JIMAR

Annual Report for Fiscal Year 2009

For Cooperative Agreements
NA17RJ1230 and NA080AR4320910

Thomas A. Schroeder, PhD
Director

Joint Institute for Marine and Atmospheric Research
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SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

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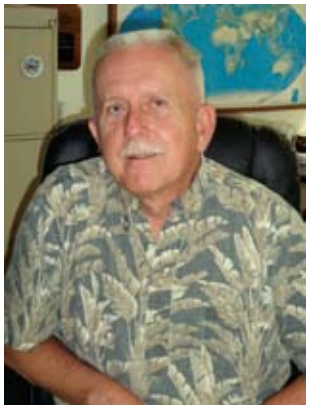
Introduction



Thomas Schroeder, Director

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 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 and NA080AR4320910.

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 2009 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. We are currently working with an interdisciplinary team in proposing a new Pacific RISA. 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 has begun 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).

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).

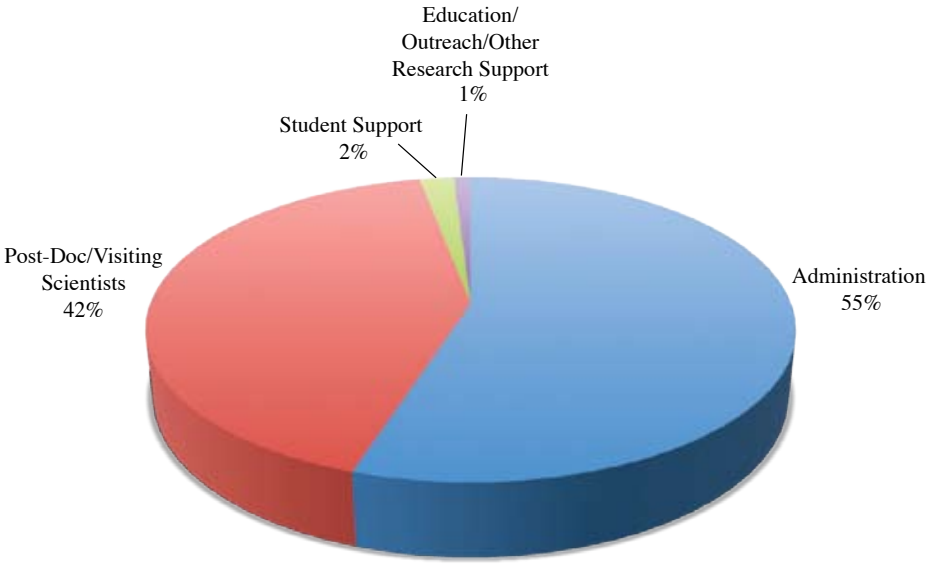
JIMAR Senior Fellows from the University of Hawaii are Dr. Gary Barnes, Dr. Steven Businger, Dr. Eric DeCarlo, Dr. Eric Firing, Dr. Charles Fletcher, III, Dr. Kim Holland, Dr. Roger Lukas, Dr. Douglas Luther, Dr. Julian McCreary, Dr. Mark Merrifield, Dr. Thomas Schroeder, Dr. John Sibert, and Dr. Bin 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.

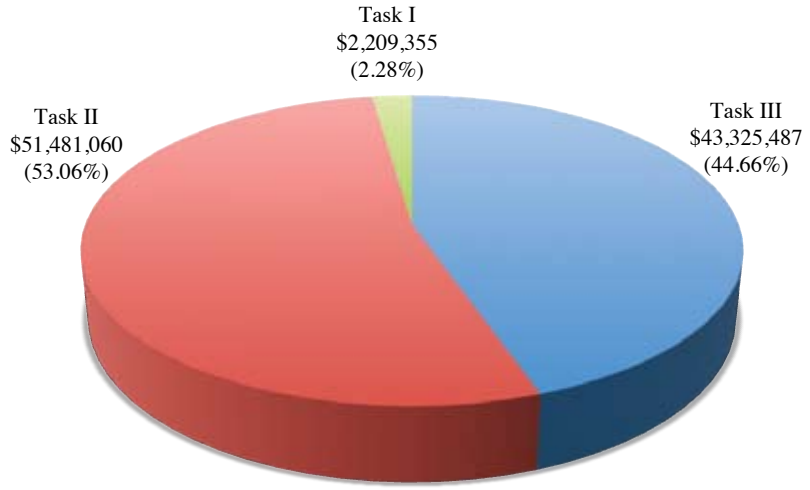
Distribution of JIMAR's Task I NOAA Funding by Activity



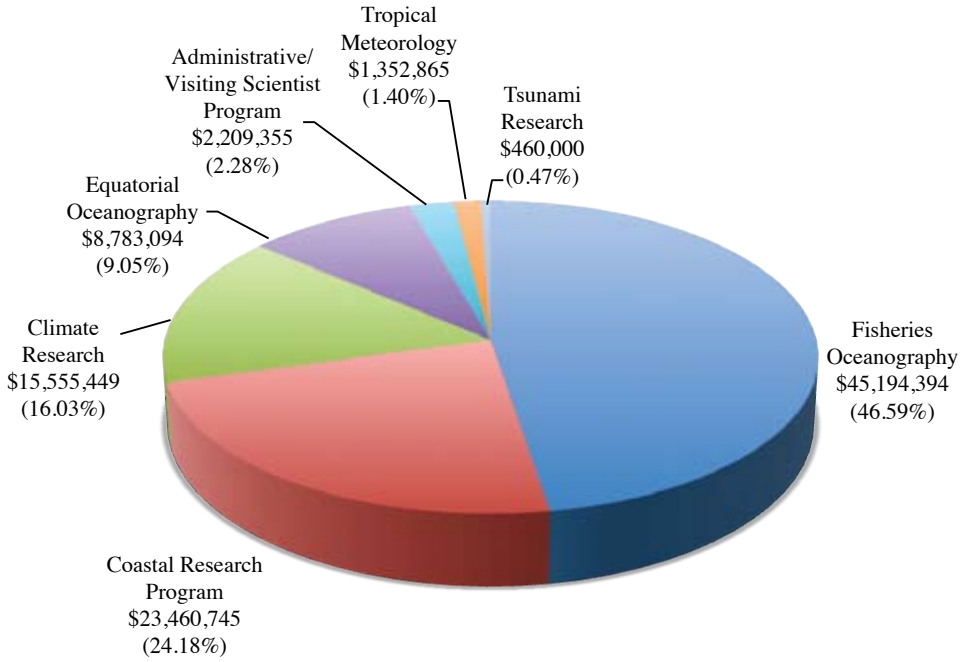
JIMAR science encompasses several dozen subprograms. In the aftermath of the Boxing Day tsunami, JIMAR has continued to play a leadership role in the development of an Indian Ocean tsunami warning network. The UH Sea Level Center had developed tide gauges that are capable of delivering near-real time 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.

John Sibert has retired and Kevin Weng has been appointed interim 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.

Distribution of NOAA Funding by Task (FY 2002-2009)



Distribution of NOAA Funding by Theme (FY 2002-2009)



Accomplishments for Fiscal Year 2009

Equatorial Oceanography

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

University of Hawai'i Sea Level Center

P.I.: Mark A. Merrifield

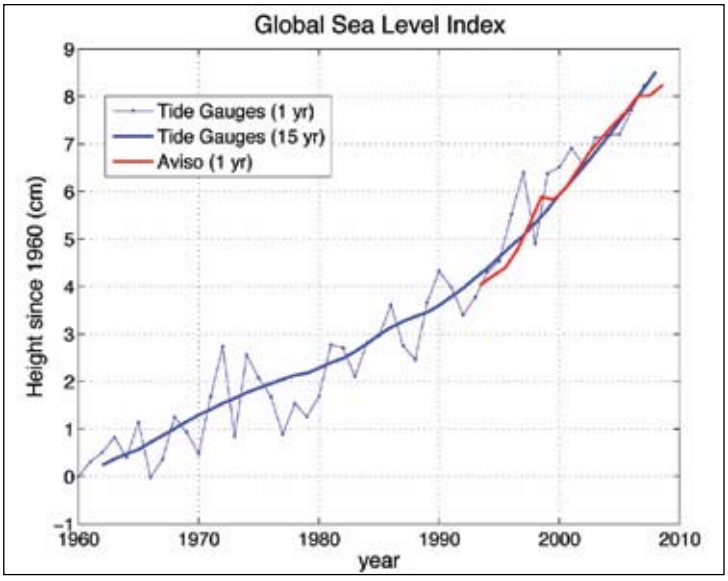
NOAA Office (of the primary technical contact): Climate Program Office

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 purpose of the University of Hawai'i Sea Level Center (UHSLC) project is to ensure that tide gauge datasets from the global network are maintained and that the data meet quality standards for climate and oceanographic research. The UHSLC collects, processes, analyzes, and distributes tide gauge data from ~450 stations maintained by 65 international agencies. The center focuses on the collection of high frequency measurements (hourly or faster) that are available in near-real time usually via satellite transmission. This activity complements the Permanent Service for Mean Sea Level (PSMSL), which is the primary archive for historic monthly-averaged time series of sea level. In addition, the UHSLC directly assists host agencies, primarily in developing countries, with the maintenance and operation of over 60 stations. Through training and ongoing technical support, the goal is to build capacity within each country or region to maintain local contributions to the global network. The UHSLC is an active contributor to the Intergovernmental Oceanographic Commission Global Sea Level Observing System (GLOSS), and participates in global observing system operations 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 critical for climate research. UHSLC stations are designed to support international tsunami warning efforts, with 1 minute averaged data transmitted at 5 to 15 minute intervals through the Global Telecommunications System (GTS) to the Pacific Tsunami Warning Center (PTWC) and other warning agencies.



Estimate of global sea level height based on analysis of tide gauge data (1 year and 15 year averages) compared to sea level from altimetry (Aviso).

Progress during FY 2009

UHSLC researchers completed a study of global sea level rise based on tide gauge data. The estimated time series of sea level rise shows a recent doubling from the late 20th century rate of about 1.5 mm/yr to the current rate in excess of 3 mm/yr. The rate increase appears to originate in the tropics and southern hemisphere. The relationship of this signal to naturally occurring multidecadal sea level oscillations is under investigation. The analysis has led to an index of global sea level height that will be maintained based on the UHSLC Fast Delivery

database. The other focus area has been on extreme sea level events and their spatial variability based on tide and storm forcing. A global assessment of extreme events has been completed and a manuscript is in preparation. UHSLC staff have also been involved in the annual assessment of sea level variability as part of the annual State of the Climate report in the *Bulletin of American Meteorology*.

The continued maintenance of the global tide gauge network was the primary operational focus of the UHSLC during FY 2009. UHSLC technicians performed on-site maintenance at stations in the Pacific, Atlantic, and Indian Oceans and provided remote technical support for international collaborators. The UHSLC supports GLOSS through the maintenance of one of the GLOSS Data Centers as well as direct support for nearly 50 stations in the GLOSS Core Network. In addition to the GLOSS network, the UHSLC is committed to implementing the 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. Our goal for FY 2009 was to help bring ten non-operational GCOS stations into the UHSLC database. The UHSLC installed a new GCOS station at Manado, Indonesia and gained access to data from Lagos, Nigeria, Pointe Noire, Congo, Nakano Sima, Nase, and Nishinoomote, Japan, and Malin Head, Ireland. Planned installations of two new GCOS stations Argentina have been delayed pending approval of a waiver of exorbitant customs fees. It may not be feasible to bring the remaining stations to operational status due to lack of cooperation by host countries, inability to access a remote site, or safety issues for technical staff. If researchers are unable to activate these remaining stations, they will propose changes to the GCOS station list to replace these stations with nearby stations that are operational.

Penetration of Anthropogenic CO_2 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 objectives of the project are as follows.

- To obtain new values of remineralization ratios for the global oceans and verify that these ratios do vary systematically among ocean basins, as preliminary results have indicated.
- To include the variable remineralization ratios for estimating the anthropogenic CO_2 inventory in the ocean and provide information from an alternative method for comparison with that derived from the popular ΔC^* method.

Progress during FY 2009

This project has resulted in one paper, currently in press, and three additional ones, which are in review.

- Measures, C. I., T. Sato, S. Vink, S. Howell, and Y. H. Li, 2009, The fractional solubility of aluminum from mineral aerosols collected in Hawai'i and implications for atmospheric deposition of biogeochemically important trace elements, *Mar. Chem*. (in press).
- Li, Y. H., Y. Sohrin, and T. Takamatsu, 2009, Lake Biwa and the ocean: a geochemical comparison, *Limnol*. (in review).
- Lin, I. I., Y. H. Li, C. W. Hwang, A. Chu, T. F. Wong, and J. P. Chen, 2009, Fertilization of an ocean desert by volcanic eruption, *Nature* (in review).
- Hsu, S. C., Y. H. Li, F. J. Lin, and S. J. Kao, 2009, Elemental compositions of suspended particulate matter over the Yangtze estuary during the 1998 flood, *Estuar. Coast. Shelf Sci*. (in review).

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 Hawai'i. JIMAR scientists have collaborated with PMEL, the Pacific Disaster Center, and Hawai'i 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

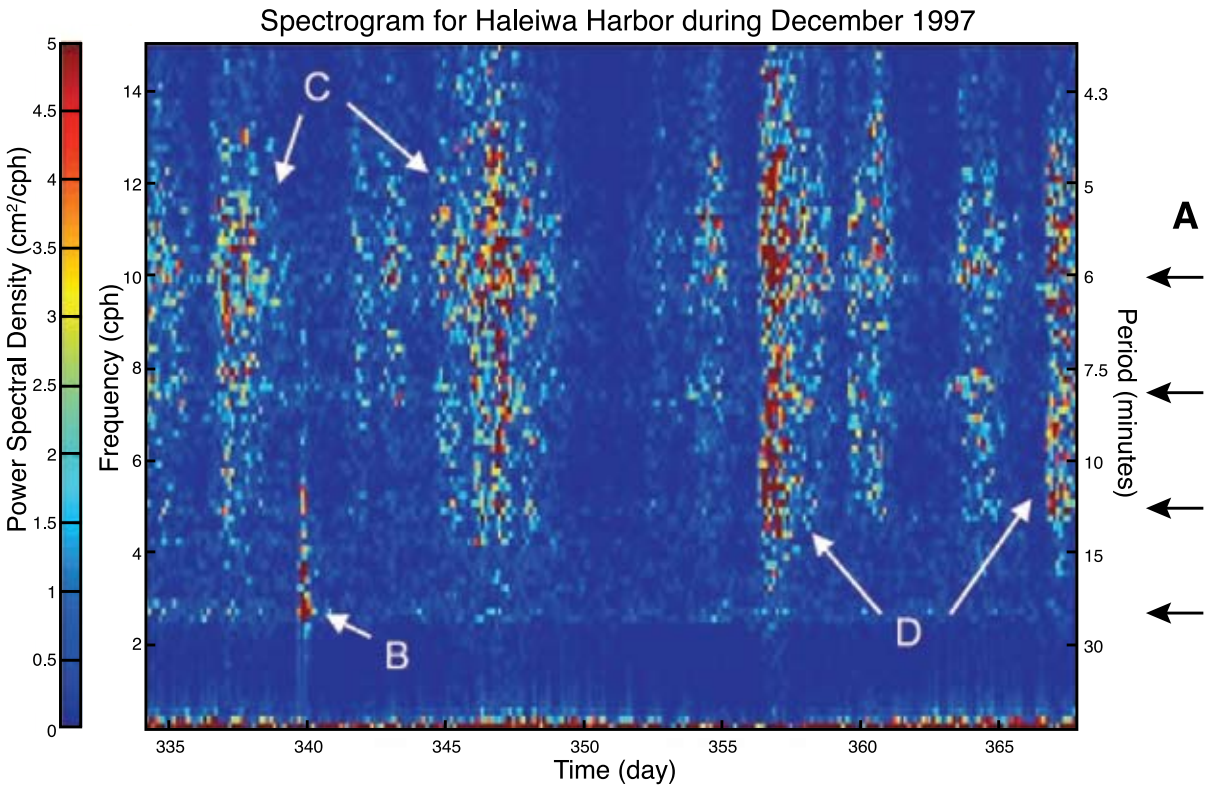
Purpose of the Project

The purpose of 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 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 for 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 period gravity wave phenomena that impact commercial and private boating activities, the ARSHSL provides historical data to the nascent Hawai'i Ocean Observing System (HiOOS), assisting investigations into the dynamics of ocean phenomena such as internal and external tides (0.5-1 day periods), coastal trapped internal waves (1.5-5 day period), wind-forced mesoscale variability (3-60 day period), mesoscale eddies (60-180 day period), and, as the dataset length increases, 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 the agency. Therefore, this data rescue activity provides as complete a dataset as possible of sea level fluctuations at the coasts of the Hawaiian Islands for current and future research and practical applications.

Progress during FY 2009

D. Luther and M. Luther, in collaboration with the NOAA-funded UH Sea Level Center (M. Merrifield, Director), maintained the ARSHSL online (http://www.soest.hawaii.edu/oceanography/dluther/arshsl.html). 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 communications previously established for ARSHSL. PTWC sea level gauge data (1-second or 2-minute samples, depending on the gauge) are automatically and, as 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 Hawai'i, 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 the PTWC. The applications range from hydrogeology to gravity wave studies to dock design. In the past year new users focused on water table fluctuations on the Big Island (USGS) and harbor seiches in support of the development of "harbor conditions" nowcasts and forecasts for the NOAA-funded HiOOS.

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. 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 included (i) elimination of the backlog of 1-second data needing processing; (ii) improvement of the procedures for editing the 1-second data from the PTWC gauges; and, (iii) updating files of concatenated, quality-controlled, hourly-averaged sea level data for studies



The plot displays power spectral density of sea height (color bar on the left) taken from Haleiwa Harbor on the N. Shore of O'ahu. The abscissa is time (approximately 35 days centered on December, 1997); this is one month of data from a 12-year time series of sea height that is available only because of the NOAA-funded ARSHSL. The linear ordinate axes display frequency (left) and period (right). The power spectral estimates are obtained from 3-hr pieces of data. The plot shows the four phenomena that provide most of the variability at infra-gravity (IG) wave frequencies in Haleiwa Harbor; these sea level variations and their associated currents are occasionally strong enough to damage boats and permanent facilities within the harbor. One component of the NOAA-funded Hawaii Ocean Observatory System is using Haleiwa and other ARSHSL and NOS sea level data to develop nowcast and forecast products of harbor conditions. The arrows along the right ordinate labeled 'A' indicate the dominant frequencies of coastal modes and harbor seiches. A 2008 study by S. Munger and K.E. Cheung identified the longest period mode (at 24 minutes) as the gravest IG coastal mode of the North Shore of O'ahu to be excited by tsunamis arriving from the northwest. Label 'B' identifies a weak tsunami created by the December 5, 1997, Kamchatka earthquake; note the excitation of the 24-minute coastal mode. Label 'C' identifies two events of high IG wave energy that were excited by the swell from Northwest Pacific storms; both events are dominated by the higher frequency IG waves. Another pair of events, labeled 'D', was also generated by swell from Northwest Pacific storms, but these swell events had longer period wave components resulting in a stronger excitation of longer-period IG waves.

of low-frequency phenomena, especially to aid modeling and prediction of sea level inundation hazards around O'ahu for NOAA's HiOOS. Gauge maintenance remains a concern because it is performed by other NOAA agencies. The six NOS sites were always brought back on-line after only brief (order of days) interruptions caused by occasional equipment failures. Of the 15 PTWC gauges, six are currently inoperative (compared with two at this time last year). Researchers have not received data from two of the seven harbors on the Big Island for over two years. Big Island gauges are more difficult to maintain due to budget constraints on travel. Finally, funding constraints for HiOOS precluded execution of the plan to begin upgrading some of the PTWC gauges, beginning with Haleiwa and Waianae Harbors on O'ahu.

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 project are as follows.
- Implement a continuum mechanics model and develop a non-hydrostatic model to describe seafloor deformation and tsunami generation in three dimensions.
- Implement the non-hydrostatic model for near-field tsunami modeling and determine the applicable range of the conventional hydrostatic approach.
- Apply the proposed model package to reconstruct and analyze the 1975 Kalapana earthquake and tsunami in Hawai'i.

Progress during FY 2009

The GeoFEM model, which is a finite element model developed by Research Organization for Information Science and Technology in Japan, was adapted to provide time-dependent seafloor deformation based on user-specified fault parameters consisting of the focal depth, dimensions, orientation, and slip. A three-dimensional finite element model of continuum mechanics can provide realistic descriptions of fault slippage and the resulting earth surface deformation. 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.

Halape on the south flank of Big Island, where the ground subsided 3 m and the tsunami reached 14 m runup as a result of the 1975 Kalapana earthquake. (Photograph by P.W. Lipman USGS)

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. Researchers developed a non-hydrostatic model for tsunami generation, propagation, and run-up and published a paper describing the results. Instead of solving the complete three-dimensional problem, a non-hydrostatic term was introduced 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 Hawai'i 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 purpose of this project 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. The UHSLC plays an active role in the development of tsunami and operational water level networks. This project has led to the expansion of high quality tide gauge stations in tsunami risk regions (e.g., Southeast Asia, Africa, the Indian Ocean, and South America). The UHSLC maintains approximately 60 tide gauge stations in the Indian, Pacific, and Atlantic Oceans. The upgrade of these stations to comply with tsunami monitoring requirements is nearly complete. The few remaining stations that have not been upgraded are in remote locations that will be serviced as soon as transportation to the site can be arranged.

Progress during FY 2009

UHSLC scientists have served on working groups for tsunami warning systems, and shared their expertise on water level observing platforms at several tsunami workshops and meetings, including the ICG/IOTWS Sea level Working Group and ITP Intersessional meetings (Nov. 2008, Bali, Indonesia), the ADPC South China Sea Tsunami Steering Group Meeting (Nov. 2008, Bangkok, Thailand), the UNDP Tsunami Workshop (Jan. 2009, Dhaka, Bangladesh), the IOC Global Meeting of the Intergovernmental Coordination Groups (ICG) for Tsunami Warning Systems (Feb. 2009, Apia, Samoa), and the IOC Global Meeting of the ICG for Tsunami Warning Systems (Mar. 2009, Paris, France). In addition, the UHSLC hosted three UNESCO Fellows from the Seychelles, Mauritius, and Indonesia for a one-month training session during July 2008 on sea level science and applications. Station design, sensor options, data collection, and data processing strategies for tsunami warning were discussed in detail.

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. Our 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

The purpose of the project is to elucidate the physical mechanisms responsible for long-term changes in the tropical Pacific climate during the last millennium. 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. For this project researchers will use several existing climate model simulations of the last 500-1000 years and combine different paleo-proxy records for ENSO. Specific questions to be addressed 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 by using coupled-atmosphere ocean general circulation model simulations for the last 500-1000 years. The 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 2009

As originally proposed, the degree of consistency amongst different previously published paleo-ENSO records was assessed. Overall, the consistency prior to the instrumental period is quite low. To extract the common signal from nine independent paleo-proxy records, researchers conducted an EOF analysis of these records. The leading EOF mode explains more than 50% of the total variance of the multivariate dataset. Its correlation with instrumental records during the 20th century is higher than that of any of the nine previously published records. The new Unified ENSO proxy (UEP) (Figure 1) was also cross validated with documentary records dating back to 1650. This comparison also revealed that the UEP has a higher degree of consistency with the independent documentary records than any of the 9 individual proxies. One of the most striking features of the UEP is the monotonic increase of ENSO variance. Researchers tested whether this is due to dating uncertainties in the original nine records. By computing the EOF of the running variances of each of the nine records, they found a similar increase in ENSO variance, which is further supported by documentary datasets and some high-resolution sediment core data from South America. Researchers hypothesize that the increase in ENSO variance might result from a continuous warming of the western tropical Pacific warm pool that was reconstructed from high-resolution sediment core data from this region.

On multidecadal timescales the detrended UEP variance timeseries does not correlate with the detrended timeseries of solar forcing (as obtained from the Lean reconstructions). This questions the notion of a strong linkage between the low-frequency cycles of solar forcing and ENSO, previously suggested based on experiments that were conducted with a highly simplified ENSO model. Whether the ENSO variance trend can be attributed to an overall increase of solar forcing during the last 350 years will be further studied in the next fiscal year.

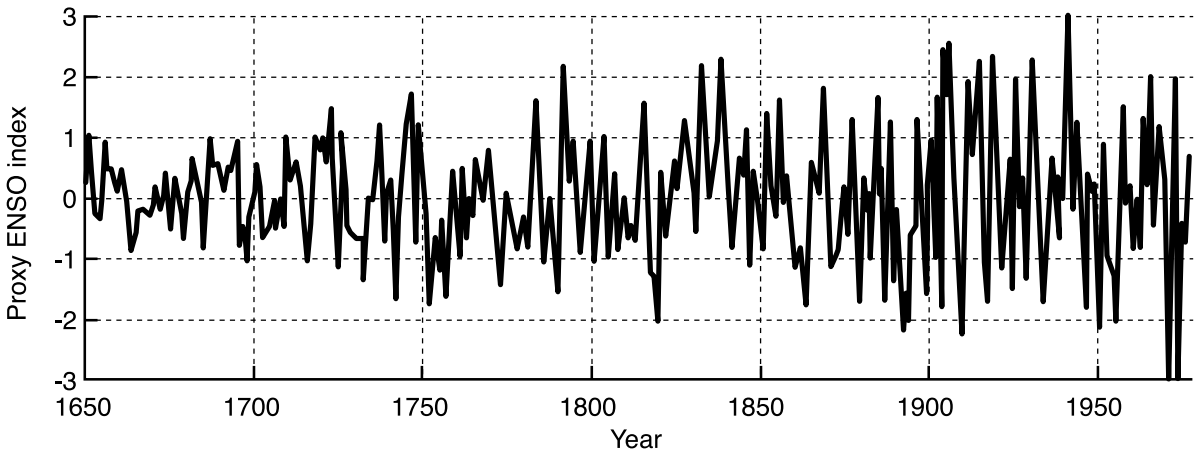


Figure 1. The UEP, obtained as the leading EOF mode of nine independent paleo-ENSO proxies for the period 1650-1978. The increase in variance is corroborated by independent methods that are not sensitive to dating errors of the individual proxies.

Another novel feature identified in the UEP is the highly significant reduction of ENSO variance in the year of a volcanic eruption (Figure 2). This feature will be further explored in the future using climate model simulations that use volcanic emission forcing. Researchers will also adopt the BJ-index formulation to quantify the effects of volcanic and solar forcing on ENSO stability and growth rate. Shayne McGregor, the postdoctoral researcher who conducted the analyses described above, began in March 2009. A paper describing the main results of the observational analyses has been submitted to the *Journal of Climate*. Given these recent successes and the identification of a new previously unrecognized sensitivity of ENSO to volcanic eruptions, the project is very much on track and has already accomplished important objectives outlined in the proposal.

For the next step (analysis of climate model data) researchers downloaded a suite of climate model simulations from the CMIP3 and Earth-System Grid data servers. These simulations include control simulations as well as experiments that use external forcings such as greenhouse gas, volcanic aerosol, and solar forcing. These experiments, which will be analyzed in the next fiscal year, were conducted with the PCM, CCSM3, GFDL, ECHO-G, ECHAM5-OM1, HADCM3, and CCSM1.4 models.

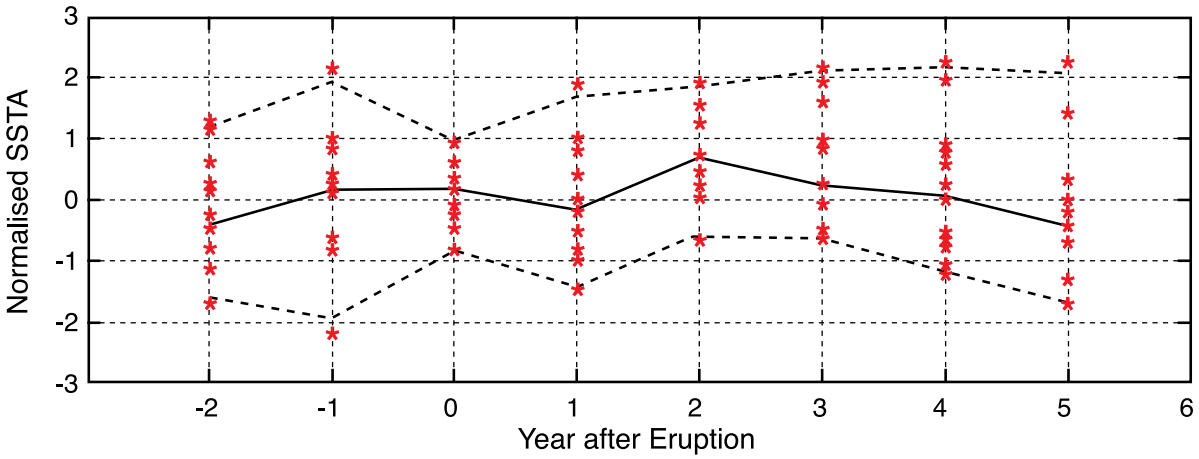


Figure 2. Composites of the UEP around years in which explosive volcanism occurred. Explosive volcanism is defined as a volcanic eruption where the sulfate aerosol forcing exceeds -18 W/m².

Compilation, Digitization, and Use of Hawai'i State Rainfall Records

P.I.: Pao-Shin Chu

NOAA Office (of the primary technical contact): National Environmental Satellite, Data, and Information Service/National Climate Data 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 compile and digitize historical monthly rainfall records archived at the Hawai'i State Climate office.

Progress during FY 2009

All state gages on the islands of Kaua'i, Maui, Hawai'i, and Honolulu were inventoried.

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

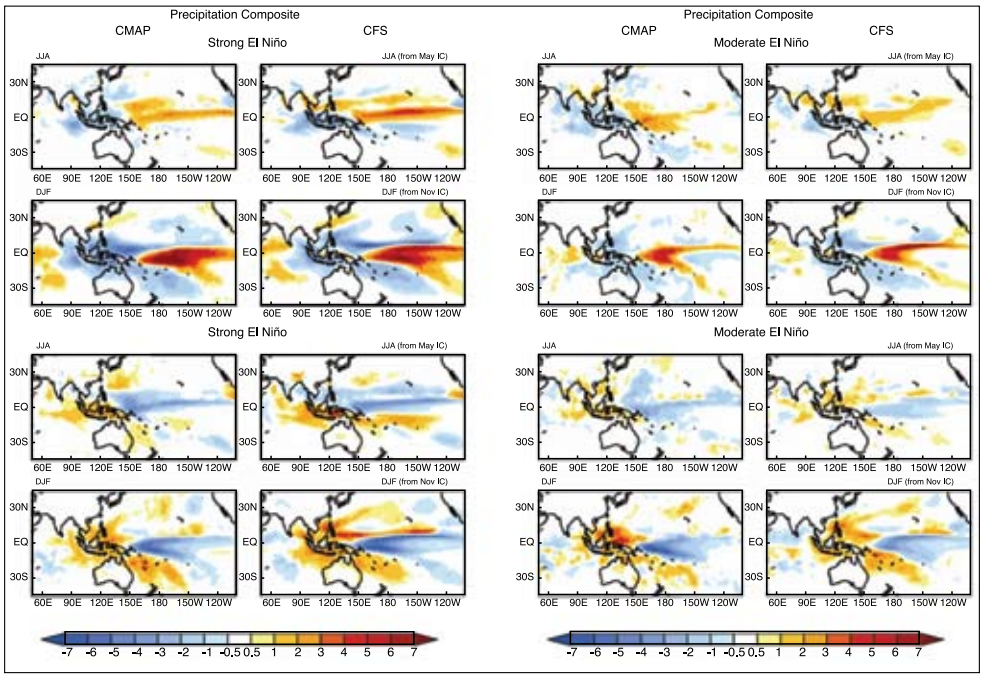
Purpose of the Project

The purpose of the project is to develop and transition an extended and long range prediction system prototype based on the NCEP's Climate Forecast System (CFS) for all U.S. Affiliated Pacific Islands (USAPI). Development of such a prediction system will fill a critical gap in the Climate Prediction Systems suite of operational forecasts for the USAPI that currently are purely derived based on empirical techniques.

Progress during FY 2009

Progress for this collaborative project involving the IPRC (UH), CPC (NOAA), and WERC (University of Guam) is summarized below.

- *Data transfer.* During the first year of the proposal, considerable effort was spent on extracting the data from the ensemble of the CFS hindcasts. The CFS hindcasts are for the period 1981-2007, and for each month a 15-member ensemble extending to a 9-month seasonal forecast exists. Monthly mean forecast data from individual seasonal forecasts for the entire hindcast period was extracted. The extraction of hindcast involved accessing hindcast archives on the NCEP Central Computing System (CCS), and required development of necessary scripts such that the process could be automated. The variables extracted include predicted values of monthly mean rainfall, sea surface temperatures, upper level height, and circulation fields. The extracted data was put on the NCEP ftp server for transfer to a research partner at the UH. Development of a hindcast database was the necessary first step towards the first year goals of this project, i.e., to perform the diagnostics of the CFS hindcast runs to assess non-linearity of response to ENSO (and its flavor), and predictability of precipitation anomalies over the Pacific Islands on a seasonal time-scale.
- *Diagnostics*. Detailed diagnostics with observations/reanalysis was performed. Based on CPC definitions, strong and moderate ENSO events were identified and composites of various ocean-atmosphere variables constructed. Each ENSO event is then analyzed in detail to document the different flavors of ENSO. An independent analysis of rainfall data from 33 stations over the Hawaiian Islands confirms the results obtained from CMAP precipitation products. Salient features from observations (see figure) include: (a) during strong El Niño events, while South Pacific islands experience dry conditions from boreal summer through the following winter, the Hawaiian Islands experience below normal rainfall during boreal winter only; (b) in sharp contrast, during strong La Niña episodes wet conditions over the Hawaiian Islands are not readily observed while South Pacific



Composites of precipitation anomalies (mm/day) for strong El Niño and La Niña (left) and moderate El Niño and La Niña (right) cases, both from observations and CFS ensemble hindcasts of one month lead time. Composites for both the boreal summer (JJA) and winter (DJF) seasons are shown.

islands receive above normal rainfall from boreal summer through winter; (c) on examining different flavors of ENSO, the researcher noted that during the 1982 El Niño wet conditions prevailed over Hawai'i from March through November, and during the boreal winter of 1998 La Niña; and (d) during certain non-ENSO years (e.g., Oct.-Dec. 2005) significant rainfall anomalies are observed over the Pacific Islands.

