing software applications and providing technical support for these applications. Project staff have designed, programmed, and implemented new and revised computer applications in the island agencies and in the central WPacFIN office to process the wide range of data collected by fisheries researchers and make these data available to users. A few applications have been redesigned and rewritten to address changes in the fisheries and new requirements. Staff responded to numerous data summary requests from the island agencies, Council, PIFSC, PIRO and NOAA Headquarters. The project met most of the proposed activities outlined last year. Two tasks were not completed due to lack of support and/or decision from participating agencies.

- Improve American Samoa Tutuila-based creel survey systems to incorporate Manu'a-based data collection, if resources permit; and
- Work with the WPFMC and islander staff to improve programs that produce the WPFMC Ecosystem Plan report modules.

Coastal Research

The JIMAR Administrative Board approved the addition of coastal research as the sixth JIMAR research theme at its November 2000 meeting. Subsequent to this decision, two initiatives focused further attention on this emerging research area. NOAA established a Coastal Services node in Honolulu and President Clinton designated the Northwest Hawaiian Island as a national refuge. To date, JIMAR research has been directed at issues related to coral reefs, a major component of the coastal zones of Hawaii and U.S.-affiliated Pacific Islands.

Applications of Satellite Ocean Remote Sensing to Living Marine Resources (Ocean Remote Sensing)

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Jeffrey J. Polovina]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The NOAA OceanWatch-Central Pacific node supplies near real-time, remotely sensed oceanographic and environmental data of the Pacific Ocean for resource managers, researchers, educators, and the general public. The satellite-derived products include ocean surface temperature, ocean color, ocean surface topography, ocean surface wind fields, environmental indicators (Empirical Orthogonal Functions [EOFs]), and high-resolution (1.1 km) thermal infrared High Resolution Picture Transmission (HRPT) imagery from the NOAA AVHRR satellites. The HRPT data is collected daily by the AVHRR receiving station located in Ewa Beach, on the Island of Oahu, Hawaii.



Near real-time sea-surface height anomaly and geostrophic currents data used for navigating an underwater glider for the surveying of a cyclonic eddy off Hawaii.

Progress during FY 2010

In FY 2010, OceanWatch continued to supply remotely sensed data and products to a wide range of users around the Pacific Rim. Technical improvements were made to the project's database including software updates and the migration of processing servers. The project continued to provide customized remote sensing products in support of various research investigations. OceanWatch also incorporated the newly reprocessed SeaWiFS ocean color dataset and developed global SeaWiFS ocean color climatologies. In addition, it established a data stream to provide real-time sea surface height data for rapid oceanographic cruise support.

Coral Reef Management Initiative

P.I.: Thomas A. Schroeder [Alan Everson, John Naughton]

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

NOAA Goal(s)

To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of the project is to enhance the management of coral reef habitat throughout the U.S. Pacific Islands. The goal of Coral Reef Management Initiative (CRMI) is to establish an enhanced coral reef management presence within the existing NMFS, Pacific Islands Regional Office (PIRO), Habitat Conservation Division (HCD). The CRMI relates directly to the JIMAR Coastal Research theme of achieving sustainable balance between the forces of coastal development and preservation. Information obtained as a result of CRMI assists resource managers in attaining this goal. It also enhances interagency cooperation and information exchange, and develops new technologies for coastal resource management. A major focus of this initiative is to investigate approaches to develop appropriate compensatory mitigation for coastal construction related loss of coral reef habitat, including but not limited to conducting follow-up studies of several coral reef mitigation projects. A coral reef classification system will be developed for use in habitat management decisions made by the HCD. The initiative will also enhance the project's capacity to address coral reef conservation issues in Guam, CNMI, and American Samoa as well as aid in the development of an integrated GIS-based system to evaluate anthropogenic impacts to coral reefs.

Progress during FY 2010

The coral reef management initiative can be divided up into four sub-projects: coral reef assessment/mitigation; Guam/CNMI/American Samoa Coral coordinators; Hawaii Local Action Strategy Coordinator; and Fishery Extension Agent.

• *Coral reef assessment/mitigation*: Overall accomplishment has been contribution to the enhanced regulation of impacts to coral reefs in the U.S. Pacific Islands. This was accomplished via: 1) implementing pertinent federal mandates entailing NEPA review, for example of the Guam Military relocation draft EIS, and providing technical advice on biological assessment/monitoring protocols and mitigation plans for proposed Army Corp projects such as harbor improvements and beach restorations; 2) building office capacity to manage nearshore water quality by among other things becoming an active member of the sediment response framework planning team and the land based pollution local action strategy steering committee; 3) improving collaboration and expertise by traveling to American Samoa to make connections with local agencies and communities, San Francisco for a Clean Water Act training course, Los Angeles to attend the National EFH Coordinator's Meeting and by attending in Honolulu a PRIMER multivariate statistics training; 4) assisting with coral damage assessment at a ship grounding site at the harbor channel off Barbers Point, Hawaii; and 5) developing a guidance document on management needs for soft sediment by identifying the ecological function and value of this habitat type.

