JIMAR

Annual Report for Fiscal Year 2008

For Cooperative Agreement NA17RJ1230

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.

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 2008 JIMAR continued to expand its role in fisheries and coastal research related to the development of the Northwestern Hawaiian Islands Marine National Monument. JIMAR has also continued to support the nascent interdisciplinary effort for developing management tools for insular urban water supplies in a changing climate. In addition to the economists, planners, and hydrologists previously involved in the effort, JIMAR is also supporting colleagues at the International Pacific Research Center in the development of regional downscaled climate models for the Hawaiian Islands. We also continue to support the Hawaiian Regional Ocean Observing System, housed within SOEST. The Director continues to advise the University Administration on emergency preparedness and curriculum development. JIMAR is also an element of a proposed Homeland Security Training Center for first responders to natural disasters. This effort has been authorized but not yet funded.

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).

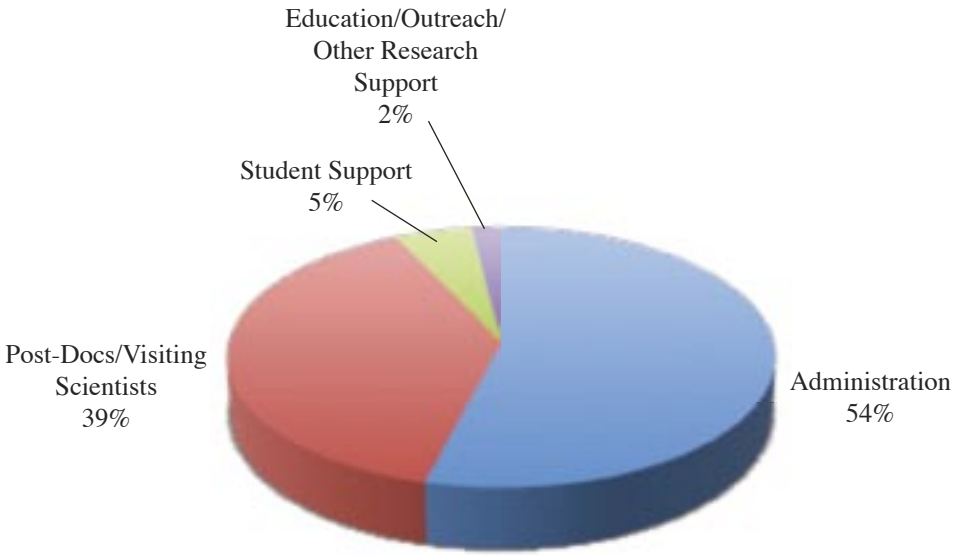
JIMAR Senior Fellows from the University of Hawaii are Dr. Gary Barnes, Dr. Steven Businger, Dr. Eric DeCarlo, Dr. Eric Firing, Dr. Charles Fletcher, III, Dr. Kim Holland, Dr. Roger Lukas, Dr. Douglas Luther, Dr. Julian McCreary, Dr. Mark Merrifield, Dr. Thomas Schroeder, Dr. John Sibert, and Dr. Bin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

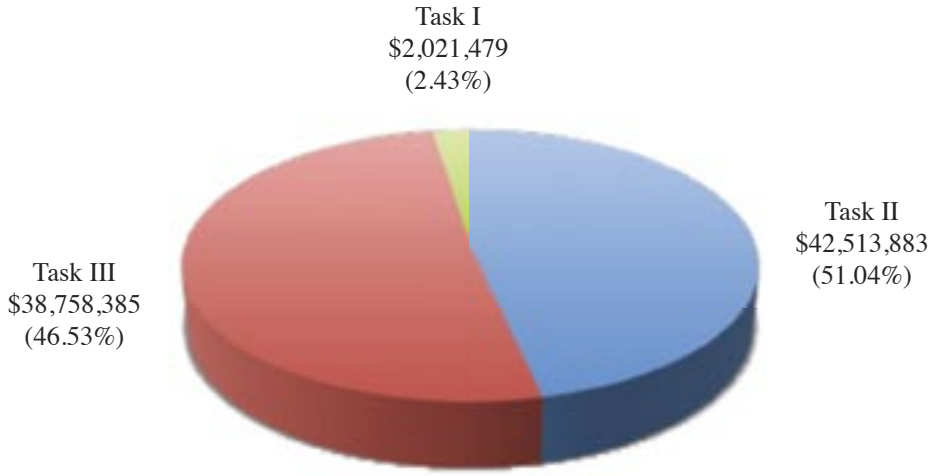
Distribution of NOAA Funding by Activity



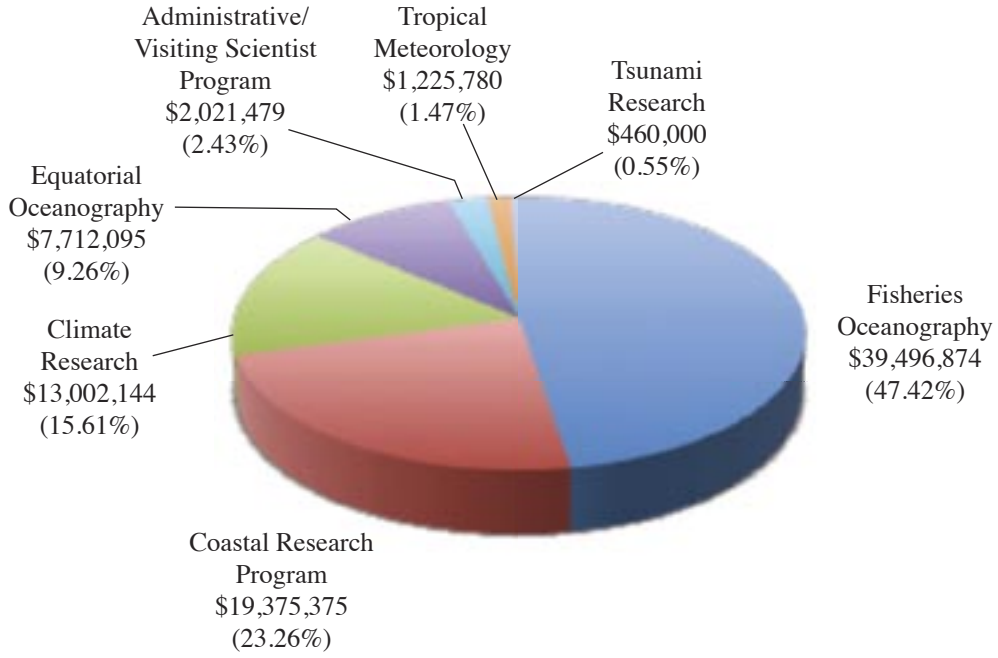
JIMAR science encompasses several dozen subprograms. In the aftermath of the Boxing Day tsunami, JIMAR has continued to play a leadership role in the development of an Indian Ocean tsunami warning network. The UH Sea Level Center had developed tide gauges that are capable of delivering near-real time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

A major transition is underway in the Pelagic Fisheries Research Program (PFRP). Program Manager John Sibert is retiring and an international search is underway for his successor. PFRP has been a vital program supporting fisheries management in the Western Pacific, both through internal research efforts and a global competitive funding program. We hope this unique program will continue and prosper.

Distribution of NOAA Funding by Task (FY 2002-2008)



Distribution of NOAA Funding by Theme (FY 2002-2008)



Accomplishments for Fiscal Year 2008

Equatorial Oceanography

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

ADCP Work During GASEX-II Project

P.I.: Eric Firing

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

As part of an extensive suite of ocean and atmospheric observations, upper ocean current measurements are made with a shipboard Acoustic Doppler Current Profiler (ADCP) during the Gas Exchange Experiment-II (GASEX-II) series of cruises. The UH contribution is the oversight of these measurements.

Progress during FY 2008

The objective during the past year was to obtain, process, and distribute a high-quality ADCP data set from the GASEX cruise on the *Ron Brown* early in 2008 (cruise RB0802). This was accomplished by Dr. Julia Hummon. Activities included configuring and installing a new data acquisition computer on the *Ron Brown*, with the UHDAS data acquisition and automated processing system; instructing NOAA personnel in its use; monitoring its performance remotely; and performing a final processing of the data from the cruise.

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

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

Progress During FY 2008

The project has extended the partial nitrification hypothesis into the equatorial Pacific Ocean (Li, Y.H., T. H. Peng and L. Menviel [2008] Nitrate deficits by denitrification and partial nitrification in the Pacific Ocean, Deep-Sea Research [in review]). One paper is in press (Li, Y.H., Factors controlling the distribution of elements in the

ocean, Transactions of the Research Inst. of Oceanochemistry, Japan). Four manuscripts have been submitted:

Li, YH, Sohrin Y, Takamatsu T (2008). Lake Biwa and the ocean: a geochemical comparison, Limnology (in review)

Measures CI, Sato T, Vink S, Howell S, Li YH (2008) The fractional solubility of aluminium from mineral aerosols collected in Hawaii and implications for atmospheric deposition of biogeochemically important trace elements, Mar. Chem. (in review)

Lin II, Li YH, Hwang CW, Chu A, Wong TF, Chen JP (2008). Fertilisation of an ocean desert by volcanic eruption, Nature.

Hsu SC, Li YH, Lin FJ, Kao SJ (2008). Elemental compositions of suspended particulate matter over the Yangtze estuary during the 1998 flood, Estuar. Coast. Shelf Sci.

University of Hawaii Sea Level Center

P.I.: Mark A. Merrifield

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

NOAA Goal(s)

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

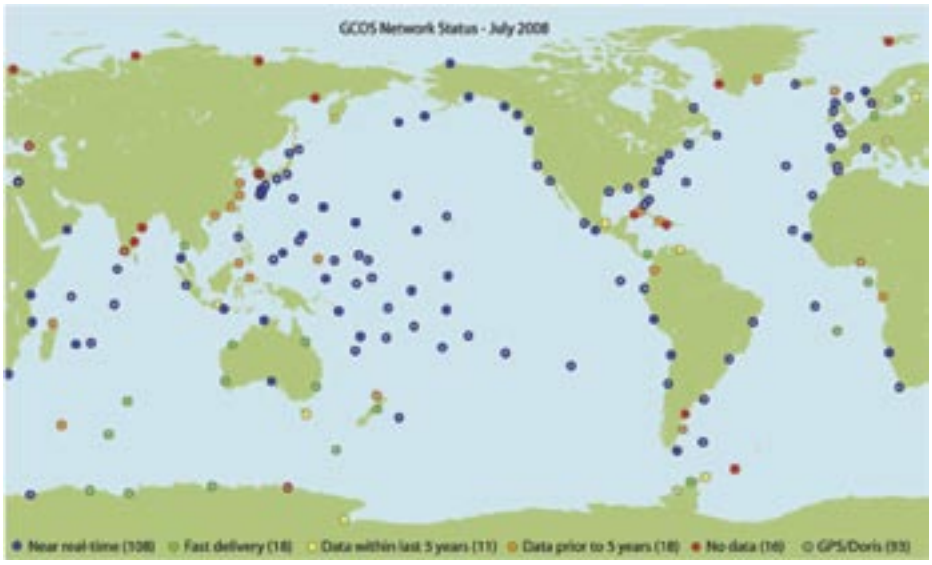
Purpose of the Project

The University of Hawaii Sea Level Center (UHSLC) collects, processes, analyzes, and distributes tide gauge data from around the world in support of climate and oceanographic research. The UHSLC focuses on the collection of high frequency measurements (hourly or faster) that are available in near-real time usually via satellite transmission. The center complements the Permanent Service for Mean Sea Level (PSMSL), which is the primary archive for historic monthly-averaged time series of sea level. Data are provided to the UHSLC from ~ 450 stations maintained by 65 international agencies. In addition, the UHSLC directly assists host countries in the maintenance and operation of over 50 stations, including 7 stations with collocated GPS for monitoring land motion at the tide gauge. The UHSLC is an active contributor to the Intergovernmental Oceanographic Commission Global Sea Level Observing System (GLOSS), and participates in global network 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 particularly important 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.

Progress during FY 2008

The UHSLC continues to take an active role in the development of tsunami and operational water level networks. The purpose of this activity has been to encourage practices and standards that ensure that tide gauge data satisfy the needs of the climate research as well as the tsunami warning communities. This strategy has led to the emergence of high quality tide gauge stations in regions that historically have been under-sampled (e.g., Southeast Asia, Africa, the Indian Ocean, South America). UHSLC researchers have taken leadership roles at national and international meetings and workshops during FY 2008 to better manage and promote this effort. Recent UHSLC research based on high frequency sea level data includes a study of extreme sea level events in terms of underlying physical causes (presented at the Aha Hulikoa 2008 workshop on "Extreme Events" and included in the conference proceedings, a more detailed manuscript is in preparation for a journal article), and an assessment of the relative importance of extreme tides and storm events across the global network (in preparation).

Tide gauge network maintenance and data center services continue to be the core activities of the UHSLC. With support from the Office of Climate Observation (OCO), UHSLC technicians visited nineteen stations during FY 2008 in the Pacific, Indian and Atlantic Oceans. A significant effort was put into upgrading existing GCOS stations with microwave radar water level sensors. New GCOS installations were installed at Johnston Island and Dakar, Senegal. Our goal for station operations for FY 2008 was to help bring at least ten new GCOS stations into the UHSLC database, fifteen new stations with near real-time reporting, and ten additional collocated GPS equipped GCOS stations. We were able to bring four new GCOS stations into the UHSLC database, four new



Status of the GCOS sea level network in terms of high frequency data at the UHCLC

stations with real-time reporting, and two new stations with CGPS. The reasons for these low numbers include: a number of previously active stations fell into disrepair during FY 2008; a lack of access for planned station upgrades in Russia, Argentina, and India; delays in the planned station installation in South Korea; and a general slow-down in the number of new CGPS stations that have been installed in recent years. We will continue to pursue these initiatives during FY 2009.

Tsunami Research

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

Archive of Rapidly Sampled Hawaiian Sea Level

P.I.: Douglas S. Luther

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

NOAA Goal(s)

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

Purpose of the Project

The purpose of the Archive of Rapidly Sampled Hawaiian Sea Level (ARSHSL) project is to provide an electronically accessible database of high quality, rapidly-sampled ($\Delta t \leq 6$ minutes) sea level observations from existing Hawaiian coastal sea level gauges maintained by NOAA agencies (National Ocean Service [NOS] and Pacific Tsunami Warning Center [PTWC]). This sea level dataset is publicly available, via the Internet, for both practical applications and research. The archive was originally established with NOAA funding in 1997 to ensure a consistent repository 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 1-10 minutes. The archive is maintained with funding by JIMAR. Beyond studies of the 1-10 minute period gravity wave phenomena that impact commercial and private boating activities, the dataset will provide input to the nascent Hawaii Ocean Observing and Information System (HI-OOIS) and will assist investigations into the dynamics of ocean phenomena such as internal and external tides (0.5 to 1 day periods), coastal trapped internal waves (1.5 to 5 days period), wind-forced mesoscale variability (3-60 days period), mesoscale eddies (60 to 180 days period), and, as

the dataset length increases, interannual variability around the Hawaiian Islands. Sea level data from two-thirds of the gauges we access would otherwise be lost without this archiving activity; that is, the data is not saved by the agency (PTWC) responsible for maintaining the gauges since 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 2008

Per the plans for this past year, the Archive of Rapidly-Sampled Hawaiian Sea Level (ARSHSL) was maintained on the World Wide Web (http://www.soest.hawaii.edu/oceanography/dluther/arshsl.html) by D. Luther and M. Luther, in collaboration with the NOAA-funded UH Sea Level Center (M. Merrifield, Director). Data have been automatically and, as necessary, manually downloaded daily, via Internet and telephone links, from six NOS and up to thirteen PTWC sites dispersed around the five main islands of Hawaii in seventeen harbors (two harbors have both NOS and PTWC gauges). The data, as originally sampled at 1, 60, 120, or 360 second intervals, are stored on the ARSHSL web site usually after both a low-level quality control check and elimination of extreme outliers (the QC activity for the 1 second data currently has a backlog due to an un-filled data analyst position). Access to the web site is unrestricted, with past users ranging from U.H. graduate students to government civil engineers, and even PTWC. The applications have ranged from hydrogeology to gravity wave studies to dock design. New users in the past year focused on harbor seiches. 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. Additional "value added" enhancement activities accomplished this past year include updating files of concatenated, quality-controlled, hourly-averaged sea level data for low-frequency studies.

Gauge maintenance, a continual concern since we are dependent upon other NOAA agencies for this activity, improved during the last year. The six NOS sites were usually brought back on-line after only brief (order of days) interruptions caused by occasional equipment failures. Of the thirteen PTWC sites, only two are currently inoperative (compared with seven at this time last year). We have not received data from two of the seven harbors on the Big Island for over a year. Big Island gauges are more difficult to maintain due to budget constraints on travel.

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

- Investigate the use of a finite element model to determine earth surface deformation from seismic parameters for tsunami source modeling.
- Develop a non-hydrostatic model to describe three-dimensional tsunami generation and near-field processes.
- Apply the proposed model package to investigate the 1975 Kalapana Earthquake in Hawaii and the 2003 Tokachi-oki Earthquake in Japan through reconstruction of the local tsunamis.
- Conduct a parametric study of near-field tsunami characteristics and determine the potential risk of local tsunamis to the population and infrastructure in Hawaii.

Progress during FY 2008

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

and a flat seafloor. GeoFEM can include earth surface relief to produce more realistic deformation over steep trenches or volcanic island slopes for tsunami modeling.

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

Halape at 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)

University of Hawaii Sea Level Center—Tsunami Research

P.I.: Mark A. Merrifield

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

NOAA Goal(s)

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

Purpose of the Project

The University of Hawaii Sea Level Center (UHSLC) collects, processes, analyzes, and distributes tide gauge data from around the world in support of climate and oceanographic research. The UHSLC focuses on the collection of high frequency measurements (hourly or faster) that are available in near-real time usually via satellite transmission. The center complements the Permanent Service for Mean Sea Level (PSMSL), which is the primary archive for historic monthly-averaged time series of sea level. Data are provided to the UHSLC from ~ 450 stations maintained by 65 international agencies. In addition, the UHSLC directly assists host countries in the maintenance and operation of over 50 stations, including 7 stations with collocated GPS for monitoring land motion at the tide gauge. The UHSLC is an active contributor to the Intergovernmental Oceanographic Commission Global Sea Level Observing System (GLOSS), and participates in global network 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 particularly important 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.

Progress During FY 2008

The UHSLC assists with the operation and maintenance of over 60 international tide gauge stations in collaboration with local operators. All of these stations transmit data via the GOES, Meteosat, or GMT satellites. The transmission cycles have historically been between 1 to 3 hours of 2 to 6 minute averaged data; however, we are in the process of converting all stations over to 5 to 15 minute transmissions of 1 to 3 minute averages, with even

higher rates at major tsunami generation zones. We completed these upgrades for all UHSLC affiliated stations in the Indian Ocean, and at the majority of Pacific Ocean stations, including several Pacific Tsunami Warning Center stations. We will turn our attention to Atlantic Ocean stations during the next fiscal year. In addition to station operations, the UHSLC plays an active advisory role for international tsunami warning activities through participation in the Intergovernmental Coordination Group/Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS) WG2 intersessional meeting in Jakarta, Indonesia, and the 22nd meeting of the Intergovernmental Coordination Group of the Pacific Tsunami Warning System (ICG/PTWS-XXII), Guayaquil, Ecuador. The UHSLC Director chairs the Global Sea Level Observing System (GLOSS) Group of Experts, which has played an active role in coordinating international partners for tsunami warning system water level network. UHSLC tsunami research has included an analysis of sensor performance for tide gauge stations that serve the dual purpose of long-term sea level rise detection as well as high frequency tsunami and storm surge monitoring.

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, the University of Guam, the Pacific Basin Development Council and NOAA Research through its Climate Program Office.

Compilation, Digitization, and Use of Hawaii 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 project compiles and digitizes historical monthly rainfall records archived at the Hawaii State Climate Office. The state data come from volunteer observers including sugar plantations, ranchers, and others. The state data are unrelated to the NOAA/National Climate Data Center (NCDC) network.

Progress during FY 2008

All state gauges on the Islands of Kauai, Hawaii, and Oahu have been inventoried.

Dynamics of Pacific Decadal Climate Variability and ENSO Modulation

P.I.: Fei-Fei Jin

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

NOAA Goal(s)

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

Purpose of the Project

Significant decadal variations in the Pacific have been identified together with evidence of strong decadal modulations of frequency, amplitude and predictability of El Niño-Southern Oscillations (ENSO). Our understanding of decadal variability is still limited. The aim of this proposed research focuses on the roles of the tropical ocean-atmosphere interaction in decadal climate variations in the tropical Pacific and decadal modulations of ENSO. Specifically, we will examine the relevance of the decadal modes (recently found as analytical solutions

of a reduced-gravity model by the PI) of tropical ocean dynamics to the decadal climate variability of the tropic Pacific. We will investigate the coupled mechanisms which modify the decadal modes of the tropical ocean into coupled modes. We will study the interaction of the coupled decadal modes with ENSO and explore nonlinear scenarios which allow large amplitude modulations of ENSO. We will also explore the implications of these deterministic processes to the regime predictability of the ENSO activity.

Progress during FY 2008

- Used an ENSO instability index to study the impact of global warming on ENSO.
- Studied the interaction between Madden-Julian Oscillation (MJO) and ENSO.

Effects of the Andes on Eastern Pacific Climate

P.I.: Shang-Ping Xie [Yuqing Wang]

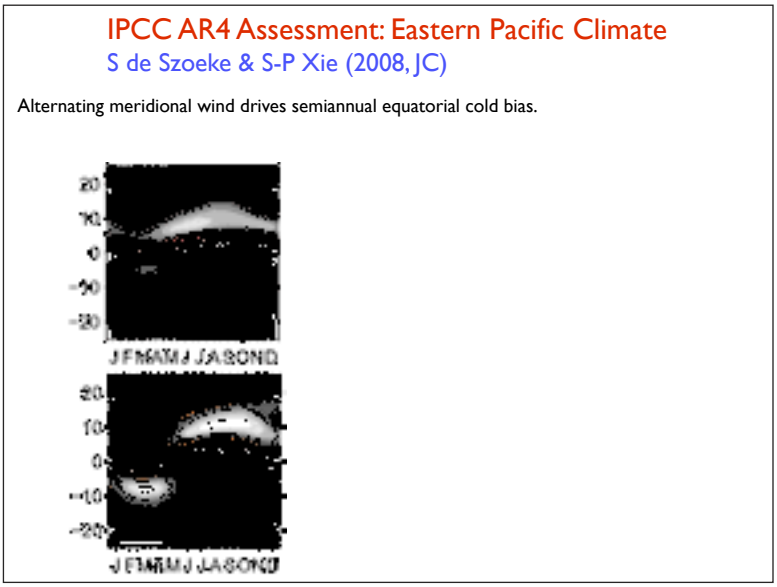
NOAA Office (of the primary technical contact): Climate Program Office

NOAA Goal(s)

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

Purpose of the Project

The 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. 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.



Left panels: time-latitude sections of SST (color shade), precipitation (gray shade) and, equatorial wind velocity vectors over the eastern Pacific in observations (upper) and a coupled GCM (lower). Right panel: Taylor diagram measure of model simulations. Many models still fail to simulate the northward-displace ITCZ, a bias that further leads to the errors in simulating the annual cycle in equatorial sea surface temperature.

Progress during FY 2008

Progress has been made in two areas: evaluation of state-of-the-art climate model simulations of eastern Pacific climate, and investigation into the Pacific response to a cooling over the North Atlantic as during the Younger Dryas and Heinrich events. 1) We have analyzed the mean state and seasonal cycle of tropical eastern Pacific simulated by coupled general circulation models participating in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). Significant improvements have been made from the previous assessments but most models still fail to keep the intertropical convergence zone (ITCZ) north of the equator. 2) A regional ocean-atmosphere model (ROAM) of the eastern Pacific has been used to simulate changes in the Pacific in response to a North Atlantic cooling. The response of the equatorial Pacific displays strong seasonality, resulting in a reduction of the annual cycle. The seasonality is due to climatological seasonal variations, especially the seasonal development of the equatorial cold tongue that prevents Atlantic influences from reaching the sea surface.

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

P.I.: Kevin P. Hamilton

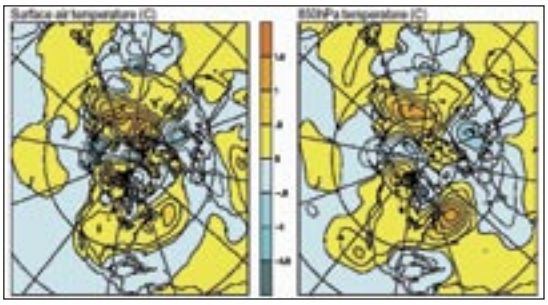
NOAA Office (of the primary technical contact): Climate Program Office

NOAA Goal(s)

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

Purpose of the Project

The project is investigating the possible role of the tropical stratospheric Quasi Biennial Oscillation (QBO) in the seasonal climate of the troposphere with a view to developing practical enhancements to current seasonal forecasting systems.



The surface air temperature (left) and 850 hPa temperature (right) averaged over DJF periods when the equatorial wind at 40 hPa was anomalously westerly minus that averaged over DJF periods when the wind was anomalously easterly. The color bar is labeled in degrees C.

Progress during FY 2008

Earlier work examining the statistical connection of tropical stratospheric QBO phase and Northern Hemisphere winter mean circulation anomalies was extended to include surface air temperature (SAT). The winter SAT anomalies over much of the high-latitude land area of the Northern Hemisphere do seem connected with the QBO phase. Notably the SAT over northern Europe and Asia is, on average, anomalously high (low) when the tropical stratospheric QBO is in its westerly (easterly) phase. The composite differences between the winter-mean SAT and 850 hPa temperature between the two QBO phases are as high as 2C in some locations, which is comparable (at high latitudes, at least) to SAT anomalies attributed to ENSO extremes or even fairly large volcanic eruptions.

In the last year we have also made progress on the modeling component of the project. Within the NCAR Community Atmospheric Model (CAM2) we have implemented a "poor man's assimilation" scheme via a simple relaxation of the zonal-mean zonal winds towards a specified field. We are particularly interested in running experiments in which the specified "target" field is either the observed historical wind for a given period or a seasonal forecast made on the basis of knowledge of the real winds at the beginning of the season. Again we are initially focussing on three month forecasts initialized from December 1.

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

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

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

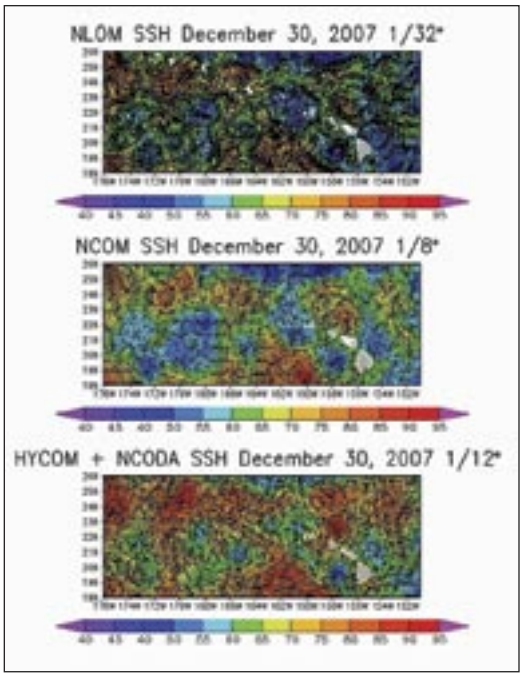
NOAA Goal(s)

- 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 enhances the operation of and the activities at the Asia-Pacific Data-Research Center (APDRC) within the International Pacific Research Center (IPRC) at the University of Hawaii. The project's overarching goals are, in part, to implement and maintain infrastructure in support of the Global Ocean Data Assimilation Experiment (GODAE) and to enhance activities in support of the Pacific Region Integrated Data Enterprise (PRIDE) in order to advance NOAA's mission objectives and meet critical regional needs for ocean, climate

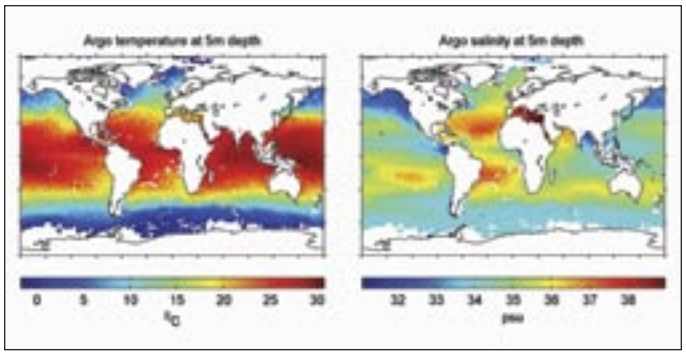
and ecosystem information for applications users. The vision of the APDRC is to link data management and preparation activities to research activities within a single center, and to provide one-stop shopping of climate data and products to local researchers and collaborators, the national climate research community, and the general public. The mission of the APDRC is to increase understanding of climate variability in the Asia-Pacific region: by developing the computational, data management, and networking infrastructure necessary to make data resources readily accessible and usable by researchers; and by undertaking data-intensive research activities that will both advance knowledge and lead to improvements in data preparation and data products.



Sea Surface Height (SSH) and upper-layer (0-100 m) circulation pathways from the NLOM, NCOM and HYCOM nowcast products for the Hawaiian Islands region. Note the strong eddy features to the northeast of Oahu and to the west of Hawaii. Products are available at http://apdrc.soest.hawaii.edu.

Progress during FY 2008

The project has continued to operate and upgrade the Data Server System (DSS) 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. In addition, the web-based data management tools continue to be upgraded to allow easy access to metadata, product information, and product search capability. Two new OPeNDAP servers have been implemented: THREDDS for data aggregation, and DChart for in situ data. Data management activities have focused on PRIDE, Earth Simulator Center and Argo products. Significant value-added products are: YoMaHa'07, a global, Argo-based, surface and deep velocity product; and a global set of 4-D gridded Argo-based fields of temperature, salinity, derived properties, and absolute geostrophic velocities in the upper and intermediate-depth ocean. Both products are updated monthly. We continue to expand our activities in support of applications and research users by providing easy access to the operational and delayed-mode ocean products prepared in the context of GODAE and Integrated Ocean Observing System (IOOS). We serve the global Navy Research Laboratory (NRL) Layered Ocean Model (NLOM) surface layer fields (both near-real-time and forecasts), and the multi-layer Navy Coastal Ocean Model (NRL NCOM) and Hybrid Coordinate Ocean Model (HYCOM) in the Hawaiian Islands region. High-resolution models, needed for downscaling operational models in the Hawaiian Islands region, have been tested with various spatial resolutions, atmospheric forcing fields, and boundary conditions and are being implemented in the Hawaiian Islands region for operational nowcasts (newscasts) and forecasts.



Multi-year mean (1997-2008) temperature and salinity at 5 m depth averaged in 2x2 degree boxes from Argo profile data. These fields and other Argo products are available at: http://apdrc.soest.hawaii.edu/projects/argo/index.html.

Additional progress includes: a continuation of PRIDE projects to develop integrated data products for the Pacific region; research in support of assimilation-based, regional high-resolution ocean models; quality control activities focusing on Indian and Pacific Ocean data; assistance with regional coordination in support of GCOS (Global Climate Observing System) and GOOS (Global Ocean Observing System) programs focusing on regional data server implementation and support; and enhancement of Argo regional center activities and products. Several PRIDE projects have resulted in publications and new extramural funding. The basic research activity has resulted in several

publications and addresses: prediction and multi-model forecasts of Pacific island rainfall; South Pacific analysis of Argo data; South China Sea studies; and North Atlantic thermohaline circulation. Results from PRIDE activities for product development and other projects are made available at the APDRC website *http://apdrc.soest.hawaii.edu* under the "Projects" heading.

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

The 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. In general, how ENSO interacts with warm pool and extratropical processes.

Progress During FY 2008

We have studied the impacts of El Niño/La Niña on Asian-Australian monsoon system (Wang et al. 2008). Using season-reliant empirical orthogonal function (S-EOF) analysis, we identified two major modes of variability for the period 1956–2004. The first exhibits a prominent biennial tendency and concurs with the turnabout of El Niño–Southern Oscillation (ENSO), providing a new perspective of the seasonally evolving spatiotemporal structure for tropospheric biennial oscillation. (Fig. 1). The second mode leads ENSO by one year. The remote El Niño forcing, the monsoon–warm pool ocean interaction, and the influence of the annual cycle are three fundamental factors for understanding the behavior of the first mode. The monsoon–ocean interaction is characterized by a positive feedback between the off-equatorial convectively coupled Rossby waves and the underlying sea surface temperature (SST) "dipole" anomalies.