An in-depth diagnostic with CFS hindcasts is currently being carried out. The process began with an assessment of the ability of CFS in forecasting various Niño SST indices (Niño3, Niño3.4, Niño4, Niño1+2) at various lead times and the sensitivity of the skill to initial conditions. For example, the model's forecasting skill is high, up to 6-7 months lead time, for July initial conditions and strong El Niño events of 1982 and 1997. In contrast, forecasting for moderate El Niño events of 1994, 2002, and 2004 is marginal at three months lead and at longer leads, the sign of SST anomalies over the equatorial Pacific is predicted incorrectly. In terms of precipitation hindcasts over the Pacific Islands, in particular during ENSO years, the one month lead forecast from CFS (see figure) captures the observed features (mentioned above) with great accuracy. Researchers are currently investigating the ability of CFS hindcasts in determining unusual precipitation anomalies in non-ENSO years and at various lead times in ENSO years. Further, the predictive skill of rainfall anomalies in five neighborhood regions (area averaged over Hawai'i, Micronesia, Marshall, Guam, and American Samoa) are being examined.

While researchers continue to perform detailed diagnostics, they are currently developing the necessary tools to apply statistical corrections on the CFS systematic errors, and assess and verify the forecast skill against observations. They collected daily and monthly observed rainfall from the Pacific Rainfall Database (PACRAIN) maintained by Oklahoma University. During summer/fall of 2009, the daily model outputs will be studied to understand the ability of CFS in extended-range forecasts.

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

This project focuses on the roles of the tropical ocean-atmosphere interaction in the decadal climate variations of the tropical Pacific and decadal modulations of ENSO. Significant decadal variations in the Pacific have been identified together with evidence of the strong decadal modulations of the frequency, amplitude, and predictability of El Niño-Southern Oscillations (ENSO). Researchers' understanding of the decadal variability is still limited. In particular, 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 will be examined. Researchers will investigate the coupled mechanisms, which modify the decadal modes of the tropical ocean into coupled modes. They will study the interaction of the coupled decadal modes with ENSO and explore nonlinear scenarios, which allow large amplitude modulations of ENSO. They will also explore the implications of these deterministic processes to the regime predictability of the ENSO activity.

Progress during FY 2009

- Different types of El Niños and their possible decadal interactions were studied.
- A study on the interaction between the (Madden-Julian Oscillation (MJO) and ENSO was extended.

Effects of the Andes on Eastern Pacific Climate

P.I.: Shang-Ping Xie [Yuqing 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

The goal of this study is to better understand and simulate eastern Pacific climate in general and the effect of the steep Andes in particular. The eastern equatorial Pacific is home to El Niño and Southern Oscillation, but the mean state and the seasonal cycle of its climate are still poorly simulated in state-of-the-art climate models.

Progress during FY 2009

Two papers were completed to test the sensitivity of a coupled ocean-atmosphere model to ocean vertical mixing and to the ocean current effect on surface stress.

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)

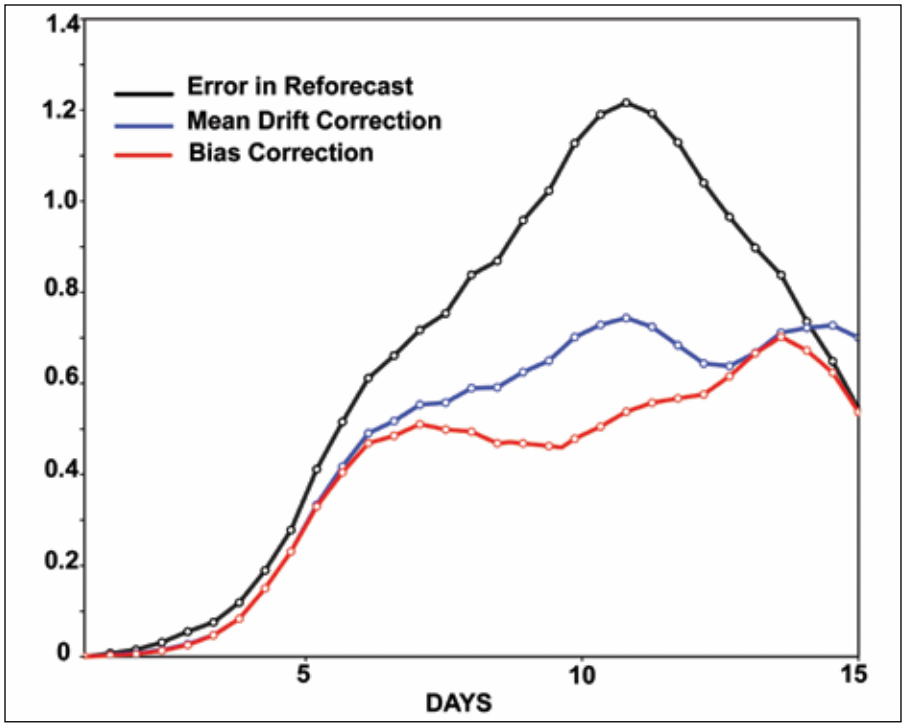
- To understand climate variability and change to enhance society's ability to plan and respond

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 2009

General circulation model integrations with an imposed QBO were continued. In order to examine stratospheric influence on the tropospheric circulation at shorter timescales, the Northern Hemisphere winter NOAA historical reforecast project results were analyzed. These consist of 15 member ensembles of 15 day NCEP MRF hindcasts for each day from 1979-2008 and are initialized with, and can be validated against, NCEP reanalyses. Systematic deficiencies in the simulation of the winter polar stratospheric vortex were found in the MRF forecasts. The



The average error in the forecast of the Arctic Oscillation index in 850 hPa geopotential as a function of lead time of the forecast (out to 15 days). The error is expressed in standard deviations of the index in the observed record. Results are for about 60 cases in which the stratospheric vortex in the initial conditions was particularly strong. The black curve shows the raw results using the ensemble mean of 15 forecasts in each case. The blue curve is obtained after the forecasts are corrected for the mean drift of the forecasts averaged over all winter cases. The red curve includes a second correction based on the behavior of just the strong initial vortex cases.

possibility that significant predictability of tropospheric anomalies might not be exploited in the MRF forecasts was examined. It was found that there are systematic biases in forecast for cases with initial large anomalies in the polar vortex. Significant improvements in the 7-15 day forecasts in these cases can be achieved by a simple statistical correction to the numerical ensemble forecasts.

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

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 (GODAE); and (iv) to conduct research to enhance understanding of climate variability and change in the Asia-Pacific region. 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 Hawai'i. The vision of the APDRC is to link data management

and preparation activities to research activities within a single center, and provide one-stop shopping of climate data and products to local researchers and collaborators, the national climate research community, and the public. The APDRC is organized around three main goals: providing integrated data server and management systems for climate data and products; developing and serving new climate-related products for research and applications users; and conducting climate research in support of the IPRC and NOAA research goals.

Progress during FY 2009

The APDRC continues to operate and upgrade the Data Server System in collaboration with national and international partners, and continues to build the data archive with focus on atmospheric, oceanic, air-sea flux, and model and satellite-derived products. The web-based data management tools continue to be upgraded to allow easy access to metadata, product information, and product search capability. The APDRC now maintains three different types of OPeNDAP servers (THREDDS, GDS, and DAPPER) allowing transparent access via many different client-end programs (Figure 1). The APDRC similarly runs two types of web-based data browsing tools (LAS and DChart), both of which can be used for gridded or in situ (point) data. A major enhancement to these servers is the ability to display/access them via Google Earth. A user can use DChart in conjunction with Google Earth to make plots or access data. A new version of LAS provides similar functionality, but is still undergoing testing. Over the past year the APDRC has also implemented "secure" servers, requiring user names and passwords, to provide authenticated services for the Ocean GCM for the Earth Simulator (OFES) output, Navy model output (NLOM and NCOM for the most recent 30 days), and a variety of regional, research-only model outputs. Researchers also worked with groups at the University of Tokyo, JAMSTEC, the South China Sea Institute and the Ocean University of China, either through site visits or by hosting visitors at the IPRC, to install and configure similar servers at those institutes. The APDRC continues to broaden its scope by starting to address the needs of non-scientific users and access to data. This past year the APDRC has configured a web-server for the Pacific regional observing systems, including the Global Climate Observing System (PI-GCOS), the Global Ocean Observing System (PI-GOOS) and the Hydrological Cycle Observing System (Pacific HYCOS). The APDRC currently maintains about 20 TB of online data for use by IPRC scientists and the broader community. This past year, the APDRC archived and configured for the servers an additional 10 TB of OFES output, mainly from the climatologically forced run at full global resolution and three-day interval. Other data sets acquired this past year were the GODAE High Resolution Sea Surface Temperature (GHRSST) data set, and updates to SODA, NCEP, SeaWIFS, QuikSCAT, and more. The APDRC was also active in providing data management services for locally generated data sets and model output. The paleo-climate modeling group has provided runs from the LOVECLIM and SIM2bl models that are now available on the APDRC servers. Similarly, HYCOM model output of the flow around the Hawaiian Islands is now archived and served by the APDRC. Access to data, projects, servers, tutorials, and other information is available at the APDRC web site: http://apdrc.soest.hawaii.edu.

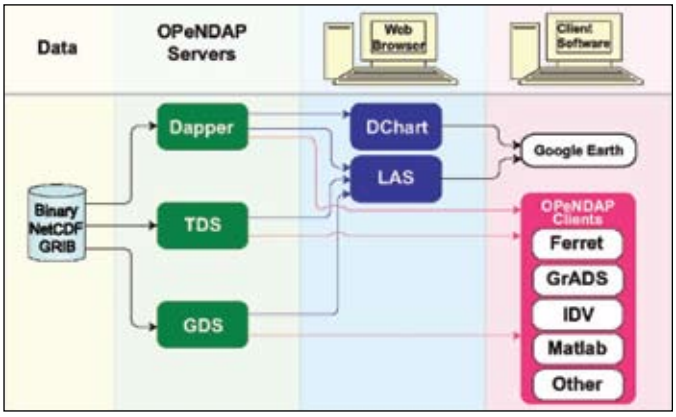


Figure 1. The above schematic shows the connection between the various software servers maintained by the DSS/DM component of the APDRC. Unlike most data centers, the APDRC effectively integrates many different servers (Dapper, THREDDS and GrADS DODS Servers) to provide binary access to data. These servers are also accessible by the web-based browsing tools such as DChart and the Live Access Server (LAS). The new versions of DChart and LAS now allow direct output to Google Earth applications.

Significant progress has been made on product development and distribution. PRIDE projects to develop integrated data products for the Pacific region are completed, and several have resulted in publications and new extramural funding. Global Argo products under development and now available on our servers include: surface and deep velocities from float trajectories; profile data interpolated on standard depth levels and isopycnals; mixed layer, isothermal layer and barrier layer depths; and statistics, climatologies, and monthly and annual averages. Products are currently updated monthly. The GODAE Product Server activities provided support for the model intercomparison efforts and resulted in substantial participation in community white papers and posters at the

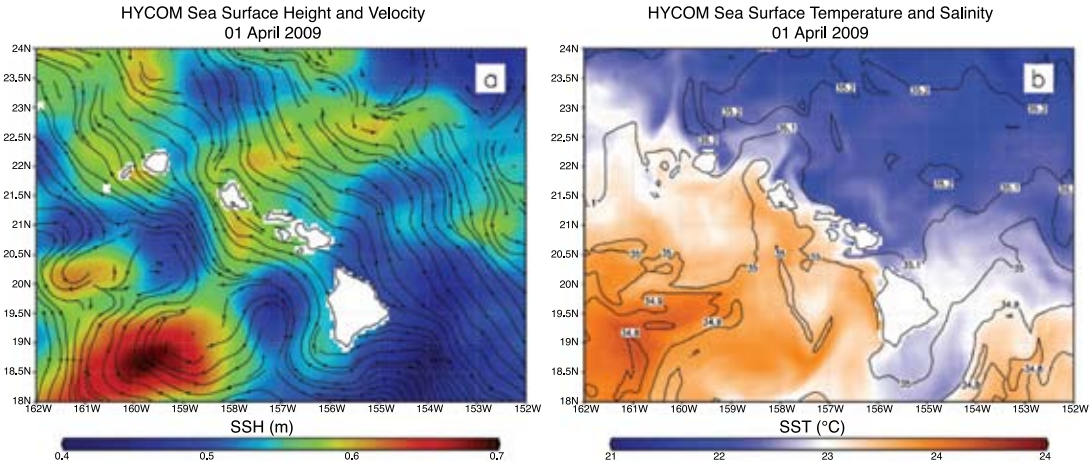


Figure 2. HYCOM results for April 2009: a) sea surface height (m) in colors and upper layer velocity in streamlines; b) sea surface temperature (°C) in colors and salinity in contours. In April 2009 a large, cyclonic eddy began to form in the lee of the Big Island. This eddy is identified by the relatively low sea surface height (a) and colder temperatures (b) between 158W and 157W, 19.5N to 20N. Eddies such as this have important consequences for biological productivity in the region, and the formation and evolution can be studied with this high-resolution ocean model.

final GODAE Symposium in November 2008. The high-resolution HYCOM model, needed for the downscaling of operational models in the Hawaiian Islands region, is currently providing nowcasts and forecasts, and two research tasks, dealing with eddy formation behind the Big Island (Hawai'i; Figure 2) and the dispersal of fish larvae, are in progress. The basic climate research activity has resulted in numerous publications and includes efforts addressing the broad scope of IPRC climate research. Research addresses: prediction and multi-model forecast of Pacific island rainfall including the use of a hybrid, coupled model; interactive air-sea coupling and model initialization; the use of Argo data to provide an improved description of the role of 13°C thermostat water in equatorial Pacific circulation and variability; and the downscaling of global forecast models for Hawai'i, in support of the NOAA/IDEA Center, to study and improve dynamic projections of climate change. Additional climate research, which benefited from project support and resulted in publications, includes: the dynamics of the equatorial Tsuchiya Jet and the Kuroshio system including the recirculation gyres; the seasonally evolving dominant inter-annual modes over East Asia; contrasting the rainfall/SST relationship in the western North Pacific between the ENSO developing and decaying summers; the satellite observed 3-D moisture structure during the summer monsoon onset; the planetary scale-selection of the Madden-Julian oscillation; the statistical downscaling of climate change scenarios in the Hawai'i region; the onset of the African Humid Period 14,500-11,000 years ago; and understanding deglacial climate change in Antarctica.

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

This project addresses 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 2009

Researchers studied the impacts of ENSO and Pacific SST anomalies on the East Asian summer monsoon variations. The current seasonal prediction of East Asia (EA) summer monsoon deals with June-July-August (JJA) mean anomalies. This study shows that the EA summer monsoon may be divided into early summer (May-

June, "MJ") and late summer (July-August, "JA") and exhibits remarkable differences in mean state between MJ and JA. This study reveals that the principal modes of interannual precipitation variability have distinct spatial and temporal structure during the early and late summer. These principal modes can be categorized as either El Niño-Southern Oscillation (ENSO)-related or non-ENSO-related. During the period 1979-2007, ENSO-related modes explained 35% of MJ variance and 45% of JA variance, while non-ENSO-related modes accounted for 25% of MJ variance and 20% of JA variance. For ENSO-related variance, about two-thirds are associated with ENSO decaying phases, and one-third is associated with ENSO developing phases (Figure 1). The ENSO-related MJ modes generally concur with rapid decay or early development of ENSO episodes, and the opposite tends to apply to ENSO-related JA modes. The non-ENSO MJ mode is preceded by anomalous land surface temperatures over southern China during the previous March and April. The non-ENSO JA mode is preceded by lasting equatorial western Pacific (the Niño 4 region) warming from the previous winter through late summer. The results suggest that a) prediction of bimonthly (MJ) and (JA) anomalies may be useful; b) accurate prediction of the detailed evolution of ENSO is critical for prediction of ENSO-related bimonthly rainfall anomalies over East Asia; (c) non-ENSO-related modes are of paramount importance during ENSO neutral years. Further establishment of the physical linkages between the non-ENSO modes and their corresponding precursors may provide additional sources for EA summer monsoon prediction.

Researchers assessed the current status of multi-model ensemble (MME) deterministic and probabilistic seasonal prediction based on 25-year (1980-2004) retrospective forecasts performed by 14 climate model systems (seven one-tier and seven two-tier systems) that participate in the Climate Prediction and its Application to Society (CliPAS) project sponsored by the Asian-Pacific Economic Cooperation Climate Center (APCC). Researchers also evaluated seven DEMETER models' MME for the period of 1981-2001 for comparison.

The MME method is a valuable approach for reducing errors and quantifying forecast uncertainty due to model formulation. The MME prediction skill is substantially better than the averaged skill of all individual models. For instance, the TCC score of a CliPAS one-tier MME forecast of Niño 3.4 index at a six-month lead initiated from May 1 is 0.77, which is significantly higher than the corresponding averaged skill of seven individual coupled models (0.63) (Figure 2). The MME made by using 14 coupled models from both DEMETER and CliPAS shows an even higher TCC score of 0.87. The effectiveness of MME depends on the averaged skill of individual mod-

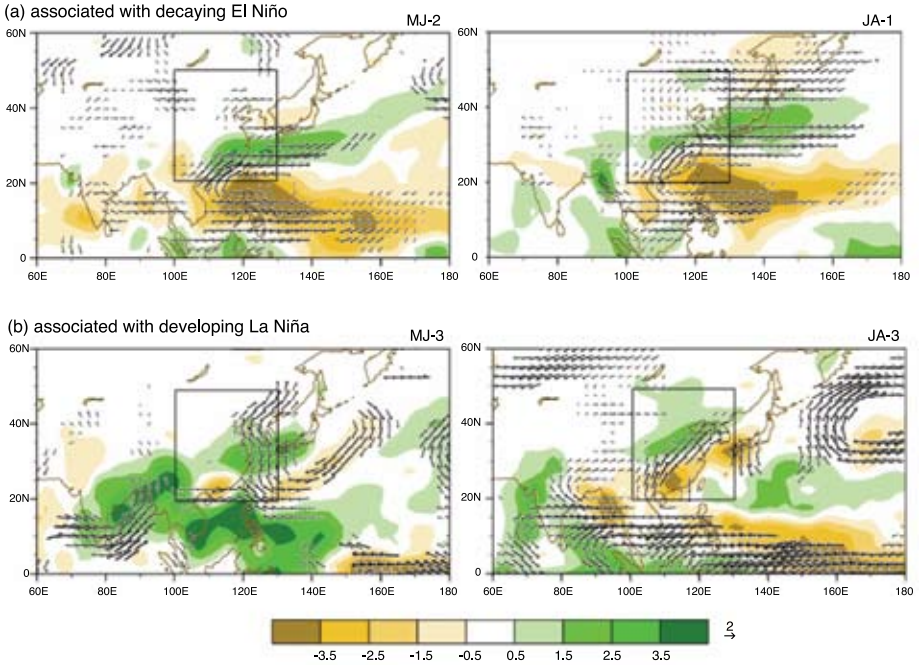


Figure 1. Regressed anomalous precipitation (colors in units of mm/day) and 850 hPa anomalous winds (m/s) associated with (a) decaying El Niño (MJ-2 and JA-1 modes) and (b) developing La Niña (MJ-3 and JA-3 modes). The regression was made with reference to the corresponding principal component. Wind vectors that are not statistically significant at the 95% confidence level were omitted. The EASM domain used for the EOF analysis (20°N–50°N, 100°E–130°E) is also outlined in each panel.

els and their mutual independency. For a probabilistic forecast the CliPAS MME gains considerable skill from increased forecast reliability as the number of models being used increases; the forecast resolution also increases for 2 m temperature but slightly decreases for precipitation.

Equatorial sea surface temperature (SST) anomalies are primary sources of atmospheric climate variability worldwide. The MME one-month lead hindcast can predict, with high fidelity, the spatial-temporal structures of the first two leading empirical orthogonal modes of the equatorial SST anomalies for both boreal summer (JJA) and winter (DJF), which account for about 80-90% of the total variance (Figure 2). The major bias is a westward shift of the SST anomaly between the dateline and 120°E, which may potentially degrade the global teleconnection associated with it. The TCC score for SST predictions over the equatorial eastern Indian Ocean reaches about 0.68 with a six-month lead forecast (Figure 2). However, the TCC score for Indian Ocean Dipole (IOD) index drops below 0.40 at a three-month lead for both the May and November initial conditions due to the prediction barriers across July and January, respectively.

The MME prediction skills are well correlated with the amplitude of Niño 3.4 SST variation. The forecasts for 2 m air temperature are better in El Niño years than in La Niña years. ENSO-decaying JJA is better at predicting precipitation and circulation than ENSO-developing JJA. There is virtually no skill in ENSO-neutral years. Continuing improvement of the one-tier climate model's slow-coupled dynamics in reproducing realistic amplitude, spatial patterns, and temporal evolution of ENSO cycle is key for long-lead seasonal forecast. Forecasting monsoon precipitation remains a major challenge. The seasonal rainfall predictions over land and during local summer have little skill, especially over tropical Africa. The differences in forecast skills over land areas between the CliPAS and DEMETER MMEs indicate potentials for further improvement of prediction over land. There is an urgent need to assess impacts of land surface initialization on the skill of seasonal and monthly forecast using a multi-model framework.

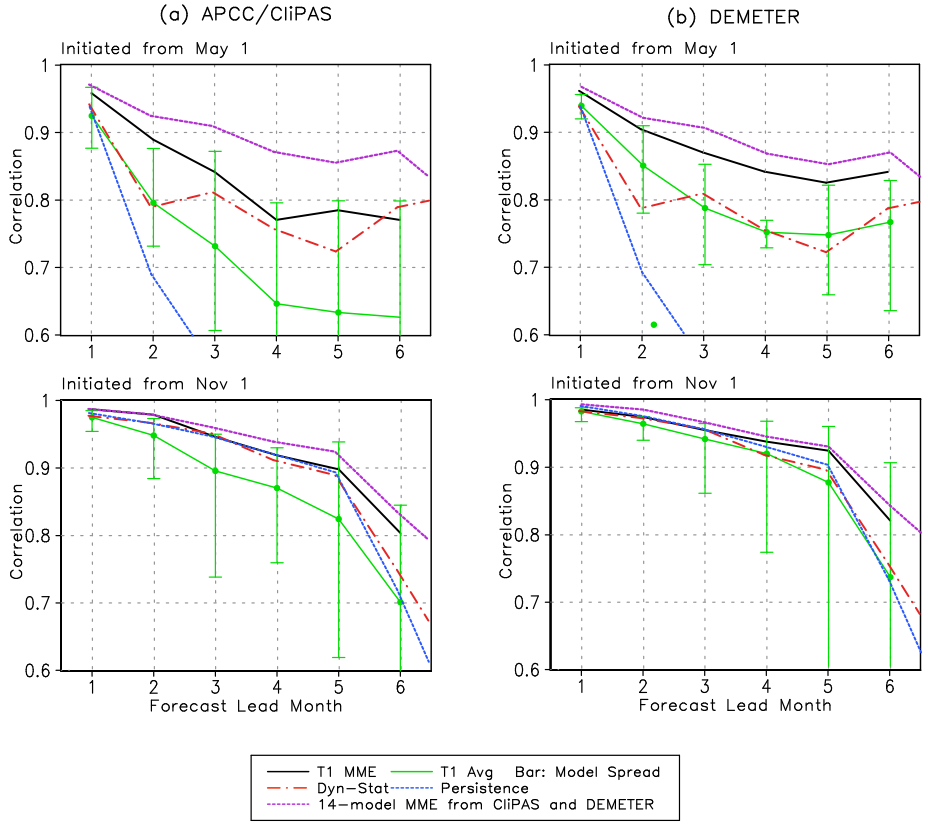


Figure 2. (a) Temporal correlation skill of prediction of Niño3.4 SST index as a function of forecast lead-time, initiated from May 1 and November 1 for the period of 1981-2001 derived from 7 CliPAS coupled models. (b) The same as in (a) but derived from seven DEMETER coupled models. The green lines indicate the averaged skill of the individual models and the bars show the range of the best and worst coupled model skills. For comparison, the skills of persistent forecast (blue), the SNU dynamic-statistical model forecast (red), and the 14-model MME from both DEMETER and CliPAS (purple) are also shown.

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 primary objective of this project is the collection of atmospheric mercury speciation data. The project will provide for the collection and analysis of semi-continuous high altitude (11,400 feet) measurements of Hg^0, reactive gaseous mercury (RGM), and Hg^P at Mauna Loa Observatory (MLO), Hawai'i. The objectives of this task are to accumulate a long-term record of ambient Hg^0, 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. The project will also measure and collect other data that may affect the transport and transformation mechanisms of atmospheric mercury. This includes 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 will 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.

Thomas Davis in front of the AIM.

Progress during FY 2009

In 2008 the addition of the new Hakalau site for collecting rain samples for mercury deposition prompted a need to hire additional staff. Thomas Davis was hired to take over the EPA project with Aidan Colton as backup support. Davis drove to Hakalau every Wednesday to change out the rain collection bottles and download the data. On Tuesdays and Fridays he worked at the observatory's mountain site. The rest of his days were spent working in the Hilo lab. The Hakalau site's last sample was in March and the sampler was shipped back on April 16, 2009. The Hakalau site was terminated as requested by the principal investigator, Matthew Landis. The reason for termination is not known and any inquires should be sent to Dr. Landis.

The prototype instrument, the Ambient Ion Monitor (AIM), was running most of the year with many fixes and "tweaking" of the procedures. This instrument provides the semi-continuous gas and particulate phase halide collection and analysis portion listed above. All other project data were collected and maintained as scheduled.

Aidan Colton working on the Dichotomous Partisol sampler.

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 Sciences and Assessments (RISA) 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 technology for video teleconferencing, the project engages in dialogue and information exchange among indigenous communities to share information, facilitate relationships among communities, and better assess needs for climate services.

Cross-RISA project poster presented at the Climate Prediction and Applied Science Workshop, March 2009.

Progress during FY 2009

During the period, three sessions were conducted. Two were cross-RISA and one was pan-Pacific because researchers discovered challenges in having nine time zones participating and further challenges with the community of resource managers who wanted to participate during typical "working hours." Records of the sessions were produced and the written notes were distributed to participants for comment and review. These final revised notes appear on the web site. The video records still need to be edited for publication on web sites. Trainings were conducted in these sessions, particularly focused on use of the Drought Impact Reporter and web portals gathering resources and documenting indigenous approaches to climate change. Researchers discovered that the technology had limitations in terms of being able to see information clearly if it is reviewed via video because of varying capacities across the region. The fourth objective involved developing materials, such as presentations, posters, a white paper, and journal article documenting lessons learned. The first two were finalized, but the last two will be accomplished in the next fiscal year.

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

Purpose of the Project

The purpose of the project was to continue operation of the Pacific ENSO Applications Center (PEAC) as a cooperative effort among the University of Hawai'i (JIMAR), University of Guam, National Weather Service Pacific Region, and the Pacific Basin Development Council. PEAC provides climate services to Hawai'i and the U.S.-Affiliated Pacific Islands. In recent years PEAC has evolved into an operational branch of the NWS Pacific Region.

Progress during FY 2009

During the recent La Niña event PEAC identified the probable impacts of sea-level rise upon vulnerable communities. Researchers provided advance information on seasonal and monthly sea level forecasts, and probabilistic outlooks on seasonal rainfall. Additionally they examined all available La Niña forecast models and developed an impact scenario. All this information was disseminated to vulnerable communities via monthly PEAC teleconferences and a printed newsletter. Through the teleconferences researchers received reports of consequences of coastal damage and abnormal rainfalls. A special bulletin describing causes and consequences of sea-level rise from regional and global perspectives was issued.

Based upon standard indices the 2007-2008 La Niña was a "moderately strong event". However, the 2007-2008 sea-level rises considerably exceeded those of stronger events in 1998-99 and 1987-89. This finding has caused researchers to consider what additional factors (atmospheric and oceanic) might be contributing to this result. They found that extreme high-water level events have been more frequent in recent decades and continue to search for causes.

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

This project has two areas of concentration.

- Float testing, deployment, and data/engineering evaluation
- Climate research using data from Argo floats and other sources

Progress during FY 2009

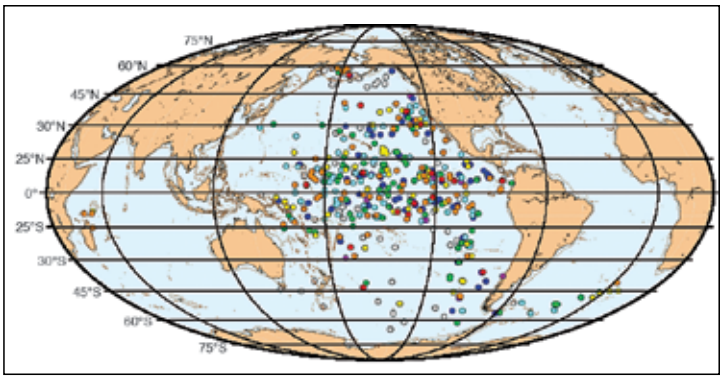


Figure 1. Locations (filled circles) of Argo floats prepared by JIMAR float research analyst E. Steffen as of 8 July 2009. Grey indicates floats that have not reported for the last 20 days or more, colors more recently reporting floats.

E. Steffen completed testing of 66 floats and installed Lithium batteries in 67 floats in FY 2009 (Figure 1). She found potentially serious problems in one or more subsystems of a large number of floats and worked with the manufacturers and other Argo groups to repair these subsystems and resolve some of the underlying manufacturing and supply problems that caused the issues. She also monitored float performance, kept up with float registrations, and helped to find and sort out float database issues. Steffen located deployment opportunities and coordinated logistics for 74 JIMAR/NOAA/PMEL float deployments from 19 cruises on eight ships (including a joint operation with Argo partner Scripps Institute of Oceanography [SIO]). She herself deployed 21 of these floats (as well as another 15 SIO floats during the joint operation) while participating in two cruises on two ships. She visited three other ships at which she tested floats, loaded floats, and gave deployment training. Steffen also visited the float facilities at to learn about developments in float technology. Additionally she tracked and arranged for recovery of a float plucked from the water by Chilean fishermen. Stated goals were met.

J. Lyman produced and analyzed (with JIMAR Senior Fellow Dr. Gregory Johnson) yearly maps of global upper ocean heat content from 1993 through 2008 (Figure 2) combining in situ thermal data and satellite altimetry data, as well as yearly maps of sea surface salinity from 2005 through 2008. They also worked on estimating global ocean heat content using irregularly sampled data, quantifying influences of equatorial Kelvin Waves reaching the Bering Sea, and effects of in situ data biases in ocean heat content estimates. This year Lyman was

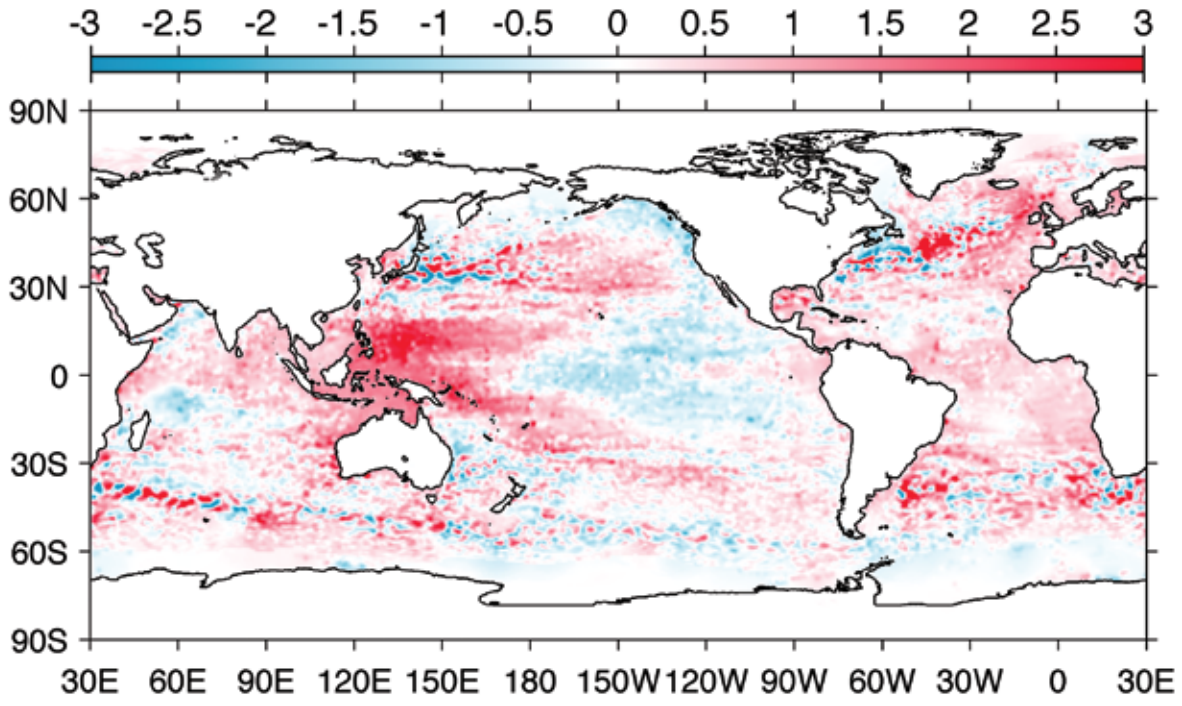


Figure 2. Upper Ocean (0-750 dbar) Ocean Heat Content Anomaly [10^9 J m^{-2}] for 2008 relative to 1993-2008 estimated using in situ (mostly from Argo in recent years) temperature data and satellite altimeter sea surface height data (in colors, with red being warm and blue cold).

first author of two published manuscripts, co-author of one, and co-author of two published reports. Stated goals were met.

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

The purpose of this project is to better understand the interaction of the ocean, atmosphere, and land and its role in tropical Atlantic variability; and to identify the sources of and reduce errors in simulating tropical Atlantic climate.

Progress during FY 2009

(1) Sea surface evaporation response to global warming has been investigated using the IPCC AR4 simulations. Increases in surface relative humidity and stability are found to slow down the evaporation increase relative to atmospheric moisture increase (Figure 1). (2) The oceanic and atmospheric pathways for a slow-down of the Atlantic meridional circulation to affect Pacific climate are investigated based on coupled model water-hosing experiments. The closing of the Bering Strait and tropical Atlantic sea surface temperature changes are found to be important for Atlantic to Pacific teleconnections (Figure 2). (3) Water vapor transport from the Atlantic to the Pacific is examined using coupled model simulations. The response of this moisture transport is found to vary depending on climate change scenarios. (4) The PI visited Global Fluid Dynamics Laboratory (GFDL) in November-December 2008 and initiated collaboration with the GFDL model development team to investigate the model's sensitivity to errors in equatorial zonal winds. The results are being analyzed and will be submitted for publication shortly.