• *Guam/CNMI/American Samoa Coral coordinators*: Guam Coral Reef Ecologist Val Brown's Guam staff continued efforts to support coral reef management and conservation in Guam through numerous activities. The



Figure 1. Size at 1st maturity workshop in CNMI showing measurement guide designed by JIMAR staff.

Guam Coral Reef Ecologist was the on-site coordinator and an instructor for the regional Responding to Climate Change workshop on Guam; supported a local community based marine debris and biological monitoring program; worked with the local agencies to begin the development of a Natural Resources Damage Program for the territory; sat on the steering committee and maintained the web site for the Limits of Acceptable Change planning process for recreational and commercial activities in the Guam Marine Preserves; continued to participate in the Guam military buildup preparations and assessments; analyzed local fisheries data; and was part of a regional team developing a fisheries education campaign. In addition, staff provided support for the Guam Coral Reef Task Force Point of Contact, Guam Coral Reef Initiative, Guam Long Term Monitoring Program, and other local agencies. • CNMI Coral Reef Ecologist: The CNMI coral reef ecologist (CRE) undertook a variety of administrative responsibilities associated with the hiring and orientation process, development of a new CNMI field office and NOAA diver certification as well as watershed, climate change, GIS, Coral Reef CSI, Micronesian Challenge, Biosecurity and priority setting workshops. The CRE also helped the local division of Fish and Wildlife (DFW) advance their oceanographic sensor and invasive species programs and coordinated all the documents to establish their ESA Section 6 agreement. He also submitted four proposals on behalf of the

DFW turtle program and wrote the pre-proposal for the CRCP project that will create a CNMI Reef Resiliency Plan and fund the associated outreach and monitoring. He also coordinated the call for bids to initiate summer monitoring during the NMI bleach watch and submitted proposals supporting research for bleaching differential recovery and MPA outreach. The CRE assisted in setting the groundwork on two traditional fishing projects and two outreach (L50) media materials projects. The CRE also worked with local school students at the CNMI 2010 Environmental Expo, one of many outreach activities he coordinated this year. Other projects included permit review and assisting the local POC with document review, interviews, priority setting and field support, including 18 days in Pagan assisting USFWS with marine surveys.

• American Samoa Coral Reef Ecologist Fatima Sauafea-Leau: On June 29th and 30th, 2010, Le Tausagi (interagency resource education group) facilitated and hosted a Teachers Environment Workshop with a theme

of "Ridge to Reefs Teachers Discovering American Samoa's Natural Resources". The primary goal of this project is to engage science teachers from elementary schools in an environmental workshop focusing on marine-related issues that will assist to prepare them to take leads during the annual Enviro-Discoveries summer camps. There were 23 participants, including students from the Gear-Up summer program of the Department of Marine and Wildlife Resources office. Teachers who participated in the workshop will take part in the Enviro-Discoveries summer camps on July 13th to the 15th to utilize the knowledge and resources gained from the workshop facilitate environment education to projects and games during the camps. In addition, the information gained from the Figure 2. American Samoa teacher's workshop 2010. workshop will assist them in improving



their teaching capabilities and developing lesson plans for the upcoming academic year. The participating teachers from the workshop will formulate a network of science teachers in partnership and collaboration with Le Tausagi in planning, developing, and implementing marine science education and awareness activities to schools. Because the pre-evaluation has identified from the teachers the major themes that they needed more resources and information, the workshop will focus on coral reefs and fisheries, water quality, and climate change. It is the project's hope that the information and knowledge sharing, resource materials, and activities will equip the participants with skills, knowledge, and understanding to educate their students about the environment as well as help enhance the project's education campaign efforts to improve the management of the environment and resources.

• Hawaii Fishery Extension Agent Mike Lameier: The Hawaii Fishery Extension Agent's work in 2010 focused on continuing several projects and starting a new project. The O'ahu Beach Access Inventory database is being reviewed by partners at the Honolulu City and County and plans for web site development have begun with partners at UH Sea Grant. The Collaborative Ciguatera Research Project expanded and supplied researchers with over 1100 Roi samples from four islands. Additionally, education and outreach activities continued at popular fishing locations, fishing tournaments, and schools including the distribution of over 30,000 fish measurement guides. Assistance has also been provided to develop fish measurement guides for American Samoa, CNMI, and Guam. In addition to on-going projects, this year, the Scientists and Fishermen Exchange (SAFE) Project was established. The mission of SAFE is to provide a safe and comfortable environment where genuine exchange of information improves communication and collaboration, builds positive relationships, encourages understanding, and fosters respect and trust among scientists, managers, and fishermen. Thus far three SAFE meetings have been conducted. The topics of discussion at the meeting have focused in invasive fish species such as Roi and Ta'ape. One exciting outcome of this project is that fishermen will be collaborating with scientists at UH and The Nature Conservancy to conduct a Roi Removal Experiment in Hawaii.