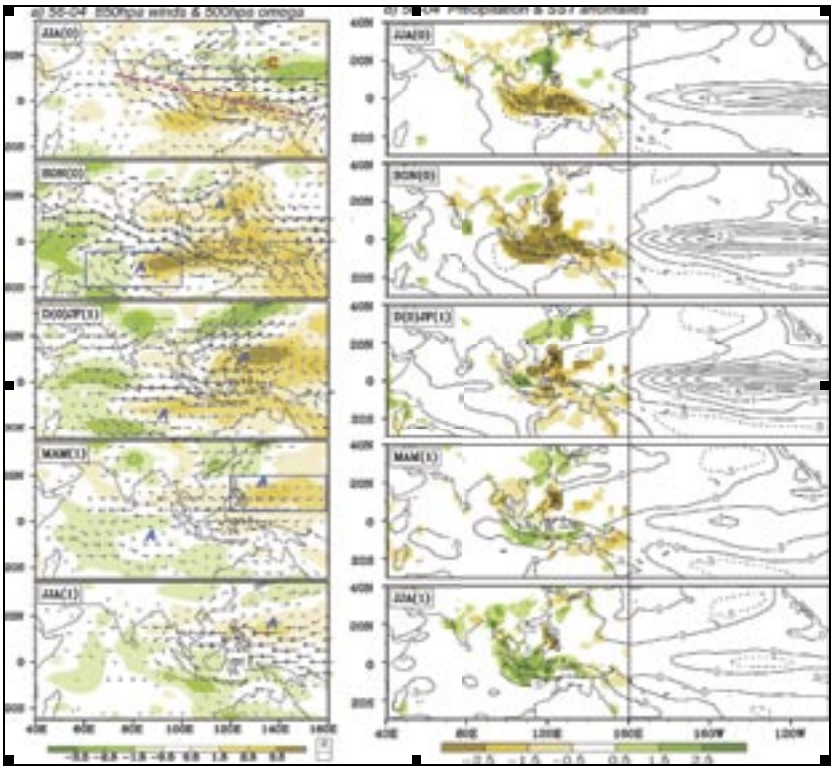


Figure 1. (a) Seasonally evolving spatial patterns of the first leading S-EOF mode of the interannual variability of the Asian–Australian monsoon system including anomalous patterns of the 850-hPa zonal winds, regressed meridional winds (wind vectors, m s_1), and regressed 500-hPa vertical (pressure) velocity anomalies (color shading, 10_2 hPa_1). Only wind anomalies with speed exceeding 0.6 m s_1 are shown. (b) The corresponding seasonal mean precipitation anomalies over the continents and islands (color shading, mm day_1) and SST anomalies (contours, K) that were regressed with respect to the first principal component.

We further reveal that since the late 1970s the overall coupling between the A–AM system and ENSO has strengthened. The relationships between ENSO and the western North Pacific, East Asian, and Indonesian monsoons have all become enhanced during ENSO's developing, mature, and decaying phases, overriding the weakening of the

Indian monsoon–ENSO anticorrelation during the developing phase. Prior to the late 1970s (1956–1979), the first mode shows a strong biennial tendency, and the second mode does not lead ENSO. After 1980, the first mode shows a weakening biennial tendency, and the second mode provides a strong precursory signal for ENSO. These interdecadal changes are attributed to increased magnitude and periodicity of ENSO and the strengthened monsoon–ocean interaction. (Fig.2)

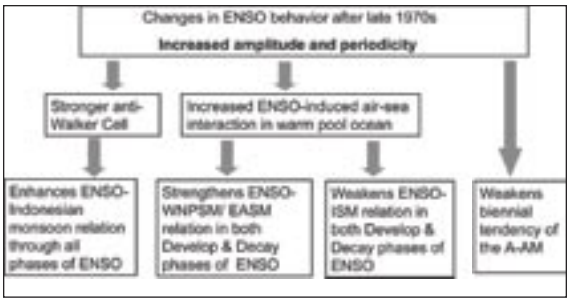


Figure 2. A schematic diagram is presented to illustrate how the A–AM responds to the increased ENSO forcing after late 1970s.

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

Primary Task

The primary task of this project is to collect atmospheric mercury speciation data and provide for the collection and analysis of semi-continuous high altitude (11,400 feet) measurements of Hg0, RGM, and HgP at Mauna Loa Observatory (MLO). The objectives of this task is to accumulate a long-term record of ambient Hg0, RGM, and HgP chemistry to (1) support atmospheric mercury chemistry research, (2) establish a baseline mercury measurement station, and (3) investigate the long range transport of mercury from South East Asia across the Pacific. In addition to this primary task, other data are measured and collected which 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 are to be organized and archived in a database. Some data and theories will be place on the MLO website and other types of media for outreach purposes.

Rain collector at Hakalau.

Inside the rain collector.

Progress During FY 2008

The second mercury analyzer was removed and returned to the Environmental Protection Agency (EPA) in January 2008 ending the intercomparison with MLO's mercury analyzer. 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. On February 13, 2008 a rain collection sampler in the Hakalau Forest Reserve was introduced. It is being used to study trace metals and mercury deposition. Collection is done once a week and samples are sent to University of Michigan for analysis.

Pacific ENSO Applications Center

P.I.: Thomas A. Schroeder

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

NOAA Goal(s)

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

Purpose of the Project

The Pacific ENSO Applications Center (PEAC) was established in 1994 as a cooperative effort among the University of Hawaii (JIMAR), University of Guam, National Weather Service Pacific Region and the Pacific Basin Development Council. PEAC provides climate services to Hawaii and the U.S.-Affiliated Pacific Islands (USAPI). In recent years PEAC has evolved into an operational branch of the NWS Pacific Region.

Progress during FY 2008

2007-2008 featured La Niña conditions. PEAC played a prominent role in identifying the probable impacts of sea-level rise upon the vulnerable communities. PEAC provided advance information on (1) seasonal and monthly sea-level forecasts and (2) probabilistic seasonal rainfall outlooks. PEAC explored all available La Niña forecast models and developed an impact scenario. All information was disseminated to vulnerable communities via monthly PEAC teleconferences and printed newsletters. User feedbacks including damages due to high tides and abnormal rainfall details, were monitored via teleconferences. A special bulletin describing the causes and consequences of sea-level rise form regional and global perspectives was also issued. From August 7 through August 18, 2007 PEAC representatives (Dr. Rashed Chowdhury and LTJG Sarah Jones) traveled to several locations in the U.S.-Affiliated Pacific Islands. There they met with Weather Service personnel and other officials involved in climate-sensitive sectors to discuss enhancement of scientific and outreach activities in those locations. A highlight of the trip was presentation of a forum lecture on "El Niño, La Niña, and Sea-level Variability" at the College of Micronesia in Palikir. This talk was arranged through the offices of the U.S. Ambassador and drew a large multi-disciplinary audience.

Throughout the 2006-2008 ENSO event many Pacific Islands experienced continuous elevated sea level. This was independent of ENSO phase. All tide gauges in the USAPI recorded elevated sea-levels from July 2006 through June 2008. This was unique in that no other El Niño event had been associated with sea-level rise in the USAPI. It is assumed that factors other than ENSO must account for this anomaly. Despite uncertainties in sea-level science, our observation is that extreme high-water levels have increased in some USAPI in recent decades.

Profiling CTD Float Array Implementation and Ocean Climate Research

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

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

NOAA Goal(s)

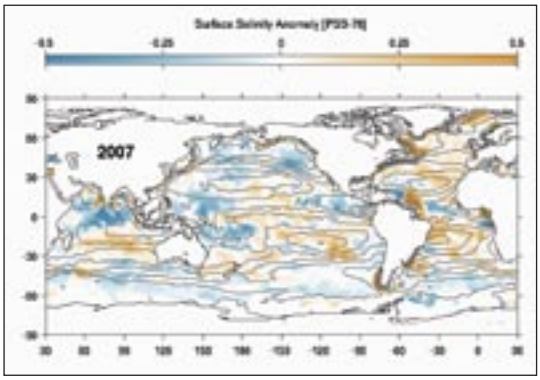
- To understand climate variability and change to enhance society's ability to plan and respond

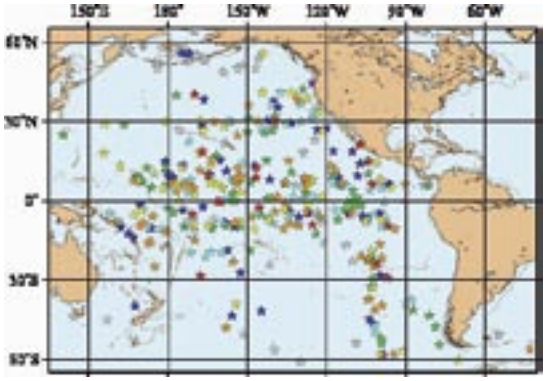
Purpose of the Project

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

Progress during FY 2008

E. Steffen completed testing of 70 floats and installed Lithium batteries in 69 floats in FY 2008. Potentially serious problems were found 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. Resolutions included a major revision to the float controller software. Steffen also monitored float performance, kept up with float registrations, and helped to find and sort out float database issues. Deployment opportunities were identified and logistics coordinated for 84 float deployments from 17 cruises on 6





(left) Surface salinity anomalies for 2007 from a mix of real-time and delayed-mode quality controlled Argo Data relative to World Ocean Atlas (2001 edition) climatological values (in colors, with climatological values contoured in grey at 0.5 intervals). Generally, subtropical salinity maxima appear higher and tropical and subpolar salinity minima appear lower in 2007 than in the climatology. (right) Locations (stars) of Argo floats prepared by JIMAR float research Analyst E. Steffen as of 9 July 2007. Grey indicates floats that have not reported for the last 20 days or more, colors more recently reporting floats.

ships. She visited 2 ships at which she tested floats, loaded floats, and gave deployment training. Stated goals were met.

J. Lyman produced and analyzed yearly maps of global upper ocean heat content from 1993 through 2007 using in situ thermal data. Using satellite altimetry data he worked with JIMAR Senior Fellow Dr. Gregory Johnson to quantify global upper ocean heat content sampling error estimates on the decadal linear trends from 1955 through 2007. They also worked on annual sea surface salinity anomalies from 2005 through 2007 and quantifying influences of equatorial Kelvin Waves reaching the Bering Sea. This year Lyman was a co-author of one published manuscript, and he presented results at a national scientific meeting. Stated goals were met.

Role of Ocean-Atmosphere Interaction in Seasonal and Interannual Variations of the Atlantic ITCZ and Roles of Ocean-atmosphere-land Interaction in Shaping Tropical Atlantic Variability

P.I.: Shang-Ping Xie

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

NOAA Goal(s)

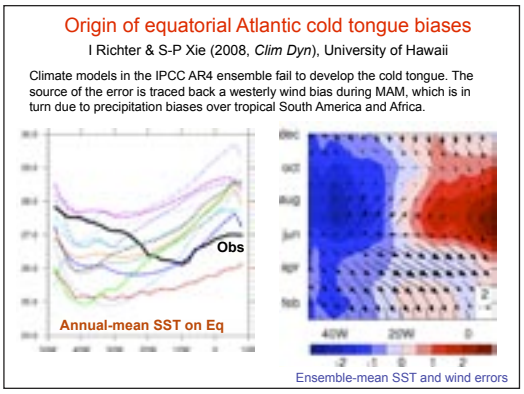
- To understand climate variability and change to enhance society's ability to plan and respond

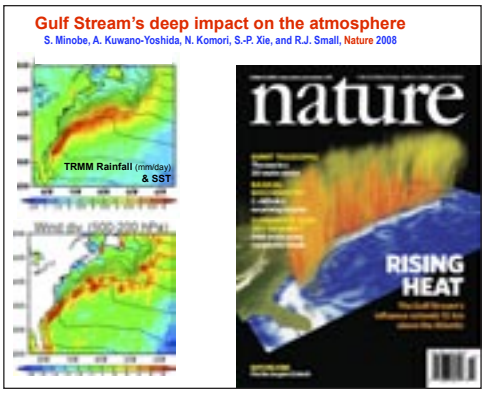
Purpose of the Project

Tropical Atlantic variability affects the climate on the surrounding continents, but its mechanisms remain unclear. The purpose of the project is to better understand the interaction of the ocean, atmosphere and land and its role in tropical Atlantic variability.

Progress during FY 2008

Progress has been made in the following areas. 1) Climate model assessment (Richter and Xie 2008). We have analyzed coupled models participating in the IPCC Fourth Assessment Report. Almost all the models fail to simulate the observed eastward decrease in sea surface temperature (SST) in the equatorial Atlantic. We show that atmospheric models suffer from a westerly wind bias during boreal spring, which prevents the equatorial cold tongue from fully developed in the subsequent season. 2) Water-hosing experiment (Xie et al. 2008; Wu et al. 2008). The shut down of the Atlantic meridional overturning circulation (AMOC) leads to climate change on a global scale. We have investigated key ocean-atmospheric processes to the AMOC global influence using global and regional coupled models. 3) Our analysis of satellite observations and experiments with a high-resolution atmospheric general circulation model (GCM) reveal a deep atmospheric influence of the Gulf Stream, penetrating into the upper troposphere. This raises the possibility of remote influences of the Gulf Stream on downstream regions such as Europe.





(above, left) Left panel: Annual-mean SST in the equatorial Atlantic. None of the IPCC AR4 models captures the eastern cold tongue. All the models show a spurious tendency for SST to increase toward Africa, a bias persisting from the earlier generation of coupled models. Right panel: SST and surface wind errors as a function of longitude and calendar month on the equator. Convection tends to be too weak over South America but too strong over Africa, driving westerly wind biases during March-May. The westerly biases depress the thermocline in the eastern equatorial Atlantic, preventing the cold tongue from developing during the boreal summer. In our study, we also examined AMIP runs and identified similar westerly biases, indicating that atmospheric model errors are key to the biases in coupled models. (above, right) Right panel: annual-mean precipitation (upper) and wind divergence in the upper troposphere (lower), along with sea surface temperature (black contours). Left panel: Nature cover graphic represents surface current speeds in blue-white colours (white is the fastest) and upward wind velocities in yellow-red colours (red for stronger winds), along with land-surface topography in eastern North America.

Tropical Meteorology

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

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

P.I.: James H. Foster

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

NOAA Goal(s)

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

Purpose of the Project

The project objective is to maximize earth-based GPS resources. It has two primary tasks; the first is to develop, operate and maintain the SkyNet network of GPS meteorology stations in Hawaii, upgrading equipment and processing approach as necessary. The second 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 2008

The SkyNet network operated continuously during FY 2008, with only minor site outages due to equipment failure. GPS sites MLES and PIIK, located on the upper slopes of Mauna Loa volcano, Hawaii Island were added

to the SkyNet network. Processing was modified to incorporate sites PAH5 and KOK5, which were previously known as PAH1 and KOK1 before they were upgraded by the US Coast Guard and given the new site names. Site PGF2 was discontinued due to deterioration of the monument, and has been replaced with collocated site PG2R. Due to the high-cost of installation and monthly network fees, the connection of site LIHU to the internet and its addition to the SkyNet network has been postponed until a more cost-effective solution can be found.

National Weather Service Fellows

P.I.: Thomas A. Schroeder

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

NOAA Goal(s)

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

Purpose of the Project

In lieu of rent supports graduate students in tropical meteorology within the UH Department of Meteorology.

Progress during FY 2008

Aaron Levine has been looking into the initiation and growth of El Niño events through the simple stochastically forced ENSO-recharge oscillator model outlined in Jin et 2007. Experiments have been run to see how other types of noise (blue and skewed) interact with the model and how they compare at a range of different multiplicative noise constants. Results show a complicated pattern of dependence on the amount of coupling involved and the types of noise involved on El Niño growth rate and variance. Further experiments have also added a non-linear damping term to the model to see which term dominates the growth of the event between these noise constants and the non-linear damping. These results show that the non-linear damping is very important and highly restricts El Niño growth rate even with high levels of feedback through the multiplicative noise.

National Weather Service International Pacific Training Desk

P.I.: Thomas A. Schroeder

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

NOAA Goal(s)

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

Purpose of the Project

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

Progress during FY 2008

The Pacific Desk had six visitors in FY 2008. Visitors came from Niue, New Caledonia (Meteo France), Indonesia, Malaysia, Cambodia and Vietnam. Trainees from New Caledonia, Indonesia and Cambodia were the first participants at the Pacific Desk from their respective nations. Since its inception in 2001 the Pacific Desk has trained weather personnel from 17 nations in the South Pacific and Southeast Asia.

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 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 Pacific Islands Fisheries Science Center, 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/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 project's purpose 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, and to conduct research related to the application of in situ and satellite remote sensing data products for marine fisheries and other ocean users requirements, based on a mechanistic understanding of the links between physical forcing and ecological response. These research efforts are being undertaken to: 1) improve understanding of marine environmental variability and its impacts on living marine resources, 2) develop

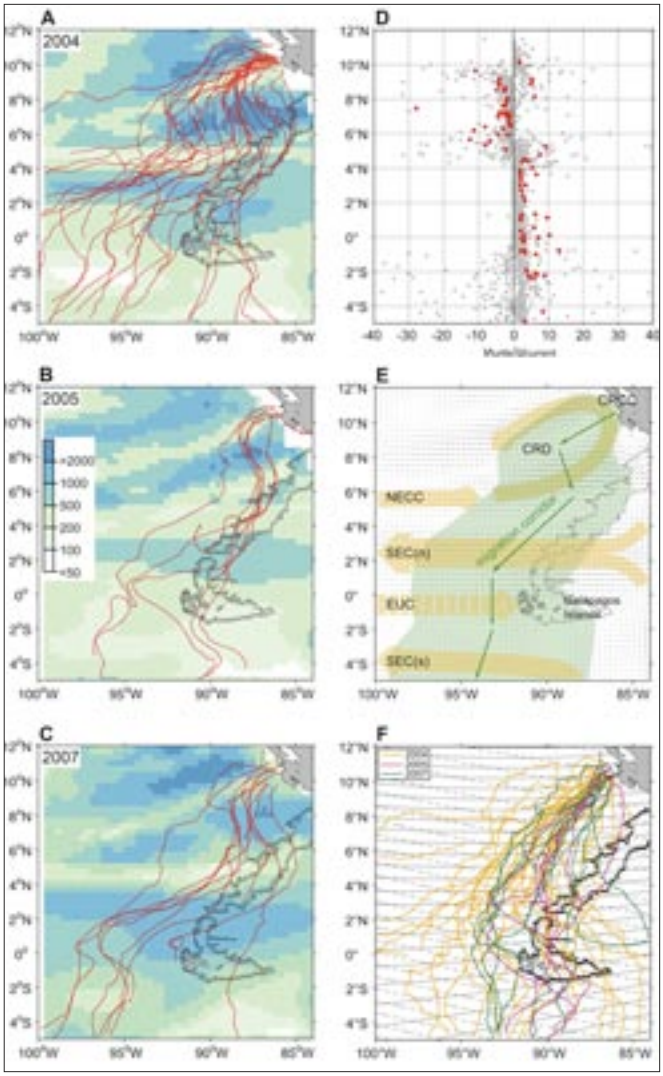


Figure 1. Leatherback movements in relation to ocean currents in the migration corridor region. (A-C) Turtle tracks overlaid on mean kinetic energy (MKE, in $cm^2 s^{-2}$) for February-April periods for 2004, 2005, and 2007. Stippling shows the 2000-m isobath highlighting the Cocos Ridge. (D) Ratio of turtle meridional velocity to current zonal velocity in the migration corridor region. Points corresponding to turtle meridional velocities faster than -70 km d^{-1} are colored in red. (E) Schematic of turtle migration corridor through the equatorial current system (current abbreviations are given in the text), based on the 75% home-range utilization distribution contour. (F) Current corrected turtle tracks from 2004 (orange), 2005 (green), and 2007 (purple), overlaid on contours of magnetic force (solid thin black lines) and magnetic inclination (dashed thin black lines). The force field has an intensity ranging from 38,314 nT in the north to 27,798 nT in the south, and contours are drawn every 420 nT. The inclination field ranges from 1.6° and 43.1°, and contours are drawn every 1.7°. From Shillinger et al. (2008).

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.

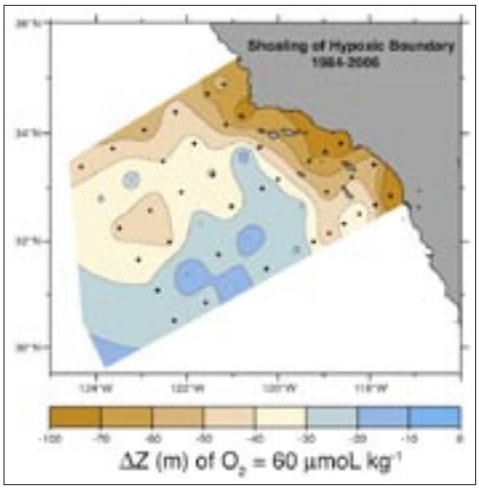


Figure 2. Total change in the depth (m) of the O_2 = 60 µmol kg^{-1} surface on the CalCOFI survey grid over the period 1984-2006. Stations with significant linear regressions ($p < 0.05$) are marked black.

Progress during FY 2008

By assembling a large team and using a multidisciplinary approach, we were able to unravel the environmental factors shaping the migration pathway of satellite-tagged female eastern Pacific leatherback sea turtles (*Dermochelys coriacea*), from their nesting beach in Costa Rica to their foraging ground in the South Pacific Gyre (Shillinger et al., 2008). While crossing the equatorial region (10°N-5°S) the turtles encountered an intricate system of zonal currents, and they traveled the fastest in this region, especially while crossing strong currents (Fig. 1A-E). Using a technique to remove the drift caused by the currents on the turtle movements, we also found that in the absence of currents the turtles would consistently take a heading of about 193°, suggesting that they use other environmental cues such as geomagnetism (Fig. 1F) to successfully navigate to their intended destination. Finally, we found that once the turtles entered the South Pacific Gyre, they tended to remain in a region characterized by very low eddy kinetic energy and phytoplankton biomass, indicating that their foraging ground is located in an oceanographic "cold spot". While the reason why the turtles migrate to this oligotrophic region remains unknown at this point, its consistency has implications for their conservation in the high seas of the South Pacific, as satellite altimetric monitoring could be used for fishery time-area closures in near-real-time. Additional studies of top predator habitat utilization in relation to oceanography, as part of the Tagging of Pacific Pelagics program, were also completed (Bailey et al., 2008; Kappes et al. 2008).

A separate effort involved estimating population abundance for several cetacean species in waters of Colombia and the Galapagos Islands in the eastern tropical Pacific, based on shipboard surveys. These results are useful for building an ecological framework for understanding how island-driven oceanographic processes influence cetacean community structure in various systems around the world. This work was presented at the 60th annual meeting of the Scientific Committee of the International Whaling Commission in Santiago, Chile (Palacios et al., 2008; Palacios and Forney, 2008).

Research in support of the US Global Ocean Ecosystems Dynamics (GLOBEC) Northeast Pacific Program 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. Two approaches have been used: (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 (Bessey and Mendelssohn 2008; Schwing et al., 2008); and (2) developing indicators of climate and environmental variability applicable to the management of living marine resources (Bograd et al., 2008a,b; Di Lorenzo et al., 2008). 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.

Recent analyses of historical hydrographic data from the CalCOFI program have revealed significant declines in dissolved oxygen at mid-depths throughout the southern California Current System, driven largely by changes in the properties of source waters to the region (Figure 2; Bograd et al., 2008a). These declines have resulted in a shoaling of the hypoxic boundary on the continental shelf by up to 90 m. Expansion of the oxygen minimum zone could lead to cascading effects on the local benthic and pelagic ecosystem, including habitat compression and community reorganization and may be related to changing ocean acidification.

ERD released version 1.00 of ERDDAP (the Environmental Research Division Data Access Program), a web-based service that helps humans and computer programs download oceanographic data in common file formats. See http://coastwatch.pfel.noaa.gov/erddap/index.html. ERDDAP offers a simple, consistent way to request data from diverse remote sources (URLs). ERDDAP also supports image file types and a series of graphics commands to customize requested graphs or maps.

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

The project provides continued data administration support for scientists and data managers. LODS, the Hawaii Longline Observer Data System, 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. The project also supports the development of the Hawaii Longline Logbook Data System (LLDS) leveraging tools and software modules designed and built for the LODS. On-going data administration support of LODS and the development of LLDS ensure efficient response to changing data collection requirements, consistent and documented data processing and data management, and secure and high quality data that is accessible to fisheries scientists and managers.

Progress during FY 2008

Work has kept on track for completing design and 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 in February with roll out to production on 4 April. Additional system enhancements allow the Observer Program data managers to create, lock/unlock user accounts and to more efficiently document experimental trips. 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 the Pacific Islands Fisheries Science Center (PIFSC) and Pacific Islands Regional Office (PIRO).

Funds for the initial phases of LLDS became available in November 2007. Work to date has focused on two areas, (1) the packaging of data management tools from the Hawaii/American Samoa Longline Logbook Data System (LODS), and (2) analyzing the federal longline logbook data in preparation for developing the Longline Logbook Data System (LLDS) for future integration with LODS. Modules for data history and user auditing are complete. A generalized System Issues Manager tool has been released for testing. Analysis of current longline logbook data processing has progressed significantly. Results from this ongoing analysis has enabled the project to implement some project tasks that were originally scheduled in Phase IV, including automated quarterly and annual reporting tools, and the implementation of a data corrections database that can integrate with the logbook data to generate a scientifically interpreted, *Longline Logbook Research Database*. These two high-value, Phase 4 tasks will continue to be addressed in the remaining Phase 1 and new Phase 2 periods as they are proving invaluable in the analysis of the as-is system and valuable to the data users.

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 the 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 are 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 2008

In FY 2008 work completed included: (1) sea turtles and seabirds incidental take estimates for year 2007; and (2) methodology was developed for estimating marine mammal incidental take by condition (non-serious injury, serious injury, mortality) and area (outside Exclusive Economic Zone [EEZ], within U.S. EEZ waters of Hawaiian Islands, Palmyra Atoll, Johnston Atoll, Jarvis, and Baker), with estimates produced for years 2002-2006.

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

The 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 tasks include support for data management of the various ocean observing system inputs, characterization of critical habitat for pelagic species, and linkages between ecosystem science and seafood safety.

Progress during FY 2008

Provided support for ecosystem studies aimed at helping to understand seafood safety concerns; for example, studies addressing the relationship of tunas and billfishes with methyl mercury and its cycling through the ecosystem via the food chain. To date the study has collected muscle tissue samples from 648 yellowfin and bigeye tunas primarily from the central tropical Pacific, but also including the western and eastern Pacific. In addition, 288 tuna prey items have been collected and identified. These tuna and prey samples are being analyzed for total mercury, methylmercury, and selenium content which ultimately will be incorporated into bioenergetics models coupled with mercury mass balance models that are being created for key pelagic tuna species in the central western Pacific Ocean.

Continued support of ongoing efforts to characterize the oceanography of the Transition Zone Chlorophyll Front (TZCF) as critical habitat for pelagic loggerhead turtles and as fishing grounds for the Hawaii-based longline fleet. During March-April 2008, a 600 nmi hydrographic survey along the 158°W longitude through the TZCF was conducted aboard the NOAA Ship *Oscar Elton Sette*. The survey conducted Conductivity-Temperature-Depth (CTD) stations at 15 nmi resolution that produced a detailed near synoptic meridional vertical section of desired parameters such as temperature, salinity, density, dissolved oxygen, and total chlorophyll. Additionally, discrete depth water sampling at each station will allow determinations of chloro- and accessory pigments using high performance liquid chromatography (HPLC) and macronutrients concentrations. The former will result in the first *in situ* assessment of phytoplankton faunal composition through this high gradient region and provide valuable insight into this complex ecosystem.

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, John H. Wang, Yonat Swimmer]

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

NOAA Goal(s)

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

Purpose of the Project

To conduct research in the area of sea turtle bycatch reduction research, which includes studies with captive sea turtles and open ocean field trials. With regard to this line of research, our activities include: 1) satellite archival tagging of sea turtles incidentally caught and released in longline fishing gear, 2) sensory and behavioral biology research on sea turtles and sharks, and 3) field trials at sea to test effects of modified fishing gear on sea turtles and target species catch rates.

Progress during FY 2008

Field trials have been ongoing for three years and have yielded extensive data regarding turtle-safe fishing practices specific to longline fishing. To date, our field trials have compared over 250,000 hooks and have shown that use of circle hooks is an effective strategy to reduce the incidental capture of sea turtles in fisheries. Our work has primarily been to coordinate funding, logistics and handle data related to bycatch mitigation field trials in Brazil, Uruguay, Italy, Indonesia and in the future Spain. The work has involved contracting a statistician to help with a metadata analysis that will allow for very a 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 as well as target species.

(top) Hooks used in experiment. Left—18/0, 10° offset circle ("C") hooks; Right—Portuguese style 9/0 stainless steel ("J") hooks. (Photo A. Domingos). (bottom) Loggerhead sea turtle caught in longline fishing gear in Uruguay. (Photo C. Barcelo).

Fisheries Oceanography: Protected Species: Marine Turtle Research Program

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Stacy A. Kubis, 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

The purpose of the project includes eleven discrete elements that consist of: 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 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 2008

In the FY 2007 annual report, the Marine Turtle Research Program (MTRP) identified the following goals for FY 2008: 1) continue research of the pelagic ecology and movements of sea turtles to develop management strategies to reduce bycatch; 2) conduct studies on the foraging ecology of green turtles in collaboration with researchers at the University of Hawaii, Hilo; 3) develop and complete a NOAA PIFSC Research Plan for the Hawaiian green turtle; 4) conduct nesting beach research at East Island, French Frigate Shoals; 5) continue captive care and rehabilitation of captive-reared and stranded turtles; 6) model juvenile survival rates and fibropapilloma disease progression and regression using 25 years of capture data from the Pala'au, Molokai study site. Progress toward these goals is discussed below.

1) A collaborative project was established in FY 2007 with the Noumea Aquarium in New Caledonia and continued in FY 2008. Loggerhead sea turtles hatched from nesting beaches in New Caledonia have been reared in captivity since March 2007. They will be released in the latter part of 2008 with satellite tags to study their behavior and movements in pelagic habitats. JIMAR Marine Turtle Research Biologist, Stacy Kubis, manages the growth data and monitors growth rates for consistency and potential health problems. JIMAR Marine Turtle Specialist, Denise Parker, 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 will be added to the database and Ms. Parker will continue to provide maps to our collaborators.
2) Stacy Kubis was instrumental in conducting studies on the foraging ecology of green turtles in collaboration with researchers at the University of Hawaii, Hilo. Ms. Kubis participated in field research activities at the Kapoho study site on the island of Hawaii including captures of live turtles, data collection, and biological sample collection. In addition, Ms. Kubis serves on the graduate committee of Katelyn Valdez.
3) Ms. Kubis developed and completed a NOAA PIFSC Research Plan for the Hawaiian green turtle. This document has been used internally and by other federal agencies to assist with planning and management activities related to marine turtles in the Pacific Islands region.
4) The Marine Turtle Research Program has conducted nesting beach research at East Island, French Frigate Shoals (FFS) since 1973. JIMAR Research Associate Irene Nurzia-Humburg was on assignment at FFS from June through July 2007 to conduct tagging and nest monitoring research for the 2007 nesting season. This was Ms. Nurzia-Humburg's second season at FFS and she served as camp leader and trained a USFWS Biological Technician in data collection and field techniques. Ms. Nurzia-Humburg authored the end of the season report and updated Standard Operating Procedures for the turtle field camp. In early 2008, Ms. Nurzia-Humburg prepared gear and supplies for the 2008 season and departed Honolulu on May 16 for FFS.
5) JIMAR staff Darren Marshall, Maria Carnevale, and Irene Nurzia-Humburg, along with NMFS MTRP staff, were responsible for the care and rehabilitation of stranded sea turtles and two captive-bred and captive-reared green turtles at the NMFS Kewalo Research Facility. Ms. 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. Ms. Kubis was responsible for coordinating and conducting monthly measurements of the two captive-reared turtles. Nearly 500 stranded marine turtles in Hawaii have been rescued, rehabilitated, and released since 1992.
6) In August 2007, Ms. Kubis attended training in Program MARK, a computer software package used to analyze mark-recapture tagging data. The goal of this training was for Ms. Kubis to model juvenile survival rates and fibropapilloma disease progression and regression using 25 years of capture data from the Pala'au, Molokai study site. Ms. Kubis assembled the data and provided a summary of capture data for Dr. Milani Chaloupka, a long-time collaborator of the MTRP, who performed the statistical analyses.

(above, left) JIMAR Marine Turtle Research Biologist, Stacy Kubis, weighs a green turtle captured at the Pala'au, Molokai study site. (above, right) JIMAR Staff from NOAA's PIFSC and PIRO participate in field work with the MTRP at Hanauma Bay. From left to right: Melissa Snover, NOAA; William Connor, JIMAR PIFSC: John Wang, JIMAR PIFSC; Irene Nurzia-Humburg, JIMAR PIFSC; Dusty Marshall, JIMAR PIFSC; Tiffany Hooper, Hanauma Bay State Underwater Park; George Balazs, NOAA; Kimberly Maison, JIMAR PIRO; front, right is Cheryl King, Hawaii Wildlife Fund.

7) A JIMAR Biological Technician position was filled in May 2008 with the hiring of William Connor. Mr. Connor began his employment as JIMAR Biological Technician Darren Marshall was preparing to depart for graduate school in Florida. The MTRP has 2 Biological Technician positions to fill that were vacated in May 2008 by Darren Marshall and Maria Carnevale.

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 purpose of the Cetacean Research Program (CRP) is to study the relationship between environmental/oceanographic parameters and identify, characterize and define habitat use by whales and dolphins in the Pacific Islands Region (PIR). Cetaceans are apex predators and represent important components of the marine ecosystem and relatively little is know about their biology and natural history in the PIR. This program is relatively young and has recently begun collecting scientific information on cetacean stock identification, abundance and population trends in PIR to fully characterize cetaceans' role in this highly complex environment. By obtaining a better understanding of the environmental factors that directly and indirectly influence protected species population growth, managers will be able to make more informed decisions concerning ongoing conservation and recovery efforts.