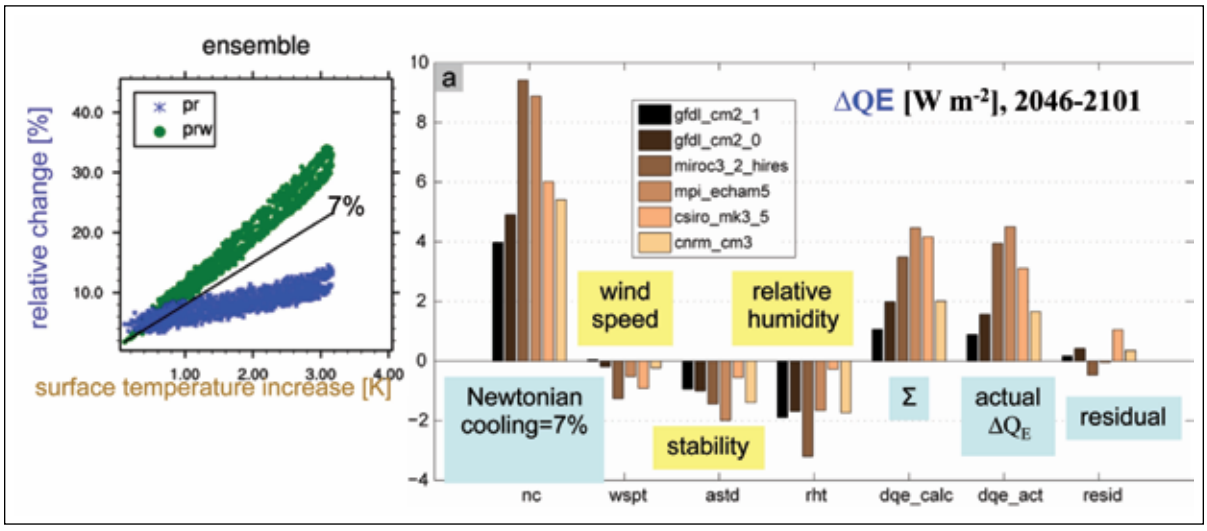


Figure 1. Precipitation increase in global warming simulations is much slower than humidity, leading to a slow down of tropical circulation. Researchers take a surface evaporation approach from its global balance with rainfall. The analysis of models in the IPCC AR4 ensemble reveals that the slow-down of evaporation is due to the increase in surface stability (S=SAT-SST) and relative humidity (RH). The CO_2-induced warming stabilizes the atmosphere and the surface sensible cooling acts to increase RH in analogue to sea fog formation.

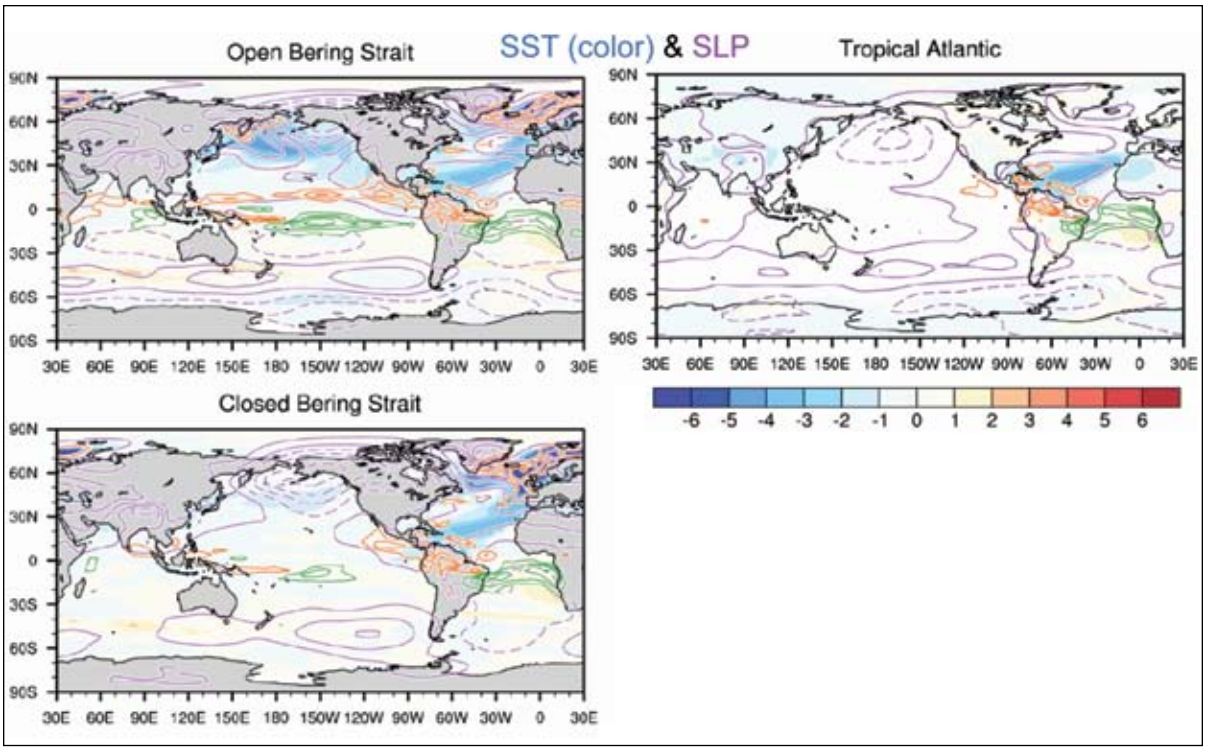


Figure 2. Change in Atlantic meridional overturning circulation is an important mechanism for abrupt climate change. Idealized experiments are carried out using CCSM by adding fresh water in the subpolar North Atlantic. The opening Bering Strait strengthens the North Pacific cooling substantially by allowing a direct export of fresh water. In addition, the tropical Atlantic cooling excites an atmospheric teleconnection to strengthen the Aleutian low.

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 the 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)

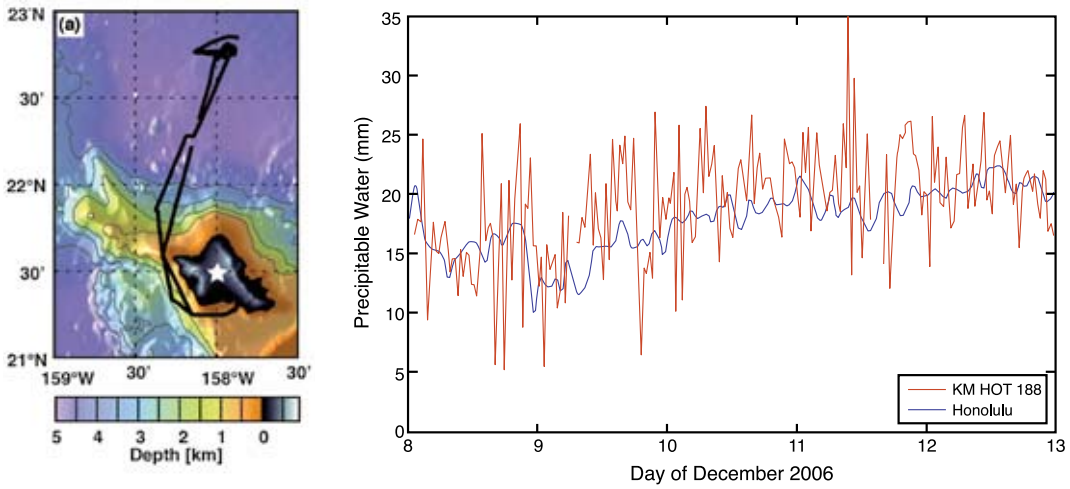
- To serve society's needs for weather and water information

Purpose of the Project

The purpose of the project is to maximize earth-based GPS resources. It has two primary tasks; the first is to develop, operate and maintain the SkyNet network of GPS meteorology stations in Hawai'i, 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 2009

The SkyNet network operated continuously during FY 2009, with only minor outages, except for O'ahu sites HWWJ and HWCC where long-standing problems have hampered operations. These sites are the current focus for the development of alternative communications in order to bring them back up to full operational status. GPS processing software has been upgraded to the latest version and is being migrated to a new processing array in order to speed up the production of solutions.



(left) Ship track for Kilo Moana *HOT188 cruise, 08-13 Dec. 2006. Reference site HWWJ used for the processing is indicated by the star. (right) Precipitable water along the track of the* Kilo Moana *for HOT188 cruise, demonstrating the feasibility of retrieving valuable meteorological information from a floating platform. Precipitable water solutions for GPS site HNLC in Honolulu are shown for reference.*

A paper entitled "Ship-based measurements of sea surface topography" was published in the *Geophysical Research Letters* journal. In it researchers demonstrate high-accuracy processing of geodetic grade GPS data from the University of Hawai'i research vessel *Kilo Moana*. Funding was secured to install a new pair of geodetic grade GPS receivers on the *Kilo Moana* permanently. The system should be in place by December and data from subsequent research cruises will be processed for investigations of meteorological processes over the open ocean.

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

This project is a part a memorandum of understanding between the University and National Weather Service (NWS) in which NWS agreed to support graduate students in SOEST academic units.

Progress during FY 2009

Aaron Levine graduated and moved into a PhD program within the Department of Meteorology. Jessica Garza joined the program as an MS student and is developing her thesis topic.

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 purpose of the project is to provide 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 Department of Meteorology at the University of Hawai'i 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 not already doing so, and for others to upgrade their capabilities.

Progress during FY 2009

The Pacific Desk hosted six interns during FY 2009. The participants were all from South Pacific Island nations, namely, Tonga, Tuvalu, Solomon Islands, and Papua New Guinea with Samoa and Vanuatu participants in later 2009. All spent six weeks at the Honolulu National Weather Service Forecast Office, which is also the Central Pacific Hurricane Center and a Regional Specialized Meteorological Center.

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 PIFSC, 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 objectives of this project are as follows: 1) improve understanding of marine environmental variability and its impacts on living marine resources; 2) develop improved living marine resource assessment models; and 3) apply telemetered tags and satellite remote sensing technology to improve the management of economically important marine resources. This will aid in our understanding of environmental variability in time and space, and improve our ability to manage economically important and protected marine resources.

The project has two primary tasks. The first is 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. The second is to conduct research related to the application of in situ and satellite remote sensing data products for marine fisheries and other ocean users requirements, based on a mechanistic understanding of the links between physical forcing and ecological response.

Progress during FY 2009

A number of projects dealing with the ecology of top predators in the eastern North Pacific were continued or completed this year. Efforts to describe the conditions that determine good foraging habitat for endangered leatherback turtles (*Dermochelys coriacea*) off central California during summer was undertaken during the Leatherback Use of Temperate Habitat (LUTH) shipboard survey, 24 August-6 September 2008, aboard R/V *David Starr Jordan*. LUTH was a collaborative SWFSC-wide study that involved scientists from several divisions, who are currently involved in post-cruise data analysis and synthesis. ERD scientists also participated in the annual aerial line-transect surveys for leatherbacks off central California as part of this effort. A separate collaborative SWFSC study described the phylogeography and population structure of California and Galapagos sea lions (genus *Zalophus*).

An ongoing Lenfest-funded project aims to analyze the migration of leatherback turtles throughout the Pacific Ocean and identify where and when interactions with fisheries are most likely to occur, as this is currently one of the greatest threats to this endangered species. Tracking data has been obtained from 134 leatherback turtles tagged in California, Mexico, Costa Rica and Indonesia. Western Pacific turtles were found to forage along California, the Kai Islands, the Philippines, and the North Pacific Transition Zone (Figure 1). The location of foraging effort differed in relation to the timing of nesting. In contrast, the eastern Pacific turtles all headed in a southwesterly direction from their nesting beaches and foraged off the Galapagos Islands and in the South Pacific Gyre. Fisheries data for the entire Pacific Ocean is now being collated for comparison with these turtle movements.

The movements of blue whales (*Balaenoptera musculus*) in the eastern North Pacific from Alaska to the Costa Rica Dome (CRD) were studied based on the tracks of 92 animals tracked by satellite. As opposed to other baleen whales that fast during the low-latitude phase of their annual migrations, a switching state-space model (SSSM) analysis indicated that these blue whales forage year-round, moving between patches of high productivity (Figure 2).

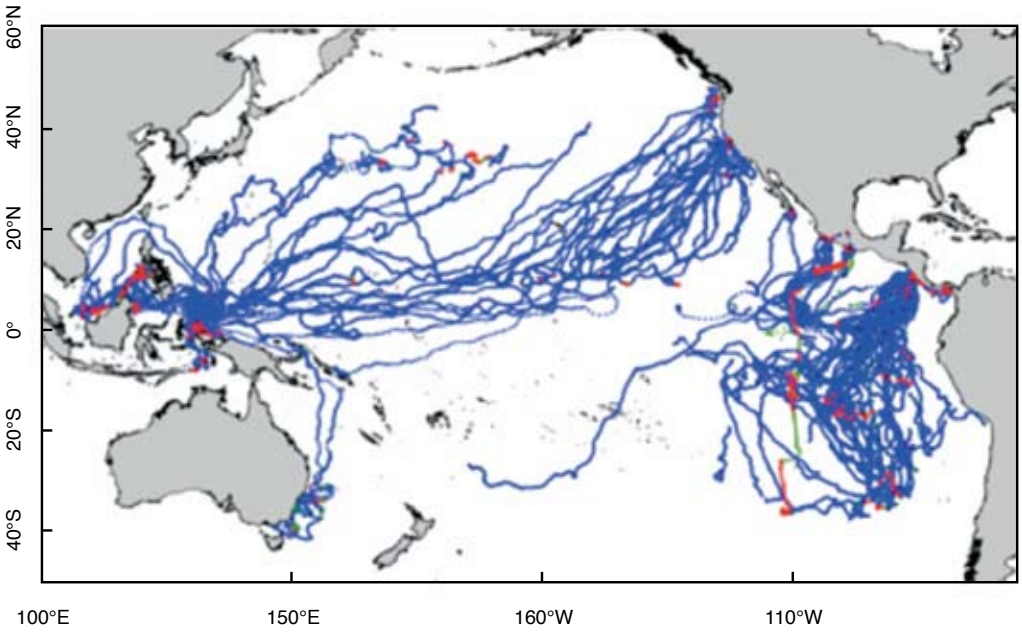


Figure 1. Map of mean positions estimates from state-space modeling of leatherback turtle tracks (n=134). Locations are color coded by behavioral mode, where blue is transiting, green is uncertain and red is foraging.

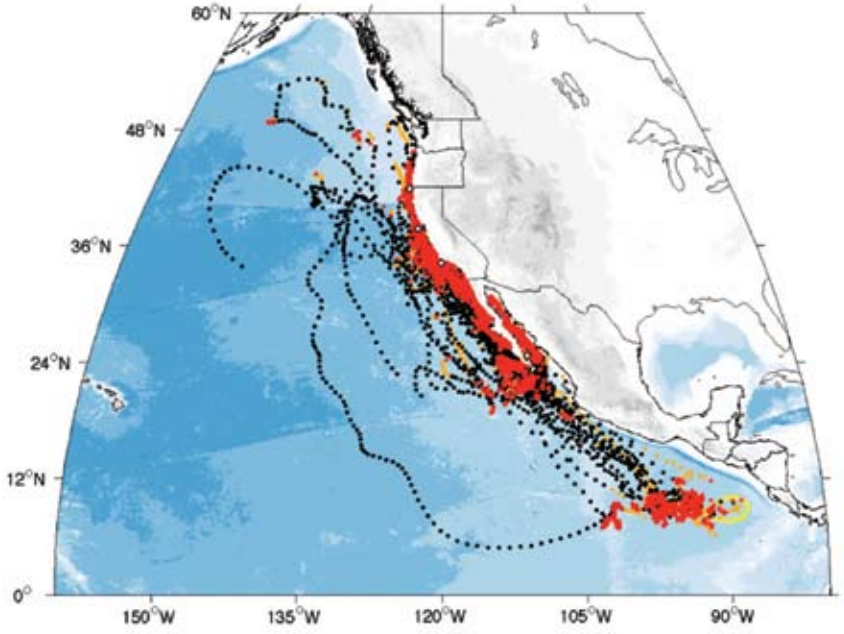


Figure 2. Balaenoptera musculus. *Map of SSSM-derived locations for blue whales satellite tagged during 1994 to 2007 overlaid on bathymetry. Locations are color coded by behavioral mode (black = transiting, orange = uncertain, red = ARS behavior). The annual climatological position of the CRD is shown as a yellow contour and the four tag deployment locations as white circles.*

Based on work presented last year at the International Whaling Commission's (IWC) Scientific Committee annual meeting, two manuscripts were completed on estimating population abundance for several cetacean species in waters of Colombia and the Galapagos Islands in the eastern tropical Pacific, based on shipboard surveys. Both papers have been submitted for publication. These results are useful for building ecological frameworks for understanding how island-driven oceanographic processes influence cetacean community structure in various systems

around the world. Involvement in related IWC activities included participation in the workshop on "Climate Change and Adaptation Options for Cetaceans and Other Marine Biodiversity of the Eastern Pacific" (Costa Rica, February 2009), the "Second IWC Workshop on Cetaceans and Climate Change" (Italy, February 2009), and the international expert workshop to assess the vulnerability of the Galapagos Islands to climate change (Ecuador, April 2009).

Research in support of the US GLOBEC Synthesis and related activities has continued to focus on understanding how local processes in the California Current and Gulf of Alaska ecosystems modulate large-scale climate forcing to produce a heterogeneous mesoscale response. Researchers used two approaches: (1) analyzing long-term time series of oceanographic variables to describe spatial (sub-ecosystem to basin and global) and temporal (intraseasonal to interannual) patterns of variability; and (2) developing indicators of climate and environmental variability applicable to the management of living marine resources. The time series analyses have focused on differentiating climate signals associated with long-term trends, changes in seasonality, and rapid climate shifts—all of which have significant ecosystem consequences. Five manuscripts were published in peer-reviewed journals.

ERD continued work on the Environmental Research Division's Data Access Program (ERDDAP), a web-based service that helps humans and computer programs download oceanographic data in common file formats. ERDDAP can access and transform data served by the IOOS Sensor Observation Service (SOS), as well as send data to an OGC Web Mapping Service (WMS) client. A web-based interface based on ERDDAP was developed for the Farallon Institute, which allowed researchers there to directly import remotely served data into the Institute's database system. This has greatly simplified their ability to access data for work on developing Integrated Ecosystem Assessments for the California Current ecosystem.

ERD also transferred all of its non-gridded data to Postgresql databases, which have been spatially enabled using PostGIS. This allows for spatial queries from the database, such as all the data within a given polygon, or all the data within a distance of a point. ERD also updated many of its Live Access Servers to the new version 7, including the newer AJAX style user interface.

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 Hawai'i 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 Hawai'i 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 2009

Work was completed for the implementation of system modifications for supporting both American Samoa data management and the new requirements for Marine Mammal Biological Data. These system changes underwent testing and acceptance and were rolled out to production. Additional system enhancements to allow the Observer Program data managers to create and lock/unlock user accounts and to more efficiently document experimental trips were included in this latest release.

Ongoing database administration, application, and web site support has continued to result in high system availability, exceeding the minimum requirements as stated in the Service Target Agreement (STA) between PIFSC and PIRO.

Work to date on the LLDS has focused on three areas: (1) the development of modular system components to allow secure user registration, authentication, account management, and electronic signing of entered data; (2) database design based on integration of Longline Observer data and State collected landings data; and (3) user data summarization and reporting capabilities. Additional reporting capabilities were developed to allow for comparison of logbook reports to observer data and estimated catch weights as derived from landings and observer measurements.

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 where there is 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 2009

Sea turtle and seabird bycatch estimates were produced for year 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, characterization of deep slope coral systems, and support for advancing public awareness of marine ecosystems observations.

Progress during FY 2009

Activities highlighting the project during FY 2009 include the following.

- Conducted 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 research cruises aboard the NOAA *Oscar Elton Sette* were successfully conducted off the Kona coast of the Island of Hawai‘i to collect young and adult stages of commercially important

bottomfish species 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 led to the discovery of a potential new species of moonfish (*Lampris guttatus*); a fish commonly captured in the Hawai'i high seas tuna longline fisheries. Genetic samples collected from morphological variants of moonfish suggest the existence of two distinct species in the catch landed by the fishery. Further research into this finding will continue through next year.

- Conducted studies of mesophotic (mid-to-deep slope) coral communities.
- Supported an acoustic tagging network designed to examine movement patterns over and around seamounts for tunas and associated species in the Main Hawaiian Islands. The network involves anchored listening stations deployed on and adjacent to the Cross Seamount that record sonic messages emitted by tagged fish. The listening stations are also by design compatible with the larger network stations in the Hawaiian Islands deployed by a consortium of scientific investigators, thus allowing for the detection of fish undergoing greater movement patterns. This project is in collaboration with PIs in the Pelagic Fisheries Research Program.
- Supported the systems design and development of the software infrastructure for a "non-commercial" reporting system; i.e., a recreational fishery reporting system.

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)

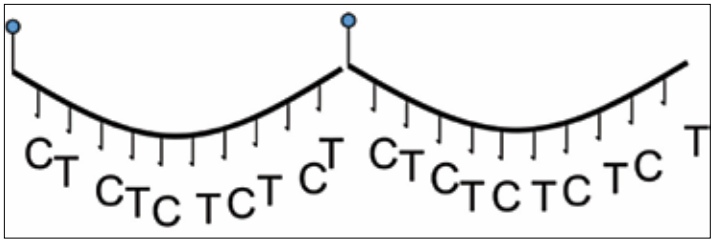
- To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The purpose of this 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 necessary for 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 2009

This is our fourth year of experimental field trials conducted throughout the globe. To date, our field trials have compared over 1 million traditional vs. experimental hooks in Italy, Brazil, Uruguay, and Indonesia. In each location, our work has shown the efficacy of circle hook use in reducing the incidental capture of sea turtles in fisheries. Circle hooks have been shown to significantly increase capture rates of tuna species. In all fisheries tested, some species by as much as two times the rate of capture on traditional hooks. Capture of billfish, primarily swordfish, has been



(left) The experimental design consists of alternating the control hook (e.g., tuna or J) with an experimental hook (e.g., circle) along the length of the mainline, or at least in segments along the mainline. (right) Loggerhead sea turtle caught in longline fishing gear in Uruguay. Photo credit: Caren Barcelo.

shown to be slightly reduced on circle hooks compared to traditional hooks, which 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 the use of circle hooks in the fisheries. The work involved contracting a statistician to help with a meta data analysis that will allow for very robust sample size enabling the potential to tease apart the relative influences of variables such as hook shape and size on rates of capture of sea turtles, sharks, and target species. In the past year, our work with this statistician has allowed researchers the opportunity to generate an Access Database that is publicly available and posted on the NOAA bycatch web site.

Fisheries Oceanography: Protected Species Investigation: Marine Turtle Research Program

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Stacy A. Hargrove, George Balazs]

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 includes eleven discrete tasks: 1) research to reduce or mitigate high-seas and coastal fishery bycatch of sea turtles; 2) research on the general biology, life history, and ecology of sea turtles in coastal marine habitats and on nesting beaches; 3) monitoring of sea turtle population trends for stock assessments; 4) simulation modeling of long term sea turtle datasets to better understand population dynamics; 5) health assessments and disease investigations with a focus on sea turtle fibropapilloma tumor disease; 6) administration of a sea turtle stranding and salvage network for research and live turtle rehabilitation; 7) training, capacity building, and sea turtle information exchange with other Pacific islands; 8) educational outreach to the public focused on sea turtle research results; 9) experimentation with remote viewing digital imagery for sea turtle monitoring and research; 10) maintenance of efficient and secure computerized storage, management, and retrieval of sea turtle research data; and 11) administration of observer training in the collection of sea turtle data aboard commercial longline fishing vessels.

Progress during FY 2009

In the FY 2008 annual report, MTRP identified the following goals for FY 2009: 1) continue research of the pelagic ecology and movements of sea turtles to develop management strategies to reduce bycatch; 2) conduct nesting beach research at East Island, French Frigate Shoals; 3) continue captive care and rehabilitation of captive-reared and stranded turtles; 4) conduct necropsies on stranded turtles and collect and manage biological samples; 5) conduct Longline Observer training; and 6) participate in field captures of marine turtles in the main Hawaiian Islands. Progress toward these goals is discussed below.

JIMAR Research Associate, Irene Nurzia-Humburg, measures a nesting green turtle on East Island, French Frigate Shoals.

- A collaborative project was established in FY 2007 with the Noumea Aquarium in New Caledonia and continued in FY 2008 and FY 2009. Forty-two loggerhead sea turtles hatched from nesting beaches in New Caledonia were reared in captivity since March 2007. They were released in September 2008 from the Maritime Nationale Patrouilleur la Glorieuse in 18°C waters between New Caledonia and New Zealand with satellite tags to study

their behavior and movements in pelagic habitats. Denise Parker, JIMAR Marine Turtle Specialist, manages a Pacific-wide satellite-tracking database, prepares maps, analyses satellite-tracking data, and provides data for publication in peer-reviewed journals. The New Caledonia satellite tracking data has been added to the database and Parker provides maps to project collaborators.

- The Marine Turtle Research Program has conducted nesting beach research at East Island, French Frigate Shoals (FFS) since 1973. Irene Nurzia-Humburg, JIMAR Research Associate, was on assignment at FFS from June through July 2008 and from May through June 2009 to conduct tagging and nest monitoring research for the 2008 and 2009 green turtle nesting seasons. She completed her third and fourth seasons at FFS in FY 2009. She served as camp leader and trained new USFWS Biological Technicians in data collection and field techniques in both 2008 and 2009. Nurzia-Humburg authored the end of the season report and updated standard operating procedures for the 2008 turtle field camp.

George Balazs and Shandell Brunsun measure a captive-bred and reared juvenile green turtle at the NMFS Kewalo Research Facility.

- William Connor, Tiffany Hooper, and Irene Nurzia-Humburg, along with NMFS MTRP staff, were responsible for the care and rehabilitation of stranded sea turtles and 12 captive-bred and captive-reared green turtles at the NMFS Kewalo Research Facility. Nurzia-Humburg was responsible for overseeing the daily care of all sea turtles under MTRP care. Daily care involved feeding, cleaning tanks, administering medication, and conducting external visual exams. More than 500 stranded marine turtles in Hawai‘i have been rescued, rehabilitated, and released since 1992.
- Shandell Brunson, William Connor, Tiffany Hooper, and Irene Nurzia-Humburg, along with NMFS MTRP staff, were responsible for conducting necropsies on stranded marine turtles. Salvaged carcasses are examined externally and a gross necropsy is performed to ascertain a cause of stranding. Biological samples such as skin for genetic analysis, food items for diet analysis, tumor tissue for disease studies, and gonads for sex and maturation analysis are collected and managed by JIMAR MTRP Biological Technicians.
- JIMAR MTRP staff along with NMFS MTRP staff conducted two Longline Observer training sessions in FY 2009. Irene Nurzia-Humburg led the training and William Connor and Tiffany Hooper assisted with the hands-on training. Nurzia-Humburg gave a 30-minute presentation on sea turtle biology and then demonstrated proper techniques for taking carapace measurements, flipper tagging, and taking a skin biopsy.
- JIMAR MTRP staff participated in marine turtle fieldwork including the capture of marine turtles on several occasions at the Hanauma Bay and Kailua Bay study sites. Juvenile green turtles were captured by hand/snorkel or by scoop net and then tagged, measured, weighed, and examined. William Connor accompanied George Balazs, on a field trip to Maui to scout out a potential capture site for hawksbills in May 2009. Tiffany Hooper accompanied Balazs and long-time collaborator, Marc Rice (Hawai‘i Preparatory Academy), to the North Shore of O‘ahu to retrieve electronic tags from basking turtles in June 2009.
- A new position was created and filled in FY 2009 for a JIMAR MTRP Administrative Associate.

Fisheries Oceanography: Protected Species: Cetacean Research Program

P.I.: Thomas A. Schroeder [Samuel G. Pooley, George Antonelis]

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

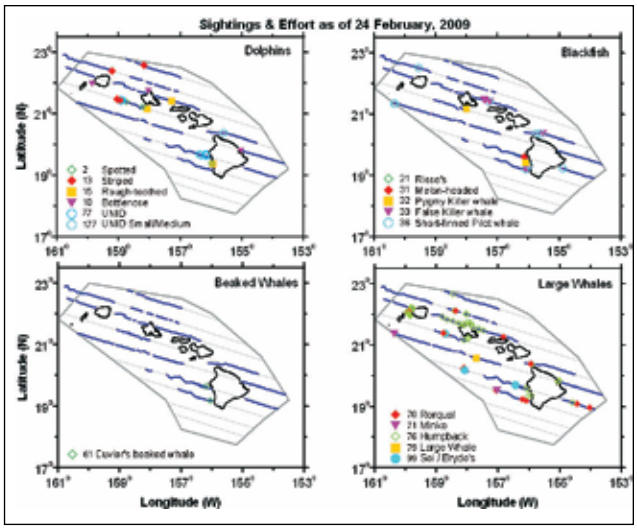
The Cetacean Research Program (CRP) is charged with assessing the status of cetacean stocks within the U.S. Exclusive Economic Zone (EEZ) waters of the Pacific Islands region (PIR), which encompasses the EEZ around the entire Hawaiian archipelago, Johnston Atoll, Kingman Reef and Palmyra Atoll, Baker and Howland Islands, Jarvis Island, American Samoa, Wake Island, Guam, and the Commonwealth of the Northern Mariana Islands. At least 25 cetacean stocks occur in the Hawaiian EEZ alone, and many more exist in the other PIR EEZs, though most are largely unstudied. Assessment of cetacean stocks includes conducting inventories of species within each PIR EEZ, followed by evaluation of the structure of the stocks within each EEZ, the population status of each stock, and evaluation and mitigation of human impacts on cetacean stocks.

Progress during FY 2009

During July 2008, the Cetacean Research Program led a research cruise off the Kona Coast of the Big Island of Hawai'i. With collaborating scientists from the University of Hawai'i, Cascadia Research Collective, Woods Hole Oceanographic Institution, Wild Whale Research Foundation, and Duke University, researchers investigated the biology and behavior of beaked, pilot, and melon-headed whales to learn more about how deep diving marine mammals dive, feed, interact with one another, and respond to sounds in their environment. Visual surveys and tagging operations were conducted from the NOAA ship *Oscar Elton Sette* and accompanying smaller launches. Researchers placed monitoring tags (DTAGs and B-Probes) on pilot whales, which recorded very detailed but short duration data of depth, pitch, roll, heading, and sound. Satellite tags, which provided longer-term data on the whales' geographical movements around the Hawaiian Islands, were placed on beaked, pilot, and melon-headed whales. In addition to deploying monitoring tags, researchers conducted CTD casts and collected fisheries acoustic (backscatter) data in order to analyze the whales' movements in relation to physical characteristics of their environment and their prey. These data sets are still being combined in order to gain insight into how these deep diving whales behave naturally in their environment and what influences their behavior.

Pilot whale carrying a Digital acoustic recording tag (DTag) during the RIMPAC08 collaborative survey off the Kona coast of Hawai'i.

In February 2009, the CRP conducted a large ship survey of the main Hawaiian Islands in order to update abundance estimates for insular populations. During the 21-day effort a team of visual observers searched along pre-determined tracklines for cetaceans using "big-eye" 25-power binoculars. 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. The team recorded 116 sightings of 12 species and obtained several photo-ID and biopsy samples for investigation into the stock structure of local cetaceans. Staff members have also maintained High-Frequency Acoustic Recording Packages (HARPs) for long-term continuous recording of cetacean occurrence off the Kona coast of the Island of Hawai'i, Palmyra Atoll, and in April of 2009, re-occupied a previous recording site at Ladd Seamount 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.



Cetacean sighting locations during the February 2009 main Hawaiian Islands survey cruise.

CRP has also continued its oversight of a community-based collaborative photo identification catalog for spinner dolphins in the PIR. For more information refer to the web site at http://pipin.org/community/.

Fisheries Oceanography: Protected Species: Hawaiian Monk Seal Research Program

P.I.: Thomas A. Schroeder [Samuel G. Pooley, George Antonelis, Charles Littnan]

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 Hawaiian Monk Seal Research Program (HMSRP) is to study the relationship between environmental/oceanographic parameters and demographic trends of the endangered Hawaiian monk seal and develop strategies to mitigate causes of mortality to enhance the recovery of the species. Much is known about monk seal population dynamics, and monitoring programs are currently place.

Progress during FY 2009

Activities undertaken by the HMSRP include population monitoring and assessment, characterization of foraging ecology, and evaluation of health and disease. In 2009, the program was able to return to full staffing levels for the annual field camps after having to operate with smaller camps due to 2008 budget shortfalls. Fully staffed, the researchers were better able to collect valuable population information, tag new pups, assist in marine debris collection, mitigate mortality by aggressive males, prevent shark predation on pre-weaned pups, and complete other duties as needed. Some key happenings in monk seal research in the NWHI this year.

- *Survival Enhancement Program Leader.* The HMSRP was able to hire a research biologist to head the Survival Enhancement Program. This critical program's purpose is to develop strategies, and metrics to measure their efficacy, to increase monk seal survival.
- *Translocation Study.* In August, six recently weaned seals were captured, biomedically sampled and transported from French Frigate Shoals to Nihoa Island. The purpose of this study was to develop the techniques to successfully transport weaned seals long distances from an area of low survival to an area of likely higher survival. The transport was successfully completed and researchers will be returning to Nihoa in August to look at survival

through year one of the transplanted seals. The work was done in collaboration with The Marine Mammal Center and Moss Landing Marine Laboratory.

- *Shark Mortality Study.* Researchers continued to address Galapagos shark predation on monk seals by using deterrents to keep sharks away from young seals. This included magnet, electromagnetic, and sound deterrents. Our program also collaborated with HIMB to support their studies of Galapagos and tiger shark behavior at French Frigate Shoals.
- *Monk Seal Assessment Study.* Studies in the Main Hawaiian Islands (MHI) continued in FY 2009 through the efforts of a full time sightings coordinator and a cadre of responders collecting data whenever seals were reported in the MHI; historical and current MHI sighting data entered into a database. The health and disease project trained field researchers in seal necropsy and sampling techniques, and processed the resulting samples from the field season. The health and disease project has been responding to hooking and injured seals in the MHI and developing research plans for the development of vaccinations for morbilivirus and other diseases.

Fisheries Oceanography: Synthesis of Historical Data and Research Results on Sea Turtle Bycatch Reduction in Longline Fishing

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

This project involves analysis and synthesis of bycatch data from historical fishery surveys and fishery monitoring, and research results from previous and ongoing NOAA/NMFS and JIMAR studies of sea turtle interaction and release from fishing gear. Goals for this project include the following:

- Comparisons between historic and recent records of sea turtle interactions;
- Utilizing data obtained from sea turtles tagged with telemetry devices at sea to determine turtle movements, habitat choices, and probability of survival after various forms and severity of fishery interactions; and
- Utilizing data on the physiological and behavioral reactions of sea turtles and fish to lights, colors and other stimuli associated with bait and fishing gear to develop ideas for improved fishing gear that would be equally or more selective for target fish species while reducing turtle bycatch.

Progress during FY 2009

- *Satellite Archival Tagging*. In the past year, researchers deployed and collected data for a total of 21 platform terminal transmitting tags placed on loggerhead turtles (*Caretta caretta*) caught and released from longline fishing gear in the South Atlantic Ocean (Figure 1). This work is part of a collaboration with Brazilian and Uruguayan fisheries observers who are also responsible for the collection of experimental longline fishing trial data (e.g., circle hook research). As of May 2009, 18 tags have transmitted their maximum data (three are still transmitting), with average transmission duration of 256 days (range: 3–587 d). In association with data obtained on hooking severity (e.g., flipper vs. mouth-hooked), the tracking data provides evidence of a relatively high post-release survivorship from these fisheries interaction, which are apparently not directly linked to the type of

Figure 1. Loggerhead sea turtle outfitted with a platform terminal transmitter (PTT) on a fishing vessel in Uruguay.