National Environmental Policy Act (NEPA) Initiative

P.I.: Thomas A. Schroeder [Charles Karnella]

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

NOAA Goal(s)

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

Under the Federal National Environmental Policy Act (NEPA), federal agencies must ensure that environmental information is made available to public officials and citizens before decisions are made and actions are taken. The purpose is to promote management and policy decisions that will prevent or eliminate damage to the environment, stimulate health and welfare of man, and enrich understanding of ecological systems and natural resources important to the Nation. The major focus of this initiative is to obtain technical assistance on an activity-and project-specific basis to ensure timely and legally sufficient agency compliance with applicable NEPA requirements. The initiative addresses NOAA Fisheries Service's NEPA compliance with international treaties and fosters international marine resource conservation measures.

While NOAA Fisheries Service has addressed NEPA compliance associated with Federal activities (i.e., development of fishery management plans) in the past, this NEPA Initiative represents a holistic effort to foster compliance with NEPA in international projects. Information and lessons learned from this NEPA Initiative will be evaluated and applied to future NEPA actions. NEPA-focused hires under this initiative will closely coordinate and collaborate with several existing organizations with marine resource protection mandates. These include, but are not limited to: NOAA Pacific Islands Region Fisheries Science Center; NOAA National Ocean Service; NOAA and NOAA Fisheries Service headquarters components; and the Western Pacific Fishery Management Council.

The primary purpose of the NEPA Initiative is the development of NEPA analyses for the promulgation of regulations to implement the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (Convention) and decisions made by the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPFC), pursuant to the authority of the Western and Central Pacific Fisheries Convention Implementation Act (WCPFCIA; 16 U.S.C. § 6901 et. seq.). The initiative also supports NEPA analyses for the promulgation of regulations to implement the South Pacific Tuna Treaty (SPTT), pursuant to the authority of the South Pacific Tuna Act (SPTA; 16 U.S.C. § 973-973r).

Progress during FY 2010

• Promulgation of regulations under the authority of the WCPFCIA or SPTA and the associated NEPA analyses involves complexities related to, among other things, whether and how to analyze environmental effects abroad, determinations of whether the agency has any discretion in the needed actions, the range of alternatives to be analyzed, and the scope of the analyses required. These factors have resulted in the need for extensive research and strategy development, which have been incorporated into NEPA documents.

• A final Environmental Assessment (EA) for the implementation of the decisions of the Fifth Regular Annual Session of the WCPFC was completed (July 2009). A supplemental EA was prepared and completed (October 2009).

• A final EA was completed (December 2009) for a proposed rule for the initial implementation of the Convention.

• Two EAs are being prepared for the implementation of the decisions of the Sixth Regular Annual Session of the WCPFC. It is anticipated that these EAs will be completed in the next fiscal year.

• This fiscal year also saw the development of new record-keeping and document management strategies and plans to support rulemaking and associated NEPA document preparation.

Sustaining Healthy Coastal Ecosystems

P.I.: Thomas A. Schroeder [Rusty Brainard]

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

NOAA Goal(s)

- · To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management
- To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

This project addresses concerns about the deterioration of coral reef ecosystems around the globe and supports interdisciplinary assessment and monitoring activities that contribute to an improved understanding of coral reef ecosystems and, in turn, serve as the scientific basis for initiating the implementation of ecosystem approaches to management and conservation of coral reefs in the U.S. Pacific Islands. The goals of this project include the following.

- Improve understanding of coral reef ecosystems through assessment, long-term monitoring, and managementrelevant applied research.
- Evaluate and reduce adverse impacts to coral reef ecosystems with particular emphasis on those impacts related to fishing activities, land-based pollution, and climate change.
- Support local, regional, and national coral reef management needs by performing integrated ecosystem-based assessments across the U.S. Pacific Islands.
- Enhance coral reef fisheries management and conservation by providing scientific support for implementation of state, territorial, and federal fishery management plans such as the Coral Reef Ecosystem Fishery Management Plan and archipelagic-based ecosystem management plans of the Western Pacific Regional Fishery Management Council.
- Provide the scientific basis to expand, strengthen, and establish marine protected areas (MPAs) to conserve coral reef resources of the U.S. Pacific Islands.

Progress during FY 2010

To support the objectives of this project, the following activities were performed during FY 2010.

• On September 29, 2009, a strong tsunami struck American Samoa, during which the devastating waves damaged property, swept villages out to sea, caused a number of deaths, and deposited a great deal of marine debris on coral reefs and in surrounding waters. A 19-member NOAA marine debris team, including nine JIMAR staff, was

deployed in American Samoa from Nov. 29 to Dec. 17, 2009, to assess and mitigate the impact that the marine debris has had on the coral reefs around Tutuila Island. Working with other federal and territorial agency representatives, village leaders, local news agencies, and volunteers, the NOAA team completed a preliminary survey of the amount and effect of marine debris in the reef ecosystems. Experienced JIMAR marine debris divers helped to survey 74 km of coral reef habitat, collect and remove a total of 8,848 lbs (4021 kg) of tires, roofing materials, clothing, and household items, and identify 253 additional targets for removal. (Note: This unexpected event added the burden of a month's preparation and deployment to American Samoa for nine staff members, thus causing delays in completion of other schedule work, such as the publication of the on-going series of Monitoring Reports.)