Progress during FY 2008

CRP successfully recovered and redeployed a high frequency acoustic recording package (HARP) on the summit of Ladd Seamount in the Northwestern Hawaiian Islands (NWHI). The top of Ladd Seamount is one large plateau, which appears to be covered in sand and ranges from 60 m to about 140 m depth. The HARP was initially

deployed during the March cetacean cruise in about 125 m of water about 3/4 of a mile from the edges of the seamount at the northern-most point of the sandy plateau. Approximately 1.3 terabytes of acoustic data were collected by the instrument, including cetacean sounds and ship noise from controlled exposures to assess the utility of passive acoustics for monitoring vessel traffic in the Papahānaumokuākea Marine National Monument.

In collaboration with the Ecosystem and Oceanography Division (EOD) of PIFSC, staff deployed and recovered two Protected Species Division (PSD)/Duke University T-POD acoustic data loggers on active longline fishing gear near Palmyra Atoll. These devices detect and log cetacean echolocation clicks, and may be useful for understanding how and when cetaceans interact with longline gear in the PIR. Both devices appear to have recorded hundreds of clicks during several deployments. Analysis will begin mid-September. Also, in collaboration with EOD, a study was completed on the first deployment of a HARP on Cross Seamount, south of the main Hawaiian Islands.

Seamounts are prominent topographic features of all ocean basins, and likely play an important role in the distribution and movements of cetaceans. In this novel study and in collaboration with whale researchers at Scripps and Whale Acoustics Inc., they discovered a remarkable diel pattern in the vocalizations of cetaceans. During a six-month deployment, echolocation sounds similar to known beaked whale clicks were consistently detected only at night. These results indicate that seamounts may provide enhanced foraging opportunities for cetaceans through a combination of vertical migrations of micronekton and "seamount effects."

CRP has also continued its oversight of a community-based collaborative photo identification catalog for spinner dolphins in the PIR. See *http://pipin.org/community/*.

Fisheries Oceanography: Protected Species: Hawaiian Monk Seal 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 purpose of MMRP 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 in currently place.

The Hawaiian Monk Seal Research Program (HMSRP) component included monk seal population monitoring and assessment, characterization of foraging ecology, and evaluation of health and disease. Our standard NWHI field camps were reduced this year for budgetary reasons. The smaller camps were still able to collect valuable population information, tag new pups, assist in marine debris collection and complete other duties as needed. Some key happenings in monk seal research in the NWHI this year:

- Juvenile Foraging Research: Fifteen satellite linked GPS dive recorders were deployed on young seals at Lisiasnki Island to try to determine why some young seals survive and others starve.
- Shark Mortality Study: Researchers attempted 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.

Photo taken at the spacious and luxurious (for a seal) Kewalo Research Facility, where only the finest and most endangered seals stay. All care is provided around the clock by dedicated staff from NOAA's Protected Species Division JIMAR, Federal staff, as well as The Marine Mammal Center of California.

Monk seal assessment studies in the Main Hawaiian Islands (MHI) continued in FY 2008 through the efforts of a full time sightings coordinator and a cadre of responders collecting data whenever seals were reported in the MHI; and historical and current MHI sighting data have been entered into a database. The health and disease project trained a smaller than normal complement of seven field researchers in seal necropsy and sampling techniques, and processed the resulting samples from the field season. The health & disease project also assisted in the captive care of Hawaiian monk seals, including an abandoned male pup maintained temporarily at the Kewalo Research Facility, as well as an adult female that swallowed a fishing hook which was held at Waikiki Aquarium. These efforts were supported by a host of partners.

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 work 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 of the project include: 1) comparisons between historic and recent records of sea turtle interactions; 2) 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 3) 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 2008

Satellite Archival Tagging. In the last year and a half, we deployed a combination of platform terminal transmitters (PTTs) and pop-up satellite archival tags (PSATs) on 25 loggerhead turtles caught and released from longline fishing boats in the South Atlantic Ocean operating out of Brazil and Uruguay. The tags have provided information on turtles' movements from 27-547 days post release from fisheries interaction, with a mean number of a year of tracking per turtle. This far exceeds the number of days we successfully tracked sea turtles with PSATs during the previous years of this study. We continue to monitor all of the turtles we have tagged with satellite transmitters over the past few years and Lianne McNaughton continues to graph their movements. Turtles' movements and updated geolocation data files are sent weekly to our collaborators in Uruguay and Brazil. We also purchased additional tags for future work in this area as well.

Sensory and Behavioral Biology Research. Progress in this area of sea turtles' responses to light and scarecrows has continued, as evidenced by the recent publication. Progress in the area of shark bycatch reduction has also occurred. Specifically, John Wang and Yonat Swimmer hosted a workshop at the New England Aquarium regarding promising methods for shark bycatch reduction methods in longline fisheries. This will be a NOAA Tech Memo that is set for publication by Sept., 2008.

Administratively, we surpassed our annual goals in hosted meetings, attended meetings, and logistics support for a number of domestic and international research programs.

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 communication, 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 Hawaii tuna longline fishery with funding provided by the Reducing Bycatch Program of NOAA.

Current commercial tuna longline setting techniques were altered to test a method developed by the Secretariat of the Pacific Community (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).

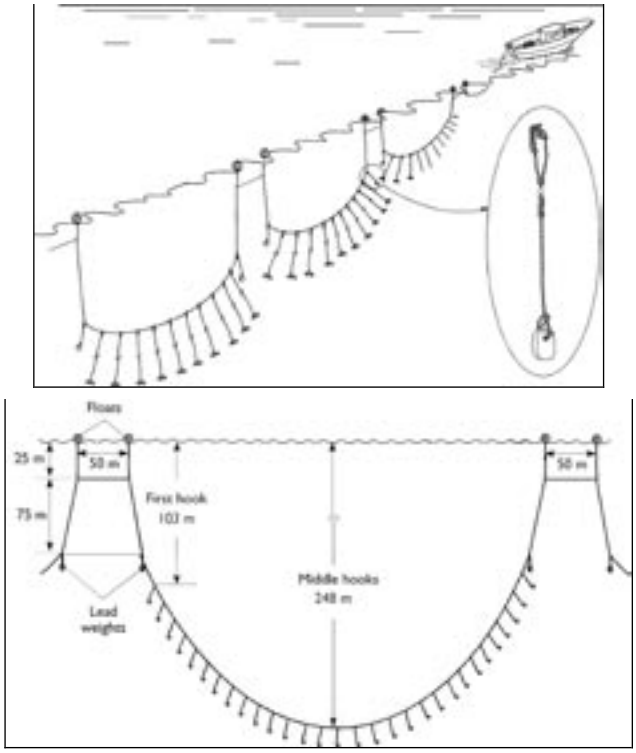
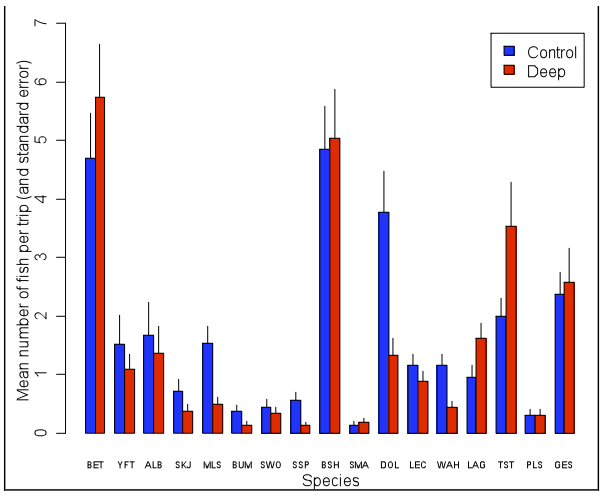


Illustration of no shallow hooks gear (not to scale) showing lead weight in inset. Shallow hook depths are approximately less than 100m.

Progress during FY 2008

As planned from the previous fiscal year, a single commercial longline vessel was contracted to perform 90 longline sets (45 sets using the deep setting technique and 45 control sets using standard methods). These experimental trials have now been completed. Project personnel have entered relevant data into a database and have performed several checks



Mean number of each species captured per control and no shallow hooks set. Vertical lines represent one standard error of the mean. Species identified with an asterisk (*) contributed significantly to the discrimination between the two set types. of the Species codes: BET, bigeye tuna; YFT, yellowfin tuna; ALB, albacore tuna; SKJ, skipjack tuna; MLS, striped marlin; BUM, blue marlin; SWO, swordfish; SSP, shortbilled spearfish; BSH, blue shark; SMA, short fin mako shark; DOL, mahimahi; LEC, escolar; WAH, wahoo; LAG, opah; TST, sickle pomfret; PLS, pelagic stingray; GES, snake mackerel. Data for longnose lancetfish are not shown due to the much higher means for both set types (control: 23.47 ± 4.549; deep: 26.36 ± 4.740).

to ensure data accuracy and integrity. Results of the project were presented at the 2008 Tuna Conference and a preliminary draft manuscript has been completed. The project has attained goals set from the previous year. A manuscript detailing the research is slated for submission to the peer-reviewed literature in July, 2008.

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 research program has focused on economic assessments on commercial and recreational fisheries in Pacific Islands Areas, initiated in July 2000.

Hawaii small boat cost earnings study: JIMAR employee Kristy SeBlonka interviews fishers on Oahu

Progress during FY 2008

1. The first task of FY 2008 was to continue efforts to assess changes in key economic indicators in the Hawaii-based and America Samoa longline fisheries through established economic data collection program. Progress made in the FY 2008 is as follows:
   - 356 Hawaii-based longline expenditure forms (including the forms with only observable data) were returned in FY 2008. The response rate was 83% for forms returned, an increase from 82% last year
   - 5 American Samoa-based longline expenditure forms were collected in the first year of data collection
   - Preformed data quality control on the data collected through 2006-2007 and entered data into the database
   - The cost data collected had been used to support other research projects (such as the cost-earnings study of the Hawaii longline fleet) in the Economic Program
2. The second task for the year was continued work on a cost-earnings study of the Hawaii longline fishing fleet, initiated in FY 2006, carrying out statistical and economic analysis based on the 2005 fishing operation status

(above, left) Hawaii small boat cost-earnings study: JIMAR employee Kristy SeBlonka interviews fisher on Kauai. (above, right) Hawaii small boat cost earnings study: JIMAR employee Kristy SeBlonka interviews fishers on Lanai

of the Hawaii-based longline fleet. Progress made in the FY 2008 is as follows:

- Integrated cost and revenue data across multiple data sources: observer collected expenditure data, fixed-cost survey data (from 2005 cost-earnings survey), and revenue data from the dealer reports
- Conducted statistical analysis on the cost-earnings status of the Hawaii longline fleet based on the integrated database
- Presented a preliminary results and findings to the Western Pacific Regional Fishery Management Council's Pelagic Plan Team meeting in April 29-May 2, 2008.

3. The third task was to design and implement a cost-earnings survey of the Hawaii small boat fishery. Progress made in the FY 2008 is as follows:
   - Designed and fielded a survey instrument with 345 completed interviews across the state of Hawaii during 2007-2008. The response rate was approximately 76%
   - A draft report for this research is in preparation. The intent of this report is to summarize the demographics of our sample, detail the methodologies employed, and present preliminary results on trip expenditures as well as the social and economic importance that small boat fishing has to the State of Hawaii
4. The fourth task involved the development of a market study of consumer preferences for attributes associated with ahi poke purchases. Progress made in the FY 2008 is as follows:
   - Facilitated a focus group study and implemented a consumer market study on consumer preferences for ahi poke. In total, we conducted 430 surveys around Oahu and the Big Island
   - Developed a database for the survey data and completed data entry
   - Conducted statistical analysis and prepared a draft of report, which is expected to be published as an administrative report
5. Finally, there were efforts made in further developing a project to investigate the impacts of reduced shoreline access on recreational fishers in Hawaii (Hawaii Recreational Fishing Shoreline Access Project)
   - Conducted an extensive literature review to explore institutional structure and agency roles with respect to public access to shorelines in the state of Hawaii
   - Designed a pilot project to map shoreline access points on Oahu and create an associated database that will include site attributes relevant to shoreline fishers
   - Explored adequacy of existing data collected by the Hawaii Division of Aquatic Resources to estimate the cultural, social, and economic effects of reductions in public access to the shoreline

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 proposal 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 will support on-going research operations conducted at the Pacific Islands Fisheries Science Center on the University of Hawaii campus, the Aiea Heights Research Facility, and at the Kewalo Research Facility.

Progress during FY 2008

Maintenance Support. 2007 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 projects.

Administrative Support. In 2007, a second administrative associate vacancy was announced. The project was unable to place a qualified candidate, and closed the recruitment without a selection. In place of one, full-time administrative associate, the project hired two, half-time student assistants. The pair were brought on board in third quarter and have taken on a variety of tasks including visitor reception, file maintenance, and invoice payment

research. 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 & 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 Fisheries Science Center

NOAA Goal(s)

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

Purpose of the Project

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

Progress during FY 2008

The JIMAR Fisheries Specialist continues to provide a high level of support to fishery monitoring activities by providing timely, high quality data to JIMAR, NMFS, and other non-agency researchers. The specialist also provides relevant and timely information dealing with all aspects of the Hawaii fisheries to NMFS. In addition, the specialist provides the fishing industry with a high level of support in information exchange and contact information with Federal and State management agencies and individuals. An additional duty in 2008 has been a limited role in testifying in court on fisheries violations.

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

P.I.: Thomas A. Schroeder [Samuel G. Pooley, Susan Kamei, 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 located at the Pacific Islands Fisheries Science Center (PIFSC).

Progress during FY 2008

Web Services. The Webmaster maintained and improved both functionality and contents of the Website. Particular attention was given to timely dissemination of technical reports, news, and announcements of current research cruises and other scientific activities. A template was created for a new home page design and site architecture enabling topic-based content delivery. This will be rolled out later in 2008. The Webmaster also built the framework for an online manuscript processing system using Ruby-on-Rails and an Oracle database.

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 developed editorial guidelines and style sheets to assist division scientists preparing draft publications. She helped prepare specifications for the online manuscript submission and clearance system. This Web-based tool, built by the Webmaster, is scheduled for completion later in 2008.

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

Part of the ongoing research under the Marine Resource Dynamics Assessment Program (MARDAP) is to develop a social and cultural database of fishing ports and associated communities in Hawaii, 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 also will allow us to document the unique social and cultural aspects of Western Pacific fishing activity, as well as reveal commonalities.

Vatia on the island of Tutuila is one of the villages participating in the American Samoa community-based fisheries management program. (Photo Stewart Allen)

Participants in the 2006 4-H Summer Fisheries Workshop head into the water to learn the technique of chenchulu fishing. (Photo Stewart Allen)

Progress during FY 2008

The 2007 annual report listed two major activities to be conducted in FY 2008;

1. Reports on Hawaii and Guam published as peer-reviewed documents. The report on Guam was published in Feb. 2008. The report on Hawaii is being finalized for peer review as an initial step in the publication process and will be sent for peer review Aug. 2008.
2. Draft report of CNMI completed and published; report on American Samoa published. The report on CNMI has been initiated, with a final report anticipated in Sept. 2008. The report on American Samoa is being finalized for peer review, with a final report anticipated in Aug. 2008.

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 program are to assess (1) the status of pelagic stocks in the Pacific Ocean, (2) the status of insular resources in the Pacific Islands Region (e.g., bottomfish), and (3) the impact of fishing on these stocks.

During technical reviews of NWHI insular resource assessment procedures, it was recommended that collaborative research programs between the industry, the PIFSC, and the University of Hawaii (UH) be developed to (1) provide independent estimates of population size, (2) generate updated estimates of population dynamics, (3) further our understanding of the ecological role of lobsters in NWHI ecosystem, and (4) advance crustacean stock assessment methodologies. Technical reviews of pelagic stock assessment procedures resulted in similar recommendations, with an eye on broadening potential collaborators to address Pacific-wide issues. Currently, PIFSC conducts assessments of pelagic fish stocks in the Pacific Ocean collaboratively with scientists from Japan, Taiwan, Korea, China, Mexico, and the Inter-American Tropical Tuna Commission (IATTC) under the auspices of the International Scientific Committee (ISC). Priority is given to billfish and oceanic sharks species in the Pacific Ocean, including marlins, swordfish, and blue shark.

Participants at the January 2008 ISC Billfish Working Group Workshop.

Progress during FY 2008

The JIMAR FY 2007 annual report outlined four goals for FY 2008, 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 2008, 3) collecting bottomfish samples from the NWHI to re-estimate biological parameters (e.g., growth) and 4) completing pelagic (blue shark and striped marlin) and insular (NWHI lobster and bottomfish) stock assessments, and advancing population model development.

Of the goals articulated, the following were accomplished:

- *Lobster tagging*. Two commercial fishing vessels were contracted (chartered) in FY 2007 to conduct lobster tagging experiments in FY 2008. One vessel was chartered from June 16 to July 15, 2007 and conducted tagging operations at Necker Island and Gardner Pinnacles. The other vessel was chartered from July 18 to August 16, 2007 and conducted tagging operations at Laysan Island and Maro Reef. JIMAR staff 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 compared to historical growth patterns. Numerous presentations on the lobster tagging experiment were presented by JIMAR staff to the Western Pacific Regional Fishery Management Council (WPRFMC) and at scientific conferences. A single vessel was contracted in late FY 2008 (June) to conduct tagging experiments in FY 2009. Results from the 2008 charter will be reported in next year's annual report.
- *NWHI lobster resource survey.* Because of budget shortfalls and loss of sea days aboard the NOAA R/V Oscar Elton Sette, the lobster resource survey was cancelled.
- *Collection of bottomfish data*. Because the lobster resource survey was cancelled, biological samples from endemic snappers and groupers were not collected
- *Complete pelagic and insular stock assessments and advance population models*. Numerous stock assessments were completed with assistance from JIMAR staff, and significant progress on population model development also occurred in FY 2008. A spatially-explicit population model for spiny lobster that incorporates all available fishery-dependent and fishery-independent data, as well as larval transport estimates, was developed in collaboration with scientists from the University of British Columbia. The model captures the spatial structure of lobster populations in the NWHI, and the connectivity of local populations through larval transport. A spatially-structured population model was developed for deep-slope bottomfish stocks in the Hawaiian archipelago, American Samoa, CNMI and Guam, and stock assessments conducted. In addition, Dr. Shelley Clarke (formally with JIMAR) along with scientists from PIFSC, Imperial College London and Japan completed a North Pacific blue shark stock assessment. The assessment is undergoing external review. Lyn Wagatsuma provided program oversight and analytical support (graphical analyses) for North Pacific pelagic stock assessments conducted by the PIFSC, most notably the striped marlin assessment that was finalized under the auspices of ISC during January 2008 in Honolulu, Hawaii.

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 Process (WPSARP) is intended to improve the quality and reliability of stock assessments conducted by NMFS PIFSC scientists, by insuring rigorous and independent scientific review of completed assessments. WPSARP is a collaborative program between the PIFSC, NMFS PIRO, JIMAR and the Western Pacific Regional Fishery Management Council.

Progress during FY 2008

During FY 2008 a Coordinator was identified and the final structure and scope of the WPSARP adopted. The forthcoming Hawaiian Archipelago bottomfish stock assessment has been identified as a candidate for the new review process and is scheduled for Spring 2009.

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 turtles species: green, hawksbill, olive ridley, leatherback, loggerhead and flatback turtles inhabit the Pacific, especially 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 the project is to introduce fishermen, fishery administrators, policy makers and other relevant stakeholders 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 2008

Solomon Islands sea turtle-fisheries interaction outreach education project. As reported in 2007, along with NOAA Fisheries, the project continues to monitor the Solomon Islands government and fisheries situation and 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, it was 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 Solomon Islands Fisheries Department also suddenly lost a fisheries employee to heart attack and that was going to cause restructuring within the fisheries department. The Director did not know when stabilization in their department would

be achieved and 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 carryout 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 Pacific Islands Regional Office with objectives: to heighten awareness of sea turtle interactions with fishing gear by familiarizing commercial fishing operators in New Caledonia, fishery observers and staff of Marine Marchande with techniques of handling sea turtles caught incidentally to 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. While training objectives were completed during FY 2007, the provision of equipment to fishermen, specifically large hoop nets and turtle dehookers, delayed project completion until late in FY 2008. Such fisheries-marine turtle interaction mitigation supplies have since been ordered and will be distributed along with new printed instructional materials to New Caledonia fishers in early FY 2009.

Educational presentation on loggerhead turtles to students visiting the Aquarium de Nouméa in Nouméa, New Caledonia

Loggerhead turtle conservation-education and outreach program. The project supports a public outreach educator at Aquarium de Nouméa. Educator responsibilities include development of educational materials (including scale models, puppets, coloring books and books), hosting visiting schools and conducting one day workshops on turtle biology and conservation. Many workshops will be given off-site at up to 120 schools within 33 townships of New Caledonia. It is anticipated that over 3,000 children will participate in these workshops.

Basic turtle biology and population dynamics will be covered to provide necessary background to the conservation program and stress the need to combine efforts at local and regional levels. In particular, programs will focus on raising public awareness regarding the following issues:

- reduction of dog predation on loggerhead nests
- minimizing disturbance to nesting turtles (lightings, turtle watchers)
- remediation for habitat loss (housing developments, beach erosion devices and siltation of sea grass beds)
- plastic bag pollution (98% of "sick" turtles brought to the aquarium suffer intestinal blockage from plastic debris)

Progress during FY 2008 included the inception of the Aquarium de Nouméa education program featuring loggerhead turtles in September 2007. Presentations are given to school groups and the general public at least weekly with daily shows in January and February. A comprehensive marine turtle library was established at the aquarium and contains scientific papers, press articles and public outreach materials including coloring books and games. This is a resource that is open to the public. Information exchange was encouraged on a French language marine turtle discussion forum. Educational displays (including a model nest) were created to enhance the educational experience at the aquarium. One third of the townships have been visited thus far and will continue as the aquarium is invited to present at the remaining townships. In addition, educational display booths were set up at several village fairs.

Pacific Islands Regional Observer Program

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

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

NOAA Goal(s)

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

Purpose of the Project

The Pacific Islands Regional Observer Program is managed through a fishery Management Plan developed by

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

Nick Wagner with a swordfish during a research cruise.

Progress during FY 2008

From July 2007 through June 2008, 447 observer trips were debriefed. Of the 447 observed trips, 307 were completed through the final data editing stage. In addition the program has completed the final data editing for 199 trips from the previous year. This puts the observer program approximately 140 trips behind in the final data editing stage for observer data. Despite having a deficit of 140 trips, the program has exceeded this year's goal of completing a minimum of 360 observed trips through the final data editing stage by more than 85 trips.

Pelagic Fisheries Research Program (PFRP): Program Management

P.I: John R. Sibert

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

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

Progress during FY 2008

The PFRP allocation for FY 2008 was less than half of historical allocations. Thus, for the second consecutive year, there was no request for new proposals. Many of the projects that were underway in 2007 reached their scheduled termination dates so that there will be very few projects in place in FY 2009.

As a consequence of these shortfalls, the frequency of the PFRP Newsletter has been decreased from four to three issues per year, and the annual PFRP Principal Inverstigators Meeting has been shortened to one and a half days.

Inertia from on-going projects enabled PFRP principal investigators to contribute 8 presentations to the 59th Annual Tuna Conference in May 2008. PFRP researchers also made presentations at the following meetings:

- Second International Symposium on Tagging and Tracking Marine Fish with Electronic Devices, October 8-11, 2007, Donostia-San Sebastian, Spain;
- PFRP Principal Investigators Meeting, Nov. 13-14, 2007, Honolulu, HI;
- First GLOBEC Climate Prediction on Oceanic Top Predators (CLIOTOP) Symposium, Dec. 3-7, 2007, La Paz, Mexico.

Progress on goals from FY 2007

1. Conduct a request for proposals and fund new projects consistent with the priorities identified in report of the 2005 research priorities workshop, "Pacific Ocean Connections: Priorities for pelagic fisheries research in the Twenty-first Century"
   - No Request for Proposals was conducted because of insufficient funds.

2. Facilitate international collaboration in research on pelagic fisheries.
   - The project, "Scaling Up: Linking FAD-associated Local Behavior of Tuna to Regional Scale Movements and Distribution" collaborated with scientists from Secretariat of the Pacific Community in joint tagging projects in the Solomon Islands and Papua New Guinea.
   - The PFRP Program Manager was a keynote speaker at American Fisheries Society's Fish Tagging Symposium on "Spatial analysis, modeling with tagging data, and implications for Fisheries Management" in Auckland, New Zealand in February 2008.
   - The PFRP Program Manager was invited to make a presentation to a special session on "Challenges to [tuna fishery] Management in the 21st Century" at the 59th Annual Tuna Conference in May 2008.
   - PFRP staff and researchers participated in the Scientific Committee and Specialist Working Groups of the Western and Central Pacific Fisheries Commission. The fourth regular session of the Western and Central Pacific Fisheries Commission (WCPFC) Scientific Committee will meet Aug. 11-22, 2008 in Port Moresby, Papua New Guinea.
   - The PFRP has taken a leadership role in the AD Model Builder (ADMB) Project, an international effort to ensure that the ADMB software will be maintained in the future. (This software is used in over 200 fisheries management agencies for statistical modeling and assessment of fish population around the world; see *http://admb-project.org/*.)

PFRP: An Analysis of Archaeological and Historical Data on Fisheries for Pelagic Species in Guam and the Northern Mariana Islands

P.I.: John R. Sibert [Judith R. Amesbury, Rosalind L. Hunter-Anderson]

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

In recent years there has been greater recognition of the value of archaeological and historical records as important sources of information on patterns of marine resource use. The pelagic species have been harvested, not just for centuries, but for millennia in the Mariana Islands. How or whether that affects fish stocks today should be taken into account in managing the pelagic fisheries. Project researchers have access to and are familiar with the long-term data on fisheries in the Mariana Islands. Earlier reports produced for the Western Pacific Regional Fishery Management Council evaluated existing evidence (archaeological, ethnological and historical) for preferential fishing rights for the indigenous peoples of the Marianas. For the project, research archaeologists will produce a report on the long-term data concerning fisheries for pelagic species in both Guam and the Northern Mariana Islands. Though the report will be based mainly on archival review, researchers plan to conduct interviews and to have one or more collections of fish bones analyzed for taxa represented, body size, habitat and catch method.

Progress during FY 2008

Micronesia Archaeological Research Services (MARS) has produced a report on the long-term data concerning fisheries for pelagic species in Guam and the Northern Mariana Islands. The report is based mainly on archival review. In addition two collections of archaeological fish bones from Guam were analyzed by Foss Leach and Janet Davidson of New Zealand to add to the data from the Prehistoric Period. A Japanese-speaking researcher, Wakako Higuchi, went to Japan to obtain fishery data from 1914-1944 in the Northern Marianas. Interviews were conducted with fishermen on each of the four major islands (Guam, Saipan, Tinian, and Rota). The report was completed in May 2008 and is currently available on the PFRP website *http://www.soest.hawaii.edu/PFRP/pub_list_misc.html*.

The reports from Foss Leach and Janet Davidson and Wakako Higuchi are included as appendices.

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

P.I.: John R. Sibert [Edward W. Glazier]

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

NOAA Goal(s)

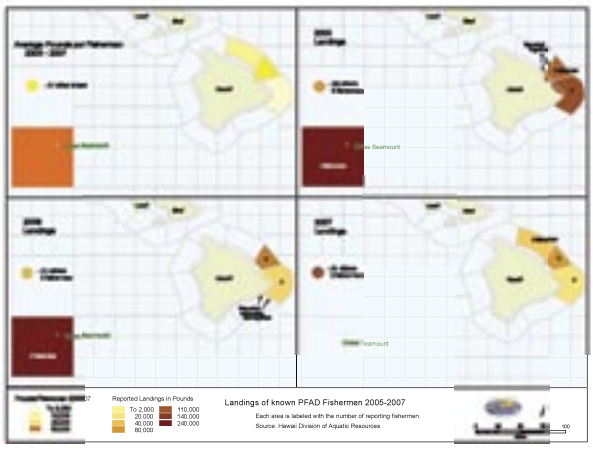
- To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

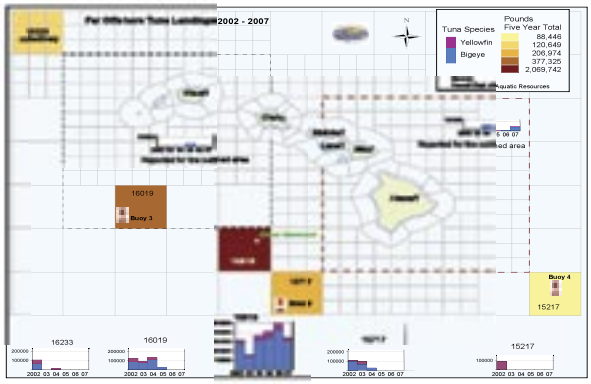
Purpose of the Project

This project is closely related to the PFRP project titled "Human Dimensions of Hawaii'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 2008

The proposed goals and objectives of the project were met during FY 2008. However, additional data collection and a variety of analyses were undertaken during FY 2008 in order to provide Council staff with new information needed in advance of upcoming management decisions regarding non-longline pelagic fisheries in the Main Hawaiian Islands. This information included: (1) detailed description, analysis, and spatial depiction of long-term trends in non-longline catch and effort in the nearshore and far offshore waters around the MHI, (2) description and analysis of contemporary challenges in the fisheries, and (3) analysis of potential fishery management options. The new materials were presented at the 2008 Pacific Pelagic Plan Team meeting, the 98th Scientific and Statistical Committee meeting, and the 142nd full Council meeting. The information was also presented by Council staff at public scoping meetings on Hawaii, Maui, and Oahu. The analyses are being incorporated into the forthcoming project report, which will include findings from both PFRP handline projects.





(above, left) Average Pounds per Fisherman (2005-2007). (above, right) Far offshore tuna landings (2002-2007)

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

P.I.: Jeffrey C. Drazen [Réka 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 projects 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:

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

Progress during FY 2008

During the last project year most of our time was spent processing samples from Cross seamount and American Samoa and analyzing the resulting data. Trawls were also sorted from the coast of Hawaii and the results suggest that the lee of the islands support a greater abundance of micronekton. These results are in addition to the original goals of the project. The Cross seamount sampling provided a great amount of insight into the impact of the seamount on micronekton. Contrary to initial expectations, the waters over the seamount summit had significantly less micronekton (abundance and biomass) than areas away from the summit and in the open ocean. Objectives 1, 2 and 4 were met. These results were presented in detail at three presentations (both local and international) and have been accepted in manuscript form at the journal Deep-Sea Research. Another cruise to Cross seamount was conducted in April of 2008 and an additional 12 tows were collected.

The American Samoa samples have been analyzed. While trawl failures prevented us from assessing the impact of eddies on micronekton we are in the process describing the micronekton community from this important fisheries area for the first time. This work almost completes our objective 3.

PFRP: The Associative Dynamics of Tropical Tuna to a Large-scale Anchored FAD Array

P.I.: Kim N. Holland [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-base management

Purpose of the Project

The purpose of the project is to apply acoustic tags and tuna monitoring techniques developed in Hawaii on a small-scale anchored FAD array to a larger system exploited by industrial-scale fisheries. The project was designed as an integral component of a medium-scale tuna tagging/assessment project of the Secretariat of the Pacific Community in conjunction with the National Fisheries Authority of Papua New Guinea (PNG). That PNG-linked project was part of Phase 1 of a larger-scale Pacific Tuna Tagging Project that encompasses the entire central and western Pacific Region. The project used a combination of tag types to address several critical issues of tuna movement and behavior in the PNG EEZ that is being heavily exploited by domestic purse seine effort on a large-scale array of anchored FADs. The PFRP portion of the PNG Tagging Project funded acoustic tagging of skipjack,

yellowfin and bigeye tuna to examine fine scale behavior of tuna resources aggregated to this large number of anchored FADs useful for management purposes.

Progress during FY 2008

The fieldwork for the project, consisting of six months of tagging cruises in PNG waters concluded in May 2007 (FY 2007). The tagging cruises equipped seven groups of anchored FADs with Vemco VR2 automated fish monitoring receivers as per the funding proposal protocols in the Bismarck and Solomon Seas of PNG. Vemco V9 and V9P sonic tags were surgically implanted and released in association with monitor-equipped FADs (69 skipjack, 135 yellowfin, 18 bigeye tuna). Monitors on five FAD groups were recovered by the tagging vessel before the end of the tagging charter with data successfully downloaded. Two monitored FAD groups were left to collect additional data and were recovered and downloaded in FY 2008. The project met all tag release goals set out in the proposal except for bigeye tuna which were simply not available in sufficient numbers during the tagging cruises. The associative dynamics of tuna to seamounts in PNG was not addressed due to a lack of tuna encountered on the few seamounts investigated during the field cruises.

Acoustic data was analyzed during FY 2008 and results presented at meetings. Work progressed on the publication of results of the project and was accepted for publication. The PIs of the project assisted the National Fisheries Authority of PNG in the planning of continued acoustic tagging work of bigeye tuna. All funds for the project were expended during FY 2008 officially ending the project activity but analysis of acoustic data will continue.

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

P.I.: John R. Sibert [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 need to determine the mechanisms involved in observed variability across species, trophic connections, and oceanic regions. In this project, two spatial bio-physical models are proposed to be run for several tuna species concurrently with different long-term (up to 50 years) climate regime datasets. It is anticipated that the models will enable researchers to evaluate potential alternative system states due to physical and anthropogenic forcing and to 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.