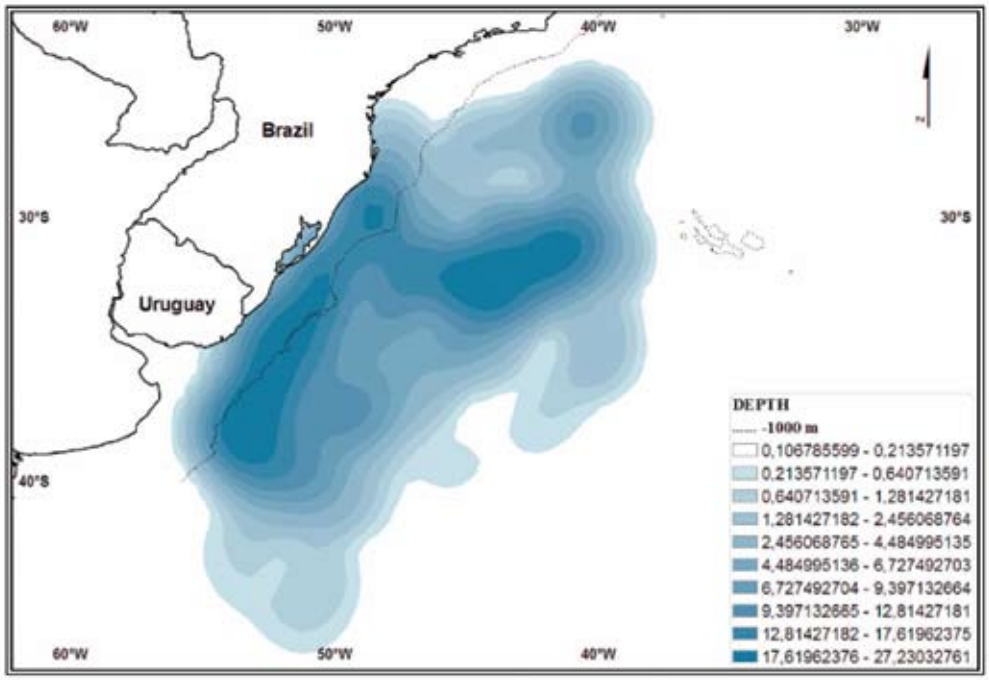


Figure 2. Kernel density estimates of loggerhead turtle movements in the South Atlantic Ocean.

injury occurred. More specifically, the data do not suggest that deeply hooked turtles have shorter duration of tag transmissions (proxy for survivorship) when compared to turtles that are hooked externally. These findings will be especially valuable as NOAA aims to provide empirical basis for the hypothesized rate of turtle mortality associated with extent of fisheries injury.

Both Caren Barcelo (operating in Uruguay) and Lianne McNaughton are responsible for managing the tracking data, including spatial analyses of kernel density estimates of loggerhead turtle movements in the SW Atlantic Ocean (Figure 2). Based on the success of this past year's work, the project recently purchased additional tags to be placed on more loggerhead turtles.

- *Sensory and Behavioral Biology Research*. Progress in this area of sea turtles' responses to visual deterrents have come primarily from continued research performed in Baja, Mexico whereby the incidental capture of sea turtles was monitored with and without lightsticks (in a night time fishery) and shark shapes (daytime fishery). Experiments have been conducted in collaboration with Aquatic Adventures Science Education Foundation from March 2008 through the present.

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

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

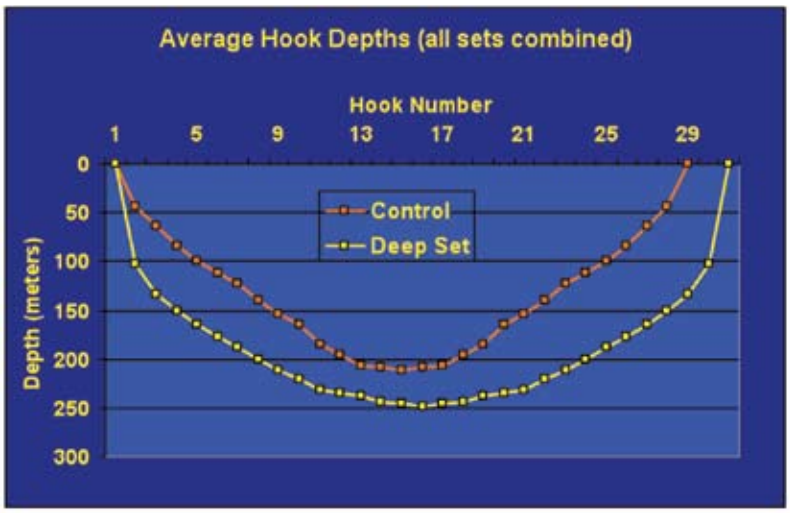
NOAA Office (of the primary technical contact): National Marine Fisheries Service/Pacific Islands Fisheries Science Center

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 communications, and using the fishermen's expertise and 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 Hawai'i tuna longline fishery with funding provided by the Reducing Bycatch Program of NOAA.



(left) Depth comparison by hook number of 45 control sets (e.g., each set ~2000 hooks) and 45 experimental sets sunk by 3 kg weights suspended at each end of the longline basket (suspended portion of longline between floats with baited hook droppers attached). Note the first hook position of the experimental set is > 100 m and the whole portion of the experimental sets is generally ~60 m deeper than control sets. Researchers document where this creates mismatches with distribution patterns of more surface dwelling epi-pelagic species like marlin, which predominately are confined to the uniform mixed layer. Thus, the experimental sets captured a significantly fewer number of these species than control (i.e., regular) sets. (Parameters were measured by temperature-depth recorders attached to the mainline). (right) Fisherman throwing the weight in order to "sink" the experimental sets.

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 2009

The results of the project were published this year in peer-review literature, Beverly, S., B. Maloney, D. Curran, and M. Musyl, 2009, Effects of eliminating shallow set hooks from tuna longline sets on target and non-target species in the Hawai'i-based pelagic tuna fishery, *Fish. Res.*, 96, 281-288.

Marine Resource Dynamics & 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)

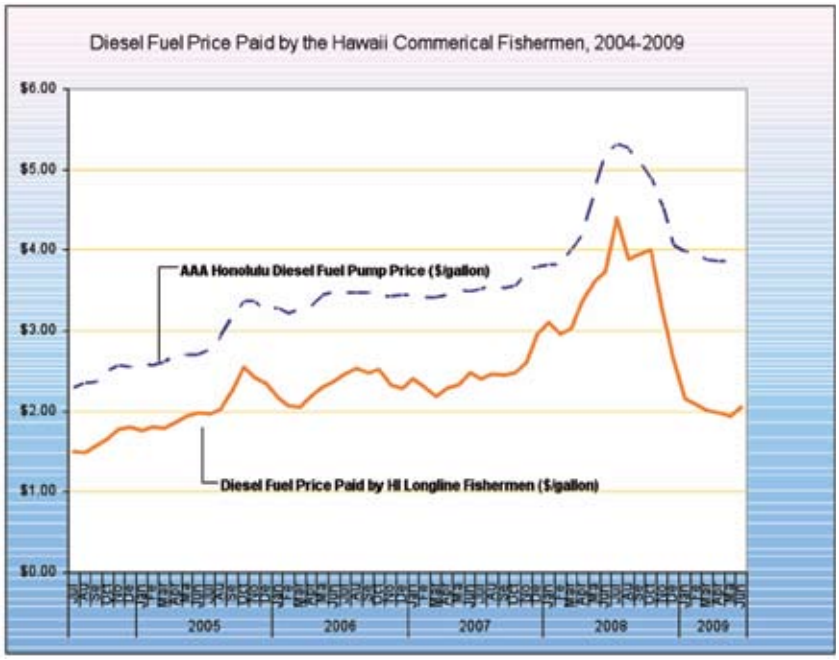
- To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

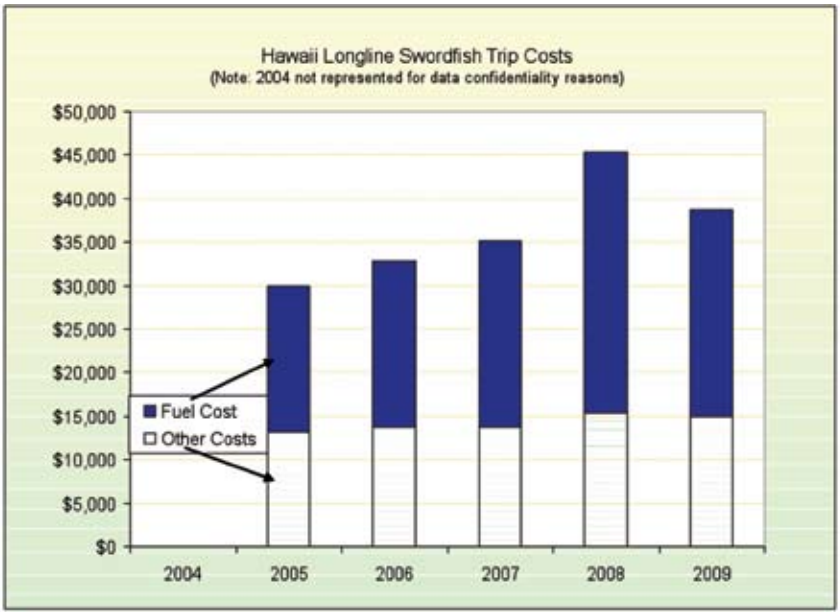
This project, initiated in July 2000, focuses on economic assessments of commercial and recreational fisheries in Pacific Island areas.

Progress during FY 2009

The first task of FY 2009 (July 1, 2008-June 30, 2009) was to continue efforts to assess changes in key economic indicators in the Hawai'i-based and American Samoa longline fisheries. This was done through an economic data collection program established in 2004 and 2007, respectively.



Diesel fuel price trend paid by the Hawaii longline fishers—Data product of an economic survey



Trip cost trend of the Hawaii longline swordfish fishing—Data product of an economic survey

Progress made in the FY 2009 is as follows.

- Developed a database and produced a time-series data summary of the key economic indicators of the Hawai‘i-based and American Samoa longline fisheries.
- Produced data on trends in fishing costs of Hawai‘i longline fisheries. Examples of the data product charts are attached at the end of this report.
- Collected economics data from 269 longline trips of both Hawai‘i longline and A. Samoa longline during the period of July 1, 2008 to June 30, 2009. The response rate was 75% for forms returned (including forms with only observable data).

- Performed data quality control on the data collected through FY 2009 and entered data into the database.

The second task was to perform an economic evaluation of the Hawai‘i small boat commercial fisheries. This study estimated the economic contribution of small boat fishing to the state of Hawai‘i through a cost-earnings survey of the Hawai‘i small boat fishery. Progress made in the FY 2009 is as follows.

- Completed fieldwork, database design, and data entry with 343 completed interviews across the State of Hawai‘i.
- Performed statistical analysis on the data and presented the preliminary findings at a professional conference and at the Western Pacific Region Fisheries Management Council.
- A draft report for this research is currently in preparation. The report details research methodologies, summarizes socioeconomic characteristics of the Hawai‘i small boat fishery, and presents results on trip expenditures, fishing activity, financial performance as well as the social importance that small boat fishing has in the State of Hawai‘i.

NOAA economist Minling Pan visited a charter boat marina in Guam

The third task involved investigating the economic dynamics and contributions of small boat fisheries in Guam and the Commonwealth of the Northern Mariana Islands (CNMI). The initial objective of the study involved establishing an economic data collection program that would provide fundamental economic information in support of economic research and fisheries management for these two geographic areas. Efforts have been made to implement an economic add-on program to the boat based creel survey managed by the Western Pacific Fisheries Information Network (WPacFIN) program. Progress made in the FY 2009 is as follows.

- Conducted fieldwork and focus groups to develop and test the survey form for data collection.
- Finalized the survey form and prepared paper reduce act clearance for the project.
- Provided training to the local staff involving with the economic data collection.

Finally, the fourth task for the year was to launch a prototype agent based model (ABM) for policy evaluation of Hawai‘i’s longline fishery. A prototype fishery management model of Hawai‘i’s longline fishery was developed using the agent-based modeling approach. The model simulates the daily fishing activities of 120 Hawai‘i longline vessels of diverse characteristics. Following the strategy of pattern oriented modeling (POM), researchers used the spatial-temporal distribution pattern of fishing efforts to calibrate the model. With this calibrated model researchers evaluated three alternative fishery regulatory policies in Hawai‘i’s longline fishery: 1) no regulation; 2) annual cap of 17 turtle interactions; and 3) closure of the north central area year around. Researchers assessed the impact on fishing productivity and interactions with protected sea turtles. The simulation results, based on 1999 data, were close to the actual performance of the fishery and consistent with the study results from existing literature. This indicated that the agent-based fishery management model could realistically capture the diverse behaviors of Hawai‘i’s longline fishermen and predict the responses of the fishery to changes in management regimes.

Akule (big-eyed scad) fishing in Guam

Marine Resource Dynamics & 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 operations as part of the ongoing research under the Marine Resource Dynamics & Assessment Program (MARDAP). Project funds support on-going research operations conducted at the Pacific Islands Fisheries Science Center on the University of Hawai'i campus, the Aiea Heights Research Facility, and the Kewalo Research Facility.

Progress during FY 2009

- *Maintenance Support*. Last year (2008) was a busy year for building improvements and projects. In addition to general upkeep of facilities, the maintenance assistant was instrumental in coordinating the activities of contractors for a number of large facilities projects.
- *Administrative Support*. The administrative associate fulfilled a variety of tasks that enabled JIMAR research staff to complete their mission goals. Duties included travel coordination and administration, procurement activities, and general correspondence and office administration.

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 the 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 Hawai'i's Federal Fishery Management Plan (FMP) fisheries in Hawai'i. It also provides the fishing industry with a point of contact for feedback and information exchange with fishery scientists and managers.

Progress during FY 2009

Dr. William A. Walsh provided significant research support to the Fishery Monitoring and Analysis Program during FY 2009 with funding from the Pelagic Fisheries Research Program (PFRP). He completed a detailed analysis of catch data for sharks in the Hawai'i-based longline fishery using records gathered by the Pacific Islands Regional Observer Program in 1995–2006 (PFRP Project No. 657157). Results of these analyses have been accepted for publication in *Marine and Coastal Fisheries*, an on-line, peer-reviewed journal of the American Fisheries Society. The most important conclusion was that the Hawai'i-based pelagic longline fishery has made substantial progress in reducing shark mortality in recent years. An additional series of analyses is in progress to provide the standardized catch rates for the common shark species (i.e., those that comprised at least 1% of the shark catch).

Dr. Walsh was also responsible for PFRP Project No. 652764, entitled "Analyses of Catch Data for Mahimahi and Wahoo", which is currently in its early stages. This work is intended to estimate catch trends for two widely distributed, economically and ecologically important mid-sized epipelagic predaceous fish.

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. The different sectors must work hand in hand to achieve effective ecosystem-based management. Support via this project helps enable the best possible catch forecasting and quota management activity, which not only ensures existing catch limits are not exceeded but also helps modeling and research to more accurately reflect the dynamics of the fishery.

JIMAR fisheries specialist Walter Machado continued 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, and has a limited role in testifying in court regarding fisheries violations. Machado conducts daily rounds to local docks to collect logbooks, then 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 Department of Commerce fulfill international obligations of the U.S. and effectively manage the fishery.

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 may mean increased logbook collection activity as well.

The scanning and archiving project seeks to preserve the 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.

Marine Resource Dynamics & 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 2009

- *Web Services*. The webmaster continued to maintain and improve both functionality and contents of the Web site. She posted technical reports, news and announcements of current research cruises, and other scientific activities in a timely fashion. The new web template system (part of "One-NOAA" marketing) was reviewed and reconciled with the revised home page design and site architecture. The new web presence will be rolled out later in 2009. The webmaster completed the workflow and user roles design framework for an online manuscript processing system. She also updated and documented the Data Request Tracking System (DARTS) application developed in Ruby-on-Rails.
- *Scientific Editing*. The scientific editor provided comprehensive professional editing services to scientific staff enabling timely submission of manuscripts to peer-reviewed journals and production of in-house technical reports. She worked with the scientific editor in CRED to develop editorial guidelines and style sheets CRED will use in their major survey reports. She designed a new layout for the Annual Report and directed the timely completion of the report. She also helped design the workflow framework for the online document processing system.
- *Scientific Information*. The scientific information specialist provided technical support to the Scientific Information Services group on various aspects of data services. He recruited, trained, and guided students who enter and verify confidential commercial fishery statistics for input to an Oracle database. He helped design and test a new web-based data entry system for Hawai'i non-commercial bottomfish catch data.

Marine Resource Dynamics & 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 a social and cultural database of fishing ports and associated communities in Hawai'i, Guam, Commonwealth of the Northern Marianas, and American Samoa. The goal is to provide a standard set of information for western Pacific fishing communities and ports that is consistent with profiles currently being developed in other parts of the country. The information generated will be used to assess the effects of fishing regulations and other actions on social and cultural aspects of fisheries. Comparison of western Pacific ports with other ports nationwide will also allow researchers to document the unique social and cultural aspects of western Pacific fishing activity, as well as reveal commonalities.

Dive tourists at Lau Lau Bay, a focus area for improved watershed management in Saipan, CNMI.

Progress during FY 2009

The 2008 annual report listed the publication of "Fishing Community Profiles for Hawai'i and American Samoa", and a final report for CNMI, as objectives for FY 2009. The final American Samoa profile has been edited by SIS, and will be published in July 2009. The Hawai'i profile is in final draft and will be published in FY 10/09. The CNMI profile is in draft form and is expected to go out for peer review in December 2009.

Case studies of fisheries institutions are also being developed, as stated in the 2008 annual report. Researchers have conducted a literature review of institutional analyses and are in the process of compiling a draft framework for analysis. They are working with American Samoa's Community-based Fisheries Management (CFMP) program, and have planned an exchange visit with Samoa's similar Community-based programs. These programs will be analyzed according to the draft framework, as will at least one additional community-based fisheries management program from Hawai'i.

Program staff from community-based and other fisheries management programs in American Samoa and independent Samoa participate in a socioeconomic assessment and monitoring training with HDRP Social Research Project Manager Arielle Levine, Pago Pago, American Samoa

Marine Resource Dynamics & 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 project are to assess: (1) the status of pelagic stocks in the Pacific Ocean; (2) the status of insular resources in the Pacific Islands Region (PIR) [e.g., bottomfish]; and (3) the impact of fishing on these stocks. During technical reviews of the Northwestern Hawaiian Islands (NWHI) insular resource assessment procedures, it was recommended that collaborative research programs between the industry, PIFSC, and University of Hawai'i (UH) be developed to: (1) provide independent estimates of population size; (2) generate updated estimates of population dynamics; (3) further our understanding of the ecological role of insular resources in NWHI ecosystems; and (4) advance insular stock assessment methodologies in the PIR. Technical reviews of pelagic stock assessment procedures resulted in similar recommendations, with an eye to 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, swordfish, and blue shark.

Progress during FY 2009

The JIMAR FY 2008 annual report outlined four goals for FY 2009 including: 1) the continuation of spiny and slipper lobster tagging experiments at Necker Island, Maro Reef, Gardner Pinnacles, and Laysan Island; 2) conducting the NWHI lobster resource survey in June 2009, and collection of bottomfish samples to re-estimate biological parameters (e.g., growth); 3) planning and participating 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.

- *Lobster tagging*. One commercial fishing vessel was contracted (chartered) from August 5-September 15, 2008 to conduct lobster tagging operations at Necker Island, Gardner Pinnacles, Maro Reef, and Laysan Island. Joseph O'Malley, a JIMAR researcher and University of Hawai'i, Hawai'i Institute of Marine Biology graduate student working with the PIFSC provided oversight on all scientific elements of the experiments. Current tagging data was analyzed to estimate spiny and slipper lobster growth and movement patterns, and these estimates were compared to historical growth patterns. JIMAR staff conducted numerous presentations on the lobster tagging experiment to the Western Pacific Regional Fisheries Management Council (WPRFMC) and at scientific conferences.
- *NWHI lobster resource survey*. The NWHI lobster resource survey was conducted from June 1-27, 2009 aboard the NOAA R/V *Oscar Elton Sette*. The survey focused on lobsters at Necker Island and Maro Reef. Initially designed to supplement fishery data in support of annual lobster stock assessments, the lobster survey now continues to provide key information for understanding the NWHI ecosystem. In particular, it provides data for monitoring changes in the lobster populations and associated benthic fauna in the absence of the fishery. In addition to studying lobsters, researchers used handline gear on the R/V *Oscar Sette* to catch specimens of deepslope bottomfish species, such as opakapaka and hapu'u'pu'u for use in biological studies. The biological data are essential for improving stock assessments of Hawaiian archipelago bottomfish. Algae found attached to the lobster traps was also collected and given to scientists at the University of Hawai'i for taxonomic and bio-geographical studies. JIMAR staff participated in the collection of lobster and bottomfish data while at sea.
- *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 (data

Participants at the February 2009 ISC Billfish Working Group Workshop, 1) Gary Sakagawa, 2) Lyn Wagatsuma, 3) Minoru Kanaiwa, 4) Michael Hinton, 5) Ai Kimoto, 6) Dean Courtney, 7) Russell Ito, 8) Jon Brodziak, 9) Chi-Lu Sun, 10) Kevin Piner, 11) Gakushi Ishimura, 12) Kotaro Yokawa, 13) Gerard DiNardo.

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. Fletcher and Wagatsuma also provided analytical support for the bottomfish assessment. In addition, Dr. Shelley Clarke along with scientists from PIFSC, Imperial College London, and Japan completed a North Pacific blue shark stock assessment.

Marine Resource Dynamics & 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 (Council), and JIMAR.

Progress during FY 2009

In June 2009, the utility and scientific advice of the recent Hawaiian Archipelago bottomfish stock assessment was assessed using the WPSAR process. The results of the review will be presented at the July 2009 meeting of the Council, which is scheduled to convene in Kona, Hawai'i.

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 known as a food source and can play important cultural roles in the lives of the inhabitants. Six marine turtle species—green, hawksbill, olive ridley, leatherback, loggerhead, and flatback turtles inhabit the Pacific, particularly, the marine areas of Melanesia. Additionally 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 (EEZ) 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 2009

Solomon Islands Sea Turtle-Fisheries Interaction Outreach Education Project. NOAA Fisheries continues to monitor the Solomon Islands government and fisheries situation and has investigated opportunities to implement the marine turtle-fisheries interaction mitigation observer training project when appropriate in the future. During September 2006, the NOAA Fisheries Pacific Islands Regional Office (PIRO) International Turtle Conservation and Management Liaison (the liaison) conducted a site visit in Honiara, Solomon Islands. In meetings with fisheries officials, researchers learned that the fisheries based in Honiara are still recovering from the destruction of many vessels in a typhoon in February 2006. The government was also attempting to stabilize after much of the capital city was burned in March 2006 when civil unrest occurred after a new prime minister took office. During the site visit in September 2006, the liaison learned that the Solomon Islands Fisheries Department suddenly lost

a fisheries employee due to a heart attack, which was going to cause restructuring within the fisheries department. The director did not know when stabilization in their department would be achieved or when the observer training could occur; however, they remain interested in this activity and will notify PIRO when implementation is feasible. In the meantime, to carry out initiative activities, funds for this portion of the Marine Turtle Conservation and Management Initiative have been transferred to New Caledonia.

New Caledonia Sea Turtle-Fisheries Interaction Outreach Education Project. A project was undertaken in New Caledonia in March, 2007 sponsored by NOAA Fisheries PIRO with the following objectives: to heighten awareness of sea turtle interactions with fishing gear by familiarizing commercial fishing operators in New Caledonia, fisher observers and staff of Marine Marchande with handling techniques for sea turtles caught incidentally in fishing operations; to provide appropriate equipment and instructions to the fishing industry on how to address specific sea turtle interactions with fishing gear in New Caledonia; to integrate appropriate topics in sea turtle interaction with commercial fishing into the ongoing work programs of Marine Marchande and the SPC Training Section; and to enhance cooperation among the different government and non-government organizations involved in fisheries management and turtle conservation, locally and regionally. These fisheries-marine turtle interaction mitigation supplies were distributed along with printed instructional materials to New Caledonia fishers in early FY 2009. Supplies and printed materials from this project were also distributed to tuna data analysis, ecological risk assessment, and observer training workshops in the Central, West, and South Pacific. This project is complete.

Loggerhead turtle conservation-education and outreach program. The aquarium outreach program has experienced staff turnover since its onset in 2007. Three people held the position for various durations. A student teacher is presently involved in project outreach activities. Turnover was somewhat disruptive for the program because organizing activities outside Nouméa depends greatly on meshing with the local populations based on personal contacts and it was almost like starting over with each new appointment. Therefore, most work during this FY concerned aquarium-based activities (with schools and visitors). Now that the new staff member is settled, his activities have been redirected towards inland villages and populations. The network has been reactivated and a new plan organized to cover the entire country. Still, as stated above, lack of public environmental awareness makes contact difficult and progress slow. Program staff have assisted a local NGO, Bwärä, during loggerhead nesting season (monitoring nesting, speaking with the public interacting with turtles), which was an opportunity to carry out onsite conservation sessions. Seventy people received formal training over two months.

The following county fairs and events were covered over the period.

- Fête de la mer in Thio (attendance = couple thousand)—staffed a booth with different education material available; several conservations (talk) [20 people]
- Farino's market (attendance = several hundred)—no booth but held conservation talks (49 people)
- Dumbea giant omelette (attendance > 15,000)—staffed a booth over two days with different education materials; conservation "talks" (20 people)

For aquarium-based activities, every weekday during the summer holiday (January and February), program staff held a "turtle encounter" around the turtle tank where each species (loggerhead, green, and hawksbill) were held. It was a popular activity and attendance was on average about 20 persons each time; it is estimated that over 800 people attended this show. Since school started in March, this encounter has been carried out every Wednesday and about every other Saturday evening. Attendance is lower but rarely under ten each time. Program staff prepared questions (and answers) for a "turtle quiz" aired regularly twice a week. Each show is attended by an average of ten people. Special school encounters/workshops are also carried out; thus far four classes have had a total attendance of 103 students. Occasionally, concerned citizens take sick or stranded turtles to the aquarium. Aquarium staff rehabilitates and releases turtles back to their environment. Program staff have also been very active in turtle husbandry.

Supported activities included production and maintenance of educational materials. During this FY, program staff organized the "turtle library" and assembled a "turtle kit" for out of town workshops. Three portable education panels were created to supplement lectures and help educate on species identification, visualize turtle life cycle, and promote awareness of threats to turtles. A tarp with a backdrop of typical reef environment was also printed. It is intended to be used on a metallic support with different magnetic figurines that children (or grown-ups) are invited to "stick" wherever they think turtles live, eat, breed, etc. to test their knowledge of turtle biology and help correct common mistakes. Program staff assisted with production of a local film on turtles (WWF) by contributing footage, pictures and distribution maps. The aquarium also made arrangements to use the film during outreach activities.

Mesophotic Reef Ecosystems of Hawai'i'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

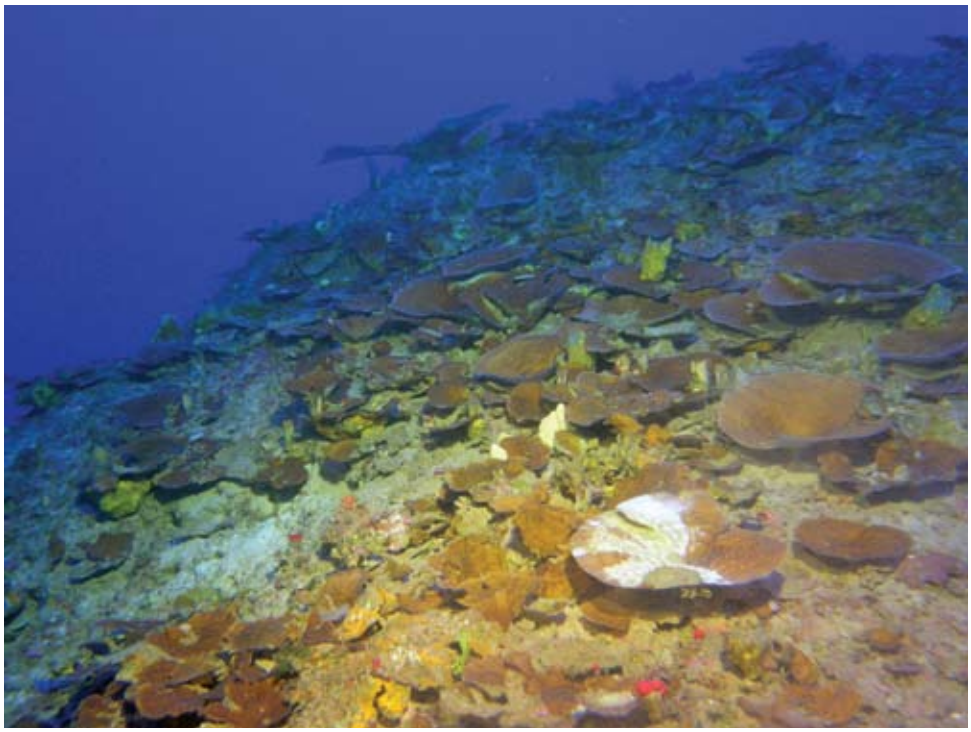
Purpose of the Project

The purpose of this project is to characterize the poorly known coral ecosystems that occur at the deep edge of photosynthesis. This work is part of a three-year collaboration with the Bishop Museum, University of Hawai'i, and State of Hawai'i Department of Land and Natural Resources funded by NOAA's Coral Reef Ecosystem Studies Program. This work involves surveys of the seafloor between depths of 50 and 150 m to identify the location and the nature of patches of *Leptoseris* coral spp. in the Au'au Channel. Information is collected on distribution of the coral, nature of the bottom habitat, environmental conditions, and any fish associations. The project is conducted on a number of research cruises that will support data collection by remote cameras, submersibles, hydroacoustics, divers, and other technology.

Progress during FY 2009

Two research cruises were conducted in the Au'au Channel during FY 2009 in support of this project. In August 2008 an 8-day cruise was conducted aboard the NOAA Ship *Oscar Elton Sette*. Objectives for this fieldwork were: 1) remote camera work to look at the spatial extent of the mesophotic reef complex; 2) hydro-acoustic transects to characterize the acoustic scattering layer; and 3) deployment of temperature and current instruments to monitor the environment. Twenty-nine camera sled dives were conducted on the cruise, which collected 46 km of seafloor video imagery from the Au'au Channel. The first day of the cruise was spent calibrating the ship's EK60 sonar system for hydroacoustic work. Thereafter, acoustic surveys were conducted at 38, 70, 120, khz to

Video transect marker being deployed on a reef of Leptoseris sp. *corals in the Au'au Channel at a depth of ca. 90 m. Photo by Max Cremer, Hawaii Undersea Research Laboratory.*



Leptoseris sp. *corals on a ridgeline in the Au'au Channel at a depth of 106 m. The diseased coral colony with the prominent white bands in the foreground was sampled moments after coral disease specialists took this photograph for histological analysis. Photo by Max Cremer, Hawaii Undersea Research Laboratory.*

characterize the scattering layer in relation to the deep coral patches. Both day and night sampling was conducted to look for patterns that could be attributed to deep reef patches. Two instrument moorings were assembled and deployed, each consisting of an Aanderra single point current meter, a Seabird 39TP temperature logger, and four additional HOBO temperature loggers, each spaced 10 m apart. Two acoustic receiver moorings were also deployed during the cruise. Casts were also made using a light meter and CTD to measure the optical, salinity, and thermal characteristics of the water column above the reef complexes. Results will enable researchers to develop a better understanding of these little-known ecosystems, enhancing our ability to manage and preserve them.

The second cruise was conducted aboard the University of Hawai'i research vessel *Kaimikai-o-Kanaloa* to make a series of dives using the Pisces submersibles. This cruise targeted deeper areas of the mesophotic reef complex that are harder for technical scuba divers to work in. A total of six submersible dives were completed, focusing on the area where instrument moorings were previously deployed to enable the collection of biological data in the vicinity of the current and water temperature data being collected by the moored instruments. Large colonies of scleractinian and zooxanthellate corals of the genus *Leptoseris* were found to extend to depths of greater than 130 m. The highest densities of coral, found between depths of 70 and 90 m, form complex structures that could play a role in sheltering reef fish populations. Large beds of densely packed, low relief, branching corals were also documented during five ROV dives. They are generally found at depths that overlap with and extend shallower than the *Leptoseris* sp. reefs. These shallower reefs cover tens of square kilometers of seafloor off of West Maui. Fish surveys were conducted from submersibles, using remote cameras to determine the species composition of these communities, and will be compared and contrasted with adjacent fish communities surveyed at shallower depths (< 30 meters). These surveys have been conducted on an increasingly focused scale. The towed camera surveys (n=29) serve to provide a broad scale survey of the fish community and the submersible surveys allow for a more defined survey area and definitive identifications of fish and their abundance. Acoustic receivers were deployed in the coral patches to see if they are the focus of visitation by large transient animals tagged as part of other research programs. Progress on the project during FY 2009 has met the objectives established for this period.

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

This project 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 Hawai'i and American Samoa. 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 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.

(above) Nick Wagner with a Tapertail Ribbonfish during a research cruise.
(below) Dan Luers conducting a safety inspection of a fishing vessel.

Progress during FY 2009

From July 2008 through June 2009, 345 observer trips were debriefed. Of the 345 observed trips, 251 were completed through the final data editing stage. In addition, the program has completed final data editing for 140 trips from the previous year. This puts the observer program approximately 100 trips behind in the final data editing stage for observer data. Despite having a deficit of 100 trips, the project has made progress this year in the deficit of trips that need final data editing completed from the previous year. A shortage in debriefing staff is the major reason for not meeting objectives this year. However, the project is in the process of hiring a full compliment of staff and researchers expect to meet objectives for 2010.

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

The goals of the project are to 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 2009

- Appointed Kevin Weng as interim program manager in January 2009. Long-time PFRP program manager, John Sibert, retired in 2008.
- Conducted a request for proposals and funded new projects consistent with the priorities identified in the report, "Pacific Ocean Connections: Priorities for pelagic fisheries research in the Twenty-first Century", from the 2005 research priorities workshop.

  Circulated a request for proposals in 2009. Twenty letters of intent were received and seven full proposals were solicited. Reviews and panel recommendations have been received, and a steering committee meeting, to make final decisions, is scheduled for August 2009.
- Facilitated international collaboration in research on pelagic fisheries.