As part of an on-going time series to monitor coral reef ecosystem health in the U.S. Pacific islands, three interdisciplinary Pacific Reef Assessment and Monitoring Program (RAMP) cruises (http://



Figure 1. JIMAR personnel offload marine debris that was removed from the coral ecosystems of Tutuila, American Samoa, after the Sept. 2009 tsunami.

asramp10.blogspot.com/) were conducted aboard the NOAA Ship *Hi*'*ialakai* around the islands and banks of American Samoa and the newly designated Pacific Remote Islands Marine National Monument—Johnston, Howland, Baker, and Jarvis Islands, Kingman Reef, and Palmyra Atoll. Scientists from NOAA, JIMAR, and



Figure 2. Of all the corals surveyed at Howland Island during the 2010 RAMP in the Pacific Remote Islands Marine National Monument, approximately 30% were bleached. Branching (Acropora sp.) and table corals were especially affected by bleaching.

partner agencies conducted integrated assessments and monitoring of fish, corals, algae, and invertebrates and collected a variety of oceanographic and water-quality observations. The number of fish surveys around Tutuila, American Samoa, was more than doubled in order to help meet the legal mandate to determine Annual Catch Limits (ACLs) for coral reef fisheries. Follow-up towed-diver assessments of the damage resulting from the 2009 tsunami were also conducted, and the condition of the coral reef ecosystems around Tutuila was judged to be quite good, considering the tsunami had struck less than six months before the surveys. During surveys at Howland and Baker, mass coral bleaching was identified, particularly on the eastern side of the islands; strong temperature anomalies were recorded by previously deployed oceanographic instrumentation.

During two cruises in the Northwestern Hawaiian Islands (NWHI) in September and October, 2009, aboard the NOAA Ship *Oscar Elton Sette*, a total of 124,230 lbs (56,468 kg) of marine debris was collected from the islands of Maro Reef, Laysan, and Lisianski Islands, Kure Atoll, Pearl and Hermes Reef, and French Frigate Shoals. The ship and crew also provided aid to protected species field camps at Laysan Island and French Frigate Shoals before, during and after the approach of Hurricane Neki.

JIMAR staff participated in a multidisciplinary cruise in the Mariana Archipelago aboard the NOAA Ship *Oscar Elton Sette* that tested multiple fisheries-independent methods to determine ACLs for coral reef fishes, including use of two baited camera stations (BRUVS and BotCam), an Automated Underwater Vehicle, and a towed camera system. In addition important fisheries resource areas, including Galvez Bank, Rota Island, Farallon de Medinilla, and several other small offshore banks were mapped from the *Sette* using a pole-mounted, 240-kHz multibeam sonar. A Guam high school teacher participated in the cruise as part of increased education and outreach activities. (http://fish250.blogspot.com/)



Figure 3. Three-D perspective views of high-resolution bathymetry at the northern Galvez Bank, showing the reef structure in comparison to nearby sandy or smooth carbonate areas. Numerous baited camera stations were deployed in this area to document the various benthic habitats and associated coral reef fishes.

Petitions to list 83 corals and the Bumphead parrotfish (*Bulbometopon muricatum*) as threatened or endangered under the Endangered Species Act were received by the National Marine Fisheries Service on Oct. 20, 2009, and Dec. 31, 2009, respectively. JIMAR personnel are serving on a Subject Matter Expert Panel in support of the Pacific Islands Fisheries Science Center's (PIFSC) Biological Review Team that is charged with using the best available scientific and commercial information to determine the present and future extinction risk of these species.