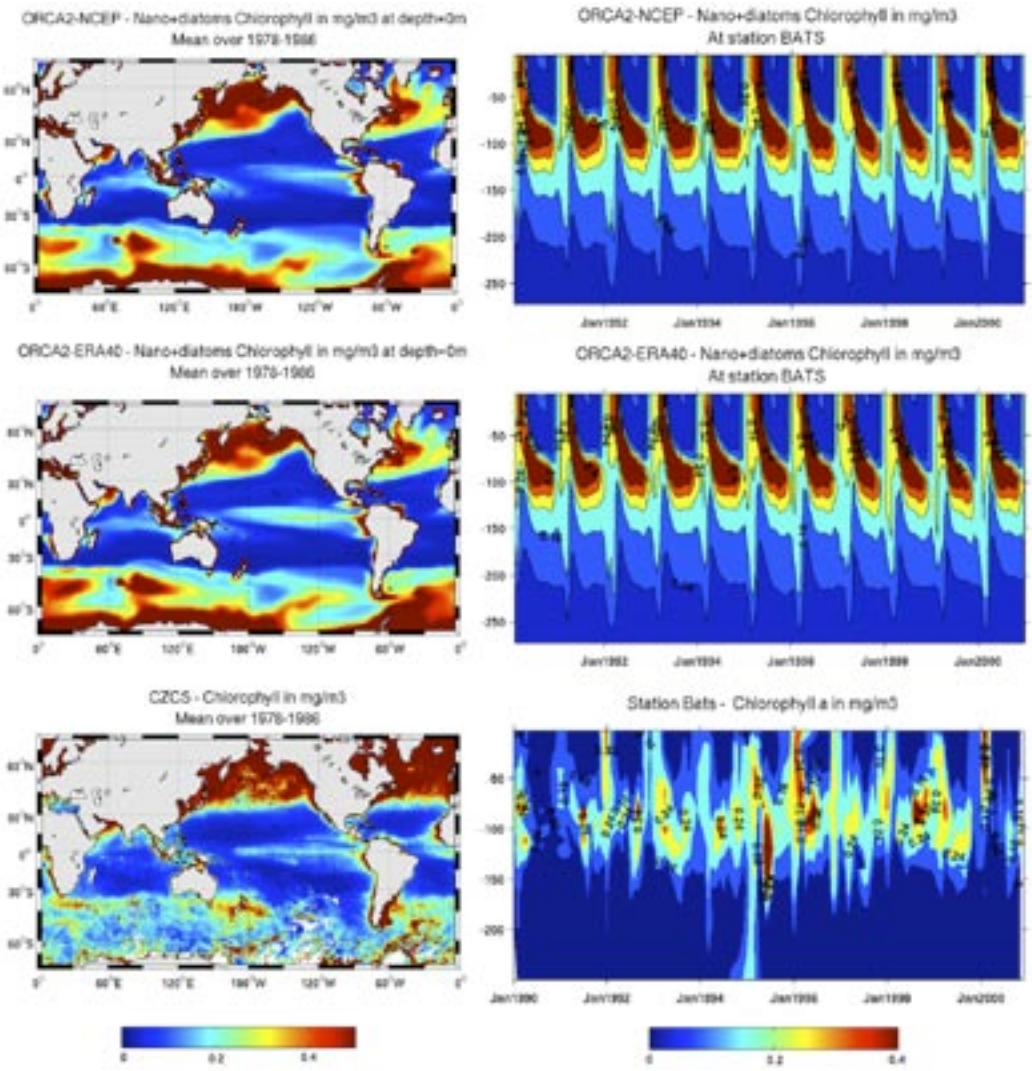
Progress during FY 2008

The planned activities for Year 2 of the project were:

1. Preparation and analyses of physical-biogeochemical reanalyses to be transmitted to CLS and IRD-Sète for starting simulations with the Spatial Ecosystem and Population Dynamics Model (SEAPODYM) and the Apex Predators Ecosystem Model (APECOSM).
2. Run physical-biogeochemical offline coupling at the Ecosystems Science Interdisciplinary Center (ESIC) at the University of Maryland to provide one additional forcing data set for the simulation ensemble.

3. Recruit a fishing database engineer to collaborate in the development of a global tuna fishing database (SARDARA) that will be accessible through the web
4. Recruit computer engineer for APECOSM for code parallelization at IRD
5. Achieve the parameterization of SEAPODYM using optimization for yellowfin tuna in the Pacific Ocean.
6. Achieve the parameterization of APECOSM for one species in the Indian Ocean.
7. Using biogeophysical reanalyses provided, run global SEAPODYM simulations with parameterization achieved in the Pacific Ocean.
8. Attend the CLIOTOP symposium in La Paz, Mexico (Dec. 2007), PI meeting in Hawaii (Nov. 2007) and/or the tuna conference in Lake Arrowhead, CA in May 2008.

The project post-doc scientist, Dr. Vincent Faure, provided the two (NCEP and ERA40) ORCA2-PISCES physical-biogeochemical reanalyses to CLS on a regular grid. Unfortunately, files were corrupted. One reanalysis (forced by NCEP) was reprocessed in CLS to be used with SEAPODYM. The other (forced by ERA40) as well as ORCA05-PISCES has been directly provided to IRD-Sète by O. Aumont. The biogeochemical outputs of the two simulations were evaluated by the postdoc scientist. In general, the modelled chlorophyll appears stronger than the observations, especially in ORCA2-ERA40. The modelled surface chlorophyll concentration appears

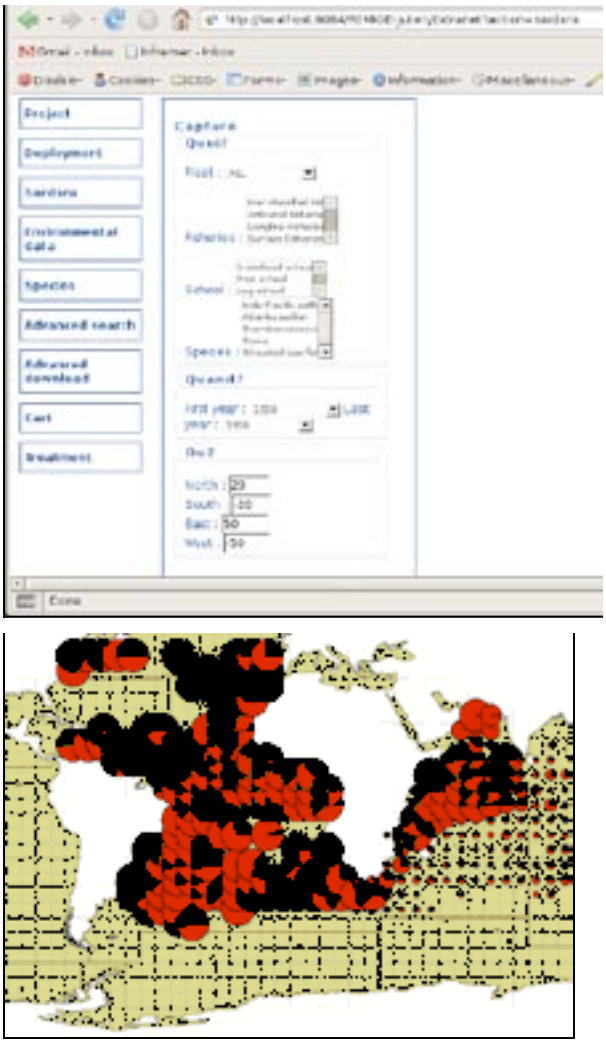


Comparison of predicted and observed chlorophyll a concentration. (left) Mean global average predicted from ORCA2-ERA40-PISCES, ORCA2-NCEP-PISCES and observed with CZCS satellite (Units: mg m^{-3}. Computed over 1978-1986). (right) Time/depth chlorophyll a concentration predicted by simulations ORCA2-NCEP-PISCES and ORCA2-ERA40-PISCES, and observed at station BATS (32°N-64°W) between 1990-2000 (Units: mg m^{-3})

correct at temperate latitudes, both horizontally and vertically. Outputs are much less satisfactory for the interannual variability and in highly dynamic zones. ORCA05-PISCES outputs have not yet been analyzed.

Dr. Faure has decided to leave the project after the first year and has been replaced by Dr. Julien Jouanno since May 1st. The initial 18-month contract has been reduced to 12 months due to the drop in the US Dollar-Euro exchange rate since the submission of the project. J. Jouanno is based in CLS, taking in charge the simulations and analysis of the SEAPODYM mid-trophic simulations. The first one with the NCEP-ORCA2 reanalysis has been produced and is currently analyzed. Unfortunately, other forcing data sets are still not available. Recruitment of a computer engineer for APECOSM has been postponed and will be effective the 1st of October.

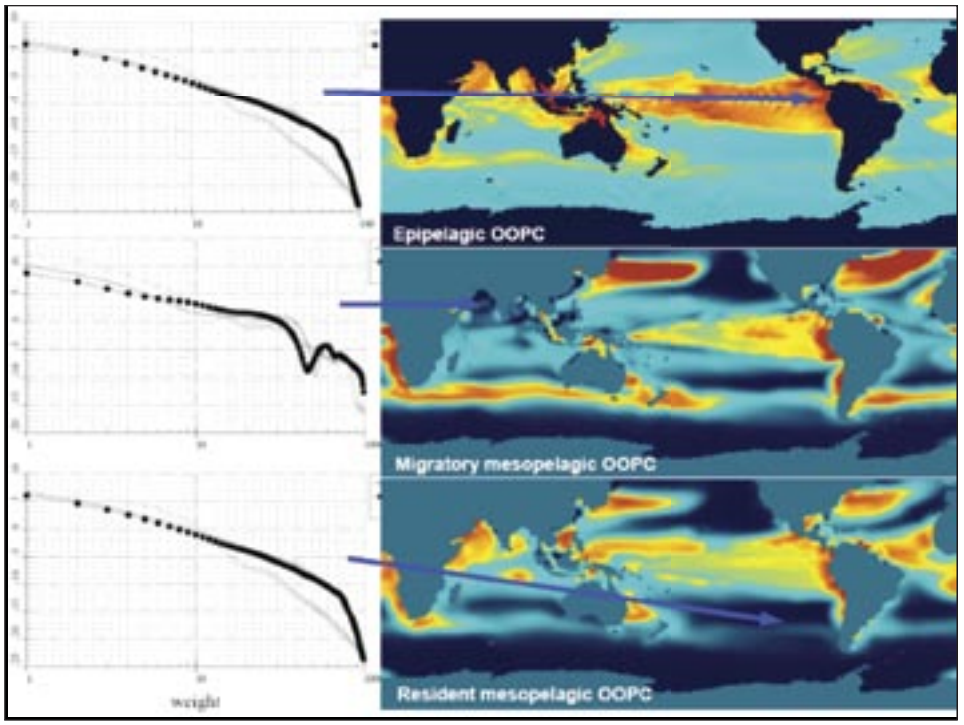
The fishing database engineer has been recruited in IRD-Sète in Nov. 2007. The new scheme of the database SARDARA and its implementation are achieved. Then, the treatments for catch and effort data have been completed for both Indian and Atlantic Oceans. For the Pacific Ocean, data should be processed after the last release by the SPC/WCPFC in the coming month. A first (alpha) version of the web site will be released soon. The goal is to provide a user-friendly interface to build requests for accessing, extracting and displaying fishing data.

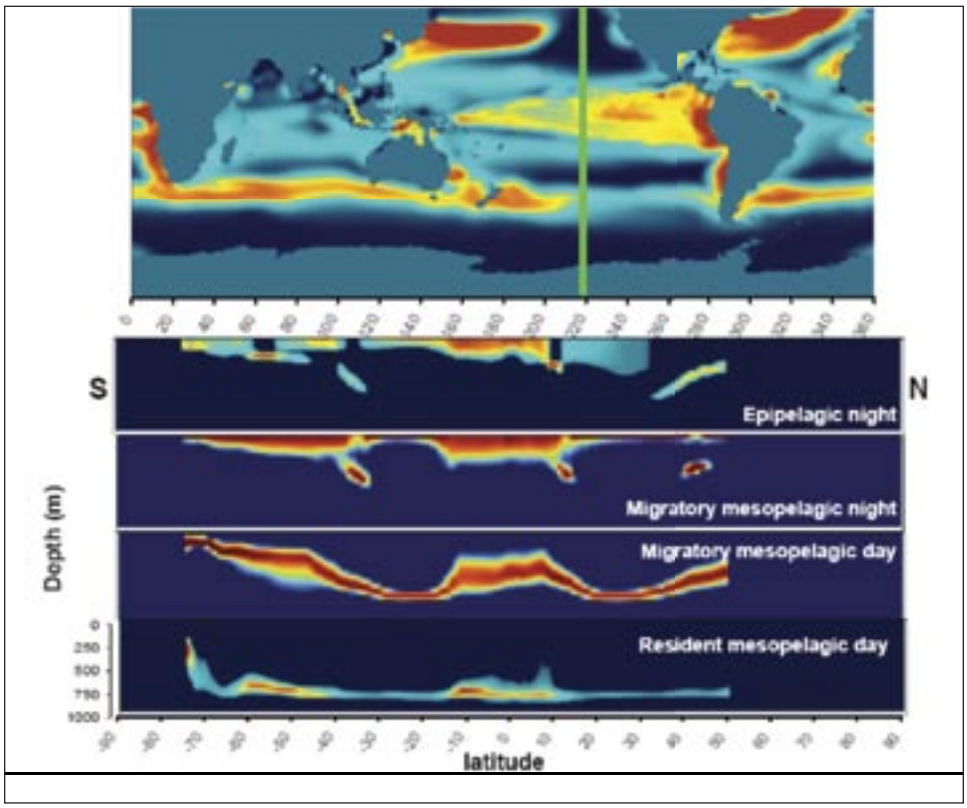


Web page of the global tuna fishing database SARDARA and example of an output with the map tool.

Due to the delay in the transmission of forcing data sets, the parameterization of SEAPODYM for Pacific tuna species was conducted with a reanalysis that was provided previously by ESSIC. Parameter optimization has been obtained for skipjack and bigeye. Size frequency data of yellowfin tuna for the eastern Pacific fisheries are still missing despite several requests by GW to IATTC. Given the importance of this region for the yellowfin tuna fisheries, we have delayed the optimization experiment for this species until we can obtain and use these data. We used a global forcing data set from a climate change scenario (IPCC A2) provided by L. Bopp (IPSL) to test at global scale the parameterization achieved in the Pacific. Results are plausible and encouraging, though a formal evaluation cannot be conducted as long as fishing data of Indian and Atlantic Oceans will be not available.

Concerning APECOSM, a 3-D 1° global grid has been designed based on a modified LEVITUS grid and the model has been modified to run on this new toric grid. APECOSM has also been modified to be explicitly 3-D to take into account variable vertical distributions and diel movements of the 3 layers of the model. This has been possible using mathematical/numerical techniques derived from the slow/fast systems theory. The model has been modified to consider explicitly variable bathymetry and it is now producing 3-D outputs. The global configuration using the inter-annual forcing 1958-2001 (15 forcing steps per year) has been set up. A new management of inputs/outputs has been developed. To achieve reasonable computing times, APECOSM has been parallelized using the open MPI standards to run on the CRH cluster of PCs. Deep modifications of the code have been undertaken for that purpose. The 6D netcdf outputs of the model (x, y, z, t, size, community) being too voluminous on the global grid, a new set of routines has been implemented to output projections of the 6 dimensional outputs on reduced numbers of dimensions. The first global 3D results have been recently presented at the AMEMR Symposium (Advances in Marine Ecosystems Modelling Research June 23-26, 2008, Plymouth, UK). Extensive tests are being conducted and a paper is being written.





Preliminary outputs from APECOSM. (top panel) Comparison of the modeled spatial distribution and size-spectra for the three modeled communities (epipelagic, migratory and mesopelagic) for a given size class, a given time and aggregated over the z dimension. (bottom panel) Preliminary outputs from APECOSM: comparison of the modeled vertical distribution of the three modeled communities (epipelagic, migratory and mesopelagic) along the green transect for a given size class at a given time.

PIs and collaborators of the project attended the CLIOTOP symposium in La Paz, Mexico in Dec. 2007. The project was presented in Hawaii PFRP-PI meeting by Dr. John Sibert. Patrick Lehodey gave a presentation at the International Symposium on the Effects of Climate Change on the World's Oceans, Gijón, Spain (May 19-23, 2008). Olivier Maury gave a presentation at the Advances in Marine Ecosystem Modeling Research Symposium (AMEMR) in Plymouth (June 23-26, 2008).

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

P.I.: John R. Sibert [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

We are conducting quantitative and qualitative analyses of existing data on the ecology, distribution and fishery interactions of leatherback and loggerhead sea turtles in the North Pacific and North Atlantic oceans. Our 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., Hawaii, Grand Banks) or major restrictions on effort and area for the US Fleet (e.g., NE Distant Sector, Atlantic). Scientific understanding of the extent and nature of world-wide 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 2008

The objective of this portion of the PASTA initiative was to examine dispersal of sea turtle hatchlings via drift simulation in order to understand possible reasons for differences in recruitment. A model was developed by David Kirby, with input from our lab, as well as that provided in our PASTA workshops, to investigate inter-annual and decadal scale variability in the areal extent of Pacific pelagic habitat for hatchlings. The motivation for the work was to investigate the hypothesis that changing ocean conditions during early life history may have impacted upon recruitment within turtle populations. An additional goal is to understand difference dispersal outcomes in the Pacific versus Atlantic basins that might provide insight on differences in population cycles.

The hatchling drift model assumes that movement results both from advection of leatherback hatchlings by surface currents and diffusion due to randomly directed swimming activity. This structural assumption in the model is a necessary simplification that neglects finer scale directed movements by the whole simulated population, but it is likely to be robust at the time step (1 day) and grid spacing (1/2 degree) used. Recent work exploring foraging behavior after extracting current vectors from adult turtle tracks (Phillippe Gaspar, pers. com.) clearly illustrates how the effects of surface currents can mask the effects of foraging, and this effect is likely to be significantly greater for hatchlings than for adults. Numerical particle tracking experiments were carried out, with populations of hatchlings released immediately offshore from known nesting beaches during the months of peak hatchling emergence. The maximum extent of occupied habitat was recorded at the end of one year of simulation and the model was run for the years 1948-2004. The results showed considerable variation in the spatial extent of hatchling habitat, with Japanese loggerheads having clearly the most disbursed population and West Papuan the most variable. There is apparent synchronicity between the spatial extent of hatchling habitat on both sides of the Pacific, reflecting the basin-scale effects of the El Niño Southern Oscillation on surface currents.

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

P.I.: John R. Sibert [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 Business Card Tag (BCT) is aimed at increasing knowledge regarding schooling cohesion and inter-species association. The overall objective of the project is to assess the feasibility of a two-way receiver tag (called 'business card' tag), through:

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

Prototype Business Card tag attached to Galapagos shark

Progress during FY 2008

Five prototype BCTs were received from Vemco by the end of Summer 2007. First tests were done in Kaneohe Bay in November 2007 in order to test the receiver and transmitter performances of BCTs. BCTs, regular tags and regular VR2s were deployed for 12 to 24 hours periods at fixed locations, and other tests consisted of testing the performance of a BCT while being dragged by a kayak. All tests were positive, showing that the BCTs were able to transmit their ID like other regular tags, and BCTs could detect the other tags like regular VR2s. These tests were also an opportunity to test the prototype software of Vemco to activate the BCTs and download the data. Those tests were also positive and we do not recommend any change.

The next phase of testing consisted in deploying BCTs on wild animals. Three BCTs were deployed on Galapagos sharks on May 19, 2008 and one on May 27, 2008 on the North Shore of Oahu. Twenty-one other Galapagos and sandbar sharks were already equipped with regular tags (V16). One of the BCTS was recovered after 20 days at liberty. The results are extremely positive in terms of the number and duration of detections of other tagged sharks. Below is a summary of the data collected from this recovered BCT:

- Detected 21 of 21 (100%) Galapagos sharks tagged with conventional V16 tags off Haleiwa
- Detected 8 of 10 (80%) sandbar sharks tagged with conventional V16 tags off Haleiwa
- Detected all 3 other BC tag-equipped Galapagos sharks on multiple occasions
- Detected a couple of tag IDs that have not been identified yet
- Strong diel patterns are already evident

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.: John R. Sibert [Jeffrey J. Polovina, Michael P. Seki]

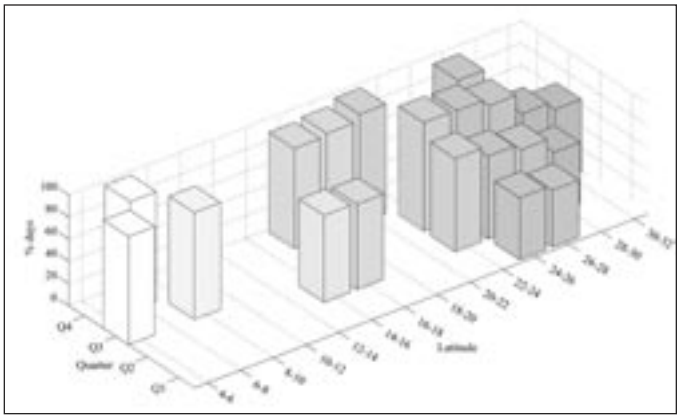
NOAA Office (of the primary technical contact): National Marine Fisheries Service/Pacific Islands Fisheries Science Center

NOAA Goal(s)

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

Purpose of the Project

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



The model predicted percentage of days with expected potential vulnerability of bigeye tuna to longline gear pooled by the quarter of the year and 2° latitude bins based on the geolocation estimates

Progress during FY 2008

We used data from pop-up tags deployed on 29 bigeye tunas to describe their vertical habitat in the central North Pacific. While bigeye are know for foraging between 300-400 m depths during the day, we found that in cooler surface waters they spent substantially less time at these depths and hence were less vulnerable to deep-set longline gear. We developed a model that predicted bigeye habitat depth based on latitude, quarter, and sea surface temperature. This work was presented at the CLIOTOP Symposium and has been submitted for publication.

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

P.I.: John R. Sibert [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 primary goal of the project is to provide fishery managers in the region with empirically-based information about variation in the manner and context of the distribution and use of pelagic seafood products in the Main Hawaiian Islands. A case study approach is being used to assess "fish flow"—seafood distribution and related cultural and community dynamics—for both consumption- and commerce-oriented small boat fleets at Waianae on the Leeward Coast of Oahu

Preparing ahi for the grill (early summer 2008).

and at Haleiwa on the North Shore of Oahu. Patterns of seafood distribution for the Hawaii-based longline fleet are also being examined.

Time to eat!

Progress during FY 2008

Fieldwork for this study was completed in June 2008. This was the culmination of an extended period of research interactions with networks of commercial, recreational, consumptive, and mixed-motivation fishermen at Haleiwa and Waianae. Once rapport with the research participants was established, a long series of in-depth interviews was conducted to aid in documenting the manner in which pelagic species were and are typically distributed in terms of percentages (a) sold, (b) kept and consumed, (c) shared, and/or (d) subjected to some form of reciprocity. Interviews also involved discussion of whether and how such patterns vary over time, and why. The locations of families and business entities receiving the seafood were carefully documented, and motivations for pursuing and using seafood in various ways in extended family and community settings were explored in depth. Field staff observed and participated in numerous fishing trips and ohana/community events related to fish and fishing so as to better understand and document the social and cultural context of fishing and consuming seafood on Oahu. Field staff also worked closely with captains in the Hawaii-based longline fleet to better understand and document patterns of commercial and non-commercial distribution of seafood products landed by that fleet, and to examine how fishing strategies are influenced by understanding of constraints and opportunities in the marketplace.

PFRP: Economic Fieldwork on Pelagic Fisheries in Hawaii

P.I.: John R. Sibert [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

Project staff will complete the assessment and documentation on the patterns of adoption of new technology and the resulting effects on fishing productivity in the Hawaii-based longline fishery. Staff will also complete the analysis on the willingness to pay for different types of activities associated with spinner dolphin excursions in Hawaii. The results from these two studies will be included in manuscripts for publication.

Progress during FY 2008

For the first research project, entitled *The Fishing Technological Changes and Their Impacts on Fishing Capacity and Productivity,* staff members have completed the inventory of the possible changes in the longline fishing technology in the Hawaii longline fleet during the past 20 years. A statistical model has been designed to examine the impacts of the fishing technological changes on fishing productivity in the Hawaii longline fishery. A draft report, "The Impact of Fishing Technological Changes on Fishing Productivity and Capacity" by Minling Pan and Quang Nguyen, has been completed.

In addition, staff members conducted and completed the *Valuation of Spinner Dolphin Excursions* study. Through conjoint analysis, this study investigated the factors that affect consumer's willingness to pay for spinner dolphin excursions. Staff completed a draft report titled *Valuation of Consumer Choices on Spinner Dolphin Excursions and the Implications on Spinner Dolphin Conservation in Hawaii* based on the study.

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

P.I.: John R. Sibert [Jock Young, Robert Olson, Valerie Allain, Jeffrey Dambacher]

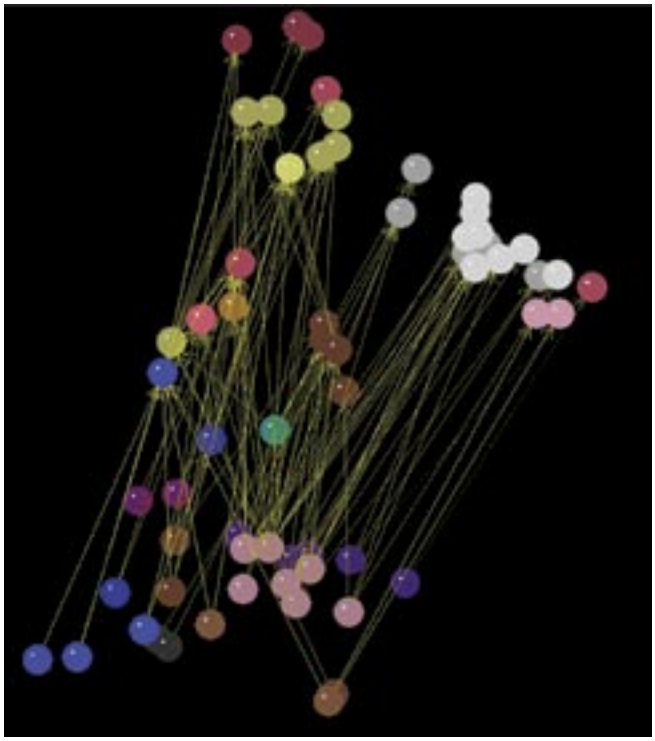
NOAA Office (of the primary technical contact): National Marine Fisheries Service/Pacific Islands Fisheries Science Center

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

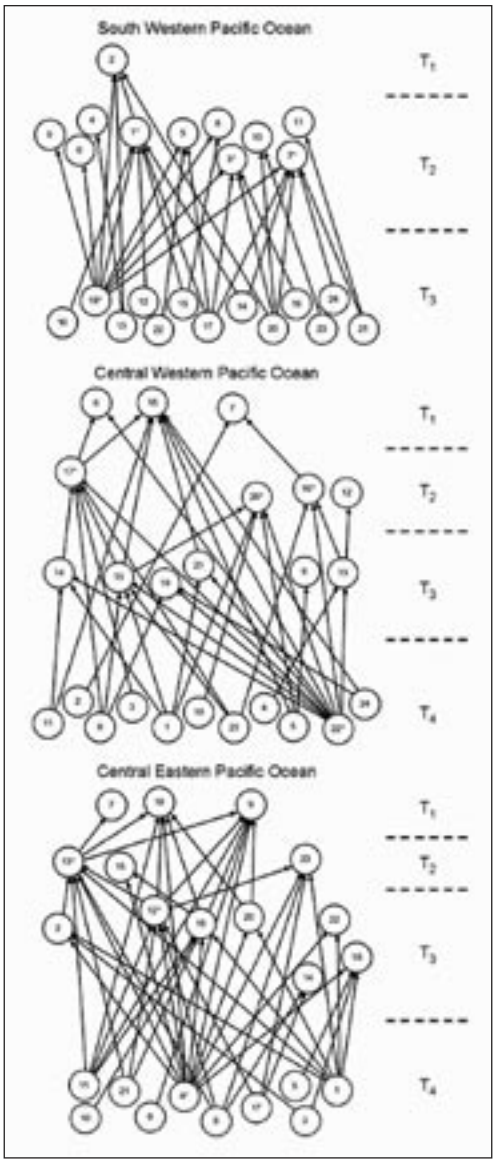
A previous trophodynamics study funded by PFRP (Trophic Structure and Tuna Movement in the Cold Tongue-Warm Pool Pelagic Ecosystem of the Equatorial Pacific) has demonstrated significant heterogeneity in trophic pathways across the tropical Pacific, associated with either the prevailing mesoscale oceanography or the seabed topography. These results have the potential 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 will conduct a study that compares the trophodynamics of the pelagic ecosystems of these regions using largely existing data sets. The analysis would combine 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. The project will 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.



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.

Progress during FY 2008

The database was updated and now has data from the Commonwealth Scientific and Industrial Research Organization (CSIRO), SPC, and IATTC pelagic feeding studies. Data from ~10,000 stomachs from 26 species are now entered along with accompanying environmental data. The data were assimilated and a series of qualitative model comparisons run for the three regions. Jeff Dambacher presented these results at the November 2007 PFRP meeting. A talk was also presented on the results at the First CLIOTOP symposium in La Paz, Mexico by Jock Young. Progress and future plans on the project were also discussed by Jock Young, Robert Olson and Valerie Allain at the symposium. A manuscript was later prepared (Dambacher et al., in review) and submitted to Progress in Oceanography as a contribution to a volume being published on the symposium.



Pelagic food web leading to top predators in the central western Pacific Ocean. Arrows lead from prey to predator species, nodes are coloured by group membership, as determined from similarity of predator-prey relationships

PFRP: Fishery Dynamics in the Samoan Archipelago

P.I.: John R. Sibert [Keith A. Bigelow, Adam Langley, John Hampton]

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

NOAA Goal(s)

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

Purpose of the Project

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

Progress during FY 2008

Objective 1. American Samoa longline logbook data were merged with oceanographic data (e.g., sea surface temperature, ocean color, dynamic height and subsurface temperature measurements) using spatio-temporal information. The resulting dataset was used to investigate variations in catch of the American Samoa based longline fishery. Generalized Linear Models (GLMs) and General Linear Mixed Models (GLMMs) were the exploratory statistical tools employed with a negative binomial error distribution. Results indicated that catch and landings were largely explained by vessel size and effort. Oceanographic variables contributed little to explaining catch or catch per unit effort (CPUE) in the fishery, due possibly to a spatial mismatch between the longline set and remotely-sensed variables and/or albacore tuna occupy upper portions of the thermocline where oceanography is not defined well from surface measurements.

Objective 2. A co-PI (Adam Langley) completed an analysis of South Pacific albacore dynamics for the Fiji and French Polynesia longline fisheries. Results indicated that catch and CPUE appeared directly related to seasonal fluctuations and trends in fisheries in adjacent EEZ waters are likely to be influenced by similar variations in oceanographic conditions. Inter-annual variation in albacore catch rates was also evident in most of the PICT fisheries. The sustained period of low catch rates that commenced in late 2002 appears to be attributable to inter-annual variation in oceanographic conditions and at a local scale, very high levels of fishing effort appear to be capable of causing localized depletion of albacore tuna.

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. Considerable reappraisal of the CPUE time-series was conducted 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 amongst 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: A General Bayesian Integrated Population Dynamics Model for Protected Species

P.I.: John R. Sibert [Mark Maunder]

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 objective of the project is to generate a general Bayesian integrated modeling framework for protected species modeling that can be applied to multiple species and used to provide management advice. Models will be developed based on the general framework and used to estimate the effect of fisheries on the protected species populations.

Progress during FY 2008

The general framework and the general covariate model applications to the Tern Island population of black footed albatross were updated and the results presented at the PFRP hosted Albatross Modeling Workshop, November 7-9, 2007. The final data sets have yet to be provided to our group and therefore the results are still preliminary.

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

P.I.: John R. Sibert [Edward W. Glazier]

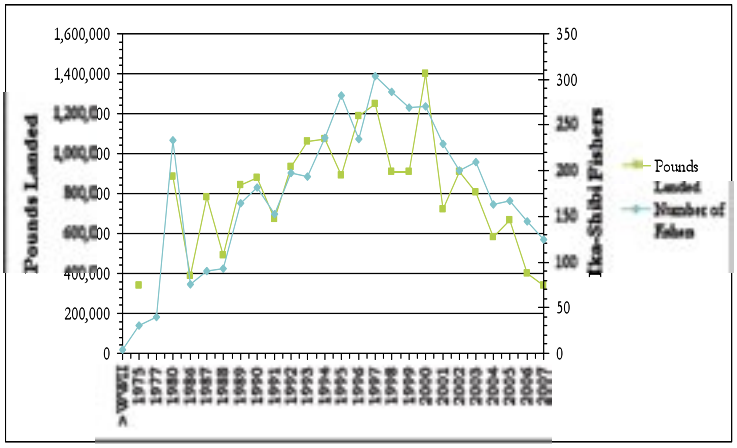
NOAA Office (of the primary technical contact): National Marine Fisheries Service/Pacific Islands Fisheries Science Center

NOAA Goal(s)

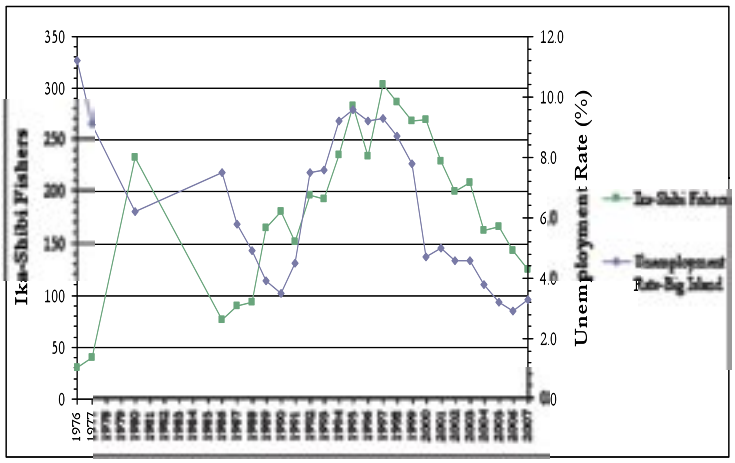
- To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

The project, *Human Dimensions Analysis of Hawaii's* Ika-Shibi *Fishery*, is closely related to the PFRP project titled *Small Boat Bigeye and Yellowfin Tuna Operations and Regulatory Scenarios in the Main Hawaiian Islands*. 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 small boat handline fisheries around the Main Hawaiian Islands. The specific goal of the ika-shibi project was 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.