  The Hawai'i Tuna Tagging Program II (HTTP II) is in place and project staff is working closely with SPC scientists on regional tagging project.

(right) PFRP scientist David Itano installs an acoustic listening station to a buoy chain in offshore Hawaiian waters, which will allow tracking of pelagic fish movements.

Skipjack tuna are important in subsistence and commercial fisheries throughout the Pacific.

PFRP: Analyses of Catch Data for Mahimahi (*Coryphaena hippurus*) and Wahoo (*Acanthocybium solandri*) from the Hawai'i-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 the first thorough, 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 catch data and then apply the model coefficients to the log-book data from the Hawai'i-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 (PIFSC). The second objective is to determine whether, and if so to what extent, intraspecific catch-per-unit-effort (CPUE) values for these species are correlated in various regions of the Pacific Ocean by use of correlation and time series techniques. Likely data sources, in addition to the Hawai'i-based longline fishery, include troll data from the Hawai'i 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 will be to use the corrected CPUE trends from the Hawai'i-based longline fishery to test predictions from ecosystem models (e.g., Ecosim, a dynamic food-web model for a pelagic ecosystem; and Ecospace, a spatial version of Ecosim) 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). The fourth objective will be to identify and estimate patterns in the sizes of these fishes. In the case of the Hawai'i-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.

Progress during FY 2009

This project is still in the early analytical stages, and none of the objectives have yet been completed. Two factors have contributed to this delay. All previous work was conducted using the statistical software package S-PLUS, however, the S-PLUS site license was relinquished by the PIFSC. The project then switched to R, another software package that is similar to S-PLUS in many but not all respects. As such, this switch required study and experimentation that resulted in a one-month delay. The second reason for delay is that revisions to a paper (see Walsh and Bigelow, Shark Bycatch—Project 657157) required almost two months of full-time effort. The resulting paper is much improved because of meticulous and thorough reviews, however, extensive work was required to achieve this.

PFRP: An Assessment of Small Boat Yellowfin and Bigeye Tuna Operations and Regulatory Scenarios in the Main Hawaiian Islands

P.I.: Kevin Weng [Edward W. Glazier]

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 closely related to the PFRP project titled "Human Dimensions of Hawai'i's Ika-Shibi Fishery." The overarching goal of both projects was to provide PFRP and the Western Pacific Regional Fishery Management Council (the Council) with valid and reliable information regarding historic and contemporary trends in the commercial yellowfin and bigeye tuna fisheries conducted by the small-boat handline fleet operating around the Main Hawaiian Islands (MHI). The project was focused specifically upon: (1) description and spatial analysis of private fish aggregating device (FAD) fishing offshore the Big Island (2) description and explanation of changes in the extent and manner of use of various handline gear types, including those used at Cross Seamount and other far offshore locations, and (3) description and explanation of trends in the marketing and distribution of BET and yellowfin by small-boat handline operators. The secondary purpose of the project was to characterize the economic, social, and cultural contexts within which the BET/yellowfin small-boat commercial fisheries are conducted in the MHI.

Progress during FY 2009

Project work has been completed and final report submitted to JIMAR PFRP.

PFRP: Assessment of the Impacts of Mesoscale Oceanographic Features on the Forage Base for Oceanic Predators

P.I.: Jeffrey C. Drazen [Reka Domokos]

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's goal is to investigate the nature and degree of the response of the micronektonic community, an important tuna forage base, to mesoscale oceanographic features using trawl surveys in conjunction with acoustic surveys. Two features of interest are Cross Seamount, which aggregates yellowfin and bigeye tuna in Hawaiian waters, and eddy features from American Samoa, which affect albacore catch. The main objectives of the project are as follows.

- Assess the impact of each mesoscale feature on the biomass and abundance of the micronekton.
- Assess the impact of Cross Seamount on micronekton community composition.
- Characterize the micronekton composition in American Samoa.
- Assess whether each mesoscale feature affects the vertical migration patterns of the micronekton.
- Compare both acoustic and trawl estimates of biomass in each region to provide acoustic "groundtruthing".

Progress during FY 2009

Project work has been completed and final report submitted to JIMAR PFRP.

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. High frequency ENSO recruitment response appears to play out into low frequency decadal variations of tuna population biomass. Large changes in Pacific tuna catch rates in the 1950s-1960s were associated with natural climatic fluctuations. 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, trophic connections, and oceanic regions. For this project, two spatial bio-physical models are proposed to run concurrently with different long-term (up to 50 years) climate regime datasets for several tuna species. 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 2009

The planned activities for year 3 of the project were:

- Obtain/prepare at least one more physical-biogeochemical reanalysis to produce the ensemble simulation with SEAPODYM and APECOSM. Proposed options were: i) an update of the reanalysis using ESSIC model, ii) an offline simulation of the biogeochemical model PISCES with the physical reanalysis SODA025. A budget of USD 54,000 (funding originally dedicated to the University of Maryland) was allocated for this reanalysis.
- Publish a first version of the fishing database and make it accessible on the web for project collaborators.
- Recruit a research engineer in IRD for one year to assist in the APECOSM model development.
- Optimize parameterization of SEAPODYM for yellowfin tuna in the Pacific Ocean, and test together with skipjack and bigeye tuna at global scale, using biogeophysical reanalyses provided.
- Optimize parameterization of APECOSM for skipjack tuna in the Indian Ocean and test at global scale.
- Participate in the PI meeting in Hawai'i in November 2008 and/or the tuna conference in Lake Arrowhead in May 2009, the GLOBEC symposium in June 2009 (Victoria BC Canada), and organize of a project meeting in spring 2009 in Toulouse.

The first two options that were intended to add one physical-biogeochemical reanalysis were not feasible. Researchers finally asked the University Corporation for Atmospheric Research (UCAR), acting on behalf of National Center for Atmospheric Research (NCAR), to produce a validated reanalysis of the World Ocean State (physics and biogeochemistry) deduced from an integration of the Community Climate System Model (CCSM) for the period Jan. 1, 1950-Dec. 31, 2005. The cost for this reanalysis was negotiated to fall within the allocated budget of USD 54,000. This reanalysis has a variable horizontal and vertical resolution ranging from 0.6° at the equator down to 3° in the highest latitude. Steve Yeager and Markus Jochum, both at NCAR, performed several centuries long integrations with CCSM3.5 in its coarse resolution forced ocean version with a full ocean-ecosystem. A spin-up of 500 yrs was used to ensure stability and a net ocean heat uptake of less 0.1 W/m^2. The run has been continued with two 55 yr cycles of interannual forcing (CORE II, yrs. 1949-2004). A final, 3rd, cycle was added and all model output was saved every five days. The NetCDF output files have been downloaded in CLS in June 2009 and will require pre-processing before use with SEAPODYM and APECOSM. The ORCA05-PISCES reanalysis was not provided to the project, as the outputs of the simulation were not validated. Finally, three global coarse-resolution reanalyses are available and called hereafter NCEP, ERA40 and CCSM.

The fishing database engineer in IRD-Sète (Julien Trolet) will complete his work under PFRP funding at the end of August 2009. The database SARDARA and its implementation are achieved and now includes all the fishing data (catch effort and size frequencies) for both the Indian and Atlantic Oceans for several tuna and billfish species including the tropical tunas, which are studied in the present project (skj, bet, yft). A request has been sent to the directors of both tuna commissions for the Pacific Ocean (IATTC: Guillermo Campéon) and the Western Pacific: Andrew Wright). After describing the project, this letter (copied to J. Sibert and K. Weng) presented two requests: i) to obtain official agreement to complete the fishing data set needed to run both SEAPODYM and APECOSM in the Pacific Ocean; and ii) to obtain the official agreement to include in the SARDARA database a public tuna fishing dataset for the Pacific that researchers were proposing to define according to gears, target species, strategy, time periods, and large oceanic regions to conserve the confidentiality on fishing nations.

IATTC responded that surface fishery data (purse seine and pole-and-line) were public but not the longline data. Individual requests to fishing States are necessary, and the first answer received from Chinese Taipei Fisheries Agency was unfortunately negative.

Discussion with the WCPFC director and the scientific/data management services provider of the commission (SPC), indicated that there is one public domain dataset with 5x5 degree aggregated catch and effort data by gear type that have been aggregated across flags, and filtered to exclude data when it is estimated that fewer than 3 vessels may have fished (http://www.spc.int/oceanfish/html/wcpfc/statistics/publicdomain/index.asp). A more detailed dataset can be used for SEAPODYM only based on existing collaboration with SPC. IRD would need to make a separate request to use this detailed dataset for APECOSM.

It should be noted that the confidentiality of several fishing datasets in the Pacific Ocean is a serious restriction on the proper application and validation of the tuna population models in the Pacific Ocean. It is hoped that this problem will be solved in the near future because it is in the interest of everyone to enable scientists to work using the best information available. Access to the SARDARA web interface (Figure 1) is still limited to the developers, but it will be released soon on a production server with open access to public domain datasets and restricted access for other datasets. A test period with restricted access will be used to get the feedback from RFMOs and to confirm their agreement on these public and restricted domain datasets.

A first optimized parameterization of SEAPODYM has been obtained for skipjack and yellowfin using the "NCEP" forcing. Another optimization was achieved using "ERA40" forcing for yellowfin. Optimization for bigeye was done previously using a previous ESSIC (Pacific only) reanalysis, and used to evaluate a global projection of population trends under the A2 IPCC scenario. Simulation experiments have shown that parameter calibration is sensitive to the oceanic environment predicted by coupled physical-biogeochemical models. For example, despite very close optimal spawning temperature habitat obtained for yellowfin in both configurations, i.e., 25.98°C and 26.53°C for NCEP and ERA40 forcing respectively, the resulting spatial distributions of larvae are quite different (Figure 2). The results are also sensitive to the length of the time period used for parameter optimization, the initial conditions, and the quality and coverage of fishing data. A stratification of fishing data into

Figure 1. Web site to access global fishing dataset, model outputs, and archival tagging data, developed with the support of French ANR, PFRP, and IRD.

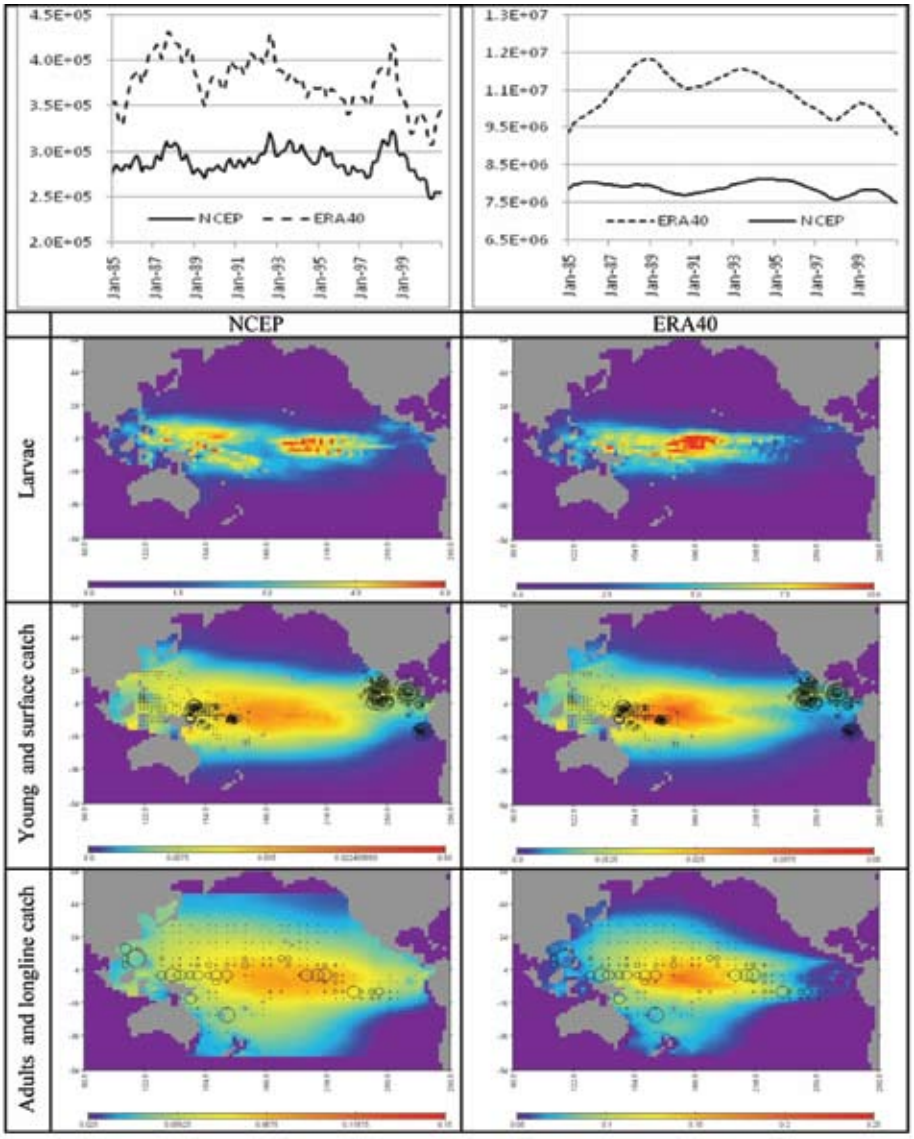


Figure 2. Application of SEAPODYM to yellowfin tuna in the Pacific (snapshots for March 1990) showing the results obtained when optimizing parameters with two different physical-biogeochemical oceanic environments, NCEP-ORCA2-PISCES and ERA40-ORCA2-PISCES

homogeneous fisheries is critical. These first simulation experiments did not include detailed size frequency data for the EPO, a key area for yellowfin, and thus need to be updated as researchers received these data recently.

Sybille Dueri, a research engineer, was recruited in IRD starting February 1, 2009 to assist in the APECOSM model developments. She is in charge of implementing the maximum likelihood based optimization for skipjack in the Indian Ocean using fisheries data available in the SARDARA database and the available tangent-linear computer code developed by Blaise Faugeras and Olivier Maury. To date, after almost 6 months, the work has progressed well and it can reasonably be expected that it will be completed at the end of Dueri's contract. Once the optimized set of parameters is available in the Indian Ocean for skipjack, global runs will be conducted to check for the consistency of the parameterized model in the two other oceans against fisheries data.

PI (Patrick Lehodey) of the project attended the PFRP-PI meeting in Nov. 2008. Olivier Maury gave a presentation at the Final GLOBEC Symposium in Victoria, B.C., (June 22-26 2009). Lehodey gave a presentation at the workshop "Applying IPCC-class Models of Global Warming to Fisheries Prediction" that was held at Princeton University from June 15-17, 2009. A presentation of the SARDARA database was made during a workshop "Tuna

purse seine and bait boat catch species composition derived from observer and port sampled data" organized in IRD Sète and gathering representatives of IATTC, IOTC, WCPFC and ICCAT. Julien Trolet is about to submit an article describing the SARDARA database to the DATABASE-Oxford journal.

PFRP: Comparing Sea Turtle Distributions and Fisheries Interactions in the Atlantic and Pacific

P.I.: Kevin Weng [Selina Heppell, Molly Lutcavage]

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's primary goal is to use a comparative approach to determine why populations of sea turtles in the Atlantic appear to be stable or increasing, while populations of the same species in the Pacific are declining, even though fisheries interactions occur in each ocean basin. Because of great concerns for turtle survival, and their protected status under the Endangered Species Act, sea turtle take in pelagic fisheries has resulted in complete closures (e.g., Hawai'i, Grand Banks) or major restrictions on effort and area for the U.S. Fleet (e.g., NE Distant Sector, Atlantic). Scientific understanding of the extent and nature of worldwide take patterns in pelagic and inshore fisheries, and impacts on stock rebuilding, is incomplete, at best. The PASTA research project is now comprised of an interdisciplinary group of sea turtle biologists, fisheries scientists, demographers, and oceanographers from federal and international agencies and academia. Steering Committee: Molly Lutcavage, Selina S. Heppell, Tomo Eguchi, David S. Kirby, Rebecca Lewison, Abigail McCarthy, Melissa Snover, and Yonat Swimmer.

Progress during FY 2009

Project work has been completed and final report submitted to JIMAR PFRP.

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 goal of the project is the development of the Business Card Tag (BCT), which is intended to increase knowledge regarding schooling cohesion and inter-species association. The overall objective of the project is to assess the feasibility of a BCT through the following activities.

- The development of a two-way "transceiver tag" prototype. The transceiver tag prototype should be able to identify and store acoustic signals sent by other acoustic tags and transmit its own coded signals. The receiver tag should be small enough to be mounted on/in tunas or similar sized animals.
- Tests of these prototype tags. The prototype tags will be tested on captive fish (controlled situation) and in situ.

Progress during FY 2009

The testing of the new tags is the main objective of year 2 and the following years. The project produced excellent results in 2009.

- *Test on Galapagos sharks*: In May 2008, four BCTs were deployed on Galapagos sharks around eco-tourism sites. At the time of the previous report, only one BCT was recovered. A second BCT was recovered in October 2008 and provided excellent data. Table 1 gives a summary of the BCT deployments on sharks.

Because results from the first recovered tag were detailed in the FY 2008 report, only results from the second tag are reported for FY 2009. The second BC tag-equipped shark recaptured (BCT #4) was detected regularly around the eco-tourism site for 24 days after release. It then left the area for 104 days (prior to tag recovery). During this time it detected three other sharks (including another BCT shark) that were beyond the range of the array of fixed receivers. This validates the concept of BC tags because the tagged animal was documenting encounters with other tagged animals at locations important to the animals, not simply where receivers had been moored. The data from the two recovered BC tags are reported in a manuscript accepted for publication in *Endangered Species Research* as a part of the Proceedings of the 3rd International Biologging Symposium.

- *Test on large tunas*: Because of these successful trials, no changes were requested from the manufacturer (Vemco), and the last ten remaining BCTs were received in Fall 2008. The principle goal is to try to deploy those tags on large tunas caught around O'ahu FADs. Difficulties in finding suitable fish did not allow researchers to deploy those tags this year.

*Table 1. Summary data for Galapagos (*Carcharhinus galapagensis*) sharks equipped with BC tags*

BCT Number	Total Length (cm)	Sex	Date Deployed	Date Recovered	Days At Liberty
1	185	M	05/19/08	-	-
2	235	M	05/19/08	06/08/08	20
3	230	M	05/19/08	-	-
4	235	M	05/28/08	10/07/08	132

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 ecosystem-base management

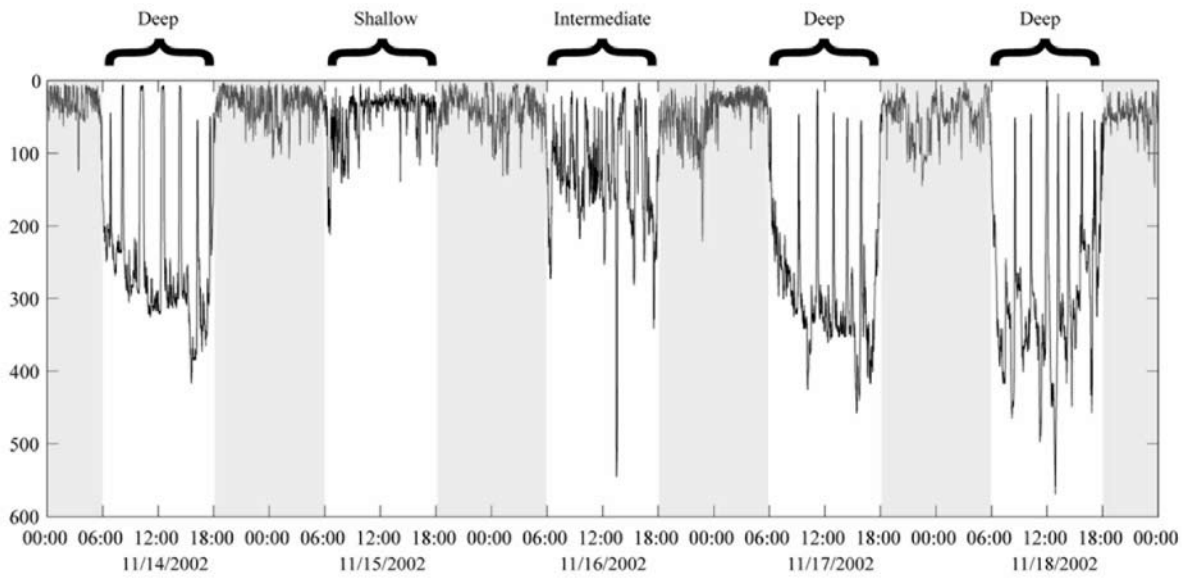
Purpose of the Project

The purpose of the 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 Hawai'i and American Samoa, and an understanding of the habitats and movements of these species is needed as a background to fisheries management.

Progress during FY 2009

In 2009 field tagging work was completed and researchers focused on using tagging data to build a spatial ecosystem model for the central North Pacific to better understand the movements of swordfish and loggerhead sea turtles. The ecosystem model is being developed as a PhD thesis by 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, which combines physiological characteristics with available forage. Progress has been made on building a loggerhead sea turtle movement model. Dr. Patrick Lehodey of CLS and the University of Toulouse is a co-advisor on Abecassis's thesis along with Dr. Jeffrey Polovina.

Secondly, a manuscript that describes the spatial and temporal variation in bigeye tuna habitat has been written and accepted for publication.



*Three types of vertical dive behavior observed in bigeye tuna (*Thunnus obesus*) from electronic tagging. Shallow dives are less than 100m, intermediate dives target 100-200 m, and deep dives exceed 200 m. The vertical axis is depth (m) and the horizontal is time and date. White bands are daylight hours, shaded bands are night.*

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

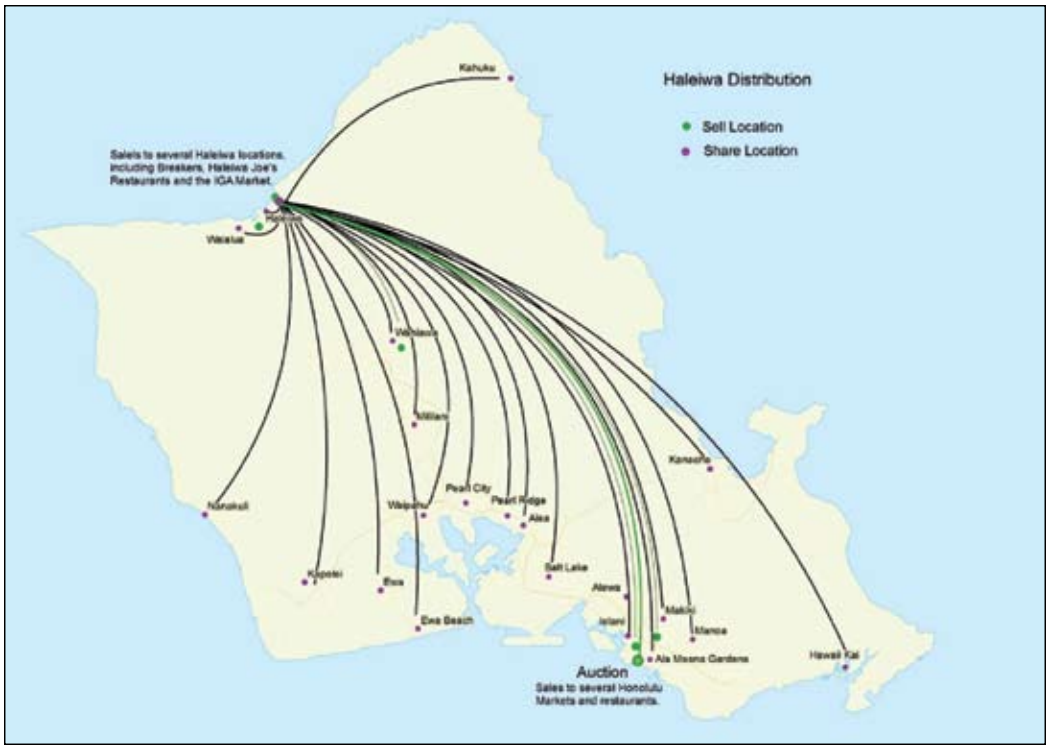
Purpose of the Project

The goal of the O'ahu 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 for small boat fleets at Waianae on the Leeward Coast of O'ahu and at Haleiwa on the North Shore of O'ahu. The analysis is being configured so that project results can be used to improve understanding of seafood distribution elsewhere in the Hawaiian Islands. Patterns of seafood distribution among captains and crew in the Hawai'i-based longline fleet are also being examined.

Preparing a large Blue marlin for the smoker, Waianae 2008

Progress during FY 2009

Fieldwork and preliminary analysis for this project were completed in 2008.



Spatial patterns of seafood distribution: Haleiwa sample

PFRP: Economic Fieldwork on Pelagic Fisheries in Hawai'i

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 project's main objective has been to investigate possible potential long-term pricing relationships among the major landings of the Hawai'i tuna longline fishery (for bigeye, yellowfin, skipjack, and albacore). In FY 2009, the project staff completed the on-going study and launched a new study on fish price/demand in the Hawai'i tuna market. It is important for fishery managers to understand fish price responses to changes in market structure, ecosystem conditions, and regulatory regimes. This study intends to identify regime shifts and price responses in relation to their own landings, explore potential price linkages with tuna sashimi prices in Japan, and investigate El Niño/Southern Oscillation cycles on tuna biomass (represented by CPUE), landings, and price.

Progress during FY 2009

A project titled "Structural Breaks and Price Linkage between Hawai'i and Japanese Tuna Sashimi Markets" was conducted to understand fish price responses to changes in market structure, ecosystem conditions, and regulatory regimes for the Hawai'i tuna market. This study was carried out through a collaborative effort between Dr. Minling Pan of the Pacific Islands Fisheries Science Center and Dr. Jenny Sun, a visiting scholar of the Inter-American Tropical Tuna Commission and Professor, National Taiwan Ocean University. The following summarizes major activities:

- Investigated the market trends of the tuna market in Hawai'i and Japan during the period of 1995-2008;
- Assessed the ecosystem conditions of the major fishing grounds of the Hawai'i tuna fishery;

- Reviewed literature and finalized the model specification for the analyses; and
- Completed an abstract and submitted it to the North Pacific Marine Science Organization (PICES) 2009 Annual Meeting on "Understanding ecosystem dynamics and pursuing ecosystem approaches to management."

PFRP: Examining Latitudinal Variation in Food Webs Leading to Top Predators in the Pacific Ocean

P.I.: Kevin Weng [Jock Young, Robert Olson, Valerie Allain, Jeffrey Dambacher]

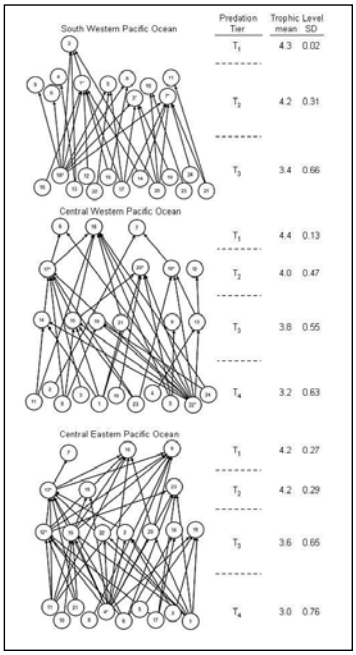
NOAA Office (of the primary technical contact): National Marine Fisheries Service/Pacific Islands Fisheries Science Center

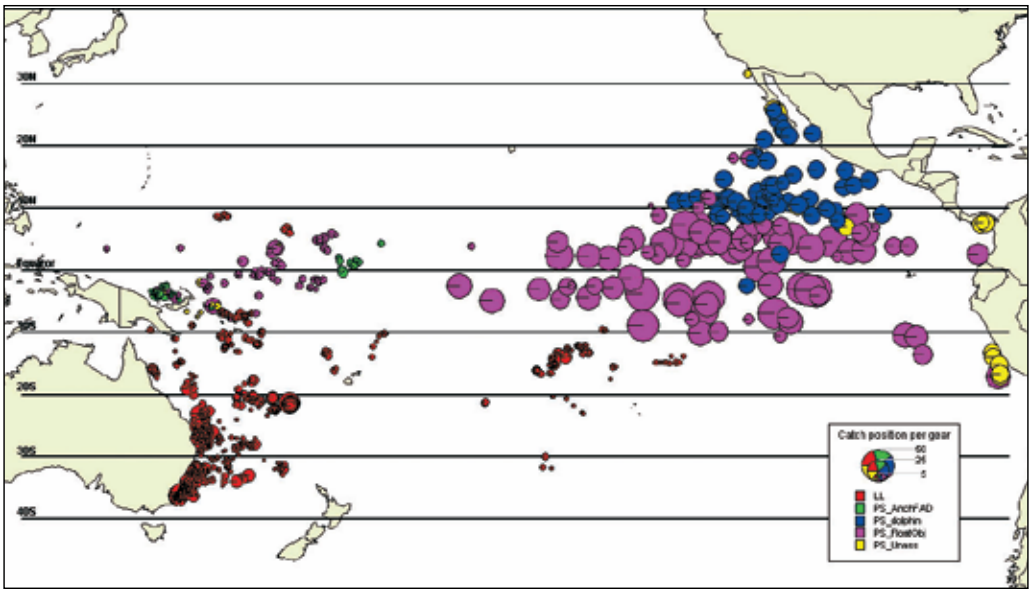
NOAA Goal(s)

- 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 aims to compare stomach contents of top predators from tropical and temperate waters of the western, central, and eastern Pacific Ocean to examine latitudinal differences in the trophic pathways of these regions. The results will be used to develop and compare qualitative models of the trophic flows within each region. A previous trophodynamics study funded by PFRP (PFRP Project #659559) has demonstrated significant heterogeneity in trophic pathways across the tropical Pacific, associated with either the prevailing mesoscale oceanography or the seabed topography. These results have the potential





(above, right) Aggregated food webs of three regions of the Pacific Ocean. Graph nodes represent groups of species with similar predator-prey relationships and are arranged in tiers with top predators in tier 1. Shown for each tier are mean and standard deviation of trophic levels of the taxa in each group. (above) Sample locations, number of samples ("catch"), and gear/purse-seine set type corresponding to diet data of yellowfin tuna, bigeye tuna, and dolphinfish collected in three large regions of the equatorial and South Pacific Ocean. The data will be used in an expanded study comparing the diets over latitudinal bands in three oceans during FY 2010. LL=longline; PS_AnchFAD=purse seine, anchored FAD sets; PS_dolphin= purse seine, dolphin sets; PS_FloatObj= purse seine, floating-object sets; and PS_Unass= purse seine, unassociated sets.

to not only identify shifts in ecosystem structure (climate change), but also may help to define stock structure of widely distributed tropical tunas. A similar, but more localized study off eastern Australia is also beginning to reveal differences not only within the region but also in comparison with the study in the tropical Pacific. Given the proximity of the two studies geographically and the potential migration of tunas between the regions, project researchers are conducting a study that compares the trophodynamics of the pelagic ecosystems of these regions using largely existing data sets. The analysis combines statistical comparisons with qualitative models to determine similarities or otherwise of the two regions. Such comparisons may offer insight into the ecosystem impacts of potential climate change expressed as ocean warming.

Progress during FY 2009

A manuscript was prepared during the previous fiscal year in which qualitative modeling was employed to examine diet data from a variety of upper-level predators in three large regions of the equatorial and South Pacific Ocean. The manuscript was submitted to the CLIOTOP special issue of *Progress in Oceanography*, and during FY 2009 was favorably reviewed, revised by the authors, and accepted for publication. The results have previously been reported at a PFRP PI meeting and at the CLIOTOP Symposium in La Paz, Mexico. An Access database that incorporates dietary data resulting from separate trophic ecology projects in Australia, New Caledonia, and the United States is well established and is now the basis of an expanded database that includes samples from the Atlantic and Indian Ocean.

PIs Jock Young, Robert Olson, and Valerie Allain met following the November 2008 PFRP PI meeting to plan and initiate a traditional diet data analysis of tunas and dolphinfish from the three large regions mentioned above. Specifically, the work entails broad scale latitudinal comparisons of the diets of yellowfin tuna, bigeye tuna, and dolphinfish. The primary habitat of these three species includes different depth strata in pelagic waters over a wide latitudinal range in the Pacific Ocean. This meeting and the ensuing analyses formed the basis of an expanded study that now includes researchers working in the Indian and Atlantic Oceans.

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 are: 1) to analyze the spatial and temporal dynamics and fishery interaction of longline fisheries within and around the American Samoa EEZ (Exclusive Economic Zone); 2) compare albacore fishery dynamics in other Pacific Island Countries and Territories (PICTs) longline fisheries; and 3) improve the regional albacore stock assessment.

Progress during FY 2009

- Objective 1: Little progress was made in FY 2009 because research in previous years concentrated on this objective. There was a study on longline gear depth in American Samoa for use by the Western Pacific Regional Fisheries Management Council in formulating management measures to alter longline gear to reduce sea turtle interactions.
- Objective 2: Little progress was made in FY 2009 because research in previous years concentrated on this objective. A co-PI (Adam Langley) previously completed an analysis of south Pacific albacore dynamics for the Fiji and French Polynesia longline fisheries, which was published as a technical report by the Secretary of the Pacific Community.
- Objective 3: A full south Pacific albacore assessment was completed in July 2008 and reviewed at the 4th Scientific Committee of the Western and Central Pacific Fisheries Commission (August 2008). Previous assessments were based on 5°-month catch and effort data from distant-water (Japan, Korea and Taiwan) fisheries. A working paper was produced for the Scientific Committee with substantial reappraisal of the catch per unit ef-

fort (CPUE) time-series by developing an albacore targeted fleet of distant-water vessels landing in Pago Pago, American Samoa and Levuka, Fiji. Operational level data consisted of >450,000 longline sets from 1960-2007. Results indicated better coherence in CPUE among fleets in the albacore targeted fleet compared to aggregated (5°-month) data. The development of an albacore targeted fleet allows catchability to be constrained (i.e., no time-series variation) in the assessment, an important structural assumption that reduces uncertainty compared to previous assessments.

PFRP: Hawai'i Tuna Tagging Project 2

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

This project is designed to update and expand knowledge of the population dynamics and dispersal rates of yellowfin, bigeye, and skipjack tuna found in coastal waters around the Main Hawaiian Islands. This is in response to the data requirements of the newly established Western and Central Pacific Fisheries Management Council and in recognition of the fact that the population dynamics of these species may have changed in recent years due to the fishing activities in the broader Pacific region. Emphasis will be placed on conventional "spaghetti tagging" augmented with some acoustic tagging.

Progress during FY 2009

This is the first year of the HTTP2 project and almost all activity has involved preparing the appropriate conditions for the fieldwork phases of the project. This included purchasing tags and refining data management systems. Considerable effort has been directed toward finding suitable fishing vessels for the fieldwork and ensuring that these vessels meet the pertinent operational and insurance requirements of the University of Hawai'i. These efforts have been tedious and time consuming but good progress has been made and researchers anticipate a productive 2009/2010 field season.