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Appendix I List of Acronyms

ACC	anomaly correlation
ACL	Annual Catch Limit
ACLs	Allowable Catch Limits
ADMB	Advection Diffusion Model Builder
APDRC	Asia-Pacific Data-Research Center
APECOSM	Apex Predators Ecosystem Model
APECOSM- E	Apex Predators Ecosystem Model–Estimation
ARL	Air Resources Laboratory
ARSHSL	Archive of Rapidly-Sampled Hawaiian Sea Level
ASOS	Automated Surface Observing System
AVHRR	Advanced Very High Resolution Radiometer
BRP	Biological Reference Points
CCA	Canonical Correlation analysis
CCSM	Community Climate System Model
CCSM3	Community Climate System Model, version 3
CITES	Convention on International Trade in Endangered Species
CFBS	Commercial Fisheries Biosampling
CFS	Climate Forecast System
CGCM	Coupled General Circulation Model
CHRT	Critical Habitat Review Team
CLIDDSS	Climate Information Delivery and Decision Support System
CLIOTOP	Climate Impacts on Oceanic Top Predators
CLS	Collecte Localisation Satellites
CNMI	Commonwealth of the Northern Mariana Islands
COOPS	Center for Operational Oceanographic Products & Services
CORS	Continuously Operating Reference Stations
CPUE	Catch-Per-Unit Effort (unit = 1000 hooks)
CRCP	Coral Reef Conservation Program
CRE	Coral Reef Ecologist
CRED	Coral Reef Ecosystem Division
CREPT	Coral Reef Ecosystem Plan Team
CRMI	Coral Reef Management Initiative
CRP	Cetacean Research Program
СТ	cold tongue
CTD	Conductivity, Temperature, and Depth
DAR	Hawaii Division of Aquatic Resources
DFW	Division of Fish and Wildlife
DMWR	Department of Marine and Wildlife Resource
ECMWF	European Centre for Medium-Range Weather Forecasts

EFH	Essential fish habitat	
EOFs	Empirical Orthogonal Functions	
EIS	Environmental Impact Statement	
ENSO	El Niño – Southern Oscillation	
EOFs	Empirical Orthogonal Function	
EPA	Environmental Protection Agency	
ERA40	ECMWF Re-Analysis for 40 yr	
ESA	Endangered Species Act	
ESRL	Earth System Research Laboratory	
ESSIC	Earth System Science Interdisciplinary Center	
FAD	Fish Aggregating Devices	
FLIP	Floating Instrument Platform	
FSWP	Fisheries Statistic of the Western Pacific	
FRS	Fishers Report System	
FUS	Fishery of the United States	
FY	Fiscal Year	
GCM	General Circulation Model	
GCOS	Global Climate Observing System	
GEOSS	Global Earth Observation System of Systems	
GFDL	Geophysical Fluid Dynamics Laboratory	
GIS	Geographic Information System	
GLOSS	Global Sea Level Observing System	
GODAE	Global Ocean Data Assimilation Experiment	
GPS	Global Positioning System	
GTS	Global Telecommunications System	
HARP	High-Frequency Acoustic Recording Packages	
HCD	Habitat Conservation Division	
HICEAS	Hawaiian Islands Cetacean Ecosystem Assessment Survey	
HIMB	Hawaii Institute of Marine Biology	
HiOOS	Hawaii Ocean Observing System	
HMSRT	Hawaiian Monk Seal Recovery Team	
HMSRP	Hawaiian Monk Seal Research Program	
HRPT	High Resolution Picture Transmission	
HSS	Heidke Skill Score	
HTTP	Hawaii Tuna Tagging Project	
IATTC	Inter-American-Tropical-Tuna-Commission	
IDEA	Integrated Data and Environmental	
IEA	Integrated Ecosystem Assessment	
IPCC	Intergovernmental Panel on Climate Change	
IPRC	International Pacific Research Center	
ICES	International Council for the Exploration of the Sea	

IMPLAN	IMpact Analysis for PLANning Software	
IRD	Institute de Recherche pour le Développement	
ISC	International Scientific Committee	
JIMAR	Joint Institute for Marine and Atmospheric Research	
LAS	Local Action Strategy	
LLDS	Longline Logbook Data System	
LODS	Longline Observer Data System	
MARDAP	Marine Resource Dynamics & Assessment Program	
MDST	Model and Data Sharing Tool	
MHI	Main Hawaiian Islands	
MJO	Madden-Julian Oscillation	
MLO	Mauna Loa Observatory	
MMRN	Marine Mammal Response Network	
MPA	Marine Protection Area	
MTRP	Marine Turtle Research Program	
NCAR	National Center for Atmospheric Research	
NCCOS	National Center for Coastal and Ocean Science	
NCEP	National Centers for Environmental Prediction	
NdPr	Neodymium-Praseodymium alloy	
NEC	North Equatorial Current	
NEOWAVE	Non-hydrostatic Evolution of Ocean WAVE	
NEPA	National Environmental Policy Act	
NERL	National Exposure Research Laboratory	
NGS	National Geodetic Survey	
NMFS	National Marine Fisheries Science Center	
NMFS	National Marine Fisheries Service	
NMI	Northern Mariana Islands	
NOAA	National Oceanic and Atmospheric Administration	
NOS	National Ocean Service	
NWHI	Northwestern Hawaiian Islands	
NWS	National Weather Service	
PAR	Photosynthetically Active Radiation at surface	
PI	Principal Investigator	
PIR	Pacific Islands Region	
PICES	North Pacific Marine Science Organization	
PIFSC	Pacific Islands Fisheries Science Center	
PIRO	Pacific Islands Regional Office, NMFS	
PLA	Participatory, Learning and Action	
PFRP	Pelagic Fisheries Research Program	
PMEL	Pacific Marine Environmental Laboratory	
POC	Point of Contact	