Long-Term Trends in Landings and Participation in Hawaii's Ika-Shibi Fishery



Participation in the Ika-Shibi Fishery vis-à-vis the Big Island Unemployment Rate

Progress during FY 2008

The proposed goals and objectives of the project were met during FY 2008. However, additional data collection and a variety of analyses were undertaken during FY 2008 in order to provide Council staff with new information needed in advance of upcoming management decisions regarding non-longline pelagic fisheries in the Main Hawaiian Islands. This information included: (a) detailed description, analysis, and spatial depiction of long-term trends in non-longline catch and effort in the nearshore and far offshore waters around the MHI, (b) description and analysis of contemporary challenges in the fisheries, and (c) analysis of potential fishery management options. The new materials were presented at the 2008 Pacific Pelagic Plan Team meeting, the 98th Scientific and Statistical Committee meeting, and the 142nd full Council meeting. The information was also presented by Council staff at public scoping meetings on Hawaii, Maui, and Oahu. The analyses are being incorporated into the forthcoming project report, which will include findings from both PFRP handline projects.

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

P.I.: John R. Sibert [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 is to evaluate the incidental catch rates of non-target fish species and sea turtles in Hawaii's longline fishery and make comparisons with other pelagic longline fisheries using a methodology patterned after Hall (1999). The final report titled *Catch to Bycatch Ratios: Comparing Hawaii'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 (WCPO) producing ultra-low temperature (ULT) 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 in addition to the information on gear and fishing practices.

Progress during FY 2008

Travel to Taiwan to collect information detailing fishing gear configurations and operating methods from Taiwanese ULT freezer tuna longline vessels could not be made due to scheduling conflicts. Graphic presentation of Bycatch top Catch (B/C) ratios for sea turtles for longline fisheries using circle diagrams was refined during this period. Work began on drafting a manuscript on the use of B/C ratios to differentiate longline caught pelagic fisheries products.

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

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 2008

After initial delays in construction, the prototype autonomous device was completed and tested by colleagues at Scripps Institution of Oceanography (SIO). Specialized batteries required for deploying the device in Hawaii for field testing have been acquired. Budget shortfalls at SIO resulted in the device not being equipped with a robust housing suitable for field deployment in Hawaii. This housing will be constructed in Hawaii with remaining project funds.

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

P.I.: John R. Sibert

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 general objective of this research is to integrate the results of different components of the Pelagic Fisheries Research Program into a consistent framework that integrates knowledge of fish movement and population dynamics, the fishing process, economics and oceanography. The primary focus is the development of spatial models of pelagic fish population dynamics that explicitly include movement, mortality, and fisheries. The work emphasizes collaboration with other PFRP projects.

Progress during FY 2008

Various state-space models developed by the PFRP for reconstructing tracks of animals tagged with electronic devices have been very well received by workers in this field. This success is an important achievement of PFRP modeling efforts.

Progress on goals from FY 2007.

- Post-doctoral researchers, Inna Senina and Anders Nielsen both left the PFRP at the end of 2007, and attempts to recruit a new post-doctoral research were not successful. Consequently some of the project goals were not fully completed.
- Conclude work on the an algorithm based on the theoretical analysis of geolocation errors for application in cases where light data from tags are not available.
  - This work is completed and a preliminary report will be published in the proceedings of the Second International Symposium on Tagging and Tracking Marine Fish with Electronic Devices, Oct. 8-11, 2007, Donostia-San Sebastian, Spain.
- Complete the initial modeling phases for combining individual and population based estimation of migration patterns.
  - Supporting the PFRP state-space models during their initial adoption by the electronic tagging community required a major time commitment from PFRP post-doctoral researcher Anders Nielsen in 2007 leaving little time for work on the project.
- Begin a comparison of movement parameter estimates across species of pelagic fish derived from different tagging methods.
  - The tag diffusion model developed for basin scale analysis of populations of tagged fish was implemented as an ADMB application. This is a major achievement that will allow more rapid future development and ease its application to new situations.
- Implement an optimized SEAPODYM model for yellowfin tuna, *T. albacares*, across the Pacific basin. The variable spatial resolution capabilities of SEAPODYM will be used to implement a model at 1/3 degree spatial resolution around the main Hawaiian islands for use in the Hawaii-Pacific Ocean Observing and Information System project at SOEST.
  - This work was not completed because of difficulties recruiting a post-doctoral researcher.

PFRP: Integrated Modeling for Hawaiian Albatross Populations

P.I.: John R. Sibert [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 2008

In November 2007 the project funded a workshop in Honolulu to consider the available data and to compare the analyses done up to that time by the project (which has two separate components, Montana State University [MSU] and Montpellier, FR), a related JIMAR-PFRP project headed by Mark Maunder, and other analyses done by the US Fish and Wildlife Service (FWS). The upshot of the data discussion at the workshop was that there were serious problems with data availability and documentation, and possibly quality. The most thorough looking data set available on albatross demography was the mark-resight data originating from FWS field efforts, compiled and reconciled by personnel at the Patuxent lab, and further rectified and organized by Sophie Veran (Montpellier, the project), covering only Black-footed albatross, only at Tern Island, for banding years 1980-2003 and resight years 1992-2004. The project (MSU) concluded that these data were valid for estimating annual survival rates for adults in ages 7-11 for years 1998-2002. Bayesian estimation of survival rates for this subset, and subsequent correlation analysis of the years survival rate with the summed indices of swordfish and tuna tonnage in the North Pacific for those years showed a definite strong negative correlation. This confirmed the analysis carried out by Sophie Veran (Montpellier) using other statistical methods and other judgments about the data, and since published. Full access to the fisheries data were never achieved so questions about the fishery indices used in this analysis remain unresolved. The correlation though is too strong to be dismissed, placing a high premium on resolving the questions about the fishery indices, and on obtaining mark-resight data for the years after 2004, to determine if the correlation continues to hold. This analysis has since been documented in a report.

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

P.I.: John R. Sibert [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

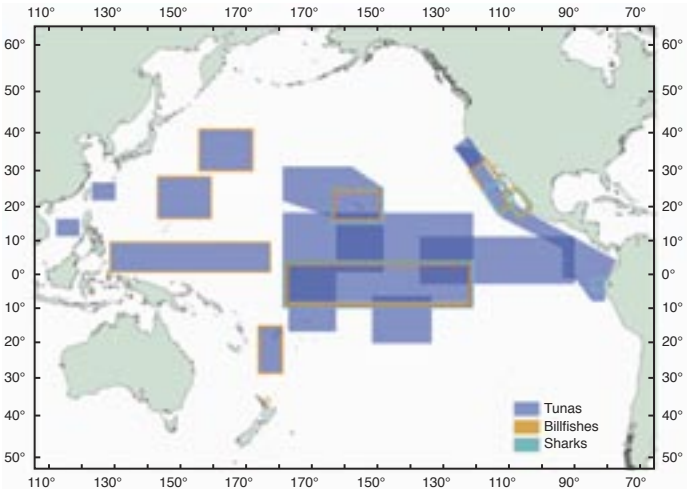
Purpose of the Project

The purpose of the project is to evaluate the importance of intra-guild predation and cannibalism on Pacific tuna population dynamics and the fisheries targeting them. The project goals are to (1) identify the sources, magnitude, and variability in predation on skipjack and yellowfin tunas, (2) determine the life history stages when predation by apex predators (tunas, sharks, marlins) has the largest impact on tuna populations, and (3) quantify biologically plausible responses of skipjack and yellowfin tuna populations to predation. Our approach for accomplishing these goals is to combine a research synthesis of the extensive historical and contemporary food habit studies of apex predators with simulation and mass-balancing modeling. The models can be used to explore the implications of predation and predator removals for management strategies and policy-relevant reference points. Additionally, the synthesis of food habits data for the project serves as a framework for the first comprehensive

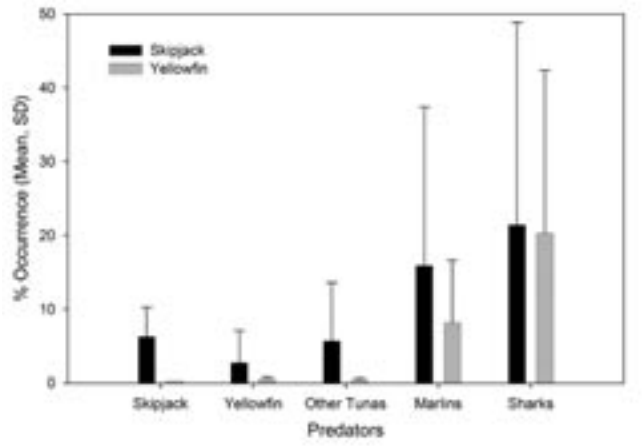
data repository of diet data for pelagic fish predators in the Pacific Ocean. This database will be shared with scientists worldwide.

Progress during FY 2008

The second year of the project has focused on the completion of the predator food habits database and a coarse evaluation of the diet data. This involved collating, organizing, digitizing, and analyzing historical and contemporary food habits data of tuna and tuna predators. To date, we have compiled summary data from 37 previously-published diet studies through an extensive literature search. The data contain diet information for 20 large-bodied predators, including seven species of sharks, five species of tuna, and three marlin species. The sampling years for these studies span nearly a 50-year time period, ranging from approximately 1950–2005. The study regions encompass the western, central, and eastern tropical Pacific Ocean. In addition, we "rescued" and digitized historical records of primary diet data for apex predators collected in the eastern and central tropical Pacific Ocean (F.G. Alverson, ETP; Pacific Ocean Fish and Invert project (POFI), CTP). Further, we nearly completed the collation of contemporary diet records for these fishes provided by researchers associated with the Inter-American Tropical Tuna Commission (IATTC), the ECOTAP research program (Etude du comportment des thonidés par acoustique et par pêche/study of tuna behavior using acoustics and fishing), CICIMAR (Centro interdisciplinario de ciencias marinas), and the NOAA-Southwest Fisheries Science Center (SWFSC). We received data from the POFI cruises near Hawai'i and have begun digitizing those data records.



Approximate locations of tuna, marlin, and shark diet studies that are compiled in the apex predator food habits database.



The percent occurrence of skipjack and yellowfin tunas in the diet contents of apex predators captured throughout the tropical Pacific Ocean between the years 1950–2004.

The project objectives established for the FY 2008 were to develop models of skipjack and yellowfin tuna populations and to assess the range of impacts that apex predators may have on stock productivity and on the values of key fisheries reference points. We used skipjack tuna as a "test case" to develop the modeling framework that will link observed information on size-structure of predated individuals, the proportional contribution of tuna to predator diets, together with information on stock sizes and age structure. The model can then predict the proportion of individuals that are not consumed by a predator while it passes through the age/size ranges at which it is vulnerable. Skipjack tuna in the western pacific ocean "warm pool" is a particularly interesting test case, as a dominant component of pre-recruit mortality comes from large skipjack who cannibalize on them. Our modeling approach indicates that a small fraction (<10%) of pre-recruit skipjack tuna avoid being consumed by larger skipjack tuna during the 6 week period when they are of the size range that makes them vulnerable to cannibalism. This work is presently being written up for publication, and the model framework will then be used to explore predation impacts on yellowfin and skipjack in various ocean regions.

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

P.I.: John R. Sibert [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

The primary goal of the project is to improve understanding of shark bycatch in the Hawaii-based longline fishery in both qualitative and quantitative terms. Improved understanding of the taxonomic composition of shark bycatch as reported by fishery observers may permit use of the diversity of these species as an indicator of ecosystem status. An improved understanding of the magnitude of shark bycatch, in the aggregate and by species, as self-reported by vessel operators in commercial logbooks, is fundamental background information required to evaluate the efficacy of bycatch reduction efforts. The need for sharks-related research in this fishery was described in a letter dated January 6, 2006 from Ms. Kitty Simonds, Executive Director of the WPRFMC, to Dr. Samuel G. Pooley, Director of the PIFSC of NOAA Fisheries. This letter referred to specific mandates in Sections 7(3) and 8 of the U.S. Shark Finning Prohibition Act that require identification of technical means to minimize shark bycatch. The secondary goal of the project is to compare catch rates for certain mid-sized predatory fishes (e.g., wahoo, *Acanthocybium solandri*, and mahimahi, *Coryphaena hippurus*) in widely separated areas of the Pacific Ocean in order to assess whether common inter- and intra-specific trends are apparent.

Progress during FY 2008

Analyses of sharks catch data reported by fishery observers (1995–2006) have been completed. A draft manuscript describing the results is in its initial review at the NOAA Fisheries PIFSC. The tentative title and abstract follow.

Shark Catches in the Hawaii-based Longline Fishery as Reported by Fishery Observers

Abstract

This paper summarizes catch data for sharks gathered by fishery observers aboard Hawaii-based longline vessels in 1995–2006, a period marked by two major developments that affected shark catches in this fishery. First, decisions enacted by the Western Pacific Regional Fishery Management Council in 2000–2001, including a closure for more than three years of effort targeting swordfish, *Xiphias gladius*, in order to protect endangered sea turtles, led to an overall decline in shark catches because this sector had historically been characterized by high shark catch rates. In addition, the practice of shark finning was prohibited by U.S. and Hawaii state laws during this period, which affected the disposition of those that were caught. Blue shark, *Prionace glauca*, was the predominant species throughout the study period (84.5% of the sharks catch). Five others (bigeye thresher shark, *Alopias superciliosus*, oceanic whitetip shark, *Carcharhinus longimanus*, shortfin mako, *Isurus oxyrinchus*, silky shark, *C. falciformis*, crocodile shark, *Pseudocarcharias kamoharai*) were relatively common (1.0–4.1%). Shark catches per unit of effort (CPUE; i.e., fish per 1000 hooks) differed significantly between the shallow-set sector targeting swordfish and the deep-set sector targeting bigeye tuna, *Thunnus obesus*, before and after the closure, and sexes. Blue shark and four other common species exhibited significant decreases in CPUE in 2004–2006, but shortfin mako CPUE on shallow sets increased, which probably resulted from an eastward shift in fleet activity relative to 1995–2000. The practice of finning virtually ceased after the prohibition. Because blue shark exhibited high apparent survival when released, we conclude that this fishery has made substantial progress toward reduction of bycatch mortality as mandated by the Magnuson-Stevens Fishery Conservation Act.

Analyses of sharks catch data as self-reported by vessel operators in commercial logbooks are in progress and will form the basis for a second manuscript. The analyses are concerned with catch data for the various Pelagic Management Unit shark species (e.g., blue shark, *Prionace glauca*, shortfin mako, *Isurus oxyrinchus*,

bigeye thresher, *Alopias superciliosus*). The intention is to submit the two manuscripts together for publication in a peer-reviewed journal at the earliest opportunity. Results from both the observer and logbook data will be presented at the national meeting of the American Fisheries Society (AFS) in Ottawa, Canada, in August 2008. Finally, an additional proposal was submitted to the Pelagic Fisheries Research Program (PFRP) in June 2008 to fund an extension of the catch rates comparisons with mid-sized predatory fishes. The initial response to this proposal from the PFRP was highly favorable, and formal acceptance is expected in the near future.

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

P.I.: John R. Sibert [Heidi Dewar, Jeffrey J. Polovina]

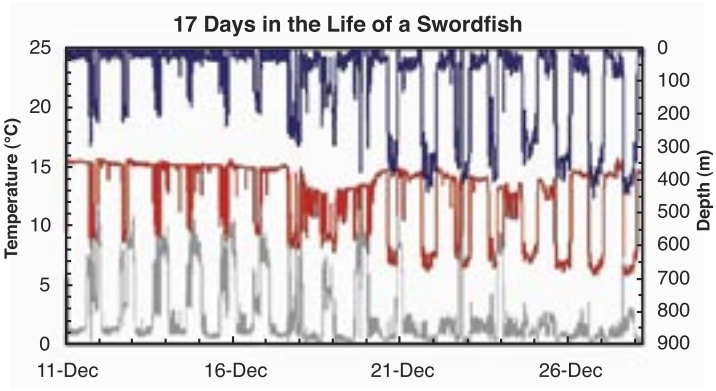
NOAA Office (of the primary technical contact): National Marine Fisheries Service/Pacific Islands Fisheries Science Center

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 management of swordfish in the Pacific is hampered by the lack of data on stock structure and essential habitat in part because of the difficulties associated with studying these large, active and aggressive fish. Electronic tags, such as the pop-up satellite archival tags, have been useful for examining the stock structure and habitat use of other pelagic fish. The goals of the project were four-fold. First, to determine the feasibility of using the California harpoon fleet to deploy pop-up satellite tags over long time periods. To do this, tags are deployed over periods of up to 6 months. The second is to test the retention rates with two different dart types. The third is to use any data obtained to determine whether the region off California is in fact a region of mixing as suggested previously and examine essential habitat in different oceanographic regions. Finally, given the diving patterns of swordfish and associated difficulty of using light to determine latitude and longitude, efforts will focus on using hydrographic features including SST to estimate locations between tag and pop-up.



An archival records showing seventeen days in the life of a swordfish including depth (blue), temperature (red) and light level (grey). This fish was tagged off California and recaptured off Hawaii nearly 4 months later. Note the transition in behavior around the middle of the record. At the beginning of the record the swordfish makes only brief forays below the thermocline. At the end of the record the more typical swordfish behavior is observed with animals leaving the surface at sunrise and generally not returning back to the surface until around sunset. Note the differences in the light record which indicates the day night cycle.

Progress during FY 2008

In the past year a total of 8 satellite tags were deployed by harpooners in the Southern California Bight. The harpoon fishery off California has a relatively high degree of variability and last year fewer fish were harpooned than usual. The entire fleet harpooned less than 100 fish which is why we were not able to get out all our tags. Of the eight tags deployed, three released early, two were recaptured (one after almost four months) and two of the remaining 3 reported to satellite. The tags were deployed with a mix of the two dart types. It is however, too early to determine which provides the highest retention rates, although the one tag that was recovered after nearly 4 months was secured using the large white dart with the highest surface area.

In addition to the tagging, we continue to make progress with efforts to confirm anecdotal reports that the

(right) This picture of a swordfish shows two features which are thought to be associated with fish of western origin, the wrinkly skin (these fish are known as wrinkle bellies) and a cookie cutter shark scar.

California Bight is a region of mixing between fish coming from the west and the south. At this point the focus is on sample collection. We have been collecting otoliths, parasites, and tissue for DNA and isotope analysis and just recently started documenting morphological differences and the occurrence of cookie cutter shark scars on swordfish. Based on the distribution of cookie cutter sharks, one would expect more scars on fish from the west than the south. A large number of samples were collected last year and we continue to work those up for ultimate processing.

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

P.I.: John R. Sibert [Michael K. Musyl, Christina Larsen, Hans Malte, Richard C. Brill]

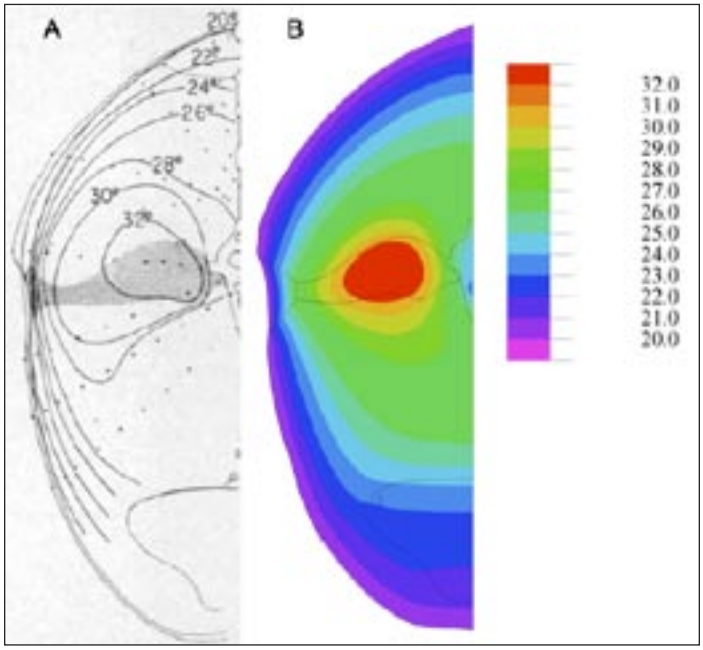
NOAA Office (of the primary technical contact): National Marine Fisheries Service/Pacific Islands Fisheries Science Center

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

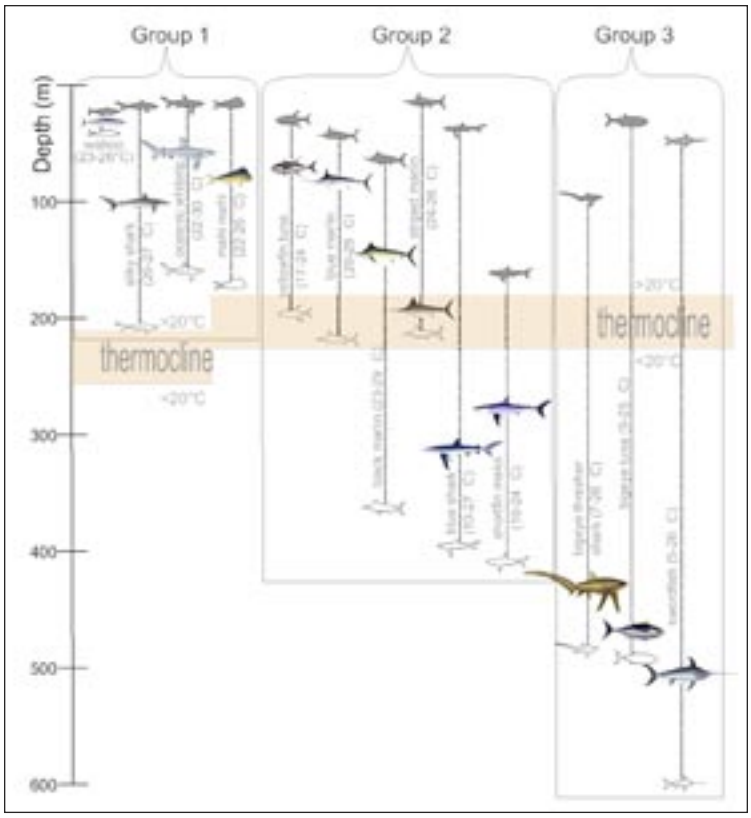
Purpose of the Project

We propose to use available data from archival and PSAT tags to develop IBMs (individual based models) to describe the eco-physiology of different species of large pelagic fishes and sharks. The 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 Hawaii/JIMAR/PFRP/VIMS/National Marine Fisheries Service, and the Dept. of Zoophysiology, University of Aarhus, Denmark. Our ultimate goal is to develop model(s), which will be applicable to many different pelagic fish and shark species. Using these models we 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 pop-up satellite archival tags (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



Plots of the isotherms in bigeye tuna. Cross-sections of the recorded isotherms (A) and the isotherms predicted by the model (B). The thermal distribution (A) as observed by Carey and Teal (1966). The isotherms are hand drawn and estimated on the basis of thermistors readings (black dots in the figure). The simulated heat transfer expressed as isotherms by the mathematical model (B) indicates close agreement and thus a role for the heat conserving abilities of the white muscle rete (Boyne et al.).

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.



Representative vertical dive profiles for pelagic fishes. Fish images represent the average depth (combined night and day) for each species. Gray-filled fish outlines represent the depth at which each species spent 95% of the time during the night. Open outlines represent the depth at which each species spent 95% of the time during the day. Values next to the common name show the temperature ranges encountered by each species. Orange shaded bar represents the thermocline, defined as depth range in which the water column is separated into the upper uniformed-temperature surface layer (i.e., water above 20°C) and the cooler deeper waters (i.e., below 20°C). Group 1: fishes that spend the majority of their time in the upper uniformed-temperature surface layer. Group 2: Fishes that undertake short excursions below the thermocline. Group 3: Fishes that make frequent excursions below the thermocline. Figure modified from Musyl et al. (2004). Wahoo (Acanthocybium solandri)*, silky shark* (Carcharhinus falciformis)*, oceanic whitetip* (Carcharhinus longimanus)*, mahimahi* (Coryphaena hippurus)*, yellowfin tuna* (Thunnus albacares)*, blue marlin* (Makaira nigricans)*, black marlin* (M. indica)*, striped marlin* (Tetrapturus audax)*, blue shark* (Prionace glauca)*, shortfin mako shark* (Isurus oxyrinchus)*, bigeye thresher shark* (Alopias superciliosus)*, the bigeye tuna* (Thunnus obesus)*, and swordfish* (Xiphias gladius)*[from Bernal et al.]*.

Progress during FY 2008

At present, the PI is adding final information to the PSAT Performance and Literature Meta-analysis databases and completing the manuscript detailing this work (slated for submission July 2008). The PSAT database contains detailed information from 731 tags across 19 pelagic taxa (including 3 marine turtle species). It is anticipated that additional information will be added later when these data are publicly posted on the PFRP website (anticipated Fall 2008). Preliminary results indicate PSATs have an overall reporting rate of ca. 79% (577 tags reporting) but PSATs attached to certain deep-diving species (e.g. swordfish, bigeye thresher shark) have lower than expected reporting rates (≈30%). The authors believe pressure may play an important role in non-reporting tags. It is important to emphasize that non-reporting tags (21%) are not synonymous with mortality. The PI has organized failure and survival analysis of the database using Weibull, log-normal, and Kaplan-Mier procedures with specialized engineering software and other procedures in the R and SAS statistical packages. Another major analysis was added to the PSAT performance and reliability research, which will considerably strengthen the overall analysis and conclusions. The PI has completed a meta-analysis examining reporting rates of 1433 PSATs provided in the peer-reviewed literature for 23 marine species from 53 papers that is included in the manuscript. According to the literature study, 1089 of 1433 tags reported (76%) is similar to our results. Twelve species are common to both the PSAT and metadata databases which will allow for comparative studies. Tagheads developed by the project are providing long term retention in pelagic fishes (e.g. swordfish, sailfish and marlin; up to 240 days).

The development of an oceanographic database (and associated tools) to examine/correlate movement patterns of PSAT tagged animals with various oceanographic parameters, on temporal and spatial scales (i.e. both horizontal and vertical vectors), is operational and PSAT information are now linked to this source ("Identification

of Large Pelagic Marine Fish Habitats and Habitat Utilization Using 'Pop-Up' Satellite Archival Tag and Oceanic Satellite Remote Sensing Technologies and 'Soda' Simple Ocean Data Simulation Model Analyses" by R. Michael Laurs, David Foley, and Michael Musyl). Dr. David Sims (Marine Biological Association of the UK, School of Biological Sciences, Univ. Plymouth) and Dr. Diego Bernal (Univ. Massachusetts) are working with Musyl and colleagues to develop IBMs using PSAT data. Dr. Malte, Univ. Aarhus, plans to continue on the project (see Boyne et al., manuscript).

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

P.I.: John R. Sibert [Jay R. Rooker, David G. Itano]

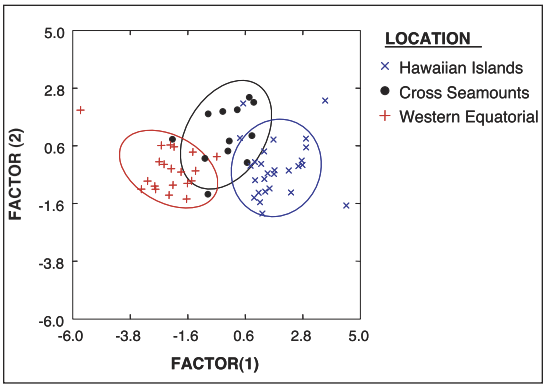
NOAA OFFICE (of the primary technical contact): National Marine Fisheries Service/Pacific Islands Fisheries Science Center

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 this project is to provide information on the source(s) of yellowfin recruits (age-1 and age-2) to Hawaii-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 yellowfin from putative spawning and/or nursery areas in Hawaii 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 yellowfin. After establishing a baseline, we will target age-1 and age-2 (sub-adult to young adult) yellowfin from the Hawaiian Island fisheries to determine their source (natal origin). Ultimately, we hope to determine the relative contribution that locally spawned residents (versus transients) make to the Hawaii-based fisheries.



Canonical scores plot from QDFA of age-0 yellowfin tuna collected from Hawaiian Islands, Cross Seamounts, and western equatorial nursery areas. Plots are based on $\delta^{13}C$ and $\delta^{18}O$ stable isotopes in otolith cores and ellipses represent 95% confidence intervals.

Progress during FY 2008

Note: Funding for project available at Texas A&M University on Jan. 18, 2008 (start date). Progress Report reflects activities during the first 6 months of project.

Our first step of the project is to develop a baseline describing the chemical signatures in otoliths of age-0 yellowfin from putative spawning and/or nursery areas in Hawaii and the broader WCPO. Samples have been obtained from potential nursery areas during year 1 (2008) of the study, these include: Hawaiian Islands (inshore FADs off Oahu and Kauai), Cross Seamounts, equatorial central Pacific (Line Islands), several locations along the equatorial western Pacific (Moro Gulf Philippines, Marshall Islands, Solomon Islands), and one location in the eastern Pacific (Baja Mexico). Preliminary data from age-0 yellowfin tuna indicate stable isotopic composition in otoliths of individuals from the Hawaiian Islands, Cross Seamounts, and the western equatorial (Moro Gulf Philippines) were significantly different (MANOVA, $P<0.05$). In general, otoliths of yellowfin from the western equatorial region were depleted relative to areas in and around Hawaii, with intermediate values observed for individuals collected from the offshore seamount in the Hawaii EEZ. Cross validated classification success from quadratic discriminant function analysis was 86%, indicating the approach has promise for identifying yellowfin tuna from different nurseries. After building our baseline data set to include additional nursery areas, otolith core material from age-1 and age-2 yellowfin tuna from the Hawaii-based fisheries will be compared to baseline data using mix-stock procedures. This will allow us for the first time to investigate the relative contribution of locally spawned versus transient yellowfin tuna to Hawaii-based fisheries.

PFRP: Oceanographic Characterization of the American Samoa Longline Fishing Grounds for Albacore, *Thunnus alalunga*

P.I.: John R. Sibert [Michael P. Seki, 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 American Samoa domestic longline fishery has undergone extraordinary growth, particularly in the fleet composition of large vessels (>20 m in length) that have fueled a fivefold increase in fishing effort and landings from 1999 to 2001. The most intense period of the expansion occurred during 2001, when the total number of hooks set increased tenfold from 860,000 during 2000 to 8.6 million in 2002. The target species of the longline fleet is albacore tuna, *Thunnus alalunga,* which dominates the catch. The fisheries performance for albacore peaked with 334,000 fish caught during 2002, which was followed by a steep decline in 2003-2005 and a modest come back in 2006. Oceanographically there has been little study regarding the pelagic habitat in the American Samoa region. The current research undertakes the task of characterizing the pelagic habitat and fishing grounds occupied by the American Samoa longline fishery through the use of satellite oceanographic remote sensing and in situ shipboard surveys. Coupled with the oceanographic assessment, fishery information is used to develop a functional understanding of the spatial and temporal occupation and movement tendencies of large South Pacific albacore and its forage, micronekton, and the role of the environment on longline gear performance and catch. These data include albacore depth distribution and gear performance obtained from commercial longlines instrumented with time-depth-temperature recorders (TDRs) and the set level catch information from the American Samoa fishery logbook program.

Progress during FY 2008

Final analyses and results confirm that the South Equatorial Counter Current (SECC) strongly influences the American Samoa Exclusive Economic Zone (EEZ) and changes strength on a seasonal and ENSO cycle. Strong SECC is associated with a predominantly anticyclonic eddy field (r^2 between the strength of the SECC and the number and strength of anticyclonic eddy activity are 0.67 and 0.74, with $p = 0.009$ and 10^{-4}, respectively) as well as increased chlorophyll-a (Chl-a) concentrations, micronekton biomass, and CPUE for albacore tuna. The origins of the higher Chl-a concentrations and micronekton biomass in SECC waters relative to those in South Equatorial Current (SEC) waters are events that are taking place seasonally at the north coast of New Guinea, near the origin of the SECC. During boreal winter, northwesterly monsoon results in upwelling at the north coast of New Guinea and the reversal of the New Guinea Coastal Current (NGCC). The upwelling results in an increase in primary productivity, as evidenced from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Chl-a maps (Figure 1, left panels). Most of the eastward flow in the NGCC feeds the SECC, which peaks a month or two later. Thus, waters relatively high in Chl-a concentrations feed the SECC, which carries the chlorophyll-a (Chl-a) rich waters to the east (Figure 1, right panels). It takes a minimum of 3-4 months for the SECC waters to reach the EEZ, during which time the higher Chl-a concentrations allow for the development of relatively high micronekton biomass. Observed differences in micronekton composition in SECC waters, relative to those in SEC waters, is consistent with having origins that differ from each other. Relatively stable anticyclonic eddies show a further increase in micronekton biomass, apparently advected in from neighboring SECC waters. The presence of forage presumably concentrates albacore, thus resulting in the observed increase in CPUE (Figure 2a).