Captain, crew and fishery scientists on the R/V Soltai 105 conducting tuna tagging and fishery resource surveys in support of the Pacific Tuna Tagging Programme and the PFRP funded Hawaii Tuna Tagging Project 2.

PFRP: Human Dimensions Analysis of Hawai'i's *Ika-Shibi* Fishery

P.I.: Kevin Weng [Edward W. Glazier]

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 overarching goal of this project is to provide PFRP and the Western Pacific Regional Fishery Management Council with valid and reliable information regarding historic and contemporary trends in the commercial small boat handline fisheries around the Main Hawaiian Islands. The specific goal of this project is to generate descriptive information and analysis needed to optimally manage the historically productive ika-shibi (squid-tuna) fishery and associated resources. More specifically, the project was designed to: (1) describe how the fishery has been and is configured in social and economic terms; (2) identify and analyze factors that have influenced change in rates of participation and production over time; and (3) describe and explain how and why participants have been implicated in and/or have reacted to such changes.

Progress during FY 2009

Project work has been completed and final report submitted to JIMAR PFRP.

PFRP: Incidental Catch of Non-target Fish Species and Sea Turtles: Comparing Hawai'i's Pelagic Longline Fishery Against Others

P.I.: Kevin Weng [John Kaneko, Paul Bartram]

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 evaluate the incidental catch rates of non-target fish species and sea turtles in Hawai'i's longline fishery and make comparisons with other pelagic longline fisheries. The final report titled "Catch to Bycatch Ratios: Comparing Hawai'i's Longline Fisheries with Others", was prepared and distributed as SOEST 0-05 JIMAR Contribution 04-352. Later in 2005, an extension of the project was awarded. The purpose of the extension is to develop (where possible) pelagic longline gear profiles of Japanese and Taiwanese longline fleets in the Western and Central Pacific Ocean producing ultralow temperature frozen sashimi bigeye tuna. Efforts will be made to expand (where possible) the pelagic longline profiles to include information on the number and size of vessels, fish hold capacity, type of refrigeration/freezer, target species and target market, and gear and fishing practices.

Progress during FY 2009

Project work has been completed and final report submitted to JIMAR PFRP.

PFRP: Instrumented Buoys as Autonomous Observatories of Pelagic Ecosystems

P.I: Kim N. Holland [Laurent Dagorn]

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 the project were the development and testing of autonomous devices for observing and quantifying the assemblage of pelagic organisms (especially those of commercial interest) that are found in association with fish aggregating devices (FADs).

Progress during FY 2009

Specialized batteries for powering the sonar unit in Hawai'i were purchased and tested. The prototype "Smart FAD" was tested in "Second Phase" testing in California.

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 the project 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, and 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.

Progress during FY 2009

This project continues to have difficulties recruiting a post-doctoral researcher, and little progress was made on the specific goals established in 2008. In addition, the PI (Sibert) for this project retired from the University in December 2008.

PFRP graduate student Eun Jung Kim has made initial progress in modeling the effects of FADs on the movement of tunas. This model uses the advection-diffusion-reaction model previously developed by this project to simulate the effects of FADs by assuming an inverse relationship between tuna diffusivity and the density of FADs. FAD density has a large negative impact on the distance tagged fish move during their time at liberty.

In mid-2008 an opportunity arose to support the on-going development of fisheries models in a fundamental way. The AD Model Builder software became an open source free software enterprise (see www.admb-project.org). The ADMB software is used in all models developed by the PFRP integrated modeling project (e.g., the diffusion models, Kalman filter track models, HTTP tag exchange and mortality models) and several other important PFRP modeling initiatives (e.g., MULTIFAN-CL). The PFRP integrated modeling project was able to provide important logistical support for the ADMB project and currently houses the source code repository. The initial phase of this work was supported by project funds. Later phases were supported though a sub-contract from the National Center for Ecological Analysis and Synthesis at the University of California at Santa Barbara.

PFRP: Integrated Modeling for Hawaiian Albatross Populations

P.I.: Kevin Weng [Jean-Dominique Lebreton, Daniel Goodman]

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

Purpose of the Project

The purpose of the project is to analyze available information concerning Black-footed and Laysan Albatross with a view to assessing the conservation implications of the population dynamics with special focus on the possible role of longline fisheries.

Progress during FY 2009

Project work has been completed and final report submitted to JIMAR PFRP.

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 2009

The database and initial analysis of feeding habits data are completed. 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 ability to describe important predators on tunas, the sizes of tunas being consumed, and to evaluate the implications of changing predator fields on the productivity of tunas. Researchers found that bigeye tuna are rarely consumed by large fish (marlins, sharks, larger tunas) 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. Finally, researchers have used these data to assess changes in the prey fields of tunas and other predators. The fish can be used as "biological samplers" that can provide an indicator of changes in prey communities. Notably, researchers found the first documented evidence for increasing cephalopod abundance over the four decades of data.

PFRP: Investigation of Shark Bycatch in the Hawai'i-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]

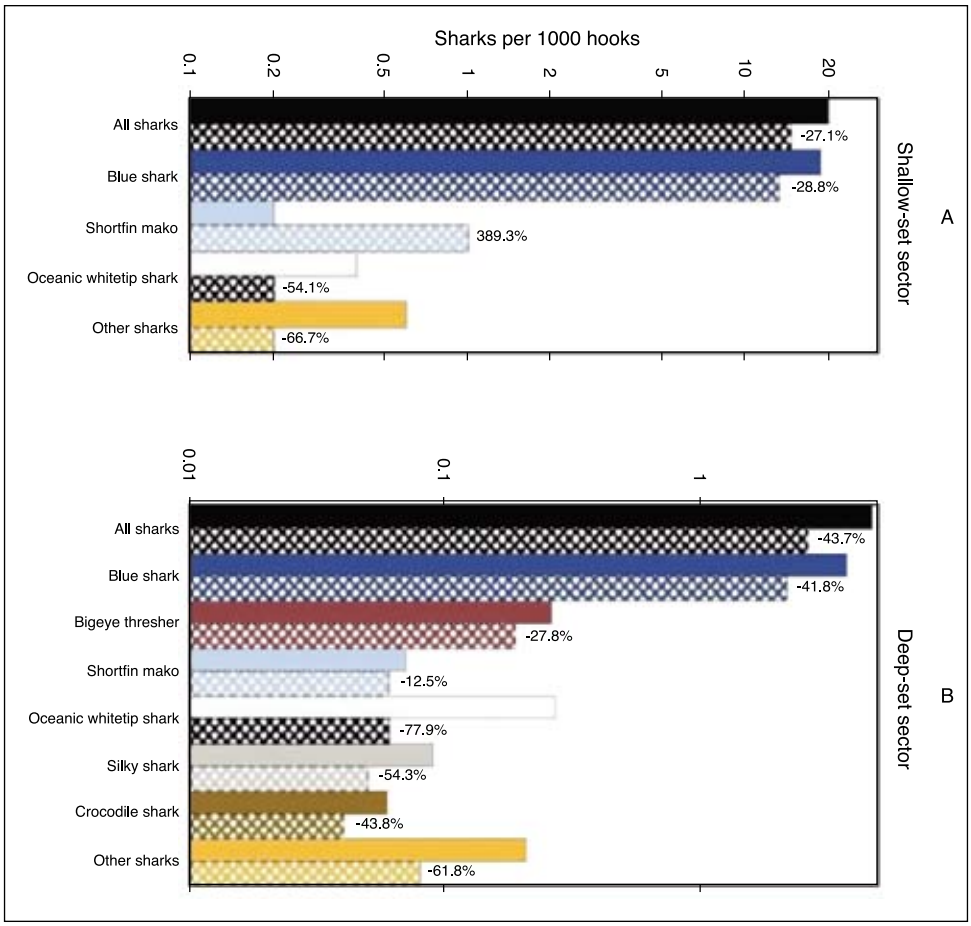
NOAA Office (of the primary technical contact): National Marine Fisheries Service/Pacific Islands Fisheries Science Center

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 focuses on biometrical research intended to improve understanding of shark bycatch in the Hawai'i-based longline fishery. For example, description of the species composition of shark bycatch may permit use of the diversity of these species as an indicator of ecosystem status, while an improved understanding of the magnitude of shark bycatch, in the aggregate and by species, is fundamental background information required to evaluate the efficacy of bycatch reduction efforts. The general principle underlying concerns about shark bycatch is



Catch-per unit-of-effort (sharks per 1000 hooks) plotted on a logarithmic scale for common sharks caught in the (a) shallow-set and (b) deep-set sectors of the Hawaii-based longline fishery. Solid bars represent mean CPUE values from 1995–2000; cross-hatched bars represent 2004–2006. The percentages represent the change in CPUE between the two periods.

that elasmobranch life history traits exacerbate vulnerability to overfishing. For this reason, fishery scientists and managers would benefit from a solid body of information upon which to base their actions.

Progress during FY 2009

The major accomplishment for this project in the last fiscal year was the completion and subsequent acceptance of a paper on shark bycatch. The outlet will be *Marine and Coastal Fisheries*, a new, on-line, peer-reviewed journal from the American Fisheries Society.

PFRP: Long-Term Deployment of Satellite Tags on Swordfish Using the California Harpoon Fleet

P.I.: Kevin Weng [Heidi Dewar, 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
- To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

The goals of this project were four-fold. The first was to determine the feasibility of using the California harpoon fleet to deploy pop-up satellite tags over long time periods. To do this, tags were deployed over periods of up to 6 months. The second was to test the retention rates with two different dart types. The third was to use any data obtained to determine whether the region off southern California are in fact an area of mixing, as suggested previously, and to examine essential habitat in different oceanographic regions. Finally, given the diving patterns of swordfish and the associated difficulty of using light to determine latitude and longitude, a fourth goal was to determine whether it is possible to use hydrographic features, including sea surface temperature, to estimate locations between tag and pop-up.

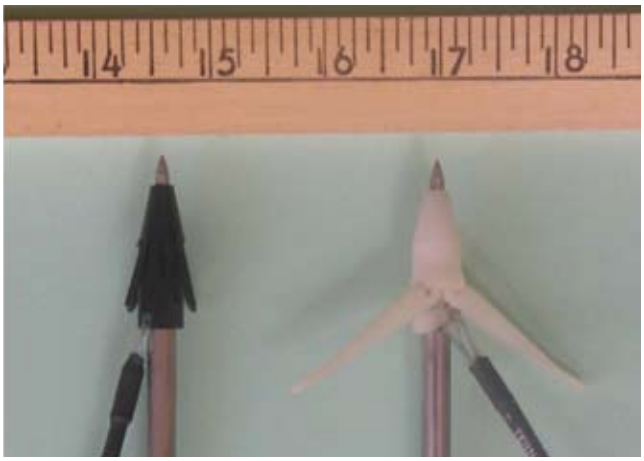


Figure 1. Picture of the two dart types; the black umbrella dart and the large white dart. The white dart appeared to increase the duration of tag deployments.

Progress during FY 2009

In the fall of 2008 harpooners in the Southern California Bight deployed a total of 12 satellite tags. More tags were deployed in 2008 than in 2007. Of the tags deployed six tags have transmitted to satellite and fishermen recovered two. The tags were deployed with a mix of the two dart types (Figure 1).

Because this was the final year of funding researchers have made an effort to provide a brief summary of the results to date in relation to their initial objectives. Work is still ongoing for the project as a whole and some efforts are still in progress.

1) *Determine the feasibility of using the California harpoon fleet to deploy pop-up satellite tags over long time periods*. Based on the results to date, the California harpoon fleet is an excellent platform for tag deployments. The mortality was incredibly low and only one swordfish died as a result of the tagging event. When tags were deployed from a longliner in earlier studies the mortality was greater than 50%. The one challenge with tag deployments is positioning the dart accurately for long-term retention. At this point tag retentions of four to six months are reasonable.
2) *Test the retention rates with two different dart types*. The two dart types are shown in Figure 1. Because of the unpredictable non-reporting of some tags, there are currently not an equal number of records for the two dart types (black darts n=14, white darts n=7). A Mann-Whitney Sum of Ranks shows no significant difference in the deployment duration. However, looking at both the mean and the median duration of deployments (black mean=79 days, median=63 days; white mean=112 days, median=115 days), the large white darts appear to have a longer retention time. Additional deployments may help to confirm this difference.
3) *Determine whether the region off California is in fact a region of mixing*. The six-month deployments are

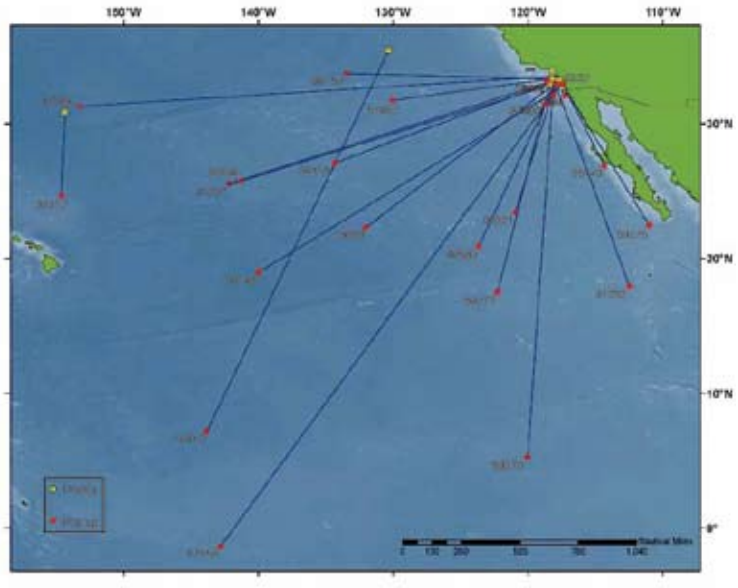


Figure 2. Map shows the deployment and pop-up locations for all fish tagged out of California as a part of the larger swordfish tagging project. The majority of these tags were deployed under the PFRP project although all data are being used in analyses.

not sufficient to determine if the Bight is a region of mixing, much longer deployment durations with intermittent geolocations are necessary. Without the intermittent locations the tags function more like fisheries-independent conventional tags (all releases are shown in Figure 2). While this is a limitation, the results obtained to date advance researchers' understanding of residence time in and movements away from southern California. Further advances in the characterization of habitats and movements should result from the incorporation of the data into a SEPoDyM model (Spatial Environmental Populations Dynamics Model). These efforts are in progress.

Because of the limitations of the pop-up tags, researchers have initiated a number of complimentary approaches to address the question about mixing: i) otoliths are being collected from around the Pacific Basin to compare micro-chemistry; ii) tissue samples are being collected to compare DNA and isotope ratios (isotope analysis is currently being conducted by colleagues in Japan); and iii) a number of additional technologies will be tested including archival tags and towed satellite tags both of which should provide intermittent geolocations. This work is ongoing. Researchers are also collecting data on cookie cutter shark scars and parasite load.

4) *Use hydrographic features including SST to estimate locations between tag and pop-up*. This work will be conducted as a part of the assessment of vertical habitat, in the later phases of analyses. This analysis has not yet been conducted.

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

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

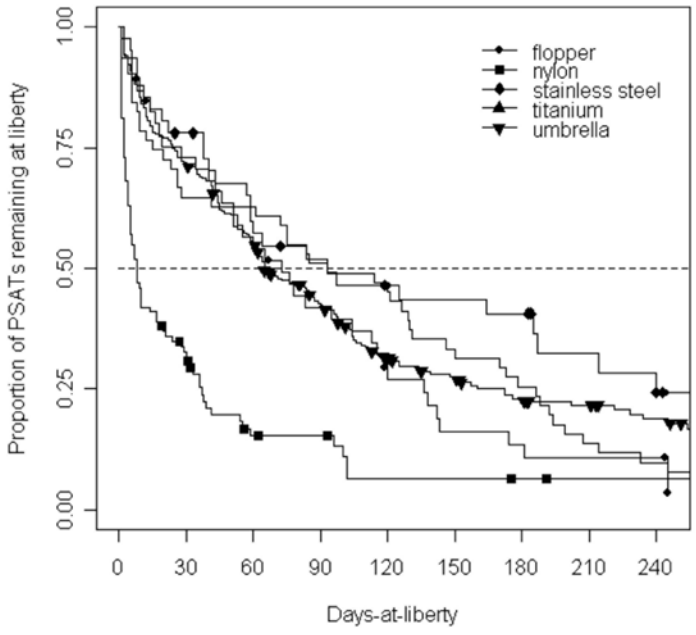
NOAA Office (of the primary technical contact): National Marine Fisheries Service/Pacific Islands Fisheries Science Center

NOAA Goal(s)

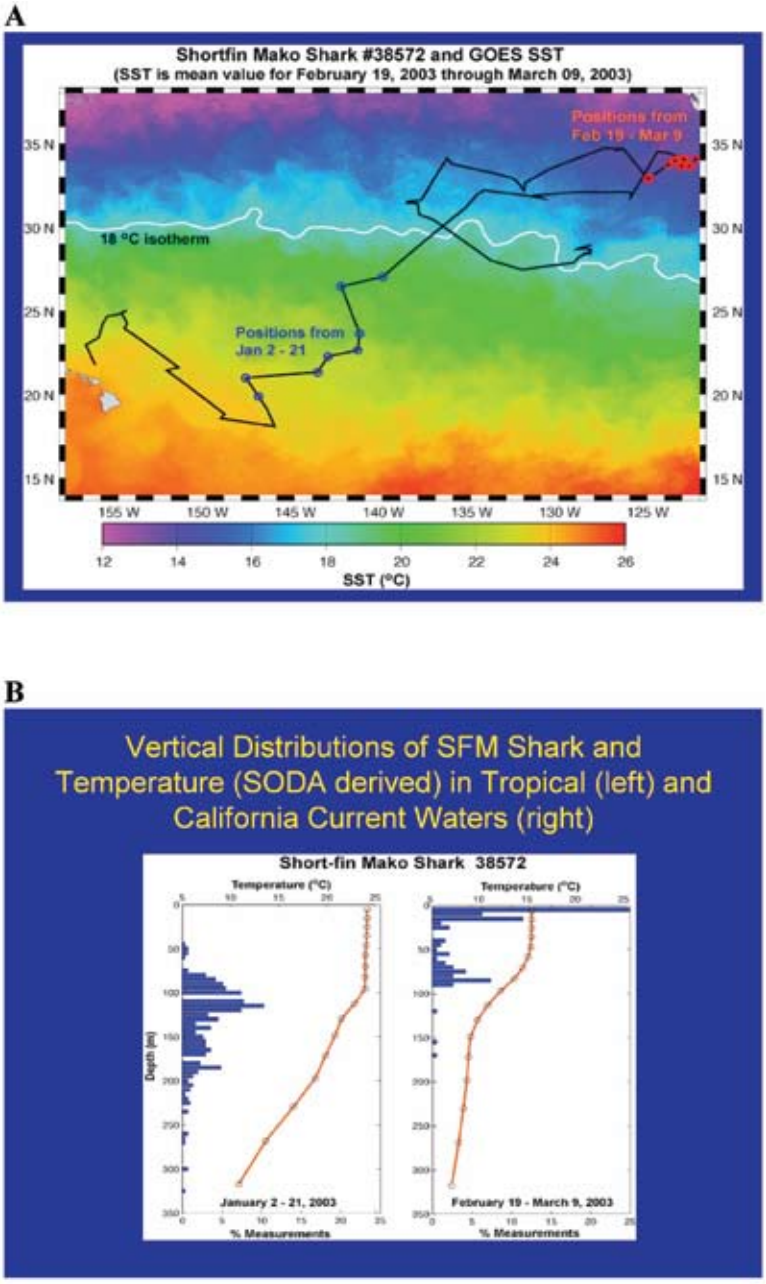
- To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management
- To serve society's needs for weather and water information

Purpose of the Project

This project proposes to use available data from archival and pop-up satellite archival tags (PSATs) to develop individual based models (IBMs) to describe the eco-physiology of different species of large pelagic fishes and sharks. This 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 collaboration between the University of Hawai'i/JIMAR/PFRP, Virginia Institute of Marine Science/National Marine Fisheries Service, and the Dept. of Zoophysiology, University of Aarhus, Denmark. Our ultimate goal is to develop model(s) that will be applicable to many



Kaplan-Meier survival curves of the proportion of pop-up satellite archival tags (PSATs) remaining attached to fishes and sharks by taghead type. A step downward on the survival curve represents a PSAT that detached early, while a symbol (legend) denotes a PSAT that hit its programmed pop-up date. The medians are found at the intersections of the lightly dashed 50th percentile line and the survival curves. Medians and sample sizes are: nylon m=8 d (n=100), umbrella m=65 d (n=253), flopper m=73 d (n=46), titanium m=93 d (n=51), stainless steel m=93 d (n=41). The differences in the survival curves were significant (likelihood ratio test, χ^2=96.6, df=4, p<0.0001). As determined by the project using Cox Proportional Hazards models, PSAT retention appears to be more a function of latitude (temperature) and depth (pressure/temperature) experienced by the tagged animal.



Horizontal (a) and vertical (b) movement patterns of a pop-up satellite tagged short-fin mako. Notice how the animal dramatically altered its vertical diving patterns (b) in relation to the position of mixed layer and thermocline (orange line estimated by SODA analyses) as it moved into cooler water (a).

different pelagic fish and shark species. Using these models researchers can evaluate the possible importance of specific oceanographic parameters in an unbiased fashion, which will 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 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 our 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 2009

Although the project was unavoidably delayed due to major knee surgery for PI Musyl in FY 2007 and in FY 2008 by medical problems with other personnel, several manuscripts have been published and submitted by project personnel, including a major review manuscript on PSAT performance and reliability. Project personnel have also completed major analyses to correlate movement patterns of PSAT tagged blue shark, silky shark, oceanic white-tip, bigeye thresher, and short-fin mako shark with various oceanographic parameters. Another manuscript detailing the post-release survival of pelagic sharks from longline gear will be submitted soon.

PFRP: Origin and Stock Structure of Bigeye and Yellowfin Tuna in the Western and Central Pacific Ocean

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

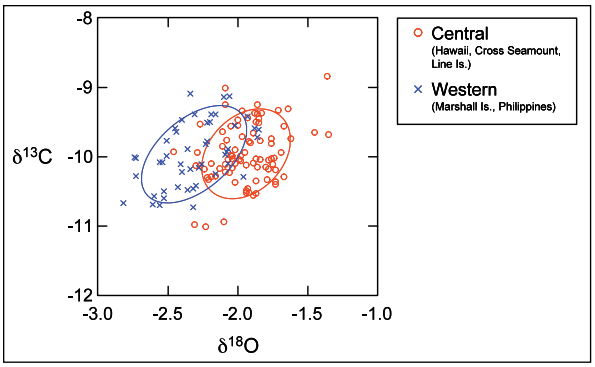
The purpose of this study is to provide information on the source(s) of bigeye and yellowfin tuna recruits (age-1 and age-2) to Hawai‘i-based surface fisheries using natural tracers (stable isotopes and trace elements) in otoliths. Our first step is to develop a baseline that describes the chemical signatures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

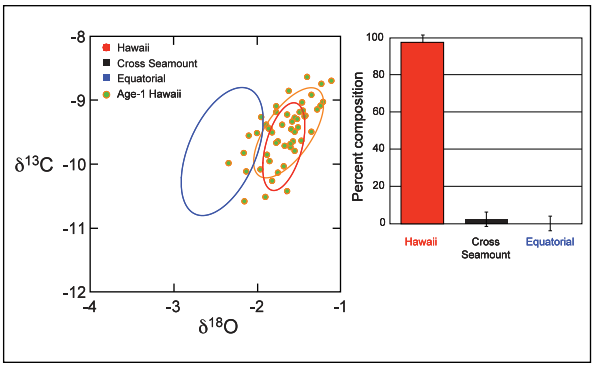
Progress during FY 2009

The first step of the project is to develop a two-year baseline describing the chemical signatures in otoliths of age-0 bigeye and yellowfin tuna from putative spawning and/or nursery areas in Hawai‘i and the broader WCPO. Samples have been obtained and analyzed from potential nursery areas in year 1 (2008) of the study including the Hawaiian Islands (inshore FADs off Hawai‘i, Kaua‘i, Maui, and O‘ahu), Cross Seamount, and several locations along the equatorial Pacific (Line Islands, Moro Gulf Philippines, Marshall Islands, Solomon Islands) (Table 1). Results from the first year of baseline data indicate stable isotopic composition in otoliths of age-0 bigeye and yellowfin tuna were significantly different (MANOVA, $P<0.05$) among nursery areas. Otolith $\delta^{18}O$ of bigeye tuna

Table 1. Total numbers of yellowfin and bigeye tuna collected in 2008 (year 1) and 2009 (year 2) of project. Currently collecting (CC) and not applicable (NA) are also shown within each nursery area by species and year.

Collection Year	Age and Species	Nursery areas					
		Hawaiian Islands	Cross Seamount	Line Islands	Marshall Islands	Solomon Islands	Moro Gulf Philippines
2008	Age-0 Yellowfin	142	27	34	52	35	30
2009	Age-0 Yellowfin	103	CC	8 (CC)	16	CC	30
2009	Age-1/2 Yellowfin	105	NA	NA	99	NA	NA
2008	Age-0 Bigeye	20	48	79	49	4	20
2009	Age-0 Bigeye	5 (CC)	CC	42 (CC)	CC	CC	30
2009	Age-1/2 Bigeye	22	9 (CC)	NA	101	NA	NA





(left) Figure 1. Otolith $\delta^{13}C$ and $\delta^{18}O$ cores of age-0 bigeye tuna collected from western and central Pacific Ocean nursery areas. Ellipses represent 1 standard deviation around the mean. (right) Figure 2. Otolith $\delta^{13}C$ and $\delta^{18}O$ cores of age-0 yellowfin tuna collected from Hawaiian Islands, Cross Seamount, and equatorial nursery areas are represented by ellipses only. Otolith $\delta^{13}C$ and $\delta^{18}O$ cores of age-1 yellowfin tuna collected from Hawaiian Islands are represented by green points and ellipse. Percent composition (histogram) represents the predicted nursery origin of age-1 yellowfin tuna collected in Hawaii using mixed-stock analysis.

was depleted in the western equatorial (Marshall Is., Philippines) relative to the central Pacific (Hawai'i, Cross Seamount, Line Is.) (Figure 1). Overall cross-validated classification success from discriminant function analysis was 81% between the central Pacific Ocean and equatorial regions (84% central Pacific, 77% equatorial). Otolith $\delta^{18}O$ of yellowfin tuna from the equatorial region was also depleted relative to areas in and around Hawai'i with intermediate values for individuals collected from the offshore seamount (Cross Seamount) in the Hawai'i EEZ (Figure 2). For yellowfin tuna, overall cross validated classification success was 78% for the regions assessed (98% for Hawai'i, 72% Cross Seamount, 70% equatorial) indicating the approach has promise for identifying both species from different nurseries, particularly yellowfin tuna from the Hawaiian Islands. Further, otolith core material from age-1 yellowfin tuna was analyzed from samples collected in the Hawai'i-based fishery during 2009. Preliminary results using mix-stock procedures show contribution estimates are primarily from locally spawned fish (Figure 2), providing evidence of local recruitment of yellowfin tuna in the Hawaiian Islands.

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 project will 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 catch per unit effort (CPUE) trends are highly influential in Pacific Highly Migratory Species (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 develop improved longline catchability models for use in population assessments.

Progress during FY 2009

The project proceeded with the research plan developed at the February 2007 workshop.

- One PI (Bach) and colleagues published a refereed paper analyzing longline experiments within the ECOTAP program (F. Polynesia) and developed estimates of longline shoaling based on gear deployment strategies and

oceanography. In particular, geometric forcing (i.e., transverse versus in-line) between current velocity and the longline set was shown for the first time from *in situ* experimental fishing data.
- The project collaborated 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 (CPUE) standardization analyses to ascertain if "true" population trends can be recovered. Catch rate standardization analyses are commonly used in fisheries stock assessment, though data simulation is perhaps the only viable method to test various standardization methods (e.g., Generalized Linear Models, Tree-based regression, statistical Habitat models).

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

The four major objectives are as follows.
- To computerize detailed individual hook information and anecdotal fishery related observations annotated during the POFI research cruises from 1951 through 1973.
- To integrate the "recovered" data into the PIFSC data holdings.
- To develop database tables of metadata, GIS plots of the cruises, distribution of the major pelagic species, and possibly other key resulting information.
- To provide some electronic access to metadata tables through a web page portal.

Progress during FY 2009

- Data Entry Institute of Hawai'i (DEIH) was awarded the data rescue contract and work began on 6/11/07. To date DEIH has computerized the last of the POFI research longline data with approximately 58,250 lines of data or 524,250 individual particulars of detailed individual hook information. However, while closing the data rescue contract, DEIH contends that there are more rescued data to be forwarded but researchers have not received the final computerized data and associated billing. Over the course of several months and numerous attempts via e-mail, telephone, and occasional site visits, both the JIMAR staff and the PI were unable to contact DEIH about the final rescued data. Currently, the JIMAR staff is working with the RCUH fiscal office to formally close the data rescue contract with DEIH.
- A total of 52,132 lines of the rescued data were integrated into the PIFSC data archives. Difference of 6,118 lines of rescued data could not be linked back to the PIFSC data archives.
- With the retirement of co-PI Robert Skillman, finding a suitable replacement has thus far been unsuccessful. Some development of the metadata and spatial analysis of the historical pelagic fishery data have been initiated.

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

This project is designed to quantify the size of the ecosystem used by tuna found in association with Hawai'i FADs. That is "where do they go when they leave here?" This information is directly applicable to formulating possible management options for Hawai'i's fishery and understanding the connectivity between Hawai'i and other regions of the Pacific. The methodology involves double tagging yellowfin and bigeye tuna with an acoustic tag and either an implanted archival tag or an externally attached pop-up satellite tag.

Inserting archival tag in double tagged yellowfin tuna

Progress during FY 2009

The reporting period saw continued high activity with over 30 sea days devoted to servicing the acoustic receiver array and in tagging additional fish. Several fish have been recaptured with times at liberty varying from a few days to several months. Data analysis workshops have been conducted to improve the quality of data management and increase the precision of light-based geolocation estimates. Low numbers of large tuna in the 2008/9 season precluded the use of satellite tags. Researchers intend to continue to tray and deploy these in the next year. The establishment of a good working relationship with commercial FAD fishermen working on Maui would improve our chances. These data are currently being analyzed. The only objective not achieved was the release of fish double tagged with satellite tags. This was due to not capturing fish of suitable size that were also in good condition. This size of fish will receive special attention during the next year's effort.

PFRP: Sociological Baseline of Hawai'i'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 extends the time frame and expands the scope of an existing JIMAR project, "Sociological Baseline of Hawai'i's Longline Fishery." The purpose of that project was to compile a comprehensive sociocultural profile of the longline fishing industry of Hawai'i 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 to extend the scope to cover seafood distribution channels of longline-caught fish in Hawai'i.

Progress during FY 2009

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 draft completed peer review to be initiated in 2009. 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). A case study of longline-caught fish was developed that will serve as a template for work to be completed in the upcoming fiscal year.

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. Cross Seamount in the Hawaiian archipelago—a seamount with a 5 nmi diameter and a 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 subadult bigeye tuna, which are 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 conventional fisheries dependent stock assessment methods 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 2009

As all proposed fieldwork for the project was completed in FY08, work during this fiscal year focused on completing all *in situ* (bioacoustics, currents, CTD casts) and satellite (sea level anomaly and sea surface color) data analyses. Because data analysis during FY 2008 revealed that micronekton biomass is higher over the plateau and flanks of the seamount than in nearby waters, and that bigeye tuna aggregate at the seamount at least partially to feed, data analysis during FY 2009 focused primarily on quantitatively describing the effect of the environment on the composition and distribution of micronekton at Cross Seamount as well as at different regions within the study area. At present, a manuscript is being prepared for publication in a referred journal on the composition and distribution of micronekton and the effects of the seamount environment on micronekton.

Data analysis during FY 2009 revealed that the increased micronekton biomass is likely due to the availability of increased forage that is not the result of a trophic cascade originating in higher primary production due to upwelling caused by island effects. Current data persistently shows downwelling over the summit and flanks of the seamount with magnitudes that can reach over 20 cm s^{-1}. Small doming of density contours was observed within 200 m of the plateau floor (Figure 1, left, bottom panel), too deep to result in upwelling of nutrients into the eutrophic zone. This corresponds with the seamount's apparent lack of effect on chloropigment concentrations (Figure 1, left, fourth panel from top). Interactions between the abrupt topography and impinging currents and internal tides are likely to trap planktonic organisms that are not able to swim against currents that can reach almost 50 cm s^{-1} magnitudes, thus providing forage for the increased micronekton biomass.