PRD	Protected Resources Division	
PRECI	Protected Species Environmental Compliance Initiative	
PRIMER	Plymouth Routines In Multivariate Ecological Research	
PSATs	Pop-up Satellite Archival Tags	
PSMSL	Permanent Service for Mean Sea Level	
PTWC	Pacific Tsunami Warning Center	
РТТР	Pacific Tuna Tagging Project	
PSMSL	Permanent Service for Mean Sea Level	
RAMP	Reef Assessment and Monitoring Program	
RISA	Regional Integrated Science and Assessment	
RGM	Reactive Gaseous Mercury	
ROV	Remotely Operated Vehicle	
RPSS	Rank Probability Skill score	
RSMC	Regional Specialized Meteorological Center	
RV	Research Vessel	
SAFE	Scientists and Fishermen Exchange	
SAM	Social Accounting Matrix	
SCUD	Surface Currents from Diagnostic Model	
SEAPODYM	Spatial Ecosystem and Populations Dynamics Model	
SeaWiFS	Sea-viewing Wide Field-of-view Sensor	
SFRO	Southwest Fisheries Regional Office	
SPC	South Pacific Commission	
SPC	Secretariat of the Pacific Community	
SS3	Stock Synthesis 3	
SST	Sea Surface Temperature	
SWFSC	Southwest Fisheries Science Center	
TAC	Total Allowable Catch	
TDR	Temperature-Depth Recorders	
TRT	Take Reduction Team	
TS	Target Strengths	
TZ	Transition Zone	
UFA	United Fishing Agency	
UH	University of Hawaii	
USAPI	U.S. Affiliated Pacific Islands	
USGS	United States Geological Service	
UHSLC	The University of Hawaii Sea Level Center	
USAPI	US-Affiliated Pacific Islands	
VIMS	Virginia Institute of Marine Science	
WCATWC	West Coast and Alaska Tsunami Warning Center	
WCPFC	Western and Central Pacific Fisheries Commission	
WP	warm pool	

WPacFIN	Western Pacific Fishery Information Project
WPFMC	Western Pacific Regional Fisheries Management Council
WPRFMC	Western Pacific Regional Fishery Management Council
WPSAR	Western Pacific Stock Assessment Review
WWF	World Wildlife Fund

Appendix II Visiting Scientists

DATE	NAME/AFFILIATION	PURPOSE OF VISIT
08/05/09-08/06/09	Nicholas Bond Research Scientist University of Washington Seattle, WA	Participate in the Climate Workshop.
09/17/09-09/22/09	Peter J. Huybers Professor Harvard University Cambridge, MA	To visit IPRC and collaborate with IPRC members in developing plans for a future collaboration on the effect of orbital forcing on the timing of deglaciations.
10/09/09-10/16/09	Anne Mouchet Scientist Institut d Astrophysique Esneux, Belgium	Visit IPRC and collaborate with Laurie Menviel and Axel Timmermann to install the latest carbon cycle version (including isotopes) of LOCH into the LOVECLIM earth-system model.
11/12/09-11/13/09	Lloyd F. Lowry Hawaiian Monk Seal Recovery Team Kailua, Kona	Participate in a monk seal meeting to discuss the application of aversive conditioning and other behavioral modification techniques as a management tool for monk seals in the main Hawaiian Islands.
11/12/09-11/13/09	Gary M. Priest Curator Zoological Society of San Diego San Diego, CA	Participate in a monk seal meeting to discuss the application of aversive conditioning and other behavioral modification techniques as a management tool for monk seals in the main Hawaiian Islands.
11/12/09-11/13/09	Steven J. Jeffries Research Scientist Washington State Dept. of Fish and Wildlife Lakewood, WA	Participate in a monk seal meeting to discuss the application of aversive conditioning and other behavioral modification techniques as a management tool for monk seals in the main Hawaiian Islands.
11/17/09-11/20/09	James F. Kitchell Professor of Zoology University of Wisconsin Madison, WI	Present his findings on predator-prey interactions and their role in food web structure at the PFRP Principal Investigators Meeting.
11/17/09-11/20/09	Ralph E. Townsend Chief Economist New Zealand Ministry of Fisheries Wellington, NZ	Present his findings on fishery management via catch shares at the PFRP Principal Investigators Meeting.
01/19/10-02/08/10	Amanda Cummins Staff Research Associate UCSD Scripps Inst. Of Oceanography La Jolla, CA	Participate in the NOAA cetacean survey cruise, SE-10-01, on board NOAA R/V Oscar Elton Sette.
01/10/10-01/15/10	Lars Bejder Research Leader Murdoch University Murdoch, W. Australia	Evaluate the potential sites for time/area closures of spinner dolphins resting bays, and to discuss the research project in detail with the various collaborating parties in Hawaii.
01/17/10-01/25/10	Edward R. Cook Doherty Senior Scholar Columbia University Palisades, NY	Visit IPRC and collaborate with Axel Timmermann, Jinbao Li and other members of IPRC to develop a new strategy for tropical climate reconstructions using Ohia Trees from high elevations on Mauna Kea.
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01/23/10-02/11/10	Javier Santiago Electronic Technician Puerto Rico Seismic Network Aguada, PR	Collaborate with Dr. Christa von Hillebrandt on the establishment of water level stations in the Caribbean Sea for tsunami warning and sea level monitoring research.
02/07/10-02/10/10	James A. Sulikowski Assistant Professor Univ. New England Biddeford, ME	Participated and made a research presentation at the International White Shark Symposium.
03/08/10-03/12/10	Keith R. Criddle Professor University of Alaska, Fairbanks Juneau, AK	Participate in the Pacific Island Region Fisheries Catch Share Workshop.
03/08/10-05/20/10	Jian Liu Visiting Professor Nanjing Institute of Geography and Limnology CAS Nanjing 210008, China	Collaborative research on the global and regional climate variability, including centennial variability of the ENSO and global monsoon, mega-droughts in China and the physical processes through which the Tibetan Plateau Mountain lift affects the formation and evolution of the Asian monsoon.
03/09/10-03/12/10	Christopher Dewees Marine Fisheries Specialist Emeritus University of California Davis Davis, CA	Participate in the Pacific Island Region Fisheries Catch Share Workshop.
03/09/10-03/12/10	Daniel S. Holland Research Scientist Gulf of Marine Research Inst. Portland, ME	Participate in the Pacific Island Region Fisheries Catch Share Workshop.
03/09/10-03/12/10	Bonnie Mccay Merritt Professor Rutgers the State University, Dept. of Human Ecology New Brunswick, NJ	Participate in the Pacific Island Region Fisheries Catch Share Workshop.
03/09/10-03/12/10	Paul Callaghan Professor Emeritus University of Guam Mangilao, GU	Participate in the Pacific Island Region Fisheries Catch Share Workshop.
03/09/10-03/12/10	James Wilen Professor University of California, Davis Davis, CA	Participate in the Pacific Island Region Fisheries Catch Share Workshop.
03/09/10-03/12/10	Gordon B. Turris Fisheries Management Consultant Pacific Fisheries Management Inc. British Columbia, Canada	Participate in the Pacific Island Region Fisheries Catch Share Workshop.