During El Niños, the seasonal signals at the north shore of New Guinea and in the SECC, and the resulting eddy activity in the EEZ, are exceptionally strong. During the past 15 years, five of the six El Niños (top arrows in Figure 2b) correspond to unusually strong peaks of eddy activity in the EEZ, with $r^2 = 0.31$, $p = 10^{-3}$. As a result of the intensification of seasonal upwelling and the eastward velocities of the NGCC and SECC, waters reaching the EEZ during El Niño years are richer in Chl-a and micronekton concentrations than during non El Niño years (Figure 1, compare top and bottom panels). As years with the highest EEZ eddy activity correspond to El Niño years, El Niño years correspond to years with the highest albacore CPUE (Figure 2a). The correlation coefficient between the Southern Oscillation Index (SOI) and albacore CPUE in the EEZ is significantly different from zero at >95%

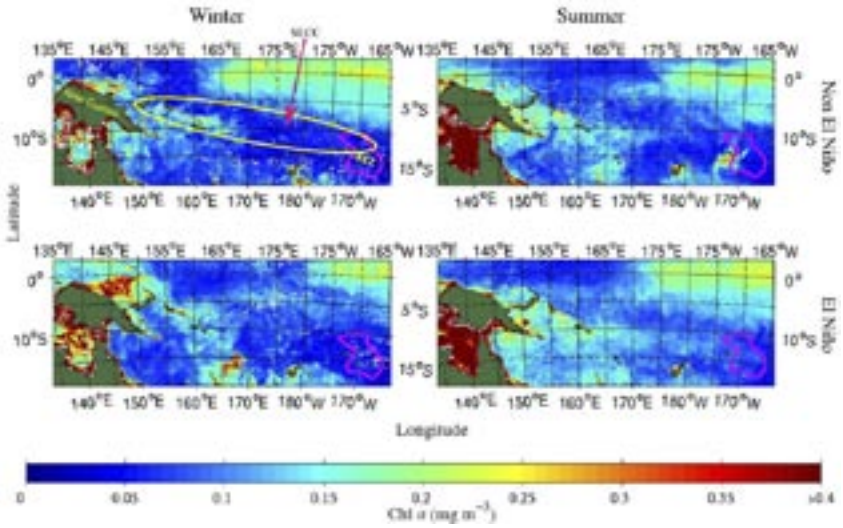


Figure 1. Example of monthly sea surface chlorophyll-a concentrations, proxy for primary productivity, at New Guinea and in the SECC in winter (left) and summer (right) during non El Niño (top) and El Niño (bottom) conditions. The borders of the American Samoa EEZ are shown at the lower right of the maps in magenta. Months are selected to show the largest Chl-a bloom at the north coast of New Guinea during winter and the furthest eastward extent of the relatively high Chl-a in the SECC during summer for a given year. Top row: January and June, 2002; bottom row: February and July, 2003.

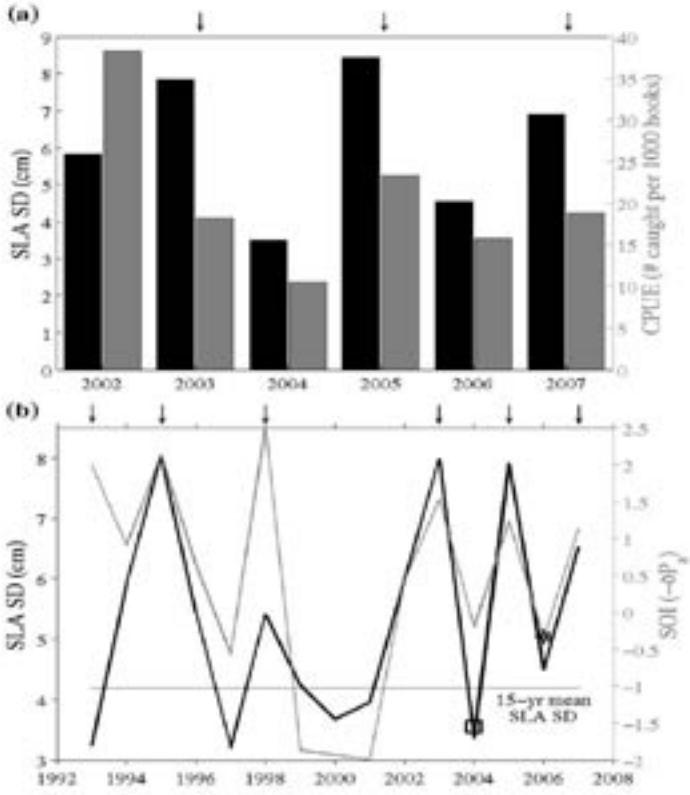


Figure 2. Time series of mean sea level anomaly standard deviation (SLA SD, the measure of eddy activity in the EEZ) (a) with albacore CPUE in the American Samoa EEZ and (b) with the Southern Oscillation Index. Means are calculated over the peak three-month periods for SLA SD (March-May) and CPUE (April-June), and for the three-month period for the previous Oct-Dec for SOI, the peak of El Niño influence at the origin of the SECC. Years in (a) represent post-expansion times only. Top arrows indicate El Niño events, while the horizontal line in (b) represents the peak-time mean weekly SLA SD for the same period.

confidence level ($r^2 = 0.35$, $p = 10^{-4}$). Results of this work suggest that the strength of upwelling and the resulting increase in chlorophyll-a concentrations at New Guinea, the strength of the SECC, and the Southern Oscillation Index could be used to predict the performance of the local longline fishery for albacore tuna in the American Samoa EEZ.

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

P.I.: John R. Sibert [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, National Research Institute of Far Sea Fisheries [NRIFSF], SPC) or committees providing scientific advice to management bodies (ISC, Scientific Committee of the WCPFC). Standardized 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 2008

The project proceeded with the research plan developed at the February 2007 workshop. A multispecies approach was conducted in collaboration with Japanese colleagues and presented to the annual PFRP workshop and a Billfish Working Group of the International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific. Two of the PIs (Bigelow/Maunder) published a paper on catchability comparisons between depth and habitat which provided a corrective view on previous CPUE standardizations which naively assumed that catchability was depth-based.

One PI (Bach) and colleagues analyzed longline experiments within the Étude du comportement des thonidés par l'acoustique et la pêche en Polynésie française (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 statistical habitat-based standardization model (statHBS) was distributed to four users/institutions during the fiscal year.

The project has one objective, to merge the statHBS (ADMB) code with R-software in order to make the model more user friendly. There was little progress on this objective due to difficulties encountered in recruiting a scientific programmer.

PFRP: Regime Shifts and Recruitment in Western and Central Pacific Ocean Tuna Fisheries

PI: John R. Sibert [David S. Kirby, Adam Langley, Valerie Allain]

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
- 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 detect and characterize long-term environmental variability in time series of physical, biological and fisheries data; to determine whether the 'regime shifts' documented for the North Pacific are evident in the tropical WCPO; and to incorporate indicators of long-term environmental variability in tuna recruitment estimation.

The project has three components, each of which has a PI and Research Assistant (RA).

i) Exploratory data analysis of ecosystem model input/output plus comparable datasets, using various methods for multivariate time-series analysis to derive ecosystem indicators (PI: David Kirby; RA: Karine Briand)

ii) Use ecosystem indicators to improve recruitment estimation for tunas in the stock assessment software MULTIFAN-CL (PI: Adam Langley; RA: Karine Briand)

iii) Stomach contents analysis for data pre- and post the regime shifts of the late 1970s and 1990s (PI: Valerie Allain; RA: Marie-Laure Coudron)

Progress during FY 2008

Component (i)

Quantitative indicators of ecosystem state were derived from multivariate analysis of physical and biological oceanographic variables for the WCPO, and then statistical tests applied to determine the existence of regime shifts in the mean and variance of the indicators. Shifts were found at times that are broadly consistent with other studies for the north Pacific (1976, 1989, 1998) although earlier shifts (ca. 1964) appear to be just as significant. There is no signal of a regime shift in 1976 in the western equatorial Pacific, although shifts are evident in 1989 and 1998. There is a strong shift in the physical variables of the central equatorial Pacific in 1976, and a strong shift in current direction and primary production in this area in 1998. The methods are sound for the purposes of ecosystem monitoring but are inadequate to build causal or predictive relationships between the ocean environment and tuna recruitment. Other statistical models—Component (ii)—have proved useful in that regard. The best single indicator for monitoring the effect of environmental variability on yellowfin tuna recruitment appears to be the area of the western Pacific warm pool, which accounts for 52% of the variance in recruitment predicted by the generalized linear model (GLM) (see below), and which expanded significantly in the early 1960s.

Component (ii)

A GLM was developed to predict yellowfin recruitment from a range of oceanographic variables, from different areas and spatial/temporal scales. The final model accounted for 68% of observed variation in quarterly recruitment for the period 1980–2003, with the inclusion of 10 different oceanographic variables derived from two zones within the equatorial region of the WCPO. The robustness of the recruitment model was investigated by cross-validation. The model was then applied to hindcast recruitment for the period 1952–1979. Recruitment predictions from the GLM closely followed trends in recruitment estimates from the assessment model through most of this period. The long-term trend in predicted recruitment was largely driven by sea surface temperature in the northwestern area of the equatorial region. This work has direct application to stock assessment for yellowfin tuna in the WCPO. Principally, the GLM enables recent (last 1–2 yr.) recruitment to be estimated more precisely, thereby increasing the precision of estimates of current biomass and exploitation rates. Increased precision of the current age structure of the population also improves the accuracy of short-term (next 1–2 yr.) stock projections from the assessment model. In a broader context, the recruitment model provides a tool to investigate how yellowfin recruitment may change in response to short- and long-term variation in the oceanographic conditions of the WCPO. The modeling approach was also applied to bigeye tuna, with the final model accounting for 72% of the observed variation in quarterly recruitment. This allows confidence in stock assessment estimates for bigeye recruitment, with similar benefits for estimating recent recruitment and carrying out stock projections as noted for yellowfin.

Component (iii)

Datasets from previous diet studies for tunas (New Caledonia: Grandperrin-IRD 1959-1974; French Polynesia: ECOTAP-IRD 1995-1997) were compared with recent work (Allain: GEF-PFRP 2001-2005) in order to identify any changes in diet that might indicate regime shifts in the pelagic ecosystem.

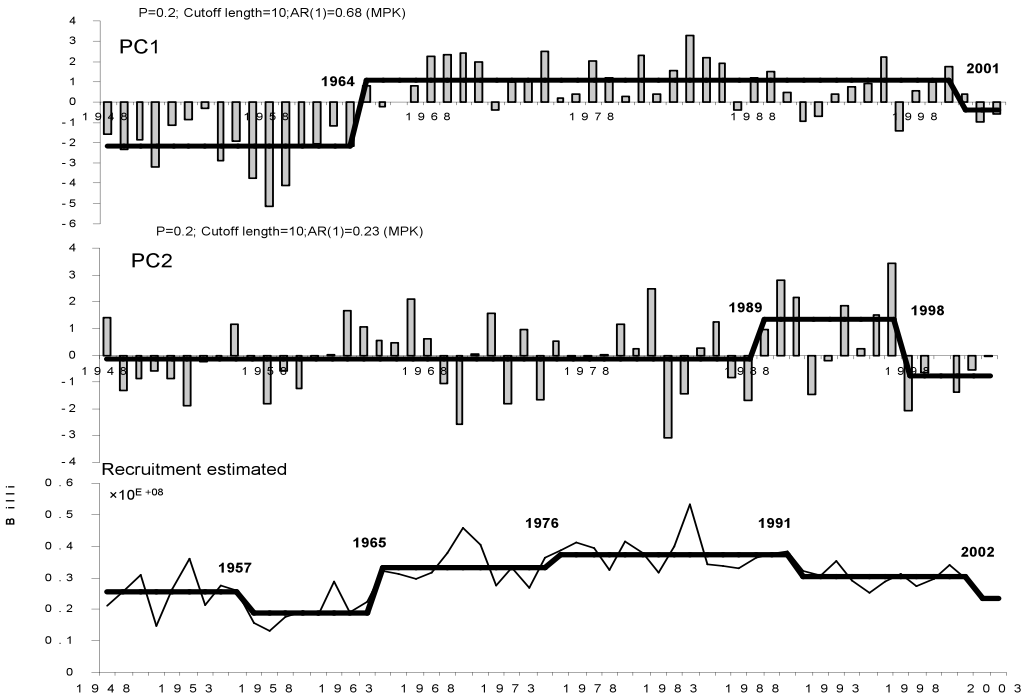


Figure 1. Statistically significant shifts (solid line, dates) in mean values of the two principal component (PC) scores (first two panels) from a multivariate analysis of oceanographic variables selected by the GLM for yellowfin recruitment (third panel)

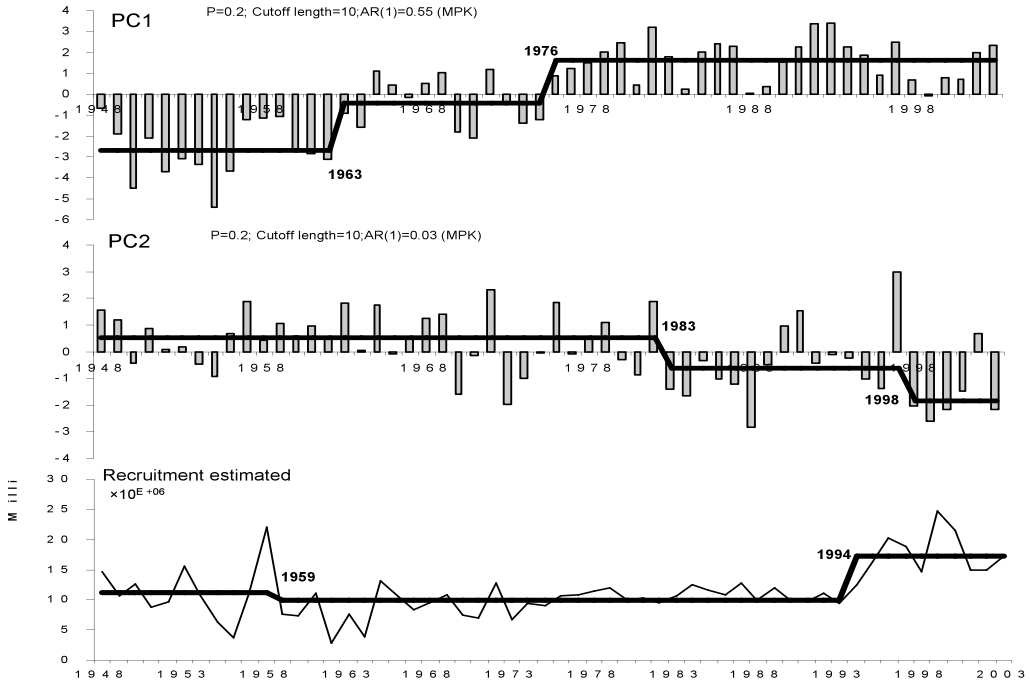


Figure 2. Statistically significant shifts (solid line, dates) in mean values of the two principal component (PC) scores (first two panels) from a multivariate analysis of oceanographic variables selected by the GLM for bigeye recruitment (third panel)

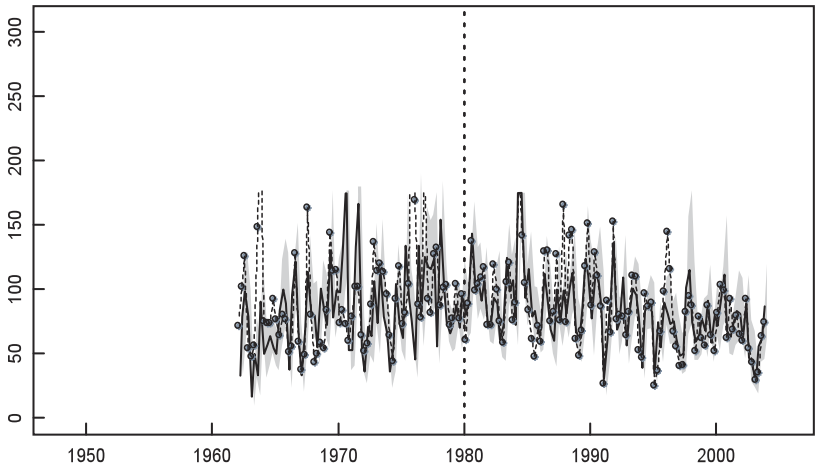


Figure 3. Recruitment GLM for yellowfin tuna. 'Observed': MULTIFAN-CL recruitment estimate; 'predicted': GLM recruitment estimate

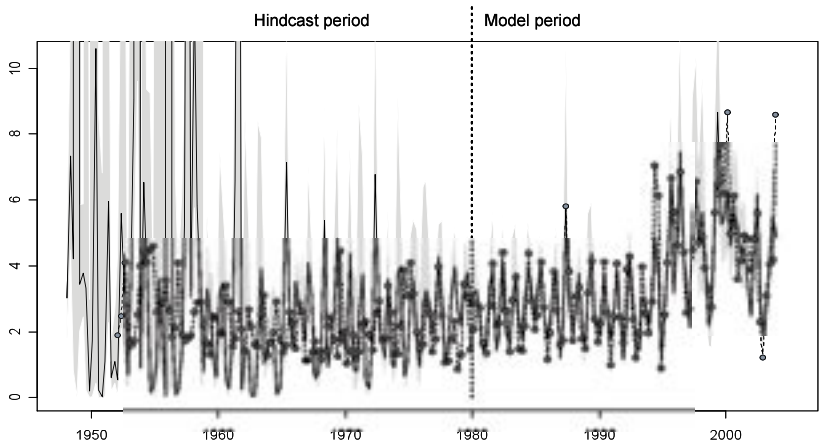


Figure 4. Recruitment GLM for bigeye tuna. 'Observed': MULTIFAN-CL recruitment estimate; 'predicted': GLM recruitment estimate

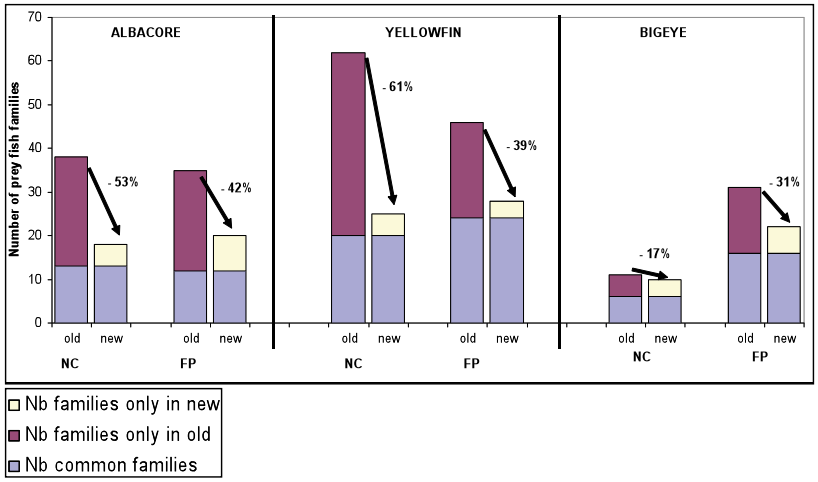


Figure 5. Diversity of fish prey families in tuna diet studies

Table 1. Sample sizes (number of individuals) for comparative diet study

	New Caledonia		French Polynesia	
Species	OLD	NEW	OLD	NEW
Albacore	235	50	82	97
Yellowfin	435	96	90	80
Bigeye	28	59	140	97

For New Caledonia, the diets of all three species seems to have changed between the two studies, although the small sample sizes (Table 1) for albacore and bigeye in the 'new' data and for bigeye in the 'old' data must limit the extent of our inference. The diversity of fish prey families (Fig. 5) fell 17% (bigeye), 53% (albacore) and 61% (yellowfin) between 'old' and 'new' studies, with albacore consuming 12% more epipelagic crustacea and yellowfin consuming 18% more epipelagic forage fish and 10% less mesopleagic molluscs.

For French Polynesia, the diets of all three species seems to have changed between the two studies. The diversity of prey families fell 31% (bigeye), 42% (albacore) and 39% (yellowfin) between 'old' and 'new' studies, with albacore consuming 46% more epipelagic crustacea and 10% less mesopleagic molluscs, yellowfin consuming 22% more epipelagic forage fish and 12% less mesopleagic molluscs, and bigeye consuming 14% more epipelagic forage fish and 7% less mesopleagic molluscs.

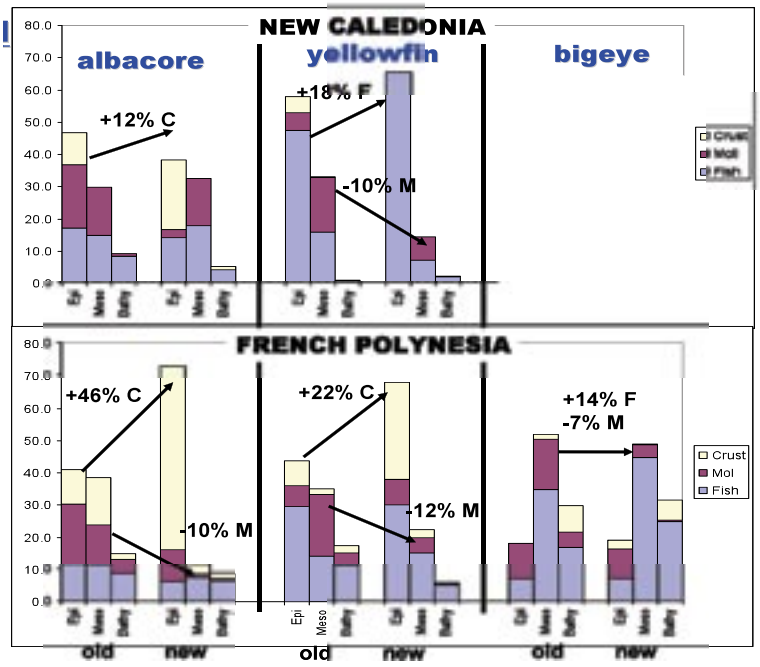


Figure 6. Changes in prey proportions by vertical class (% weight). Epi: epipelagic; Meso: mesopelagic; Bathy: bathypelagic; Crust: crustacea; Mol: molluscs; Fish: fish

Comparing diet studies is a difficult task, especially when working on 'rescued' data; this study highlighted the importance of metadata. Taxonomic identification level appears to be a major problem in the comparison process as it highly depends on the identification skills; analysis of the data at the family level is probably a good compromise between accuracy and precision. Environmental variability is highly likely to have played an important role in the changes apparent in the diet data. However, the lack of continuous monitoring means that it is difficult to discern interannual (ENSO type) variability from that at a decadal scale. Furthermore, the lack of precision in the 'rescued' data make it difficult to conclude that apparent changes are the result of an ecosystem regime shift.

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

P.I.: John R. Sibert [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 project provides access to detailed historical individual catch and hook data that were not originally digitally captured; and supports efforts to build sustainable U.S. Fisheries in the central Pacific Ocean by establishing a pelagic fisheries baseline database. Data procedures of the project would provide quality control methods before making the data available.

Progress during FY 2008

With a late start in the project due to administrative changes to the initial proposal, the data entry contractor (Data Entry Institute of Hawaii) to date has submitted 78,277 lines of rescued data that included 10 data fields within each observational line. Although the contractor has been plagued with computer problems and power disruptions within the building, the data rescue section of the project is expected to be completed by the end of August 2008.

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

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 project is designed to quantify the size of the ecosystem used by tuna found in association with Hawaii FADs. That is "where do they go when they leave here?" This information is of direct applicability to formulating possible management options for Hawaii's fishery and understanding the connectivity between Hawaii 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.

A geolocating archival tag being surgically implanted in a yellowfin tuna

Progress during FY 2008

Fifty-five boat days were dedicated to either fishing/tagging efforts or in maintaining the acoustic receiver system that is central to the success of the project. Thirty-three yellowfin were double tagged with acoustic and archival tags. Of these, seven have been recaptured with times at liberty of up to six months. 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 Hawaii Longline Industry

P.I.: John R. Sibert [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 Hawaii-based longline fishing industry has been heavily regulated with little analysis of the socio-cultural impacts of those regulations and management. The ethnically diverse makeup of longline industry participants in Hawaii and the dynamic nature of the industry highlight the need for primary data on contemporary sociocultural characteristics. Project researchers are addressing this problem by:

- Compiling a comprehensive social profile of the longline fishing industry of Hawaii; and
- Providing social profile information to decision-makers on regulatory impacts and implementation strategies.

Progress during FY 2008

Our focus on the longline industry during FY 2008 was on a project funded by the Fisheries Disaster Relief Program examining fishermen's perspectives on bycatch reduction techniques. As described in our FY 2007 annual report, a portion of that effort was directed towards distribution channels. Data collection for the project has been completed except for additional interviews with individuals involved in the distribution channels for longline-caught fish. During the past two years, a number of publications and presentations have summarized results of the study.

PFRP: Spatial Modeling of the Tradeoff between Sea Turtle Take Reduction and Economic Returns to the Hawaii Longline Fishery

P.I.: John R. Sibert [Minling Pan, Shichao Li]

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 designed to construct a bio-economic model to explore tradeoffs between sea turtle take reductions and economic return for the Hawaii-based longline fishery. Through simulation analysis of multiple time and area closures, the study assesses possible policy options that allow fishing opportunity to be maximized without exceeding the caps on sea turtle interactions.

Progress during FY 2008

The project staff:

- Successfully developed a bio-economic model to explore tradeoffs between sea turtle take reductions and economic returns, and updated the model with the current available data up to 2006;
- Applied the model to examine the impacts of fisheries management alternatives (time-area closure) on the sea turtle interactions and economic returns, as requested by the WPRFMC. This analysis will assist the Council to prepare the Swordfish effort Environmental Impact Statement (EIS)/Draft Amendment in response to the Hawaii Longline Association (HLA) proposal on changing the swordfish effort cap; and
- Prepared multiple reports and revised the manuscripts based on the reviews from the Council staff and fellow economists.

PFRP: Survivorship, Migrations, and Diving Patterns of Sea Turtles Released from Commercial Longline Fishing Gear, Determined with Pop-up Satellite Archival Transmitters

P.I.: John R. Sibert [Yonat Swimmer, Christofer Boggs, Richard C. Brill]

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

NOAA Goal(s)

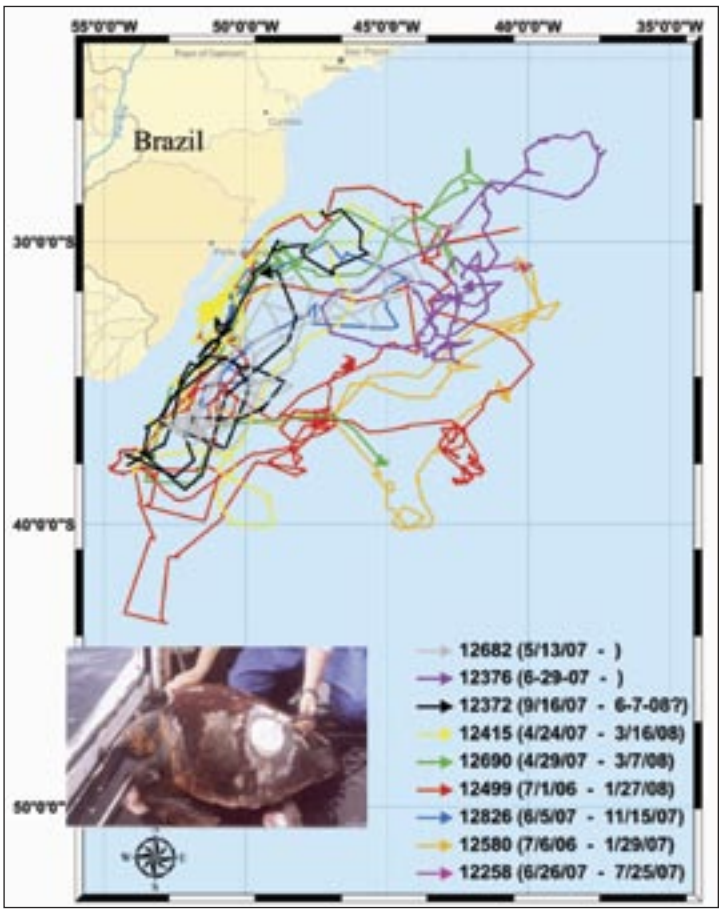
- To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management

Purpose of the Project

For the past 6 years, the objectives of the project have been two-fold: 1) to provide estimates of delayed mortality in sea turtles following interactions with longline fishing gear, and 2) to compare the movements and behaviors of sea turtles caught and released from longline gear to free-swimming controls. To do this, we have deployed satellite transmitters on longline-caught and free-swimming hard-shelled turtles in the Eastern Tropical Pacific, the North Pacific, and the South Atlantic Oceans and tracked their movements over time in order to infer the impacts of these fisheries interactions.

Progress during FY 2008

Due to the poor tag retention for PSATs on hard shelled turtles (independent of attachment technique), we ceased our application of PSATs on turtles and instead chose to work with platform terminal transmitters (PTTs) to improve our understanding and inference of post-release survivorship based on long-term tracking of animals. In the last year and a half, we deployed a combination of PTTs and PSATs on 25 loggerhead turtles caught and released from longline fishing boats in the South Atlantic Ocean operating out of Brazil and Uruguay (see figure right). The tags have provided information on turtles' movements from 27- 535 days post release from fisheries interaction, with a mean number of over 350 days of tracking per turtle. This far exceeds the number of days we successfully tracked sea turtles with PSATs during the previous years of this study.



Locations of loggerhead sea turtles in the South Atlantic Ocean after their release from interactions with longline fishing vessels as determined by platform terminal satellite tag technology.

This is a higher number of animals tracked than previously predicted, which has been possible due to additional funding from a variety of sources that allowed us the opportunity to hire personnel in Uruguay and Brazil.

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.: John R. Sibert [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 400 m deep plateau, rising from a 5000 m seafloor and lying in the path of the North Equatorial Current and internal tides generated at the Main Hawaiian Islands chain, is known to aggregate economically important fish such as juvenile and subadult bigeye tuna, a population which is heavily targeted by the local fishery. Reported moderate exploitation rates have recently raised concerns that the local fishery removes too many juveniles that could otherwise recruit to adult grounds and help maintain Pacific stocks. Since adult bigeye tuna are an important target species of both local and international fisheries, reducing 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. Since 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, since 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 2008

During FY 2008, a second shipboard survey was conducted to Cross Seamount. The survey design was optimized based on information obtained on movement patterns and distribution of bigeye tuna during the FY 2007 cruise. Data collected during the cruise consisted of acoustic data to study both bigeye and its forage, micronekton, and environmental variables such as current profiles, temperature, salinity, dissolved oxygen, and chloropigments. Acoustic data were groundtruthed by fishing efforts and midwater trawl samples for tuna and micronekton, respectively.

Preliminary results from the FY 2008 shipboard survey show increased bigeye tuna and micronekton biomass at the seamount, consistent with previous observations. Further, the seamount has an effect on the vertical distribution of micronekton over the plateau and at its flanks. Over the plateau, several layers of micronekton occupy depths of 200-400 m (Figure 1), a layer which is devoid of organisms away from the plateau. The deep scattering layer is thicker and vertically extended at the flanks. Micronekton is observed to be actively swimming against the currents during their diel vertical migration periods (Figure 1) and their composition is different at the seamount than away from it. These facts indicate that the Seamount is likely to be occupied by resident species of micronekton. While the effects of the Seamount on micronekton extend to slopes which are at 800-900 m depth or further, bigeye tuna are tightly associated with the plateau or slopes not deeper than about 600 m. Bigeye tuna appear at dawn at the upcurrent, southwest edge of the plateau to feed on specific micronekton layers which are migrating downward from the shallow scattering layer (Figure 2). At this time, bigeye are tightly concentrated in a small area, highly mobile, and form very loose aggregations. During the early morning hours, bigeye spread and occupy the southwest end of the plateau, still feeding. By late morning, they are spread over the plateau area south of the summit. During the afternoon and early evening, bigeye occupy the entire area of the plateau and tend to form thicker aggregations. At around sunset, bigeye start dispersing and seemingly leave the plateau, to appear next dawn again at the upcurrent edge. As opposed to bigeye tuna, large, thick aggregations of fish, likely to be monchong, appear after sunset and occupy the entire area of the plateau, not farther than 50 m from the seafloor. At sunrise they descend along the flanks, predominantly on the upcurrent side of the plateau, and occupy depths of the deep scattering layer, at around 500-750 m.