Cross Seamount's effects on micronekton are confined to the plateau and the immediate flanks, not extending to more than 1-2 km from the shallow, 700-1500 m flanks (Figure 2). On a 24 hr. cycle, the largest difference between micronekton biomass in the shallow scattering layer (SSL) over the plateau and away from it is between 00:00 to 18:00. After 18:00, as micronekton start migrating into the SSL, the SSL biomass increases over the flanks and surpasses that over the plateau by 20:00. Between 20:00 and 24:00, micronekton migrate over the plateau and restore the overall daytime and nighttime pattern. On larger scales, the region surrounding Cross Seamount tends to have lower biomass of all regions in the study area except for a region south of Cross Seamount. As all other study regions are located to the east and north of Cross Seamount, it is likely that those

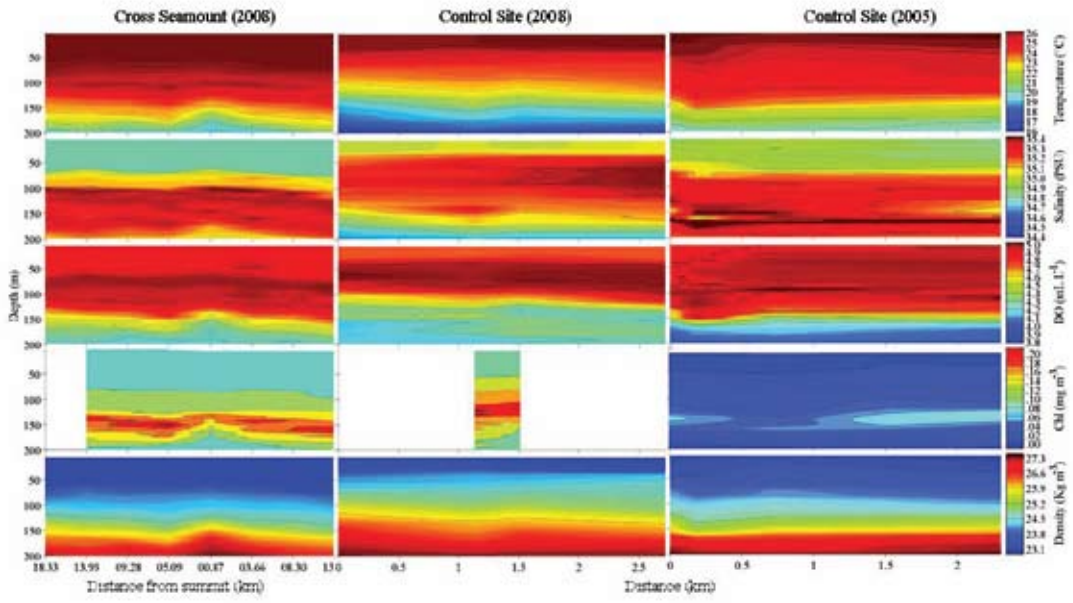


Figure 1. Upper 200 m temperature, salinity, dissolved oxygen, chloropigments, and density (σ_t) at Cross Seamount in 2008 (left panel), and at the "Control Site" in 2008 (middle panel) and in 2005 (right panel), as measured by in situ *CTD casts. During the 2008 cruise, not all casts had fluorometer on them resulting in missing values at some of the stations.*

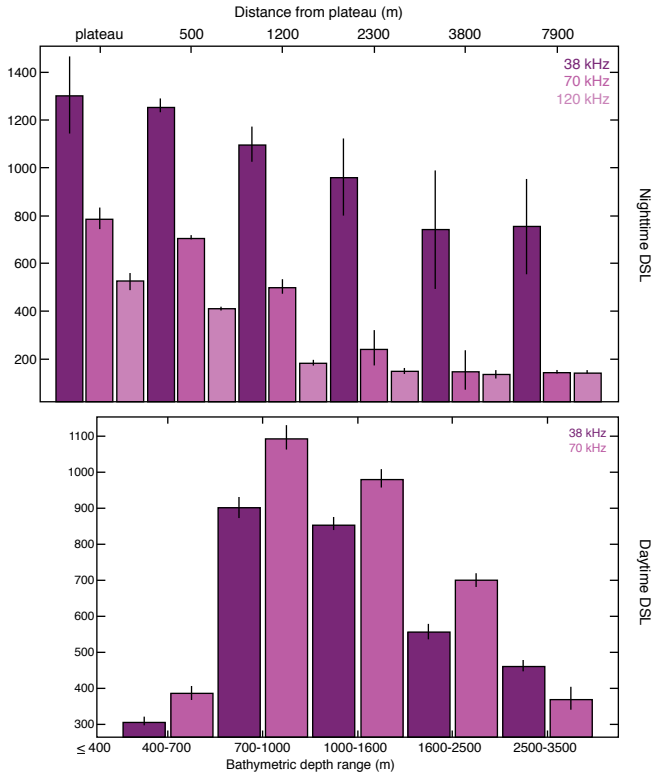


Figure 2. Nautical Area Scattering Coefficients (NASC), a proxy for relative biomass, in the nighttime SSL (top) and in the daytime DSL (bottom), moving from the plateau (left) to deeper waters (right). NASC values are shown at 38, 70, and 120 kHz for the SSL and at 38 and 70 kHz for the DSL as the higher frequency signals attenuate before reaching the DSL. The x-axis on the bottom shows the bathymetric depth ranges while the top the corresponding distance from the edge of the plateau. Note that the very low NASC in the 400-700 m range are due to most of the DSL not being present, as the depth of the DSL is typically between 500 and 900 m.

regions are affected more by the eddies generated in the islands' wake than Cross Seamount, which lies at the south edge of the path of these eddies. Eddies were observed to have a profound effect on micronekton biomass. During the 2008 cruise, a large cyclonic eddy occupied the region called "Control Site", located about halfway between Cross Seamount and O'ahu. The signature of the eddy can be readily seen in the *in situ* temperature, salinity, dissolved oxygen, chloropigments, and density records (compare Figure 1 middle and right panels), as well as satellite altimetry data. During the 2008 observations, micronekton biomass both in the SSL and the Deep Scattering Layer (DSL) were dramatically higher than those during the 2005 observations.

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 use various electronic tags and acoustic survey methods to document the behavior and feeding ecology of tuna associated with FADs and other topographical features.

Progress during FY 2009

During the reporting period, maximum effort was focused on exploiting researchers' excellent working relationship with commercial fishers using private FADs (PFADs) on the north coast of Maui. The principle PFAD broke loose during this period, which caused a temporary halt in activity and loss of some data. However, two new PFADs are now in place and both are equipped with sonic receivers. Additional fish were tagged in 2006/9 including bigeye tuna that were double tagged with pressure sensitive acoustic tags and archival tags. Three of these fish were recaptured and one was detected by an acoustic receiver on HH FAD (O'ahu).

Retrieving an acoustic data logger from a FAD

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 goals of the projects are as follows.

- Develop and implement strategies to further recover marine species protected under the Endangered Species Act (ESA) and /or the Marine Mammal Protection Act (MMPA).
- Conduct section 7 consultations under the ESA. Revise and maintain the marine mammal stranding program to fulfill mandates of the MMPA.

- Assist in the analysis and procedural requirements to manage federal fisheries in compliance with the ESA and the MMPA.
- Develop and deliver outreach and education campaigns for the public concerning protected resources issues.

The project also provides supplementary staff to augment federal employees assigned to this mission.

Progress during FY 2009

The objectives established for this period included: 1) sea turtle conservation, management and fisheries related mitigation activities within the PRECI; 2) draft informal section 7 consultation responses to other federal agencies in response to their submissions of project plans and permit applications; 3) draft ESA biological opinions and MMPA negligible impact determinations to analyze the specific actions on marine mammals; 4) research and review species for the NOAA Fisheries Convention on International Trade in Endangered Species of Wild Flora an Fauna (CITES) Task Force; 5) prepare, review, and analyze scientific and policy documents concerning management of marine mammals in the Pacific Island Region; 6) provide marine mammal biological expertise during the preparation and review of management and policy documents; 7) assist in outreach and education mission by developing outreach materials, coordinating volunteer groups, and creating partnerships with other federal and state agencies and non-profit organizations; 8) provide administrative support to federal and JIMAR project staff in the Protected Resources Division.

- Krista Graham, JIMAR resource specialist, resigned from JIMAR to join NOAA Fisheries Protected Resources in mid-September 2008. However, in her final months as a JIMAR employee, she assisted with a sperm whale carcass removal on the North Shore of O'ahu, participated in a cetacean research cruise off the Kona coast of the Big Island, and worked on the 90-day finding for the petition to revise Hawaiian monk seal critical habitat. Krista also took on the duties of regional ESA Section 6 coordinator, and continued directing the ESA Section 4 Pacific Islands Region Species of Concern Program. In early September, she attended a "Cooperative Conservation of Marine and Anadromous Species" workshop in Silver Spring, MD. The workshop collaborated with a variety of stakeholders to improve conservation partnerships and strategies. The workshop ultimately developed a five-year strategic plan to increase capacity for cooperative conservation of NOAA trust resources.

Krista Graham using big-eye binoculars to search for cetaceans off the Kona coast of the Big Island.

- Jen Metz, JIMAR PRD outreach and education specialist, continued to provide assistance and guidance with the various outreach and education efforts for PRD. She 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 in finalizing the Hawaiian monk seal school power point presentation, "An Endangered Treasure" and developing several new displays to use at outreach events focusing on various monk seal management issues. Metz also began developing a Hawaiian monk seal Historical Time Line and drafted Statements of Work for a future Hawaiian monk seal film project and a public attitude assessment project. Working closely with her PRD colleagues, she continued outreach efforts to create more awareness about the Hawaiian spinner dolphin. Projects included a new spinner dolphin webpage entitled "Six Facts about Swimming with Wild Dolphins", which highlights the scientific information about the Hawaiian spinner dolphin often lacking on commercial web sites that promote swimming with wild spinner dolphins. She also developed Hawaiian spinner dolphin information signs to be placed on the beaches of spinner dolphin resting bays where swimmers often seek out the dolphins. In collaboration with all the species team leads, Metz created a three-hour training for hotel staff, "Responsible Wildlife Viewing and Marine Mammal Stranding on Response Training." The training included information concerning all PRD management issues that concern the tourism sector. The training was successfully piloted at the Four Seasons Resort hotels on Lanai and will be revised and implemented at other hotels around the state. Metz continued to represent PRD interests at various outreach events as well as on steering committees such as the Watchable Wildlife Steering committee and the Kaena Point Advisory Council.
- Karen Frutchey, JIMAR International Fisheries Division (IFD) international turtle conservation and management liaison, continues to serve as the NOAA Fisheries Service International Fisheries Program point of contact for

western and central Pacific marine turtle conservation and management projects and acts as a liaison between marine turtle conservation and management project principal investigators or relevant project staff internationally and NOAA Fisheries PIRO. During FY 2009, as territory lead, Frutchey made technical site visits to the CNMI, Guam, and American Samoa. An additional site visit was conducted in Vietnam for a trial fisheries observer project. At the 29th Symposium on Sea Turtle Biology and Conservation, she presented a summary on marine turtle nesting in the Micronesian region and informed the Secretariat of the Pacific Regional Environment Programme (SPREP) side meeting participants on PIRO's marine turtle project activities. She continues to provide technical support for a marine turtle genetic sampling project working with NOAA Southwest Fisheries Science Center scientists to characterize western Pacific green turtle nesting stocks by assisting countries and territories with sample organization, analyzing green turtle skin samples, and obtaining mitochondrial DNA haplotypes. Frutchey also reviewed and commented on internal NOAA documents including several NOAA marine turtle grant applications, which required National Environmental Policy Act (NEPA) analysis. She provided comments to PIRO IFP on draft Western and Central Pacific Fisheries Commission (WCPFC) marine turtle fisheries interaction mitigation related documents. NOAA awarded Frutchey with the designation of Team Member of the Year for her work during FY 2009.

- Michelle Yuen, JIMAR PRD marine mammal biologist, assisted with several management projects for marine mammal species in the Pacific Islands Region. She was instrumental in the preparation for the take reduction planning process for false killer whales that are incidentally caught in the Hawai'i-based longline fishery. She provided species biological information, assisted with contracts and purchases, and regularly coordinated with other biologists and stakeholders. Yuen also regularly assisted with several projects for the recovery of the Hawaiian monk seal, particularly with the implementation of NMFS' Recovery Plan (2007) and with 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 Newsletter*; presenting species information to several schools, trainings, and organizations; mentoring college students for independent research projects; and assisting with the coordination of the Pacific Islands Region Marine Mammal Response Meeting. She also coordinated and organized the annual meeting in December 2008 for the HMSRT, developing agendas, materials, and other logistics. Yuen has also contributed to PRD Hawaiian spinner dolphin management and regulatory efforts by drafting chapters for the upcoming draft *Environmental Impact Statement on the Human Interactions with Hawaiian Spinner Dolphins,* assisting with travel and logistics for visiting researchers to consult with NMFS about the project, and providing presentations for public meetings. In coordination with the Cetacean Team leader, she also assisted with the annual Humpback Whale Researcher Meeting in Lahaina, Maui, organizing the meeting logistics, coordinating with the researchers, and providing the agendas, materials, and presentations. Finally, Yuen completed various consultations under section 7 of the Endangered Species Act, providing protected species guidance and response to other federal agencies in regards to their conservation and research projects.
- Kim Maison, JIMAR PRD Sea Turtle Biologist, continued to collaborate with state of Hawai'i DLNR to address incidental take of sea turtles in near shore and shoreline fisheries and assisted DLNR in seeking additional funding for the Incidental Take Permit Program. She also worked with partners on various Hawksbill recovery projects including co-organizing the 2009 Hawai'i Hawksbill Recovery Group meeting; drafting an Action Plan for Research and Management of Hawksbills in Hawai'i; and aiding Hawai'i Island Hawksbill Recovery Project in applying for NOAA grant funding. Maison reviewed six grant proposals and served as technical monitor for three grant funded projects including Hawai'i hawksbill monitoring and conservation, outreach efforts for the green turtle on O'ahu's north shore, 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 and provided PIRO recommendations for the ESA Observer Rule Annual Determination to NOAA headquarters. She also continued to maintain a Sea Turtle Reference database for PRD and served as a supporting team member on section 7 consultations, providing technical assistance to the regulatory team on numerous projects and consultations. She attended and presented at two professional conferences (in Hawai'i and Australia) on the effects of climate change on sea turtles. Finally, Kim repeated the long distance education project about sea turtles and Hawai'i with a first grade class in Allamuchy, New Jersey that she began last year.
- In June of 2009, Jean Higgins was hired as endangered species biologist for the ESA team of the Protected Resources Division. As part of the ESA team she is responsible for implementing the federal Endangered Species Act in the Pacific Island region. NOAA has been petitioned to revise critical habitat for the endangered Hawaiian monk seal in accordance with section 4 of the ESA. As part of the revision process, she is collaborating with vari-

ous agencies, stakeholders, and volunteers to familiarize herself with commonly used habitat throughout the main Hawaiian Islands. She has recently visited the islands of Molokai and Kaua'i, working in cooperation with individuals from various groups including volunteers, state workers, the National Park Service, the Nature Conservancy, private land owners, and the NAVY to understand how the various habitats are used by seals and the unique management challenges that the various sites face. This effort will be continued throughout the main Hawaiian Islands to gain first hand site knowledge and to increase cooperation between NOAA Fisheries and the various stakeholders. Higgins has also joined the ESA team in providing guidance to the NAVY for the updates to the Integrated Natural Resources Management Plan and is providing comments to strengthen their monitoring efforts in support of their conservation goals.

- Naomi Yamamoto, JIMAR PRD administrative assistant, continued to provide excellent support in areas of travel, procurement, budget planning and spending, contracts, records and inventory. Her most time consuming responsibility consisted of processing a high volume of travel authorizations/requests, travel vouchers/completions, and local travel reimbursements. Due to the demanding travel schedule of all twelve PRD staff, she processed three times as many travel orders than any other division in PIRO over the past year. She also played an integral role in many PRD conferences and meetings this year, registering attendees, troubleshooting and making sure that each event ran smoothly. Her exceptional editorial skills have allowed her to rigorously review various internal documents, improving the quality of materials that are distributed from the PRD office. These documents included the PIRO brochure for hawksbill sea turtles and the quarterly Pacific Islands Region Marine Mammal Response Network Activity Update Newsletter. Finally, Yamamoto was involved in the newly redesigned federal budgeting process. After completing training in federal government budget management, Naomi was required to immediately demonstrate her proficiency by preparing and submitting draft FY08 spend plans to NMFS leadership. These spend plans total over two million dollars of federal funding and cover a suite of conservation and management projects for protected species.
- In January of 2009, Shelley Steele was hired as a JIMAR Outreach and Education Coordinator for NOAA Fisheries Service Pacific Islands Region. She has assisted with a variety of outreach and education projects and programs for both the Pacific Islands Regional Office and the Pacific Islands Fisheries Science Center. She worked to purchase outreach equipment and hardware, i.e., easels, banner stands, button maker, etc. Steele has also designed and developed a number of outreach and educational activities such as an 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, Steele and the team 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 also include maintaining the 2009 Outreach Calendar of Events, monthly outreach and education reporting, logistical arrangements for events and presentations, and a draft 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.

Shelley Steele (far right) at Iolani School Earth Day event

Reducing Shark Bycatch with Electropositive Metals in Hawai'i-based Fisheries

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

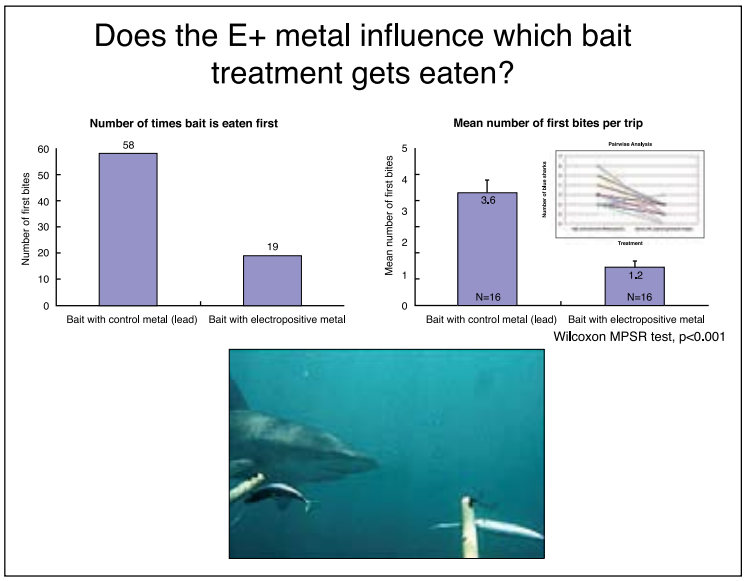
NOAA Office (of the primary technical contact): National Marine Fisheries Service/Pacific Islands Fisheries Science Center

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 examines potential deterrents that may be useful in reducing shark interactions with fishing gear. The incidental capture of sharks is estimated at over 300,000 metric tons annually and often comprises a large proportion of the total catch. Because sharks are among the top predators in marine ecosystems, the continued depletion of their populations could result in detrimental cascading effects for high seas biodiversity. 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".

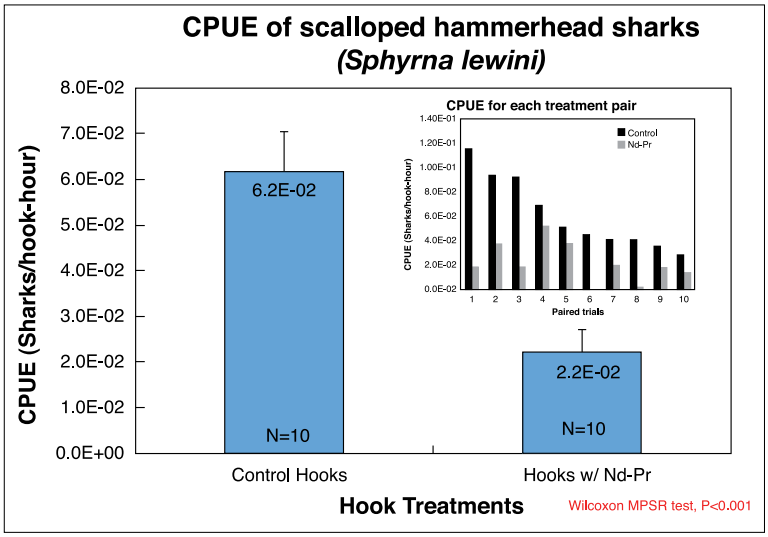


The number of bites for all trials and for each trip. Analysis with the Wilcoxon paired sample test indicates a significant difference (p<0.001) between the two treatments indicating that the presence of the metal reduced the number of times bait associated with the Pr-Nd metal was eaten.

Progress during FY 2009

Researchers concluded experiments to test the ability of electropositive metals to deter sharks from feeding on bait. Utilizing a shark-viewing cage, they conducted paired choice experiments to examine the feeding behaviors of Galapagos sharks (*Carcharhinus galapagensis*) and sandbar sharks (*Carcharhinus plumbeus*). Researchers completed 16 trips to the North Shore in which they conducted paired trials (displaying two treatments simultaneously). Out of the 16 trips researchers carried out 77 trials—with 58 trials ending when the bait associated with a control metal was eaten first and only 19 trials ending when the bait associated with E+ metal was eaten first

Researchers collaborated with Dr. Kim Holland of the University of Hawai'i's Hawai'i Institute of Marine Biology (HIMB) located on Coconut Island in Kaneohe Bay. Working with Melanie Hutchinson, a graduate student in the Holland lab, researchers have initiated two experiments, one



Preliminary results suggest that shark catch rates on demersal longlines decrease when Nd/Pr metals are present.

focusing on the effects of Nd/Pr (Neodymiun/Praseodymium) alloy on the catch rates of sharks on bottom set longline gear, and the other examining the effects of Nd/Pr alloy and other lanthanide alloys on the feeding and swimming behavior of scalloped hammerhead (*Sphyrna lewini*) and sandbar (*C. plumbeus*) sharks. Preliminary results from longline field trials in Kaneohe Bay, Hawai'i suggest that catch rates of juvenile scalloped hammerhead sharks are reduced by 86% on branchlines when the Nd/Pr alloy is attached to branchlines as compared to lead weight-controls.

Collaborating with Dr. Stephen Kajiura from Florida Atlantic University, researchers also investigated the physical properties of the Nd/Pr alloy as well as other lanthanide metal alloys. The exact electrochemical properties that trigger the aversion responses in sharks are not well understood. It is thought that the electric field generated during the oxidation reaction is sufficiently strong that it disrupts the electrosense of the shark. As a first step, researchers measured the electric field produced as the Nd/Pr alloy reacts in water. They also have made initial voltage measurements in seawater of the Nd/Pr alloy, Nd metal, and stainless steel hooks (16/0 circle hooks). Subsequently, researchers also made measurements of Nd/Pr alloys and Nd alloys under different temperature regimes.

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)

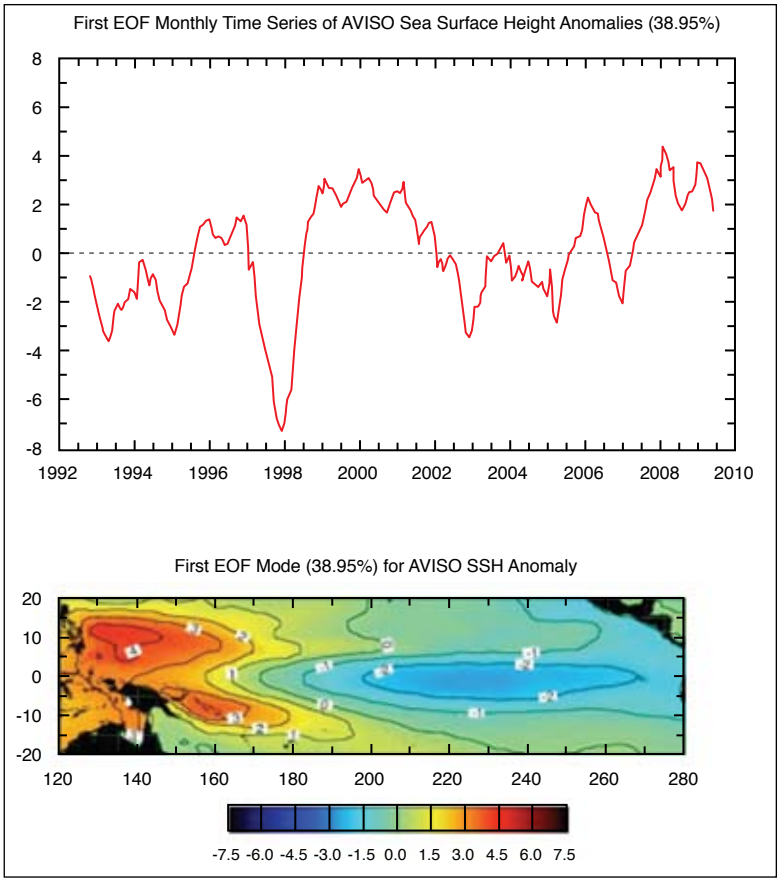
- To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

This project has two related aspects. To use satellite remotely sensed oceanographic data to describe ocean dynamics, particularly features of importance to living marine resources, and to use satellite remotely sensed data together with fishery data or tagging data to advance our understanding of aspects of the pelagic ecosystem including its spatial and temporal dynamics.

Progress during FY 2009

In FY 2008 researchers published a paper showing that satellite-remotely sensed surface chlorophyll declined over a broad area in the North Pacific including the fishing ground of the Hawai'i-based longline fishery. In FY 2009 researchers used fishery logbook and observer data to describe significant changes at the top of the ecosystem over the past 10 years in the Hawai'i longline fishery. The changes at the top of the ecosystem were declines in the apex predators and increases in mid-trophic level species suggesting that fishing pressure was primarily responsible for these changes. However previously



An Empirical Orthogonal Function (EOF) analysis of satellite-based sea surface height in the equatorial Pacific showing the 1997-98 El Niño and 1999-2001 and 2008 La Niñas.

observed declines in phytoplankton may have contributed as well. A paper on this work has been accepted for publication.

Satellite Remote Sensing Research Related to the West Coast Integrated Ocean Observing System

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
- To serve society's needs for weather and water information
- To support the nation's commerce with information for safe, efficient, and environmentally sound transportation

Purpose of the Project

The purpose of this project is 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 efforts are undertaken to: 1) improve understanding of marine environmental variability and its impacts on living marine resources, 2) develop improved living marine resource assessment models, and 3) apply satellite remote sensing technology to the improvement of management of economically and ecologically important marine resources.

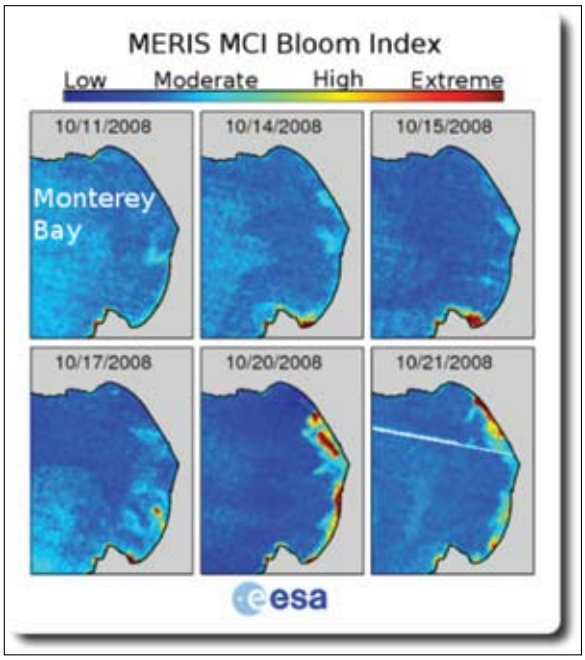


Image showing the evolution of a red tide event in Monterey Bay, captured in near real time using new high- resolution data (300 meters) from the Medium Resolution Imaging Spectrometer on the ENVISAT spacecraft (data provided courtesy of the European Space Agency)

Progress during FY 2009

The Satellite Remote Sensing project in FY 2009 was focused on developing and expanding infrastructure and communication systems for a wide variety of satellite data and products in support of NOAA's mission and the Regional Associations and partners of IOOS. This is in addition to the fundamental goal of supplying oceanographic data sets as the West Coast regional node (WCRN) of the NOAA CoastWatch program. Several highlights from FY 2009 efforts are listed below.

- *New Harmful Algal Bloom Detection Product*. In FY07, CoastWatch developed and deployed a near real time chlorophyll deviation product to assist sampling efforts of state and municipal agencies concerned with the detection and monitoring of harmful algal blooms in the State of Oregon. This work will continue through FY 2010, performed in collaboration with the Cooperative Institute for Oceanographic Satellite Studies at Oregon State University.
- *Client-side Tools for Data Integration*. Having established a variety of data servers to provide data to customers, researchers have shifted focus to develop so-called "client-side" tools that enable data users to import data directly into the software environment of their choice. These tools are popular with non-specialists as they allow the integration of a full suite of satellite data sets without the need to learn new programming languages or handle a seemingly endless array of data formats. The programs have been introduced to over 100 scientists and managers through a series of training workshops held in California, Oregon, Hawai'i, and Indonesia.
- *Climatologies for CoastWatch Data Browser*. Researchers have developed long-term means (or "climatologies") in order to help marine researchers and resource managers place the near real time environmental data

within the context of the regional ocean dynamics. These compliment the time series for the many geophysical parameters that are served via IOOS DMAC-recommended methods by the OceanWatch Live Access Server and the CoastWatch Browser. This work was supported by out year funding from the NOAA Satellite Research and Operations Program.

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 (SFI) is to foster sustained optimal use of fishery resources and to provide maximum protection to marine endangered and threatened 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 other applicable laws, such as the Endangered Species Act, Marine Mammal Protection Act, and National Environmental Policy Act. SFI uses the best scientific information available, and commensurately, SFI collects and analyzes scientific data, including socio-economic information. SFI also evaluates biological, environmental, and economic issues such as protected species interaction with fishing gear, bycatch mitigation, and fishermen outreach in U.S. domestic fisheries in the western Pacific Ocean. The desired outcome is to increase food supply, enhance the region's economy, maintain and foster island cultures, maximize commercial and non-commercial (recreational, subsistence) fishing opportunities while preventing overfishing, and foster ecosystem-based marine resource management in the U.S. flag island areas in the Pacific Ocean.

Progress during FY 2009

- Hired SFD compliance associate in December 2008. The associate worked on the following SFD NEPA tasks.
  - Assisted with preparation of Final Supplemental Environmental Impact Statement (Final SEIS) for Pelagics FMP Amendment 18. This amendment involved changes to the Hawai'i-based shallow-set longline fishery management measures.
  - Assisted with preparation of the Final Programmatic EIS (FPEIS) associated with four Fishery Ecosystem Plans (FEPs) for the western Pacific region.
  - Assisted with the preparation of environmental assessment (EA) for the Specification of the Total Allowable Catch for MHI Bottomfish 2008-09 fishery year.
  - Assisted with EA for the proposed Northwestern Hawaiian Islands Commercial Bottomfish and Lobster Fishermen compensation.
  - Reviewed preliminary internal draft EA for American Samoa fishery management measures related to longline and purse seine fisheries.
  - Participated in the development of NEPA Categorical Exclusion for new fishing vessel identification marking requirements.
  - Participated in discussions on community development plan (CDP) process for fisheries, and drafted a Categorical Exclusion.
  - Assisted with maintaining the administrative record for various SFD NEPA projects; reviewed, recorded, and managed documents for disposal or archiving files.
- Continued regional marine turtle work in Yap State, Federated States of Micronesia on nesting turtle tagging and monitoring project conducted on Loosiep Island. This work was concluded on this island 18 July 2008. Loosiep Island was monitored a total of 84 nights out of the 88 day project duration. Nesting turtles encountered were tagged using flipper tags and PIT tags and sampled for DNA analysis. A total of 66 nesting green turtles (*Chelonia mydas*) and three male green turtles were tagged. The number of individual nesting green turtles tagged on Gielop Island between 2005 and 2007 totaled 888. The average inter-nesting interval was 12 days with the shortest being 9 days (mean = 12.8, n = 9). Clutch frequency (number of observed clutches per female) was 1.5 clutches per female (n = 41). The mean clutch size was 101.4 (n = 9) ranging from 80 to 139.

Curved carapace length (CCL) ranged from 92.0 to 117.0 cm (n = 66) with a mean of 103.4 cm. Curved carapace width (CCW) ranged from 82.0 to 107.0 cm (n = 66) with a mean of 94.1 cm. Three males were caught mating or swimming in the reef near Loosiep and measured with a CCL of 88 cm, 96 cm, and 106 cm and CCW of 76.5 cm, 82 cm, and 92 cm. Carapace lesions were present on 5.8% (four) of green turtles observed during the monitoring period. Lesion biopsy samples were collected from four turtles for histological analysis and skin samples were collected from 61 turtles for mitochondrial DNA sequence analysis. Monitor lizards were present on the island and predated 82% of marked nests.

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

This project 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, University of Hawai'i, 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, Hawai'i, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI) develop and implement their fishery-dependent data collection programs; and provide data needed to support these clients' monitoring of established total allowable catch (TAC), quotas, data requests, Fisheries Ecosystem Management Plans and Reports.

Working with DMWR staff to QA/QC collected data.

Training DAR staff to use the data processing software applications

Progress during FY 2009

The WPacFIN JIMAR Project continued to make significant progress in supporting the WPacFIN program at PIFSC. Project staff worked on programming, creating databases, processing data, writing administrative reports and system processing documentation; creat-

ing summary reports and data summaries to address data needs. Many other products and support jobs provided by WPacFIN-JIMAR staff are recurrent.

Specific FY 2009 accomplishments include:

- Assisted islanders in compiling their statistical data summaries for the WPFMC's Fisheries Ecosystem Plan reporting modules.
- Produced and submitted to NOAA HQ the 2008 Fisheries of the United States (FUS) fisheries data summary for American Samoa, CNMI, Guam and Hawai'i.
- Updated and maintained the WPacFIN data web site at the PIFSC.
- Provided data and status reports to support the monitoring of the Main Hawai'i Islands "Deep 7" Bottomfish TAC.
- WPacFIN JIMAR staff processed the Hawai'i fishermen catch and fish dealer data on a fast-track to ensure the TAC was not exceeded.
- The project also created weekly summary statistical reports and charts, and online information on current landings of the fishery
- Data summaries were provided to management and as outreach material to educate fishermen.
- Designed and implemented a fish dealer data processing system for Hawai'i, and installed this system at two dealer sites on the Island of Hawai'i (Hilo Fish and Hilo Suisan).
  - These companies now use this system to process their daily fish intake and submit weekly electronic data to the Hawai'i Division of Aquatic Resources (HDAR) to meet monthly data submission requirements.
  - Implementation of this system eliminated the need for HDAR to manually enter the data, freeing up limited staff resources and greatly reducing the incidence of data entry errors.

The project accomplished most of the proposed activities during the past year. Activities that were not completed (carried over from last year) were mainly due to lack of participation. Required specifications from parties involved were as follows: expand the American Samoa Tutuila-based creel systems to incorporate Manu`a data collection; develop applications and a database to store fishery independent (ecosystem monitoring) data for American Samoa, Guam and possibly CNMI (carried over from last year); and create applications for the Coral Reef Ecosystem Plan Team (CREPT) Fishery Management Plan (FMP) to output annual reports in Word document format for all islands.

Guam Boat-based survey—catch of the day

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 Islands 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 Hawai'i 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]

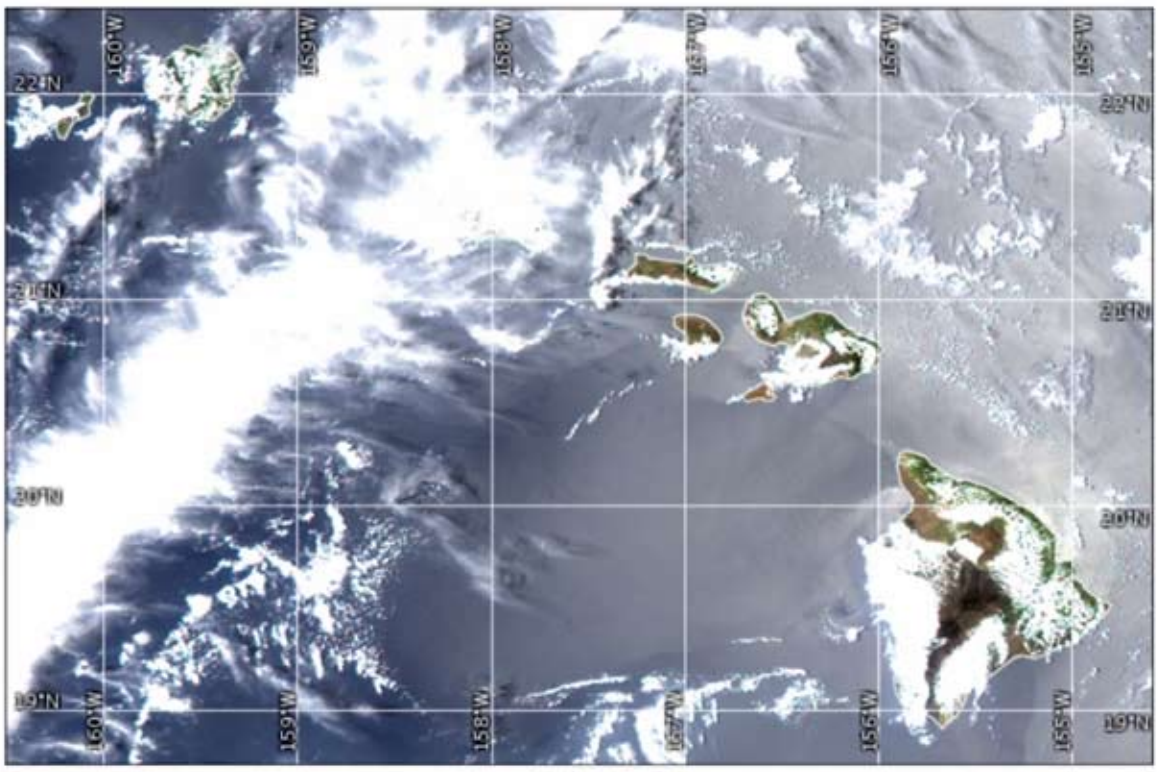
NOAA Office (of the primary technical contact): National Marine Fisheries Service/Pacific Islands Fisheries Science Center

NOAA Goal(s)

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

Purpose of the Project

The goal of the project is to supply near-real time, remotely sensed oceanographic and environmental data for the entire Pacific-based community, including resource managers, researchers, educators, and the general public. The satellite-derived products include ocean surface temperature, ocean color, ocean surface topography, ocean surface wind fields, environmental indicators (Empirical Orthogonal Functions—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, O'ahu (Hawai'i).