03/09/10-03/12/10	Seth S. Macinko Associate Professor University of Rhode Island Kingston, RI	Participate in the Pacific Island Region Fisheries Catch Share Workshop.
03/09/10-03/12/10	Diane P. Dupont Professor Economics-Brock University St. Catharine's, Ontario Canada	Participate in the Pacific Island Region Fisheries Catch Share Workshop.
03/09/10-03/12/10	Gilbert Sylvia Superintendent, COMES Oregon State University Newport, OR	Participate in the Pacific Island Region Fisheries Catch Share Workshop.
03/09/10-03/12/10	Ralph E. Townsend Chief Economist New Zealand Ministry of Fisheries Wellington, New Zealand	Participate in the Pacific Island Region Fisheries Catch Share Workshop.
03/17/10-03/19/10	Alexander Badyaev Professor University of Arizona Dept. Ecology and Evolutionary Biology	Keynote speaker and invited guest for the 2010 Albert L. Tester Memorial Symposium.
04/13/10-05/04/10	Amanda Cummins Staff Research Associate UCSD Scripps Inst. Of Oceanography La Jolla, CA	Participate in the NOAA cetacean survey cruise, SE-10-04, on board NOAA R/V Oscar Elton Sette.
04/18/10-04/19/10	Adina Paytan Associate Research Scientist UC Santa Cruz Institute of Marine Science, UC Santa Cruz	To give a talk in the Department of Oceanography at UH Manoa.
04/26/10-04/30/10	Stephan Lorenz Scientist Max Planck Institute for Meteorology Hamburg, Germany	Visit IPRC and collaborate with Axel Timmermann on the impacts of volcanic eruptions on ENSO and give a seminar presentation titled "Climate impacts of volcanic eruptions simulated in Last Millennium Simulations of the KOSMOS model."
04/27/10-04/30/10	Richard Murnane Scientist Risk Prediction Initiative Garrett Park, MD	Visit IPRC and collaborate with IPRC members on research related to impacts of climate variation and change.
05/03/10-05/07/10	Sara Iverson Professor Dalhousie University Halifax, NS, Canada	Collaborate on ongoing Hawaiian monk seal research on the analysis and interpretation of monk seal fatty acid data. Assist with completion of reports and scientific manuscripts.
05/11/10-06/06/10	Eric Anderson Resident, Zoological Medicine North Carolina State University Morehead City, NC	Participate in NOAA monk seal research cruise, SE-10-05, on board NOAA R/V Oscar Elton Sette.