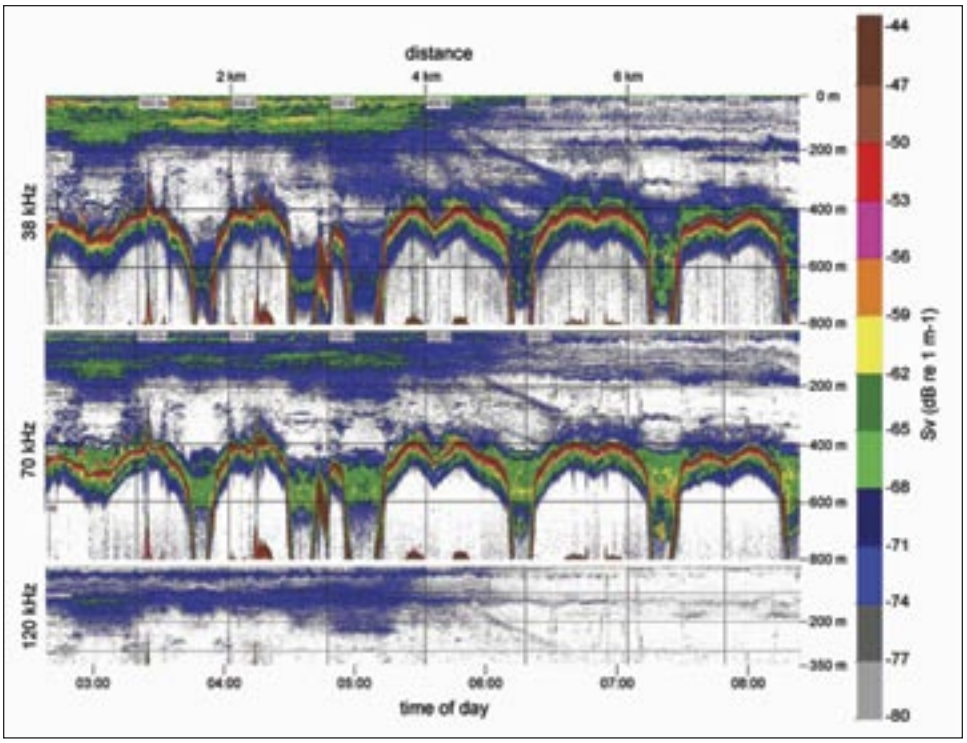


Figure 1. Echograms showing the micronekton scattering layer over the plateau and flanks of Cross Seamount, including a nighttime to daytime transition period. Note the differences in backscatter properties of micronekton at the 38 kHz (top), 70 kHz (middle) and 120 kHz (bottom) frequencies, the micronektonic layers between 200 and 400 m depths, and the presence of large aggregations of fish over the plateau floor during night and at the flanks during day. Micronekton is shown to descend to the deep scattering layer along both downcurrent (at ~06:00-06:30) and upcurrent (at ~07:00-07:03) flanks. Bigeye tuna is seen after 06:00, most noticeable on the 120 kHz echogram.

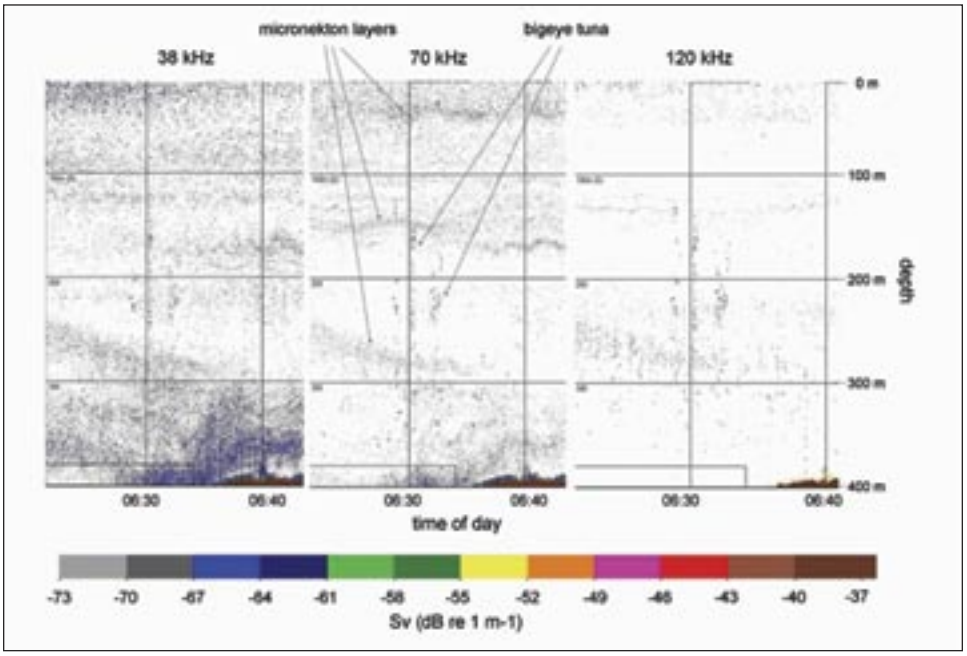


Figure 2. Loose aggregations of bigeye tuna foraging on descending micronekton layers after dawn at the upcurrent flank of the Seamount. Note that as opposed to micronekton, tuna backscatter is similar at all three frequencies.

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

Retrieving an acoustic data logger from a FAD.

Progress during FY 2008

During the reporting period, effort was split between analysis and publication of papers and ongoing field work which included the release of additional tagged fish. Of particular importance was the opportunity to work with commercial fishermen to deploy electronic tags on bigeye tuna associated with a private FAD (PFAD) on Maui. Understanding the FAD associated behavior of bigeye is a high priority in Hawaii and throughout the Pacific. The collaboration with fishermen and work on PFADs will continue in the upcoming year.

PFRP: Trophic Structure and Tuna Movement in the Cold Tongue-Warm Pool Pelagic Ecosystem of the Equatorial Pacific

P.I: John R. Sibert [Valerie Allain, Robert Olson, Felipe Galván-Magaña, Brian Popp]

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

Previous modelling suggested that tuna productivity in the western and central Pacific Ocean was tied to upwelling along the equator in the central and eastern Pacific. The project proposed to test this hypothesis by combining diet analysis, stable isotopic analyses, and food-web modelling to study trophic-level variation and tuna movements in the equatorial Pacific. Our hypothesis predicted that tunas that reside near equatorial upwelling regions fed at relatively low trophic levels. Opposite trends were expected in equatorial regions with little upwelling, such as the warm pool of the western Pacific, where tunas were expected to feed at higher trophic levels and move extensively, searching for less-abundant prey. The main objectives of the project were to define the trophic structure, establish an isotope-derived biogeography, and characterize large-scale tuna movements in the pelagic western, central, and eastern tropical Pacific. Results of this study should help define ecosystem linkages leading to tuna production and the effect of climate variability on the systems. This information is important for both fisheries production and ecosystem modelling of the equatorial Pacific Ocean.

Progress during FY 2008

Biological analyses (stable isotope analysis and stomach content analysis) in the western, central, and eastern Pacific were terminated as the end of the project approached. A total of 3844 samples of stomach contents from 68 pelagic fish species, and 1809 stable isotope samples (nitrogen and carbon) from predators and prey have been analyzed during the project in the western and central Pacific. In the eastern Pacific, a total of 9495 samples of stomach contents from 44 predator species, and 735 stable isotope samples of predators and prey were analyzed during the project. Analyses of the data were pursued by the project participants in the different areas of the Pacific to prepare scientific papers for publication and presentations for meetings, as listed below.

Given this is the final annual report for the project, we summarize the major findings below:

a) An ontogenetic diet shift in juvenile yellowfin tuna from nearshore Oahu, determined by stable-isotope and stomach-content analyses, demonstrated that the onset of endothermic capability required for accessing deep-dwelling prey occurred at about 45 cm fork length (Graham, B.S., D. Grubbs, K. Holland, and B.N. Popp, 2007. A rapid ontogenetic shift in the diet of juvenile yellowfin tuna from Hawaii. *Mar. Biol*., 150, 647-658.).

b) Results of compound-specific isotope analysis (CSIA) of specific amino acids from yellowfin tuna in the eastern tropical Pacific indicated that ^{15}N enrichment in the north was due to changes in the $\delta^{15}N$ values at the base of the food web. The implication of our results is that $\delta^{15}N$ analyses of individual amino acids in yellowfin can be used to estimate the $\delta^{15}N$ values at the base of the food web and the trophic level of the predator, using a single sample (Popp, B.N., B.S. Graham, R.J. Olson, C.C.S. Hannides, M.J. Lott, G.A. López-Ibarra, F. Galván-Magaña, and B. Fry, 2007. Insight into the trophic ecology of yellowfin tuna, *Thunnus albacares*, from compound-specific nitrogen isotope analysis of proteinaceous amino acids. In Dawson, T.E., and R.T.W. Siegwolf (eds.), *Stable Isotopes as Indicators of Ecological Change*, San Diego, Elsevier-Academic Press, Terrestrial Ecology Series, pp. 173-190).

c) CSIA also indicated that the trophic level (TL) of small and large size classes of yellowfin from Hawaii did not differ. Instead, the observed rapid ontogenetic shift in the $\delta^{15}N$ values of white muscle tissue reflected a change in the vertical foraging habitat, with juveniles confined to the surface mixed layer and larger individuals foraging over a greater vertical range. Furthermore, bulk and amino acid isotope results for larger yellowfin suggest there were at least two general foraging strategies in the regional Hawaiian "population", with one group foraging at greater depths than the other group. Overall, the compound-specific isotope results revealed that tuna $\delta^{15}N$ values reflect processes that occur at the base of the food web and that CSIA can be applied to examine vertical and horizontal foraging patterns in the pelagic environment.

d) Results from a diet shift conducted on captive yellowfin tuna showed that, of four tissue types, liver had the fastest turnover rate and white muscle the slowest turnover rate, with tissue half lives estimated as 12 and 63 days, respectively. Tissue turnover rates measured in captive and wild yellowfin were similar for liver, but those for muscle were considerably slower in the captive tuna. The difference in muscle turnover rate may be due primarily to rapid growth and protein turnover in wild tuna, which increases estimates of N turnover. These tissue-turnover rates provide a temporal framework on which to base interpretations of stable isotopic data of tropical tunas (Graham B.S., B. Fry, B.N. Popp, R.J. Olson, and K. Holland, 2008. Tissue turnover rates of an endothermic teleost, yellowfin tuna, *Thunnus albacares*, in captivity and in nature. *J. Exper. Mar. Biol. Ecol*., submitted).

e) Stable isotope analysis of three tropical tunas (yellowfin, skipjack, and bigeye) and of wahoo and dolphinfish suggest limited movement behavior throughout the equatorial Pacific. In the eastern Pacific, yellowfin tuna appear to be largely resident at the same scale as zooplankton (Figure 1).

f) The trophic level occupied by yellowfin tuna shows little significant variation across the Pacific, as judged by amino acid $\delta^{15}N$ values, although a study in the eastern Pacific shows that there may be an onshore/offshore increasing gradient in TL, especially if little seasonality occurs in basal $\delta^{15}N$ values.

g) An Ecopath with Ecosim (EwE) model developed for the western and central Pacific, based on diet studies, revealed a different trophic structure than that described for the eastern Pacific based on a previous EwE model. A small scombrid, *Auxis spp*., has a very important role in the food web in the eastern Pacific, while it is absent in the western Pacific, where skipjack may have a similar trophic role. Sensitivity analyses revealed an important impact of changes in cephalopod biomass in both systems (Allain, V., S. Nicol, T. Essington, T. Okey, R.J. Olson, and D. Kirby, 2007. An ecopath with ecosim model of the Western and Central Pacific Ocean warm pool pelagic ecosystem. Third regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission, WCPFC-*SC3*-EB SWG/IP-8, Aug. 13-24, 2007, Honolulu, HI, pp. 1-42).

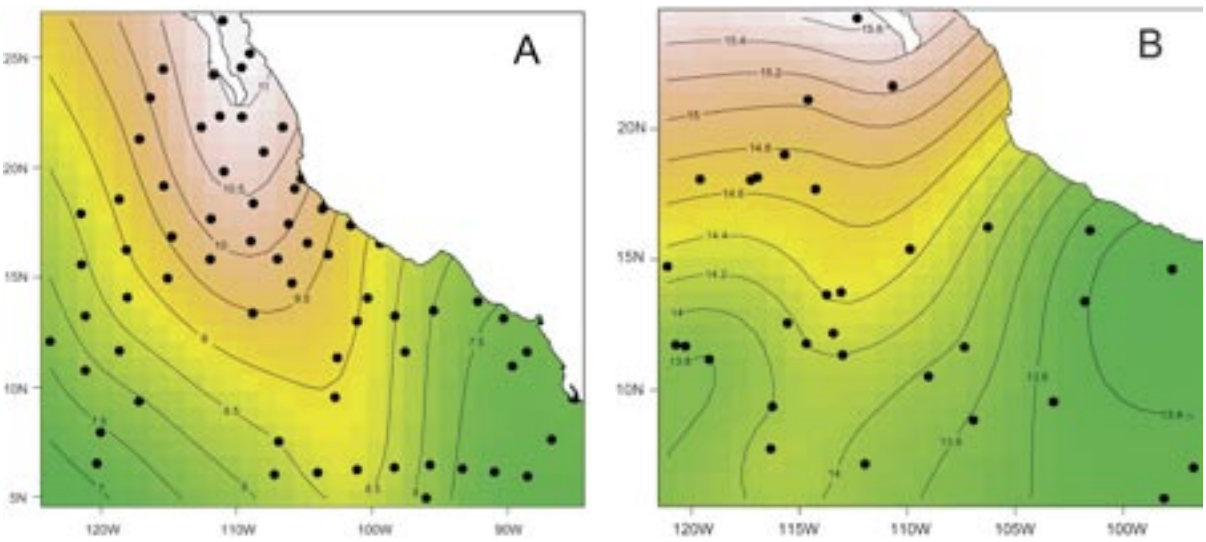


Figure 1(A). Contour plot of the bivariate latitude-longitude surface for abundance weighted-average $\delta^{15}N$ values (‰) of omnivore copepods estimated from a generalized additive model. The filled circles are 68 sampling stations where the omnivore copepods were sampled by bongo net. There is a strong south-to-north gradient of increasing $\delta^{15}N$ values in the eastern Pacific Ocean. (B). Contour plot of $\delta^{15}N$ values (‰) from 50 composite samples of up to 6 yellowfin tuna each. The filled circles are the locations where the fish were caught in purse-seine sets. As with the copepods, yellowfin tuna showed a general south-to-north gradient of increasing $\delta^{15}N$ values in the eastern Pacific.

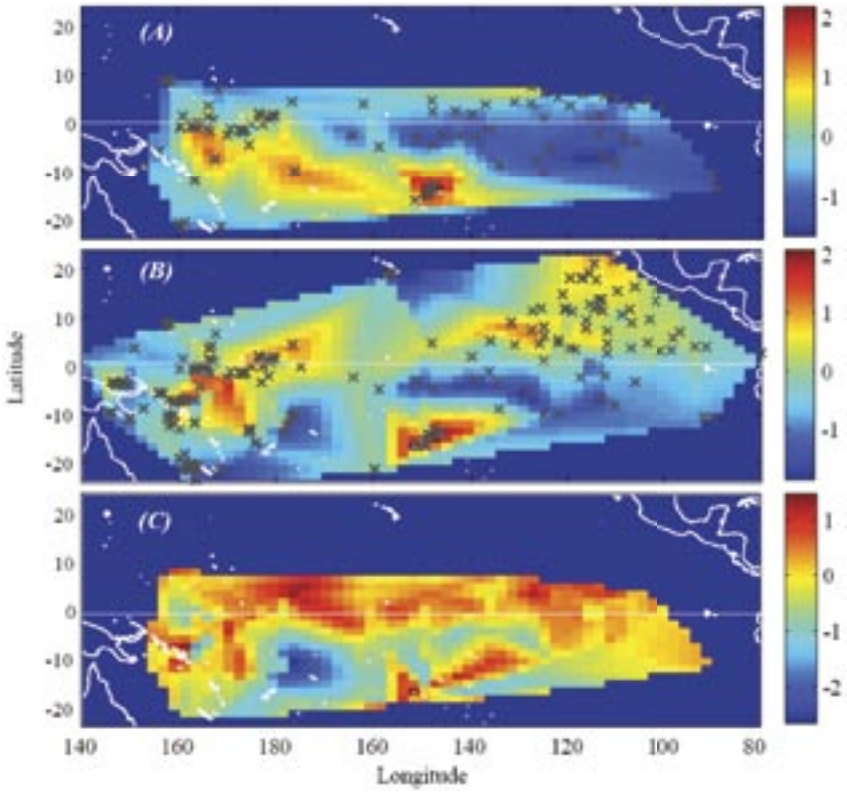


Figure 2(A). $\delta^{15}N$ isoscapes for (A) bigeye (n = 196) and (B). yellowfin (n = 387) tuna. Crosses indicate sample locations. Samples collected in the eastern tropical Pacific represent a composite of ~5 individuals. The $\delta^{15}N$ values for each species were normalized against the average value for that species within the study region. (C). Map of the residuals between the interpolated $\delta^{15}N$ values for the two species (i.e., observable difference between the normalized values). Regions with positive residuals represent areas where the $\delta^{15}N$ values of yellowfin tuna are greater than those of bigeye and negative residuals represent areas where the $\delta^{15}N$ values of bigeye are greater than those of yellowfin.

h) Stable isotope spatial patterns of mesopelagic myctophid fishes are distinct from those of epipelagic zooplankton species and yellowfin tuna in the eastern tropical Pacific. Mesopelagic myctophids might reflect the $\delta^{15}N$ value of the N at depth, and this $\delta^{15}N$ value is enriched in ^{15}N relative to that in the euphoic zone. Mesopelagic, vertically-migrating squid showed spatial patterns of the epipelagic type, despite published stomach-contents studies showing a diet dominated by myctophid fishes.

i) Stable isotope analysis provided the first broad-scale depiction of trophic relations among the pelagic copepod community in the eastern Pacific Ocean. Several copepod species were reclassified as either herbivores, omnivores, or carnivores.

j) Analyses of diet data of fishes associated with the purse-seine fishery in the eastern Pacific Ocean showed a direct trophic relationship among floating objects and small "intranadant" fishes, which feed on algae and invertebrates that inhabit the objects. Large apex predators, such as sharks, billfishes, and wahoo preyed on the intranadant fishes, and therefore showed an indirect trophic relationship with floating objects. The tunas showed no trophic relationship with floating objects.

k) Co-occurring yellowfin and skipjack tunas, caught in purse-seine sets on tunas associated with dolphins and in unassociated schools, did not appear to share prey resources in the eastern Pacific, suggesting that the function of these inter-specific aggregations may be predator avoidance.

Protected Resources Environmental Compliance Initiative

P.I.: Thomas A. Schroeder [Christopher Yates]

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

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. Project provides supplementary staff to augment federal employees assigned to this mission.

Progress during FY 2008

The objectives established for this period included: 1) sea turtle conservation, management and fisheries related mitigation activities within the Protected Resources Environmental Compliance Initiative (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 involved in protected resource issues; and 8) provide administrative support to federal and JIMAR project staff in the Protected Resources Division (PRD).

Progress during FY 2008

JIMAR Resource Managment Coordinator, Krista Graham, continued directing the ESA Section 4 Pacific Islands Region Species of Concern Program. She collaborated with a variety of stakeholders to promote species conservation, including recommending funding for conservation and research projects for each species. Examples of these projects include working with the Waikiki Aquarium to captively propagate the Hawaiian reef coral *Montipora dilatata* as

well as captively rear the inarticulated brachiopod *Lingula reevii*. She is also working with two researchers from the University of Hawaii to conduct extensive field surveys for both of these species in Kaneohe Bay, Oahu, as well as genetically analyze the Hawaiian reef coral and all other Hawaiian *Montipora* species. Krista also worked with the PRD Endangered Species Act (ESA) team, drafting informal Section 7 consultation responses to other Federal agencies in response to their submissions of project plans and permit applications. Program leads have recently been established within the ESA team, and Krista has assumed the role of program lead for any consultation taking place within the bounds of the Papahanaumokuakea Marine National Monument, as well as consultations conducted by the National Marine Fisheries Service, Pacific Islands Fisheries Science Center. Krista is also a member of the PRD Spinner Dolphin team. She assisted this group in creating outreach and education documents, as well as helped draft sections for the draft Spinner Dolphin-Human Interaction EIS and Proposal Rulemaking. Krista was awarded a NOAA Team Member of the Year Award for her hard work and efforts over the year.

Krista Graham (JIMAR), Chris Yates (PRD), and Norton Chan (Waikiki Aquarium) in front of a saltwater tank with captively reared inarticulated brachiopods (Lingula reevii).

JIMAR Outreach and Education Specialist, Jen Metz, continued to provide assistance and guidance with the various outreach and education efforts. She helped the former Honu Guardian Volunteer Program in their successful transition to becoming an independent nonprofit organization, "Malama Na Honu Foundation." In other sea turtle outreach and education, Jen assisted the PRD Sea Turtle Biologist with the development of a new Hawksbill brochure and met with the education staff at the Maui Ocean Center about the future possibility of creating a Hawksbill display at their aquarium. Jen continued to work closely with the PRD Marine Mammal Response Coordinator on various outreach efforts aimed at promoting awareness and conservation of the Hawaiian monk seal. These programs included coordinating a monk seal school presentation pilot project for local fourth graders which included an evaluative component to help measure the success of the presentation. She will complete the revised version and have it available to teachers by the fall of the 2008-2009 school year. Jen also gave marine mammal stranding / monk seal presentations to lifeguards across Oahu and developed a "Hawaiian Monk Seal Natural History Card" to assist volunteers out in the field with their education efforts. She also partnered with the Waikiki Aquarium and Natural Area Reserve System to plan details for future signs about the Hawaiian monk seal. Working closely with her PRD colleagues, Jen created a webpage for the Spinner Dolphin Human Interaction EIS and completed a Frequently Asked Questions sheet about Hawaiian spinner dolphins. She is also working closely with the PRD NEPA Specialist on assisting with outreach elements of growing volunteer Hawaiian spinner dolphin monitor-

Kim Maison in attendance at the 2008 Hawaii Hawksbill Recovery Group Meeting, on a field trip to hawksbill nesting habitat in Makena, Maui.

Jen Metz with Hawaiian monk seal volunteer, Julie Lopez, at the Molokai Earth Day Celebration.

ing efforts on Hawaii and Maui as well as continuing to extend Hawaiian spinner dolphin outreach efforts across the state. Jen built new partnerships with various organizations including the Hawaii Conservation Alliance, The Maui Ocean Center, and the Hawaii Tourism Authority, and created a protected species kids game to use at outreach events.

Naomi Yamamoto celebrates her 2007 RCUH Outstanding Employee of the Year award with her fellow JIMAR/PRD staff members.

JIMAR International Turtle Conservation and Management Liaison, Karen Frutchey, continues to serve as the 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 2008, Karen made three site visits to the Republic of the Marshall Islands (RMI) to provide technical support for a marine turtle genetic sampling project and affiliated satellite telemetry activities. In addition, she has been working with NOAA Southwest Fisheries Science Center scientists to characterize western Pacific green turtle nesting stocks by analyzing green turtle skin samples and obtaining mitochondrial DNA haplotypes. Karen also reviewed and commented on internal NOAA documents including several NOAA marine turtle grant applications which required National Environmental Policy Act (NEPA) analysis. Karen's comments were provided to PIRO IFD on draft WCPFC marine turtle related documents.

JIMAR Marine Mammal Biologist, Michelle Yuen, assisted with several marine mammal projects for the recovery of the Hawaiian monk seal. She worked with other NOAA Fisheries biologists to release the first revision of the *Recovery Plan for the Hawaiian Monk Seal* since 1983. This plan is required for all endangered species by the Endangered Species Act. Michelle also assisted with the coordination of the Second and Third Semi-annual Hawaiian Monk Seal Count, which is a program aimed to generate awareness about the seal and encourage more volunteers to join Monk Seal Response Teams across the main Hawaiian Islands. She presented species information about the Hawaiian monk seal to several schools and organizations and generated support for legislation that designated the Hawaiian monk seal as the official mammal of the State of Hawaii. Providing assistance to the Marine Mammal Response Network (MMRN), Michelle continued to edit the quarterly *Marine Mammal Response Network Newsletter* and assisted with the coordination of the Pacific Islands Region Marine Mammal Response Meeting. Finally, Michelle worked with PRD staff to draft chapters for the upcoming draft *Environmental Impact Statement on the Human Interactions with Hawaiian Spinner Dolphins* and was involved in various informal consultations under Section 7 of the Endangered Species Act. Michelle was also awarded a NOAA Team Member of the Year Award for her excellent work and efforts.

JIMAR Sea Turtle Biologist, Kim Maison collaborated with state of Hawaii Department of Land and Natural Resources (DLNR) to address incidental take of sea turtles in near shore and shoreline fisheries. She provided background materials and informational support to the newly hired Incidental Take Permit Coordinator. Kim also worked with partners on various Hawksbill recovery projects including co-organizing the 2008 Hawaii Hawksbill Recovery Group meeting; completing an educational brochure on Hawaii's hawksbills, maintaining a communication network for the hawksbill community in Hawaii; and aiding Hawaii Island Hawksbill Recovery Project in applying for NOAA grant funding. Kim also continued to maintain a Sea Turtle Reference database and served as a supporting team member on Section 7 consultations, providing technical assistance to regulatory team on several occasions. She helped to plan and convene a regional meeting of sea turtle experts to prioritize recovery efforts for Pacific sea turtles, at which she offered two presentations including Hawaiian Hawksbill Sea Turtles and the Effects of Climate Change on Sea Turtles. Finally, Kim engauged in a long distance education project about sea turtles and Hawaii with a first grade class in Allamuchy, New Jersey.

JIMAR Administrative Budget Associate, Naomi Yamamoto, 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 staff, Naomi processed three times as many travel documents than any other division/project at PIRO over the past year. Naomi also

played an integral role in many conferences and meetings this year, registering attendees, troubleshooting and making sure that each event ran smoothly. Naomi's exceptional editorial skills have allowed her to rigorously review various internal documents, improving the quality of materials that are distributed from the project. These documents included a brochure for hawksbill sea turtles and the quarterly Pacific Islands Region Marine Mammal Response Network Activity Update Newsletter. Finally, Naomi was involved in the newly redesigned budgeting process. After completing a training in budget management, Naomi was required to immediately demonstrate her proficiency by preparing and submitting draft FY 2008 spending plans. These spending plans total over two million dollars of federal funding and cover a suite of conservation and management projects for protected species. Naomi also made her fellow PRD colleagues proud when she won a 2007 RCUH Outstanding Employee of the Year award for her hard work and efforts.

Satellite Remote Sensing Research Program

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

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

NOAA Goal(s)

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

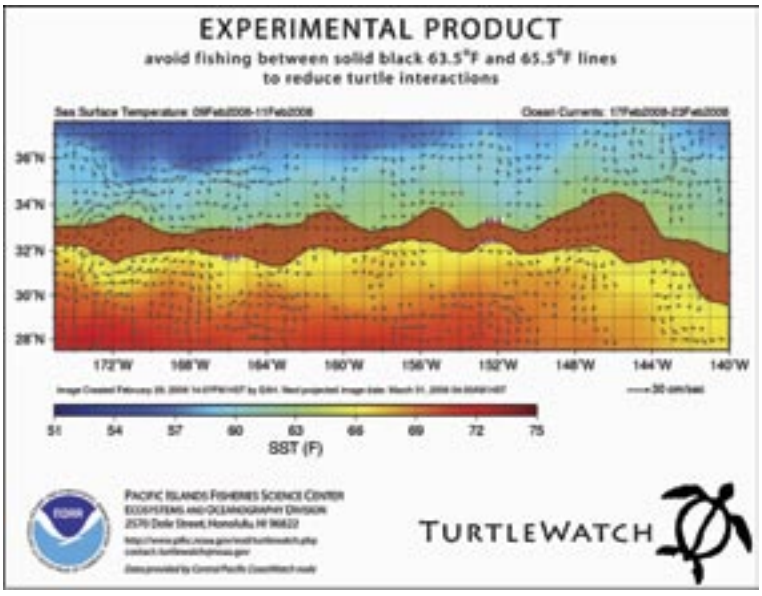
Purpose of the Project

The 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 data on movement of pelagic animals to define the critical oceanic habitats of these pelagic animals.

Progress during FY 2008

Progress was made in both theme areas. Data from Argos tags deployed on loggerhead sea turtles were analyzed and two resulting manuscripts were published. One paper describe loggerhead habitat across the entire North Pacific and the other paper presented a tool (TurtleWatch) that uses sea surface temperature to define the area within the Hawaii based longline fishing ground with the highest probability of loggerhead turtle bycatch.

In the area of basin-scale ocean satellite remote sensing, SeaWiFS surface chlorophyll data were analyzed and a paper published showing that over the past decade least productive areas, defined as areas with surface chlorophyll not exceeding 0.07 mg/m^3, within the subtropical gyres in most oceans have expanded at rates ranging from 1-4% per year. Over the 9-year SeaWiFS time series these least productive areas in the North and South Pacific and North and South Atlantic have expanded by a combined 6.6 million km^2.



TurtleWatch map which identifies zone in brown representing the area with the highest probability of loggerhead sea turtle bycatch in the Hawaii-based longline fishing ground. This zone is defined as the area between 63.5˚ and 65.5˚ F sea surface temperature. Background colors represents sea surface temperature and arrows show satellite-derived geostrophic currents.

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 the 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.

Progress during FY 2008

The Satellite Remote Sensing project in FY 2008 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 near real-time oceanographic data sets as the West Coast regional node (WCRN) of the NOAA CoastWatch program. Several highlights from FY 2008 efforts are listed below.

A. New Harmful Algal Bloom Detection Product

In FY 2007, CoastWatch developed and deployed a near real-time Chlorophyll deviation product derived from the SeaWiFS sensor carried aboard the Orbview-2 spacecraft to assist sampling efforts of state and municipal agencies concerned with the detection and monitoring of Harmful Algal Blooms (HABs) for the State of Oregon. Due to the failure of the Orbview-2 spacecraft in FY 2008, and a continuing demand for the data product, CoastWatch developed a related product using data from the Moderate Imaging Spectrometer (MODIS) flown on NASA's Aqua spacecraft. A high-resolution analog appropriate for use in bays and large estuaries is also in development based on data from the Medium Resolution Imaging Spectrometer (MERIS) made available by the European Space Agency under a Category-1 proposal on which David Foley is a co-Investigator.

B. Pathfinder SST

In partnership with the NOAA National Oceanographic Data Center, and the Southwest Fisheries Science Center's Environmental Research Division, CoastWatch is now serving as the official NOAA site for distributing Pathfinder version 5 sea surface temperature (SST) data via the Thematic Real-time Environmental Distributed Data Service (THREDDS). This allows for the full integration of this keystone data set with other "climate quality" records from ocean color, ocean surface vector winds, and altimetric sensors. CoastWatch will continue to update the Pathfinder SST data as it is produced. Data currently served spans the period January 1, 1985 to December 31, 2007.

C. Coastal Altimetry

As part of an ongoing partnership with researchers from the Cooperative Institute for Oceanographic Satellite Studies at Oregon State University, CoastWatch has implemented a special product that blends satellite altimetry and tide gauge data to generate maps of near-shore geostrophic currents. This is part of a larger push towards improving the quality of satellite altimetry in the coastal zone. Foley continues to participate as a member of the international working group for coastal altimetry.

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 (NEPA). These activities are based on the best scientific information available, and commensurately, SFI collects and analyzes scientific data, including socio-economic information, and, as appropriate, applies these data to fisheries management and conservation actions. SFI also evaluates biological, environmental, and economic issues such as protected species interaction mitigation, including fishermen education and data collection/monitoring in U.S. domestic fisheries in the western Pacific Ocean. The desired outcome is to increase food supply, enhance the economy, maintain and foster island cultures, and maximize commercial and non-commercial (recreational, subsistence) fishing opportunities in the U.S. flag island areas in the Pacific Ocean.

Progress during FY 2008

Education and Outreach

1. Disseminated NEPA environmental impact analyses through direct mailings and through the Pacific Islands Regional Office (PIRO) public website and regulations.gov website.
2. Provided periodic updates of sea turtle and seabird interactions in the Hawaii longline fishery.
3. Posted public notices, published rules, and permit applications on PIRO website.

Sustainable Fisheries Permits

The JIMAR Permit Assistant assisted with processing applications for Hawaii longline limited entry permits, Western Pacific longline general permits, NWHI bottomfish permits, High Seas Fishing Compliance Act permits, and 2,072 Hawaii longline shallow-set certificates. The Permit Assistant also assisted with preparing and distributing Federal western Pacific permit summaries to NOAA Office for Law Enforcement, NMFS Observer Program, U.S. Coast Guard, NMFS Pacific Islands Fisheries Science Center and other government agencies. The Permit Assistant also prepared ad hoc permit data reports as requested. The Permit Assistant participated in the development and implementation of the NMFS National Permits System for the Pacific Islands Region. The National Permits System will eventually replace or supplement regional permit systems and provide online accessible permit application and renewal for fishermen.

NEPA and Regulatory Actions

In FY 2008, SFI published a final supplementary environmental impact statement entitled, "Measures to End Bottomfish Overfishing in the Hawaii Archipelago" and facilitated the approval of Amendment 14 to end bottomfish overfishing and issued a Record of Decision. SFI also completed a rulemaking package that addressed overfishing of bigeye tuna pursuant to the Magnuson-Stevens Act. Additionally, SFI collaborated with WPFMC to prepare a draft programmatic environmental impact statement addressing the shift from species-based fishery management plans to place-based ecosystem plans. Finally, SFI reviewed fishery conservation and management measures developed by WPFMC for marine turtle conservation in the Hawaii pelagic longline fishery.