A MODIS 250-meter true color satellite image showing the location of a rain front propagating through the main Hawaiian Islands.

Progress during FY 2009

In FY 2009 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 database. Researchers also began distribution of MODIS 250m True Color satellite imagery in support of the HiOOS Regional Association. Researchers provided a training session on applications of remotely sensed data for coral reef researchers at TNC in Bali, Indonesia.

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 US 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), and 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 inter-agency cooperation and information exchange as well as 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

JIMAR Coral Reef Ecologist, Val Brown, documents a gray reef shark, Carcharhinus amblyrhynchos, at Asuncion, CNMI during the 2009 Mariana Archipelago Reef Assessment and Monitoring cruise. Photo: R. Schroeder, NOAA CRED

will be developed for use in habitat management decisions made by the HCD. The initiative will also enhance researchers' 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 corals reef.

American Samoan youths working on their wishes for the Environmental wish banner.

Progress during FY 2009

Coral reef management initiative can be divided up into four sub-projects: coral reef assessment/mitigation; Guam/CNMI/American Samoa coral coordinators; Hawai'i local action strategy coordinator; and fishery extension agent.

Coral reef assessment/mitigation. Danielle Jayewardene was hired in October 2008. She assisted in the implementation of federal mandates by reviewing and providing technical advice where necessary on biological assessment/monitoring and/or compensatory mitigation for over fifty projects involving harbor improvements, beach replenishments, shoreline stabilization, sewer systems upgrades, dump retrofits, and aquatic farm expansions. She gained expertise to improve regulation of impacts to near shore water quality by attending conferences and trainings, learning about the existing regulatory framework for waster quality permits, conducting site visits to streams and construction sites, and attending watershed management stakeholder meetings. Jayewardene assisted in the facilitation of the Hawai'i Coral Program Workshop, coordinated partnership involvement in Malama Maunalua's outreach activities, and participated in several intra-agency projects including the Hawai'i bleaching/disease and crown of thorn outbreaks rapid response training. Jayewardene also assisted in the review of over thirty-five habitat restoration project proposals, which sought stimulus funding via the American Recovery and Reinvestment Act.

Guam/CNMI/American Samoa coral coordinators. Guam Coral Reef Ecologist Val Brown continued efforts to support coral reef management and conservation in Guam through numerous activities. She coordinated the Guam Year of the Reef Campaign, continued to participate in the Guam military buildup preparations and assessments, enabled the Natural Resource Damage Assessment for Coral Reefs Workshop, facilitated the Guam Coral Reef Protection Workshop, and analyzed local fisheries and marine protected area data. In addition, staff provided support for the Guam Coral Reef Task Force Point of Contact, Guam Coral Reef Initiative, and other local agencies, provided interview and facilitation assistance for the NOAA Coral Reef Program's Coral Reef Integrated Observing System Pacific Workshop, and participated in the Mariana Archipelago Reef Assessment and Monitoring Program 2009 cruise.

CNMI Coral Reef Ecologist. This position was vacant for most of the reporting year. Steve McKagan was hired in July 2009. American Samoa coral reef ecologist Fatima Sauafea-Leau worked closely with the Fisheries Local Action Strategy (LAS) coordinator in revising and redrafting the Am. Samoa Coral Reef Fishery Management LAS. Fatima also provided assistance to the local Coastal Management Program with its Community-based Wetland Management Program by conducting a Participation, Learning, Action (PLA) workshop in Tula village. The workshop assisted the program in identifying issues on Tula's wetland and actions to address the issues. Moreover, the workshop assisted the program with information to develop a Community Wetland Management Plan for Tula. Fatima conducted a household survey in two MPA sites in February 2009, followed by data analysis as part of the SEM-Pasifika Assessment at MPA villages. The final report will be completed by the end of July. On June 30-July 2, 2009, American Samoa had its annual Enviro-Discoveries Summer camp for students ages 8-13. Enviro-Discoveries Camp is an annual event put together by the Le Tausagi group to educate the young people of American Samoa on the importance of conservation and management of our resources while fostering and promoting their stewardship and interest. Le Tausagi is a group of educators and technical experts from various resource agencies, both local and federal. The three days-two nights camp provided the students with hands-on activities such as skits, plays, drawing, presentations, swimming, kayaking, and snorkeling that connects them to their land and marine environments. One of the activities that Fatima organized was an Environmental Wish Banner. In this activity, the students were asked to envision what they would like to see in the future in their

environment and write them down as a vision on a piece of paper. Each student was then asked to take their vision and make it into a wish. Each student wrote their wishes on the banner and created a Wish Banner that included all the wishes of what they would like to see in their environment in the very near future. Fatima also gave a presentation to a group of 46 students in June for their GEAR-UP summer program. The presentation was on basic Fisheries Management information with a Vision PLA tool facilitated to the students on how they would like to envision their marine resources and environment in the future.

Hawai'i Local Action Strategy Coordinator: Jason Phillibotte conducted sustainable Fisheries training in Viet Nam for 30+ people, including local fishermen and government officials. Conducted MPA Management Planning training in El Nido, Philippines for local community organizations for the IUCN El Nido Ecologically Critical Area Network. Phillibotte conducted MPA Management Planning training in Barcelona, Spain in association with the IUCN WCPA World Conservation Congress. Training included 20 participants from 15 different countries. He participated in training at the Climate Change Adaptation workshop for 20 registered participants at the International Marine Conservation Congress in Washington DC. Strategic planning (FLAS and CRWG) activities included: development of two projects for NOAA/DAR Coral Management funding for $125,000 to support two creel surveys (Haena, Kaua'i and Kaneohe Bay, O'ahu) and a DAR Law Fellow; through the Fisheries LAS, funded three life history projects on priority coral reef resource fish, support through USFWS Sportsfish Aid funding. He acquired $90,000 in funding, and developed and prioritized five objectives with associated activities for the Fisheries Local Action Strategy. Phillibotte also identified causes and effects of overfishing in Hawai'i; assisted with the development of the overarching coral strategy and facilitation of Hawai'i's Coral Reef Working group; assisted with the development of a strategy to implement NOAA coral program's national objectives in the Pacific (Pacific Island Regional Management Team); facilitated the American Samoa Fisheries Management workshop; assisted in the development of the Fisheries LAS web site; provided technical assistance for the Maunalua Bay creel survey and served on the Maunalua Bay Fishermen Hui; wrote "Site Characterization" and "Identifying Targets" chapter for the *How is Your MPA Managed* workbook (not yet published).

Hawai'i Fishery Extension Agent: Mike Lameier mainly focused on fostering favorable relationships with the local recreational shoreline fishing community throughout the Hawaiian Islands using a variety of approaches to gain the trust and confidence of fishermen and women and other resource users. Lameier acts as a liaison between resource users and resource managers for state, federal and private organizations in order to improve communication, relationships, and information exchange. Fisheries Extension work in 2009 focused on developing several projects, partnerships, and additional outreach activities. This year, the fieldwork for the O'ahu Beach Access Inventory was completed. The Collaborative Ciguatera Research Project has expanded and supplied researchers with over 600 Roi samples from four islands. Also, a strong partnership with University of Hawai'i's Sea Grant Program has been established and Sea Grant has extended Lameier a non-compensated affiliate faculty status. Additionally, outreach continued at popular fishing locations, fishing tournaments, schools and also included one appearance on Ben Wong's TV show "Let's Go Fishing" and an article on "Fishing Ethics" published in *Hawai'i Fishing News*.

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

The purpose of this project 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. Under the Federal National Environmental Policy Act (NEPA), federal agencies must insure that environmental information is made available to public officials and citizens before decisions are made and actions are taken. 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 ad-

dressed 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 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), and other international fisheries agreements.

Progress during FY 2009

Promulgation of regulations under the authority of the WCPFCIA and 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 draft Environmental Assessment (EA) was completed (May 2009) for a proposed rule for the initial implementation of the Convention and public comments were accepted. A final document is anticipated in calendar year 2009.

A draft EA for the implementation of the decisions of the Fifth Regular Annual Session of the WCPFC was completed (May 2009) and public comments were accepted. A final document is anticipated in calendar year 2009.

One JIMAR employee participated in a workshop titled "Climate Change and Marine Resources Impact Analysis Under the National Environmental Policy Act" in order to receive information about key developments in this emerging aspect of NEPA analysis to support future NEPA needs.

Specific research goals were identified to support the longer-term NEPA needs for implementation of the future decisions of the WCPFC and regulations under the SPTA. Implementation of the WCPFC's decisions can require meeting stringent deadlines and, given the time generally required to prepare NEPA documents, anticipating research needs in advance will be beneficial.

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

*Bumphead parrotfish (*Bolbometopon muricatum*) and Napoleon wrasse* (Cheilinus undulatus) *at Wake Atoll. Courtesy: PIFSC Coral Reef Ecosystem Division*

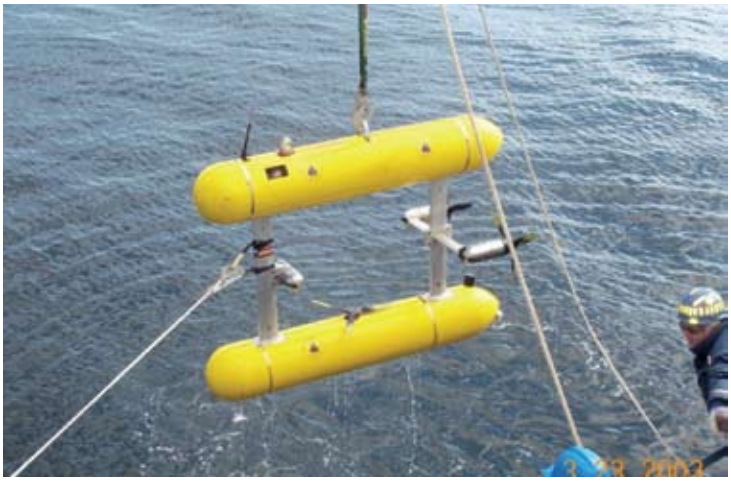
Purpose of the Project

This project addresses concerns about the deterioration of coral reef ecosystems around the globe and supports interdisciplinary assessment and monitoring activities that

Intermittent plumes of steam from N. Pagan volcano were observed at Pagan Island in April 2009 during the HI0902 RAMP cruise. Courtesy: PIFSC Coral Reef Ecosystem Division

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 management-relevant 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.



In partnership with the Northwest Fisheries Science Center and Woods Hole Oceanographic Institution (WHOI), CRED participated in three training and field operations using a newly acquired SeaBED AUV. This vehicle enhances the photographic and video mapping of coral-rich environments, providing data in a greater range of depths and more effectively than do towed vehicles attached to a surface vessel. Courtesy: WHOI Deep Submergence Laboratory

Progress during FY 2009

To support the objectives of the JIMAR "Sustaining Healthy Coastal Ecosystems" project, the following activities were performed during FY 2009.

- Five interdisciplinary Pacific Reef Assessment and Monitoring Program (RAMP) cruises were conducted aboard the NOAA Ships *Oscar Elton Sette* and *Hi`ialakai* around the northwestern Hawaiian islands (NWHI), the main Hawaiian islands (MHI), Wake Atoll, the Commonwealth of the Northern Mariana Islands (CNMI), and the Territory of Guam. Scientists from NOAA, JIMAR, and partner agencies conducted integrated assessments and monitoring of fish, corals, algae, and invertebrates and collected a variety of oceanographic and water-quality observations.
- To complete mapping of coral reef habitats, benthic habitat mapping operations included three deployments on various platforms to study mesophotic corals in the MHI—two small-boat, multibeam mapping operations to support management priorities in the MHI, and three training and field operations with a recently acquired SeaBED autonomous underwater vehicle (AUV).
- Six scientific liaison positions, assigned to JIMAR researchers, were established to facilitate better communications and understanding between the Coral Reef Ecosystem Division (CRED) and each of the six jurisdictions in which scientific research is conducted.
- Over the past several years, CRED has been working on a series of Coral Reef Ecosystem Monitoring Reports and initial integrated ecosystem assessments using the data collected since 2000 during Pacific RAMP and mapping operations throughout the Pacific. In FY 2009, the first in this series, *Coral Reef Ecosystem Monitoring Report for American Samoa: 2002–2006* was published, characterizing the seven islands of American Samoa.
- In a continued effort to assess biodiversity of coral reefs as part of the international Census of Marine Life's Census of Coral Reef Ecosystems (CReefs) project, there are now 322 autonomous reef monitoring structures (ARMS) deployed across the Pacific Islands, Australia, Brazil, Florida, and the western Indian Ocean.
- The collaborative, long-term efforts, to locate and remove derelict fishing gear and other marine debris from fragile coral reef ecosystems of the Hawaiian Archipelago continued. Debris specialists removed 5.9 tons of debris from the beaches of O'ahu, clearing 98 of 107 marine debris accumulations that had been detected by aerial surveys. In addition, staff participated in a Papahānaumokuākea Marine National Monument led effort to determine the long-term impacts of derelict fishing nets on coral reef habitats at Midway Atoll.

CRED Marine Debris team removes derelict fishing nets from the shores of O'ahu. Courtesy: PIFSC Coral Reef Ecosystem Division

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Appendix I List of Acronyms

A2 IPCC	A2 Scenario under Intergovernmental Panel on Climate Change
ABM	Agent Based Model
ADMB	AD Model Builder
AJAX	Asynchronous JavaScript and XML
ANR	L'Agence Nationale de la Recherche (French National Research Agency)
APCC	Asian-Pacific Economic Cooperation Climate Center
APDRC	Asia-Pacific Data-Research Center
APECOSM	Apex Predators Ecosystem Model
ARMS	Autonomous Reef Monitoring Structures
ARS	Area Restricted Search
ARSHSL	Archive of Rapidly Sampled Hawaiian Sea Level
AUV	Autonomous Underwater Vehicle
AVHRR	Advanced Very High Resolution Radiometer
BCT	Business Card Tag
BET	Bigeye Tuna
CCL	Curved Carapace Length
CCS	Central Computing System
CCSM	Community Climate System Model
CCW	Curved Carapace Width
CDP	Community Development Plan
CFMP	Community-based Fisheries Management Program
CFS	Climate Forecast System
CITES	Convention on International Trade in Endangered Species
CLIOTOP	Climate Impacts on Oceanic Top Predators
CliPAS	Climate Prediction and its Application to Society
CLS	Collecte Localisation Satelliete
CMAP	Climate prediction center Merged Analysis of Precipitation
CNMI	Commonwealth of the Northern Mariana Islands
CORE II	Common Ocean-ice Reference Experiments version 2
CPC	Climate Prediction Center
CPUE	Catch Per Unit Effort
CRD	Costa Rica Dome
CRED	Coral Reef Ecosystem Division
CReefs	Census of Coral Reef Ecosystems project
CREPT	Coral Reef Ecosystem Plan Team
CRMI	Coral Reef Management Initiative
CRP	Cetacean Research Program
CRWG	Coral Reef Working Group
CTD	Conductivity, Temperature, and Depth
DAPPER	DAta MAPPER

DAR	State of Hawaii Division of Aquatic Resources
DARTS	Data Request Tracking System
DEIH	Data Entry Institute of Hawaii
DEMETER	Development of European Multi-model Ensemble system for seasonal to inTERAnnual Prediction
DJF	December-January-February
DLNR	Department of Land and Natural Resources
DMAC	Data Management and Communications
DODS	Distributed Ocean Data Server
DSL	Deep Scattering Layer
DSS/DM	Data Server System/Data Management
DTAG	Digital Acoustic Recording Tag
EA	East Asia
EA	Environmental Assessment
EASM	East Asian Summer Monsoon
Ecosim	a dynamic food-web model for a pelagic ecosystem
Ecospace	a spatial version of Ecosim
ECOTAP	Étude du comportement des thonidés par l'acoustique et la pêhe en Polynéie françise
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
ENSO	El Niño-Southern Oscillation
EOF	Empirical Orthogonal Function
EPA	Environmental Protection Agency
EPO	Eastern Pacific Ocean
ERA40	40 year European Re-Analysis
ERD	Environmental Research Division
ERDDAP	Environmental Research Division's Data Access Program
ESA	Endangered Species Act
ESSIC	Earth System Science Interdisciplinary Center
FADs	Fish Aggregating Devices
FEPs	Fishery Ecosystem Plans
FFS	French Frigate Shoals
FLAS	Fishery Local Action Strategy
FMP	Fishery Management Plan
FPEIS	Final Programmatic EIS
FUS	Fisheries of the United States
GCOS	Global Climate Observing System
GDS	GrADS Data Server
GEOSS	Global Earth Observation System of Systems
GHRSST	GODAE High Resolution Sea Surface Temperature
GIS	Geographic Information System
GLOSS	Intergovernmental Oceanographic Commission Global Sea Level Observing System

GODAE	Global Ocean Data Assimilation Experiment
GPS	Global Positioning System
GrADS	Grid Analysis and Display System
GTS	Global Telecommunications System
HARPs	High-Frequency Acoustic Recording Packages
HCD	Habitat Conservation Division
HDAR	Hawaii Division of Aquatic Resources
HDRP	Human Dimensions Research Program
HH FAD	Hawaii State fish aggregating devices, named “HH”
HIMB	Hawaii Institute of Marine Biology
HiOOS	Hawaii Ocean Observing System
HMS	Highly Migratory Species
HMSRP	Hawaiian Monk Seal Research Program
HMSRT	Hawaiian Monk Seal Recovery Team
HRPT	High Resolution Picture Transmission
HTTP II	Hawaii Tuna Tagging Program II
HYCOS	Hydrological Cycle Observing System
IATTC	Inter-American Tropical Tuna Commission
IBMs	Individual Based Models
ICCAT	International Council for the Conservation of Atlantic Tunas
ICG	Intergovernmental Coordination Groups
IDEA	Integrated Data and Environmental Applications
IFD	International Fisheries Division
IG	Infra-Gravity
IOD	Indian Ocean Dipole
IOOS	Integrated Ocean Observing System
IOTC	Indian Ocean Tuna Commission
IOTWS	Indian Ocean Tsunami Warning and Mitigation System
IPCC	Intergovernmental Panel on Climate Change
IPRC	International Pacific Research Center
IRD	Institut de Recherche pour le Développement
ISC	International Scientific Committee
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
JA	July-August
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
JGOFS	Joint Global Ocean Flux Study
JIMAR	Joint Institute for Marine and Atmospheric Research
JJA	June-July-August
LAS	Live Access Server
LAS	Local Action Strategy

LLDS	Longline Logbook Data System
LODS	Longline Observer Data System
LOVECLIM	LOch-Vecode-Ecbilt-CLio-agIsm Model
LUTH	Leatherback Use of Temperate Habitat
MARDAP	Marine Resource Dynamics Assessment Program
MHI	Main Hawaiian Islands
MJ	May-June
MJO	Madden-Julian Oscillation
MLO	Mauna Loa Observatory
MME	Multi-Model Ensemble
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area
MRF	Medium Range Forecast
MTRP	Marine Turtle Research Program
MULTIFAN_CL	a length-based, age and spatially-structured statistical model for fisheries stock assessment
NASC	Nautical Area Scattering Coefficients
NCAR	National Center for Atmospheric Research
NCEP	National Center for Environmental Prediction
NCOM	Navy Costal Ocean Model
NEC	North Equatorial Current
NEPA	National Environmental Policy Act
NetCDF	Network Common Data Form
NGO	Non-Governmental Organization
NIDIS	National Integrated Drought Information System
NLOM	Navy Layered Ocean Model
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NRIFSF	National Research Institute of Far Seas Fisheries
NWHI	Northwestern Hawaiian Island
NWS	National Weather Service
OFES	Ocean GCM for the Earth Simulator
OGC	Open Geospatial Consortium
OPA	Océan Parallélisé
ORCA	generic name given to global ocean configurations using the ocean general circulation model OPA
PACRAIN	Pacific Rainfall Database
PASTA	Pacific-Atlantic Sea Turtle Assessment Project
PEAC	Pacific ENSO Applications Center
PFADs	Private FADs

PICES	North Pacific Marine Science Organization (nicknamed PICES for a Pacific International Council for Exploration of the Seas)
PICTs	Pacific Island Countries and Territories
PIFSC	Pacific Islands Fisheries Science Center
PI-GCOS	Pacific Islands Global Climate Observing System
PI-GOOS	Pacific Islands Global Ocean Observing System
PIR	Pacific Islands Region
PIRO	Pacific Islands Regional Observer Program
PIRO	Pacific Islands Regional Office
PISCES	Pelagic Interaction Scheme for Carbon Ecosystem Studies
PLA	Participation, Learning, Action
PMEL	Pacific Marine Environmental Laboratory
POFI	Pacific Oceanic Fisheries Investigations
POM	Pattern Oriented Modeling
PRD	Protected Resources Division
PRECI	Protected Resources Environmental Compliance Initiative
PRIA	Pacific Remote Island Area
PRIDE	Pacific Region Integrated Data Enterprise
PSATs	Pop-up Satellite Archival Tags
PSMSL	Permanent Service for Mean Sea Level
PTWC	Pacific Tsunami Warning Center
QBO	Quasi-Biennial Oscillation
RAMP	Reef Assessment and Monitoring Program
RAs	Regional Associations
RCUH	Research Corporation of the University of Hawaii
RFMOs	Regional Fishery Management Organizations
RGM	Reactive Gaseous Mercury
RH	Relative Humidity
RISA	Regional Integrated Science and Assessment program
ROV	Remotely Operated Vehicle
RSMC	Regional Specialized Meteorological Center
SARDARA	name of a database developed by IRD to manage the tuna fisheries data as provided by Tuna Commissions (raw and corrected data) including catch and fishing effort and length frequencies of catch following standard spatio-temporal stratification. The database is developed with the open source PostgreSQL, is physically on the server ALIPA 9Ifremer, Brest) and will be accessible to the public through internet
SEAPODYM	Spatial Ecosystem and Populations Dynamics Model
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SEIS	Supplemental Environmental Impact Statement
SEM	Socio-Economic Monitoring
SEPoDyM	Spatial Environmental Populations Dynamics Model
SFD	Sustainable Fisheries Division

SFI	Sustainable Fisheries Initiative
SIO	Scripps Institution of Oceanography
SODA	Simple Ocean Data Assimilation
SOS	Sensor Observation Service
SPC	Secretariat of the Pacific Community
SPC	South Pacific Commission
SPTA	South Pacific Tuna Act of 1988
SPTT	South Pacific Tuna Treaty
SREP	Secretariat of the Pacific Regional Environment Programme
SSL	Shallow Scattering Layer
SSSM	Switching State-Space Model
SST	Sea Surface Temperature
STA	Service Target Agreement
SWFSC	Southwest Fisheries Science Center
TAC	Total Allowable Catch
TCC	Temporal Correlation Coefficient
TNC	The Nature Conservancy
UCAR	University Corporation for Atmospheric Research
UEP	Unified ENSO Proxy
UH	University of Hawaii
UHSLC	University of Hawaii Sea Level Center
ULT	Ultra-Low Temperature
US GLOBEC	U.S. Global Ocean Ecosystems Dynamics
USAPI	U.S. Affiliated Pacific Islands
USD	US Dollars
USFWS	US Fish and Wildlife Service
USGS	United States Geological Survey
WCPA	World Commission on Protected Areas
WCPFC	Western and Central Pacific Fisheries Commission
WCPFCIA	Western and Central Pacific Fisheries Convention Implementation Act
WCPO	Western and Central Pacific Ocean
WCRN	West Coast Regional Node
WERC	Water and Environmental Research Institute
WHOI	Woods Hole Oceanographic Institution
WMS	Web Mapping Service
WOCE	World Ocean Circulation Experiment
WPacFIN	Western Pacific Fisheries Information Network
WPFMC	Western Pacific Regional Fisheries Management Council
WPSAR	Western Pacific Stock Assessment Review
WWF	World Wildlife Fund

Appendix II Visiting Scientists

DATE	NAME/AFFILIATION	PURPOSE OF VISIT
8/18/08	Douglas G. Meyer Partner Bernuth & Williamson	Participate in AFS Annual Meeting in Ottawa, Canada 8/18/2008-8/19/2008 as an invited presenter.
9/2/2008-10/7/2008	Jong-Ghap Jhun Professor Seoul National University School of Earth and Environmental Science Seoul, Korea	Visit the monsoon research group at the IPRC, School of Ocean and Earth Science. Conduct collaborative research on the study of the ENSO-Asian monsoon, ENSO-East Asian monsoon relationship, and biennial oscillation. Conduct a seminar on "Variability & Teleconnection of East Asian Summer Monsoon."
9/20/2008-9/27/2008	Amy C. Hirons Research Professor Nova Southeastern University Oceanographic Center Dania Beach, Florida	Collaborate on a Hawaiian monk seal research project 9/20/2008-9/27/2008 in sampling monk seal bone and prey samples to determine trophic shifts in the foraging of Hawaiian monk seals from 1800's-2000's.
10/17/2008-11/20/2008	So-Young Yim Researcher Seoul National University School of Earth and Environmental Science Seoul, Korea	Conduct collaborative research on the study of the ENSO-Asian monsoon, ENSO-East Asian monsoon relationships, and biennial oscillation. Visit the monsoon research group at the IPRC, School of Ocean and Earth Science and Technology.
11/5/2008-11/6/2008	Gregory Skomal Senior Marine Fisheries Biologist Massachusetts Division of Marine Fisheries	Participate in "Shark Predation on Hawaiian Monk Seals" Workshop 11/5/2008-11/6/2008.
11/5/2008-11/6/2008	Ralph Dean Grubbs Assistant Scholar Scientist Coastal & Marine Laboratory Florida State University	Participate in "Shark Predation on Hawaiian Monk Seals" Workshop 11/5/2008-11/6/2008.
11/12/2008-11/14/2008	Carol A. Reeb Research Associate Hopkins Marine Station Stanford University	Participate in a meeting 11/12/2008-11/14/2008 in Honolulu, Hawaii to review fishery statistics, life history parameters, and genetic data from swordfish and striped marlin in the North Pacific Ocean with the goal of developing plausible stock structure scenarios.

11/12/2008-11/14/2008	Jamie Alvarado-Bremer Associate Professor Texas A&M University Galveston, Texas	Participate in a meeting in Honolulu, HI 11/12/2008-11/14/2008 to review fish statistics, life history parameters, and genetic data from swordfish and striped marlin in the N. Pacific Ocean, with the goal of developing plausible stock structure scenarios.
11/17/2008-11/20/2008	Elliot L. Hazen Post-Doc Researcher Duke University Marine Laboratory	Participate in PFRP Principal Investigators Workshop 11/18/2008-11/19/2008 as an invited presenter (presented on top predator distribution in the central Pacific Ocean). Participate in SEAPODYM modeling meeting 11/17/2008 and pelagic food webs meeting 11/20/2008.
11/17/2008-11/19/2008	Robert K. Cowen Professor Rosenstiel School of Marine & Atmospheric Science University of Miami	Participate in PFRP Principal Investigators Workshop 11/18/2008-11/19/2008 as an invited presenter (presented on Ichthyoplankton imaging research). Participate in SEAPODYM modeling meeting 11/17/2008.
12/2/2008-12/4/2008	Greg Holland Division Director Boulder, Colorado	Visit JIMAR to meet with Dr. Yuqing Wang and his postdoctoral fellows and students to exchange ideas on tropical cyclone research. Participate in "The 3rd Workshop on High-Resolution and Cloud Modeling: Tropical Cyclones and Climate" 12/2/2008-12/4/2008 at UH.
1/17/2009-2/16/2009	In-Sik Kang Professor Seoul National University Seoul, Korea	Visit IPRC to discuss the CLiPAS project related science issues, in particular the hindcast experiment for monsoon intraseasonal prediction, the metrics and analysis methods.
2/2/2009-3/6/2009	George Boer Scientist University of Victoria Victoria, British Columbia, Canada	Visit IPRC 2/2/2009-3/6/2009 and collaborate with Minoru Kadota and other IPRC members on the stratospheric influence on the interannual variability of climate.
2/25/2009-2/27/2009	Allen H. Andrews Research Associate Moss Landing Marine Laboratories Moss Landing, California	Present research establishing new longevity estimates for Opakapaka 2/25/2009-2/27/2009 in Honolulu, HI.
3/31/2009-4/6/2009	Amy C. Hirons Research Professor Nova South Eastern University Oceanographic Center Dania Beach, Florida	Collaborate on a Hawaiian Monk Seal research project in Honolulu, HI.

4/1/2009-4/3/2009	Daniel Pauly Professor The University of British Columbia Vancouver, British Columbia, Canada	Participate as a keynote speaker and invited guest at the 2009 Albert L. Tester Memorial Symposium 4/1/2009-4/3/2009.
4/2/2009, 4/5/2009-4/16/2009	David R. Burdick Biologist Guam Coastal Management Program Mangilao, Guam	Participate in Coral Reef Ecosystem Division Pacific Reef Assessment and Monitoring program (RAMP)—Marianas Cruise.
4/29/2009-5/6/2009	Minoru Kanaiwa Assistant Professor Tokyo University of Agriculture Yasaka, Abashiri, Hokkaido Japan	Participate in collaborative analyses of catch per hook and TDR data from North Pacific Longline fleets and electronic tagging data from marlins in the N.Pacific Ocean, with the goal of identifying factors that influence the catch of striped marlin.

Appendix III Workshops and Meetings Hosted by JIMAR

PFRP Principal Investigators Workshop
November 18-19, 2008
Pacific Room, Imin Conference Center, UH-Manoa

Melanie Abecassis
Valerie Allain
Johnoel Ancheta
Paul Bartram
Keith Bigelow
Brian Bowen
Karine Briand
Courtney Carothers
Anela Choy
James Cooke
Xavier Couvelard
Robert Cowen
Paul Dalzell
Joe Dettling
Reka Domokos
Jeffrey Drazen
Charles Farwell
Nuno Fragoso
Felipe Galvan
William Monty Graham
Marcia Hamilton
David Hamm
Nils Olav Handegard
Donald Hawn
Elliot Hazen
Kim Holland
Melinda Holland
Justin Hospital
Evan Howell
Simon Hoyle
David Itano
Julian Jouanno
Jesus Jurado
John Kaneko
EunJung Kim
Pierre Kleiber
Don Kobayashi
Dodie Lau
Michael Laurs
Patrick Lehodey
PingSun Leung
Molly Lutcavage
Charles Lutcavage
John Lynham
Sean Martin
Andrew Mason
Carl Meyer
Nicole Milne
Earl Miyamoto
Nicole Milne
Roy Morioka
Michael Musyl
Simon Nicol
Anders Nielsen
John O'Sullivan
Robert Olson
Minling Pan
Jeffrey Polovina
Sam Pooley
Brian Popp
Bo Qiu
Jay Rooker
Craig Severance
Janna Shackerhoff
John Sibert
Alexander Shor
Sylvia Spaulding
Bill Walsh
Kevin Weng
Jock Young
Run Yu

SEAPODYM Modeling Meeting
Monday, November 17, 2008
Washington Room, Imin Conference Center, UH-Manoa

Karine Briand
Xavier Couvelard
Robert Cowen
Charles Farwell
Nuno Fragoso
Felipe Galvan
Elliot Hazen
Simon Hoyle
David Itano
Julian Jouanno
Jesus Jurado
EunJung Kim
Patrick Lehodey
Andrew Mason
Nicole Milne
Simon Nicol
Bob Olson
John O'Sullivan
Jay Rooker
John Sibert

Examining Food Webs and Pelagic Predators Meeting
Thursday, November 20, 2008
Washington Room, Imin Conference Center, UH-Manoa

Valerie Allain
Melinda Braun
Karine Briand
Xavier Couvelard
Reka Domokos
Charles Farwell
Nuno Fragoso
William Graham
Nils Olav Handegard
Elliot Hazen
Simon Hoyle
Jesus Jurado
Patrick Lehodey
Molly Lutcavage
Raghu Murtugudde
Simon Nicol
Robert Olson
John O'Sullivan
Jock Young

Appendix IV JIMAR Personnel

Information as of June 30, 2009

Category	Number	High School	Associates	Bachelors	Masters	Ph.D.
Research Scientists	22	0	0	0	0	22
Visiting Scientists	0	0	0	0	0	0
Postdoctoral Fellows	8	0	0	0	0	8
Research Support Staff	140	3	4	84	41	8
Administrative	18	1	2	14	1	0
Undergraduate Students	27	27	0	0	0	0
Graduate Students	14	0	0	12	2	0
Received less than 50% NOAA support	7	0	0	4	0	3
Total	**236**	**31**	**6**	**114**	**44**	**41**
Located at Lab (include name of lab)	ESRL: 6 NWS: 1 PFEL: 6 PIFSC: 124 PIRO: 21 PMEL: 2					
Obtained NOAA employment within the last year	7					
Postdoctoral Fellows and Students from Subgrantees	Postdocs: 3 Students: 2					

Appendix V Awards

Valerie Brown
2008 RCUH Outstanding Employee of the Year, 1st Place

Karen Frutchey
NOAA Fisheries Team Member of the Year

Howard Gerboc
NOAA Fisheries Team Member of the Year

Arielle Levine
NOAA Fisheries Team Member of the Year

John Rooney
NOAA Fisheries Team Member of the Year

Nick Wagner
Nominated for 2008 RCUH Outstanding Employee of the Year

Bin Wang
American Meteorological Society Fellow

John Wang
Nominated for 2008 RCUH Outstanding Employee of the Year

Coral Reef Ecosystem Division, Pacific Islands Fisheries Science Center
2008 NOAA Bronze Medal

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.

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