05/17/10-05/20/10	John R. Sibert Professor Emeritus UH SOEST Honolulu, HI	Participate in the 61st Tuna Conference in Lake Arrowhead, CA.
05/18/10-05/27/10	Keith Criddle Professor University of Alaska, Fairbanks Juneau, AK	Prepare a publication titled 'Right-Based Fisheries Management in the Aspect of Pacific Island Commercial Fisheries'
06/24/10-06/26/10	Keith Criddle Professor University of Alaska, Fairbanks Juneau, AK	Participate in a meeting of the Study Group on Human Dimensions under the North Pacific Marine Science Organization in Yokohama, Japan.

Appendix III Workshops and Meetings Hosted by JIMAR

PFRP Principal Investigators Meeting, November 19-20, 2009 Asia Room Imin Conference Center, UH-Manoa

Melanie Abecassis David Itano James Anderson Karen Arthur Robin Baird Keith Bigelow Anela Choy Dean Courtney Gerard Dinardo Reka Domokos Jeffrey Drazen Kalisi Faanunu Eric Fletcher Steph Floyd Rini Ghosh Ed Glazier Dawn Golden Phyllis Ha Donald Hawn Roger Hill Kim Holland Melinda Holland Justin Hospital Evan Howell **Robert Humphreys** T. Todd Jones

John Kelly Bert Kikkawa Eun Jung Kim James Kitchell Pierre Kleiber Chi (Tim) Lam Michael Lameier Patrick Lehodev PingSun Leung PingSun Leung (staff) PingSun Leung (staff) Dan Luers John Lynham Takayuki Matsumoto Carl Meyer Roy Morioka Jeff Muir Bruce Mundy Michael Musyl Ryan Nicols Irene Nurha-Humburg Yannis Papastamatiou Michael Parke Sarah Pautzke

Jeffrey Polovina **Brian** Popp Alison Rieser Jay Rooker Skaidra Scholey John Sibert Megan Sundberg Nori Tarui Thomas Tinhan Rob Toonen Ralph Townsend Roger Uwate Ana Vaz Oriana Villar **Bill Walsh** John Wang Dave Wells Kevin Weng Brett Wiedoff **Toby Woods** Phoebe Woodworth Johnoel Ancheta Dodie Lau

TrackIt Workshop November 18, 2009 Washington Room, Imin Conference Center, UH-Manoa

Melanie Abecassis Johnoel Ancheta Reka Domokos Roger Hill Kim Holland Melinda Holland Evan Howell David Itano Jim Kitchell

Pierre Kleiber Tim Lam Carl Meyer Jeff Muir Michael Musyl Yannis Papastamatiou John Sibert Kevin Weng Phoebe Woodworth

Appendix IV JIMAR Personnel

Category	Number	Unknown	High School	Associates	Bachelors	Masters	Ph.D.
Research Scientist	25	0	0	0	0	0	25
Visiting Scientist	0	0	0	0	0	0	0
Postdoctoral Fellow	12	0	0	0	0	0	12
Research Support Staff	152	0	3	5	92	40	12
Administrative	16	0	0	2	13	1	0
Undergraduate Students	31	0	31	0	0	0	0
Graduate Students	33	0	0	0	28	3	2
Received less than 50% NOAA support	6	0	0	0	1	0	5
Total	275	0	34	7	134	44	56
Located at Lab (include name of lab)	PMEL: 2 PFEL: 5 PIRO: 19 PIFSC: 130 ESRL: 7 NWS: 1						
Obtained NOAA employment within the last year	8						
Postdoctoral Fellows and Students from Subgrantees	Postdocs: 2 Students: 4						

Information as of June 30, 2010

Appendix V Awards

Melanie Abecassis Fishery Bulletin Best Paper Award, 2009

Tomoko Acoba NOAA Fisheries Team Member of the Year

Ethan Brown NOAA Fisheries Team Member of the Year

Marie Hill NOAA Fisheries Team Member of the Year

Kyle Koyanagi Nominated for 2009 RCUH Outstanding Employee of the Year

Kim Maison NOAA Fisheries Team Member of the Year

Audrey Rivero NOAA Fisheries Team Member of the Year

John Wang NOAA Fisheries Team Member of the Year

Phoebe Woodworth *Fishery Bulletin* Best Paper Award, 2009

Yoshiki Yamazaki

2009 Benchmark Challenge at the Inundation Science and Engineering Cooperative (ISEC). Developed a numerical inundation model, known as NEOWAVE (Non-hydrostatic Evolution of Ocean WAVE).

Appendix VI Publication Summary

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

		FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10
Peer-Reviewed	JIMAR Lead Author	18	36	50	36	32	31	47	40
	NOAA Lead Author	33	22	26	20	26	25	22	17
	Other Lead Author	20	30	26	28	43	51	42	68
Non-Peer-Reviewed	JIMAR Lead Author	16	39	31	24	11	18	18	24
	NOAA Lead Author	10	17	14	16	18	8	18	9
	Other Lead Author	14	21	17	17	20	17	9	9