International Fisheries Program

The International Fisheries Program (IFP) implemented marine turtle conservation, management and fisheries related mitigation activities. Marine turtle projects included a subcontract in Papua New Guinea (PNG) and continuing work in Yap State, Federated States of Micronesia.

The Papua New Guinea Sea Turtle Interaction Mitigation and Outreach Program Phase II continued during

FY 2008 and consisted of one remaining subcontract with the Papua New Guinea (PNG) National Fisheries Authority (NFA). This supply project was completed in June 2008 with the construction of 21 turtle excluder devices (TEDs) in Papua New Guinea that NFA will distribute to PNG prawn trawlers. Implementation of TEDs in PNG is expected to reduce incidental catch of marine turtles in the Papua New Guinea prawn trawl fishery.

Yap State Marine Turtle Research Project

A nesting sea turtle tagging project was conducted on Gielop Island, Ulithi Atoll. This research was to assess the number of nesting turtles, hatching success and to sample turtles with carapace lesions or tumors. Turtles are an integral part of many aspects of Yapese life, predominantly in the outer islands. The uninhabited island of Gielop may be among the largest green turtle rookeries in Micronesia. Gielop Island was monitored a total of 55 nights out of the 67-day project duration. Nesting turtles encountered were tagged using Secretariat of the Pacific Regional Environment Programme (SPREP) titanium flipper tags and passive integrated transponder (PIT) tags and sampled for DNA analysis. A total of 250 nesting green turtles (*Chelonia mydas*) were tagged. Mean hatching success for 16 nests was 56.6% and the mean hatchling emergence success was 53.7%. Carapace lesions were present on 3.6% 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 all 250 turtles for mitochondrial DNA sequence analysis. Sampling results are pending as of the date of this report. There has not been a long-term study on marine turtles conducted in Yap, which has led to gaps in important information regarding the local nesting green turtle population. This field season builds upon information collected from Gielop during 2005-2007. A long-term tagging effort of five to ten consecutive years or more should ideally be implemented to better understand population trends on Gielop, as it is important when applying turtle management practices for these islands. In August 2007, Dr. Steve Kolinski, PIRO Coral Reef Ecologist, provided technical assistance with satellite transmitter deployment on six post-nesting green turtles. The Philippines and Japan appear to be an important foraging areas for post nesting Gielop turtles based on turtle tracks from the 2007 and 2006 seasons along with one from 2005 (Kamdidi). In addition, one turtle's transmitter discontinued transmitting within the boundaries of Yap State and another has discontinued in foraging grounds in Malaysia. Tracking services and expertise were provided by Denise Parker, JIMAR/PIFSC Marine Turtle Research Specialist and George Balazs, Leader, Marine Turtle Research Program PIFSC.

JIMAR and PIRO IFP continued to support the project for a fourth consecutive year and the non-governmental organization, The Oceanic Society, has continued administration with a former Peace Corps volunteer, now graduate student with the University of Exeter, and the locally based field crew remaining intact. From May 1, 2008 through the end of the JIMAR fiscal year 2008, this group has explored and monitored additional islands in Yap State for marine turtle nesting and will report findings in the next annual report. Tagging and nesting beach monitoring will continue through August 2008.

Western Pacific Fisheries Information Network Project

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

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

NOAA Goal(s)

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

Purpose of the Project

The Western Pacific Fisheries Information Network Project (WPacFIN) improves the availability of accessible, timely, and high-quality fisheries data needed for research and fisheries management. WPacFIN integrates local and federal island data, shares them through data share agreements, and manages them in the WPacFIN's central office at PIFSC. WPacFIN also provides direct access to data for authorized users and fulfills data requests for researchers and fisheries management agencies. In this way, WPacFIN improves the data processing and management capabilities of fisheries scientists, researchers, and managers at JIMAR, the University of Hawaii, the National Marine Fisheries Service, and the Western Pacific Fisheries Management Council. It also gives technical support to participating fisheries agencies in American Samoa, Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI). JIMAR staff primarily provide applications development/maintenance

and technical support for American Samoa and Hawaii, assist in producing routine annual report products such as the *Fisheries of the United States* (FUS), *Fishery Statistics of the Western Pacific* (FSWP), and provide status reports for the Bottomfish and Pelagics Fishery Management Plans for American Samoa and Hawaii. Staff also update and maintain the WPacFIN Program website at the PIFSC.

Progress during FY 2008

The WPacFIN project continued to make significant progress. Throughout the year, project staff designed, programmed, and implemented both new and upgraded applications to support fisheries data collection and summary reporting. Staff also responded to numerous data requests from island agencies, the Council, the PIFSC, the Pacific Islands Regional Office (PIRO) and NOAA Headquarters.

Major accomplishments:

1. Produced annual summary reports, such as *2007 Fisheries of the United States (FUS) of American Samoa, CNMI, Guam and Hawaii* and *2005 Fishery Statistics of the Western Pacific (FSWP) Volume 22*. In addition, staff assisted islanders with compiling the statistical data summary portion of the Council's Bottomfish, Pelagic and Coral Reef Plan Team reports.
2. Updated and maintained the WPacFIN Program website, which provides public access to nonconfidential fisheries data, charts, various reports, and general information on related fisheries and island agencies.
3. During the open season of the Main Hawaii Islands deep 7 bottomfish TAC monitoring (MHIBF), WPacFIN produced the weekly update of the MHIBF landings summaries for the public website and the independent bottomfish website (*http://www.hawaiibottomfish.info/*), and provided weekly landings status to the MHIBF's principals for the oversight of this fishery. The fishery was closed on April 16, 2008, with a total landing of 192,000 pounds.

Boat-based survey interview: taking fish measurement (CNMI Division of Fish and Wildlife staff)

Meeting with Hilo Fish Company, Inc. staff to gather specifications for developing the Fish Dealer application

Working with American Samoa Department of Marine and Wildlife Resources staff to resolve fisheries data issues

We accomplished most planned activities for last year. However, there were three uncompleted tasks, which will be part of next year's objectives. The first task was expansion of American Samoa Tutuila-based creel systems to incorporate Manu`a island data collection. This was delayed because of changes in staffing at the American Samoa's Department of Marine and Wildlife Resource. The second task was to develop applications and a database to store fishery-independent (ecosystem monitoring) data for American Samoa, Guam and possibly CNMI; lack of participation by local leaders delayed completion of this activity. The third task was to create applications for the Coral Reef Ecosystem Plan Team (CREPT) Fishery Management Plan (FMP) to produce

annual reports in Word document format for American Samoa, CNMI, Guam and Hawaii. The project has been postponed pending CREPT's establishment of final guidelines.

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 have focused further attention on this emerging research area. NOAA has established a Coastal Services node in Honolulu and President Clinton designated the Northwestern 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 Hawaii and U.S.-affiliated Pacific Islands.

Coral Reef Management Initiative

P.I.: Thomas A. Schroeder [Alan Everson]

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 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), Habitat Conservation Division (HCD). The CRMI relates directly to the JIMAR Coastal Research theme of achieving sustainable balance between the forces of coastal development and preservation. Information obtained as a result of CRMI assists resource managers in attaining this goal. It also enhances interagency cooperation and information exchange 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 will be developed for use in habitat management decisions made by the HCD. The initiative will also enhance our 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 reefs.

Progress during FY 2008

The Coral Reef Management Initiative can be divided up into four sub-projects: Coral reef mitigation/restoration; Guam/CNMI/American Samoa Coral coordinators; Hawaii Local Action Strategy Coordinator; and Fishery Extension Agent.

Coral reef mitigation/restoration staff continued to participate with EPA, US Fish and Wildlife Service (USFWS), Army Corps of Engineers, the State of Hawaii and the Government of Guam in the Pacific Region Interagency Coral Reef Mitigation Working Group (PRIWG) as part of the process of standardizing mitigation plans for marine projects. Honolulu and Guam staff continued restoration work associated with the *F/V Cape Flattery* ship grounding that occurred in 2005. This position became vacant in late 2007 and we are currently recruiting for a replacement.

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 projects, including coordinating the Guam Year of the Reef Campaign through a $35,000 grant from NOAA, organizing the Guam Coral Reef Symposium, assisting with NOAA workshops and visits, and continuing to develop the long term monitoring program on Guam. Numerous site investigations were conducted with other PIRO staff as well as participants from USFWS and the local Guam resource agencies in support of the Guam military buildup preparations and assessments. The Department of Defense is planning on relocating Marines from Okinawa to Guam phased over the next few years. Support in the form of environmental review and site assessment will be an important component of

Val's work in the coming years. Val's expertise in standardizing mitigation plans for marine projects through the use of the Habitat Equivalency Analysis model will be utilized extensively during this process. Other duties and accomplishments included overseeing the process for the Guam Fisheries Management Local Action Strategy, collaborating with the Guam Coral Reef Task Force Point of Contact and other local agencies on numerous projects, and assisting PIRO Honolulu staff with Corps of Engineers permit review.

CNMI Coral Reef Ecologist Teny Topalian continued conducting interviews with fishermen in Saipan, Tinian and Rota on their perception and attitudes towards marine conservation and resource management issues. She attended and participated in meetings for Pride/Rare Campaign, Marianas Islands Nature Alliance, Chamorro and Carolinian conferences, and the WPRFMC. Teny also contributed to regional programs including Pacific Islands Marine Protected Area Coalition, and Micronesian Challenge. In addition, she reviewed the natural resource management program for the Northern Marianas College Advisory Council, participated in International Year of the Coral Reef activities, and the CNMI Environmental Exposition.

American Samoa Coral Reef Ecologist Fatima Sauafea-Leau continued planning for additional Participatory, Learning, and Action (PLA) workshops for local villages to engauge community members in information gathering, developing, and implementation of coral reef resource management. A Traditional Knowledge and Resource Management Project was started in August 2007 and completed in March 2008. The goal of the project was to gather information on traditional fisheries from the community of elder fishermen, both men and women ages of 50 and above. It is hoped that this information on traditional resource management can used to improve existing and future management. Information was gathered through a survey at 28 villages from both Tutuila and the Manu'a islands, with 78 people surveyed. The information collected will help managers and scientists better understand community perceptions on big reef fish species, the most common reef species, both fish and invertebrates, and the issues or problems that contribute to reef damage and depletion of some marine species. Recommendations on tools or ways to improve management were also collected. In addition, a Community-based Wetland PLA Workshop was conducted in May for the village of Tula. Tula is one of the many villages with a wetland area that is now co-managed and protected by both the village community and the Coastal Management Program under the American Samoa Department of Commerce. Main goals of the workshop were to raise awareness, promote stewardship, and build village capacity in planning, facilitating, and coordinating projects and activities to improve their resources. In addition, the workshop assisted the village community in designing and implementing a Community Action Plan that will guide them in developing management activities to support their co-management efforts. A Community-based Enforcement Workshop sponsored by the Department of Marine and Wildlife Resources in collaboration with NOAA Fisheries PIRO was also held in May. The purpose of this workshop was to assist marine protected area (MPA) villages to integrate capacity building into their management plans and to enhance their capabilities for enforcing the new village MPA regulations. Lastly, Fatima coordinated and facilitated the first Strategic Planning Meeting for the American Samoan Fisheries Local Action Strategy.

Participants at the PLA Wetlands workshop in Tula, American Samoa. The villagers were asked to draw pictures of what they think the wetland should look like in the future

Our Hawaii Local Action Strategy Coordinator Jason Phillibotte revised, updated, and coordinated Hawaii's Fisheries Local Action Strategy (LAS), a collaborative effort between NOAA and Hawaii State Department of Aquatic Resources to address overfishing in Hawaii. Responsibilities included the oversight of a scientific advisory committee, management of program funds, project development, and strategic planning. He developed

and administered 6 LAS priority projects in the two years as LAS coordinator totaling approximately $200,000 in funding, including grantee follow-up and report writing. He increased Fisheries Local Action Strategy funding base from $80,000 to $185,000 in first and second year as FLAS coordinator (100% of program budget). Jason also facilitated a workshop in Fiji on setting national priorities for future applied scientific research relating to marine managed area monitoring and evaluation, which was attended by 40 fishery biologists and marine scientists working in government, non-government, and academic organizations. Other international work included conducting a community visioning and MPA network development workshop in Fiji for 40 participants, including the nine paramount chiefs of Kadavu Island; facilitating a marine protected area management planning and evaluation workshop for 12 staff of the El Nido Foundation (ENF), 6 local government unit partners and 35 community members and a "Developing a Sustainable Fisheries" workshop in Quy Nhon, Viet Nam for 30 local marine managers, fishermen, and government officials; and leading a contingent from the Pacific Islands (Hawaii and Micronesia) on a public outreach and education exchange visit to discuss community involvement in marine resource management to Guam, Saipan, and Rota.

Fishery Extension Agent Mike Lameier shows young fisher a fish measurement guide at the Bishop Museum's family day

The Hawaii Fishery Extension Agent's (Mike Lameier) main focus is to foster 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. The fishery extension agent 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. Outreach efforts in 2008 have increased to include activities at shoreline and spear fishing tournaments on Oahu and Hawaii, public fishing and environmental outreach events, fishing clubs and supporting local enforcement organizations. Additionally, efforts are extending out to the other main Hawaiian Islands. Mike, in cooperation with the Hawaii State Division of Aquatic Resources, designed a guide to enable fishers to identify and measure their catch to determine if it is legal sized or has reached size at first reproduction (size at which the fish is first able to spawn). Over 12,000 fish measurement guides have been distributed state-wide to the fishing community and through a collaborative effort with the Hawaii State Department of Education. A fish measuring activity will also be provided to 180 schools state-wide.

National Environmental Policy Act (NEPA) Initiative

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

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

NOAA Goal(s)

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

Purpose of the Project

Under the Federal National Environmental Policy Act (NEPA), federal agencies must insure that environmental information is made available to public officials and citizens before decisions are made and actions are taken. The purpose is to promote management and policy decisions that will prevent or eliminate damage to the environ-

ment, stimulate health and welfare of man and enrich understanding of ecological systems and natural resources important to the Nation. The major focus of this initiative is to obtain technical assistance on an activity- and project-specific basis to ensure timely and legally sufficient agency compliance with applicable NEPA requirements. The initiative addresses NOAA Fisheries Service's NEPA compliance with international treaties as well as fosters international marine resource conservation measures. While NOAA Fisheries Service has addressed NEPA compliance associated with Federal activities (i.e., development of fishery management plans) in the past, this NEPA Initiative represents a holistic effort to foster compliance with NEPA in international projects. Information and lessons learned from this NEPA Initiative will be evaluated and applied to future NEPA actions. NEPA-focused hires under this initiative will closely coordinate and collaborate with several existing organizations with marine resource protection mandates. These include, but are not limited to: NOAA PIFSC, NOAA NOS, NOAA and NOAA Fisheries Service headquarters components, and the WPRFMC.

The primary purpose of the NEPA Initiative is the development of NEPA analyses to implement the Western and Central Pacific Fisheries Convention (WCPFC) and decisions of the WCPF Commission.

Progress during FY 2008

The WCPFC Implementation Act became law in January 2007 and the United States deposited its instrument of ratification with the Convention depositary in June 2007. The NMFS then had authority to take the regulatory and other actions needed to implement the Convention, as well as the need to complete the necessary NEPA analyses for such actions.

Implementation of the Convention 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, and the scope of analysis required. These factors have resulted in the need for extensive research and strategy development. A NEPA strategy that recognizes the need for a broad programmatic NEPA analysis has been prepared. Research to establish the baseline condition has progressed substantially and a description of the affected environment has been prepared.

For the initial round of implementing regulations, a notice of intent to prepare an Environmental Assessment (EA) was published in the Federal Register (February 2007) and public comments accepted. Preparation of the Environmental Assessment is underway: alternative actions have been crafted and analyses of the impacts of the alternatives have been initiated and an internal draft document has been circulated for comment. Responses are being incorporated and a final document is anticipated calendar year 2008. The final EA, in addition to supporting the initial round of implementing regulations, will serve as a source document for the Programmatic Assessment.

To support the Environmental Assessment and the longer-term NEPA needs for implementation of the Convention, administrative record-keeping and documentation strategies and plans have been constructed.

Ocean Remote Sensing/Ocean Watch

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
- 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 NOAA OceanWatch-Central Pacific node supplies near-real time, remotely sensed oceanographic and environmental data for the entire Pacific-based communities, including resource managers, researchers, educators and the general public. The satellite-derived products include ocean surface temperature, ocean color, ocean surface topography, ocean surface wind fields, environmental indicators (Empirical Orthogonal Functions-EOFs), and high-resolution (1.1 km) thermal infrared High Resolution Picture Transmission (HRPT) imagery from the

NOAA Advanced Very High Resolution Radiometer (AVHRR) satellites. The HRPT data is collected daily by the AVHRR receiving station located in Ewa Beach, Oahu (Hawaii).

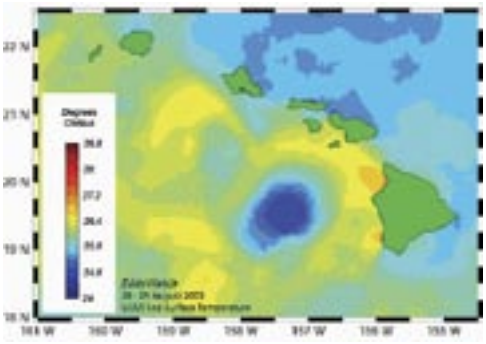


Image generated by the EddyWatch monitoring program available at OceanWatch-Central Pacific. The image shows the spin-up of a mesoscale oceanographic eddy off the Big Island, resulting in the upwelling of cool nutrient-rich deep water into the surface. Image was collected by the Geostationary Operational Environmental Satellite (GOES) during 28-29 August 2003.

Progress during FY 2008

Following the reprocessing of the entire satellite remote sensing data archive at NOAA OceanWatch-Central Pacific (OWCP) completed throughout FY 2007, in FY 2008 OWCP finalized the installation of the newly-implemented Live Access Server (LAS). Following its public release in FY 2008, the new OWCP LAS has been utilized successfully in a variety of ways, including the near real-time support of oceanographic research cruises, as well as rapid-response efforts of emergency managers and oil-spill hazard mitigation teams. The new Thematic Real-time Environmental Distributed Data Services (THREDDS)/Open-source Project for a Network Data Access Protocol (OPeNDAP) infrastructure provides an unprecedented access and flexibility to the user for obtaining the datasets they are interested in, and allows them to conduct on-the-fly spatial and temporal sub-settings of the dataset of interest. Datasets include sea-surface temperature, sea-surface height, ocean color, and ocean surface winds. Collaboration efforts are currently underway with a variety of agencies and institutions, including the NOAA Integrated Data and Environmental Applications (IDEA) Center.

Sustaining Healthy Coastal Ecosystems

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

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

NOAA Goal(s)

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

Purpose of the Project

The purpose of the project is to address concerns about the deterioration of coral reef ecosystems around the globe, the project supports multi-disciplinary efforts to assess, monitor, map, restore, and protect coral reef ecosystems of the U.S. Pacific Islands. The goals of the project are to:

- Improve understanding of coral reef ecosystems through assessment, long-term monitoring, and applied research;
- Evaluate and reduce adverse impacts to coral reef ecosystems with particular emphasis on those related to fishing activities;
- Enhance coral reef fisheries management and conservation by providing scientific support for implementation of the Coral Reef Ecosystem Fishery Management Plan, and archipelagic-based ecosystem management plans; and
- Provide the scientific basis to expand, strengthen, and establish marine protected areas (MPAs) to conserve coral reef resources of the U.S. Pacific Islands.

Progress during FY 2008

The JIMAR Sustaining Healthy Coastal Ecosystems project is funded by the NOAA Coral Reef Conservation Program and is staffed by over 60 researchers, support personnel, and students. This includes 41 JIMAR personnel, 1 UH graduate student, and 5 UH undergraduate students. The research accomplishments and success of the program has been critically dependent on the expertise and efforts of JIMAR scientists and staff in the Coral Reef Ecosystem Division (CRED) and the Pacific Islands Fisheries Science Center (PIFSC).

In order to support the objectives of the JIMAR Sustaining Healthy Coastal Ecosystems project plans for FY

2008 include:

- Continue long-term monitoring and assessment of fish, corals, algae and macro-invertebrates in coral reef ecosystems of U.S. Pacific Islands
- Continue long-term monitoring of the oceanographic environment of coral reef ecosystems of U.S. Pacific Islands
- Complete mapping of coral reef habitats in U.S. Pacific Islands
- Continue long-term marine debris removal in the Northwestern Hawaiian Islands (NWHI)
- Initiate a marine debris removal program in the Main Hawaiian Islands (MHI) based on aerial surveys

During FY 2008, the Sustaining Healthy Coastal Ecosystems project conducted multi-disciplinary research cruises aboard the NOAA Ships *Oscar Elton Sette* and *Hi`ialakai* in U.S. Pacific Islands. These research cruises conducted assessments and monitoring of the fish, corals, other invertebrates, and algae in the context of their benthic and oceanographic habitats of the coral reef ecosystems of the Northwestern Hawaiian Islands, American Samoa, Johnston Atoll, Phoenix Islands, and Line Islands. These research cruises also conducted benthic habitat mapping activities consisting of multi-beam acoustic surveys and towed diver and towed camera optical validation surveys. This multi-disciplinary approach to research provides an improved understanding of coral reef ecosystems, which will serve as the scientific basis for management plans and conservation efforts. Project activities that evaluate and reduce adverse impacts to coral reef ecosystems included marine debris removal efforts in the NWHI and MHI.

Ecological Assessment—Fish

Ecological assessments of reef fish were conducted in the NWHI (July-August and September-October, 2007), at Johnston Atoll (January-February, 2008), the U.S. Phoenix Islands [(Howland and Baker) February, 2008], the American Samoa Archipelago (February-March, 2008), and in the U.S. Line Islands [(Jarvis, Palmyra, and Kingman) March-April, 2008]. These assessments were conducted by scientists from the project, and its partner agencies, from the NOAA Ship *Hi`ialakai* and NOAA Ship *Oscar Elton Sette*.

Two separate research cruises to the Northwestern Hawaiian Islands (NWHI) took place during the report period. The first research expedition to the NWHI aimed to evaluate the influence of wind wave exposure on the distribution and abundance in numerical density of newly recruited fishes at Kure Atoll (KUR) and Pearl and Hermes Reef (PHR) in the NWHI. In situ surveys of recruit (≤ 5 cm total length, TL) and resident piscivore (> 5 cm TL) reef fishes and benthic habitats were conducted July-August 2007. Totals of 30 and 57 stations were surveyed at approximately 0.5 km spacing around the entire back reef perimeters of the two atolls (KUR: 23 km; PHR: 65 km). Five species of Hawaiian endemic fishes (four labrids—*Stethojulis balteata, Thalassoma duperrey, Macropharyngodon geoffroy, Coris venusta*; and one scarid—*Scarus dubius*) comprised 90-95% of all recruits throughout windward and leeward sectors. Recruit densities were generally greater overall at PHR and lower at the windward sectors of each atoll. Small (≤ 2 cm) recruits of each of four of the five top-ranked species, moreover, were disproportionately less abundant (by 44-81 %) along leeward versus windward PHR. These observations suggest that the windward barrier reef at PHR, the atoll with the threefold larger perimeter, has a more prominent physical lee that affects the advective transport and settlement of reef fishes at this atoll. Results of this study are being presented at the 2008 International Coral Reef Symposium as well as published in the scientific journal Coral Reefs (in review).

The second research cruise to the NWHI served as a continuation of the Coral Reef Ecosystem Division's assessment and monitoring program. However, in addition to the primary mission to conduct ecosystem monitoring of the species composition, size, and density of all fishes on shallow-water (<35 m) coral reefs around the islands, an ancillary project to evaluate two scientific methods was also performed. Specifically a stratified random approach was tested in the NWHI as part of the HI0708 RAMP cruise undertaken by the Papahanaumokuakea Marine National Monument (PMNM). This effort was conducted in conjunction with the use of amended in situ protocols that may increase efficiencies of field data collection for each sub-discipline. A preliminary analysis has been conducted and the results and findings are being included in a scientific manuscript (in prep).

At Johnston Atoll and Howland and Baker Islands in the U.S. Phoenix Islands, ecosystem monitoring of the species composition, size, and density of all fishes was conducted on shallow-water (<35 m) coral reefs around these islands. A combined total of 26 REA survey sites for all fishes and 26 towed-diver surveys (for large fishes) were completed at Johnston Atoll and Howland and Baker Islands in the U.S. Phoenix Islands. Weather prevented scientists from conducting a full complement of surveys at Johnston Atoll. Generally, fish stocks continued to appear healthy with large predators such as sharks, jacks and barracuda being commonly observed at most sites.

A multidisciplinary research assessment and monitoring cruise was conducted around the islands of American

Samoa (Tutuila, Ofu and Olosega, Tau, Rose Atoll, and Swains Island) as part of the project's biennial monitoring program. Survey efforts focused on conducting ecosystem monitoring of the species composition, size, and density of all fishes was conducted on shallow-water (<35 m) coral reefs around these islands. One hundred twelve Rapid Ecological Assessments (REA) survey sites for all fishes and 110 towed-diver surveys (for large fishes) were completed throughout the American Samoa Archipelago. Generally, fish stocks continued to appear to occur in low densities around most of the islands close to population centers (e.g. Tutuila). Large fish, predators, and other commonly fished species were particularly rare at most sites, in comparison to Rose Atoll and Swains Island which are geographically located away from anthropogenic influences. Although large predators were observed, they were not encountered at the frequency and size as that of some of the other remote U.S. Pacific islands such as Howland, Baker and Jarvis.

The U.S Line Islands survey consisted of ecosystem monitoring of the species composition, size, and density of all fishes and was conducted on shallow-water (<35 m) coral reefs around these islands. 71 REA survey sites for all fishes and 59 towed-diver surveys (for large fishes) were completed in the U.S. Line Islands (Jarvis Island, Palmyra Atoll, and Kingman Reef). Overall the fish stocks in the Line Islands appeared to be healthy with large predators such as sharks and jacks comprising a majority of the total fish biomass. Overall, fish assemblages around the U.S Line Islands were similar to that found during our previous two biennial surveys. The general trend still indicated a greater abundance of larger fish than observed at islands close to human population centers. Notable observations included the International Union for Conservation of Nature (IUCN) Red Listed (Endangered) humphead wrasse (*Cheilinus undulatus*) at Palmyra Atoll. C. Undulatus were commonly observed during all surveys around the atoll and indicated a healthy breeding population. A manuscript identifying the status of rare and endangered species in the U.S. Pacific Islands is in preparation.

Previous efforts to streamline data entry, error checking, and preliminary analysis have been expanded upon to further advance the program's ability to conduct scientific analyses. This will then allow scientists to produce reports and statistical analysis and in effect publish scientifically defensible manuscripts in respected scientific journals in a timely manner. During the past year, two manuscripts have been submitted to such journals and are in review, four manuscripts are in preparation for submission and six abstracts were accepted to the International Coral Reef Symposium. The project's fish ecology team also contributed to the completion of the American Samoa Monitoring Report and the U.S. State of the Reef report, released July 2008. Scientists from the project have made efforts to initiate collaborative projects with other scientists from the Scripps Institute of Oceanography and other PIFSC senior scientists. These collaborations will enhance the quality of products created by the project and lead to future funding and research opportunities.

Analyses of fish data indicate that the population status of targeted reef fish species across U.S. Pacific island reefs is strongly correlated with local human densities. We continue to find the highest fish biomass to be found around the uninhabited, or sparsely populated, isolated islands and atolls of the central Pacific, such as Howland, Baker, Jarvis, Wake, Palmyra and Kingman. These findings have been presented by the project's scientists and collaborators at numerous meetings and symposia. Survey efforts over the current report period showed a similar trend to previous survey efforts with fish biomass on these reefs ranging from two to six metric tons per hectare. We continue to observe the lowest fish densities (~0.5 mt/ha) around heavily populated islands, such as Oahu, in the Hawaiian Archipelago, and Guam, in the Marianas Archipelago. Our analyses also show that reef fish biomass around the more remote/uninhabited islands is dominated by large apex predators, such as sharks (>60% of total biomass), while biomass on reefs close to population centers are comprised primarily of herbivorous fishes (>40% of total biomass).

Ecological Assessment—Corals

Three manuscripts on which Dr. Jean Kenyon is the lead author and one on which she is co-author have been published since Summer of 2007. An additional manuscript regarding coral reproduction in the northern Line Islands has been accepted for publication. Two manuscripts are being reviewed by refereed journals; one describes a localized outbreak of crown-of-thorns starfish off Oahu, and the other describes coral community structure at Kure Atoll. Two additional manuscripts are undergoing review within the Pacific Islands Fisheries Science Center; one is the product of a 6-year study of coral recruitment at remote locations throughout the U.S. Pacific, and the other describes coral community structure at Maro Reef. Dr. Bernardo Vargas-Angel is lead author on two manuscripts currently in review by refereed journals. One is a synopsis of coral disease surveys throughout American Samoa undertaken in 2006, and the other describes an outbreak of encrusting tunicates at Swains Island in American Samoa. An additional manuscript by Dr. Vargas-Angel undergoing review within the

PIFSC is a synopsis of coral disease surveys throughout the northern Line Islands undertaken in 2006. One oral and five poster presentations by Dr. Kenyon, Dr. Vargas-Angel, and Jacob Asher relating to studies of coral communities have been accepted at the 2008 11th International Coral Reef Symposium, and two oral presentations by Dr. Kenyon have been accepted at the 2008 Hawaii Conservation Conference. An oral presentation describing coral community structure at Pearl and Hermes Atoll at the 2007 Hawaii Conservation Conference by Dr. Kenyon was well received by resource managers attending the session.

JIMAR scientific staff Sarah Myhre conducting small coral surveys at Pearl and Hermes Atoll during the 2007 NWHI RAMP Papahanaumokuakea Marine National Monument Cruise in September-October 2007

More inclusive products on which the coral team shares authorship included (1) several chapters of the 2008 State of the Reef Report; a national-level report that describes the status of coral reefs in all U.S. jurisdictions, and (2) The project's 2002-2006 American Samoa Monitoring Report. A biogeographic analysis of the Hawaiian Archipelago using data supplied by the project's coral team is currently in progress through NOAA's National Ocean Service. Dr. Vargas-Angel also prepared several new pages on coral disease for the project's web site.

In 2007 the Papahanaumokuakea Marine National Monument (PMNM) set out to test the implementation of a stratified random approach design for survey site selection, in conjunction with amended in situ protocols, aimed at increasing efficiencies of field data collection for coral reef ecosystem monitoring in the Northwestern Hawaiian Islands. JIMAR Scientist Dr. Bernardo Vargas-Angel and scientific staff Jason Helyer and Sarah Myhre participated in this effort as members of the benthic team, assessing coral community and population attributes, including, abundance, diversity, density, size class distribution, and disease. Within this context project staff conducted a total of 45 coral population and disease surveys at French Frigate Shoals, Pearl and Hermes Atoll, and Neva Shoals from September 18 to October 13, 2007, on board the NOAA Ship *Hi'ialakai*. These surveys are part of the PMNM strategy to statistically evaluate the existing biological monitoring methods in the region and initiate discussions aimed at the possibility of refining the existing protocols in order to optimize the ability of NOAA's monitoring program to detect population changes. NOAA's Coral Reef Ecosystem Division (CRED) has been conducting coral reef ecosystem monitoring in the Northwestern Hawaiian Islands since 2000, and thus is a key player in these analyses and discussions.

Outbreak of the colonial tunicate Diplosoma similes at Swains Island, American Samoa, March 2008

Comparable Rapid Ecological Assessments (REAs) documenting coral reef community structural parameters and prevalence of coral disease were conducted across the U.S. Equatorial Pacific Reefs between January and April 2008 on board NOAA's Ship *Hi'ialakai*, as part of the project's Pacific Reef Assessment and Monitoring Program (RAMP). JIMAR Scientists Drs. Bernardo Vargas-Angel and Jean Kenyon, and scientific staff, Jason Helyer and Sarah Myhre completed all field work, totaling 115 independent surveys at Johnston Atoll, the US Phoenix and Line Islands, and American Samoa, employing protocols developed since 2002 and implemented throughout all the US-affiliated Pacific Islands monitored by the Coral Reef Ecosystem Division. As in 2006, levels of bleaching and coral disease detected in the US Equatorial Pacific during the 2008 surveys were low. However, of note was the discovery of a population outbreak of the colonial didemnid tunicate *Diplosoma similis* at Swains Island (American Samoa). Quantitative benthic community surveys conducted by Dr. Vargas-Angel

indicated relative abundances of the tunicate as high as 76.5% and 35.0%, and aggressive overgrowth on species of stony coral and macroalgae.

Ecological Assessment—Algae

During 2007-2008, ecological assessment of marine algae were conducted at 49 sites in the Northwestern Hawaiian Islands (September-October 2007), at 12 sites at Johnston Atoll and the Phoenix Islands (January-February 2008), at 62 sites in American Samoa (February–March 2008), and at 35 sites in the Line Islands (March–April 2008). Quantitative relative abundance data of macroalgal populations was collected in the field together with photoquadrat images that will be used for percent cover analyses. Voucher specimens of algae associated with each photoquadrat/site were collected and are slated for eventual deposition at the Herbarium Pacificum in the Bishop Museum, Honolulu, Hawaii after taxonomic analysis is complete.

Two manuscripts that incorporate data collected by the project's phycology laboratory have been published since 2007: (1) a comprehensive algal flora of Howland and Baker Islands; and (2) temporal and spatial comparisons of macroalgae in the Mariana Archipelago. Four manuscripts are currently in review: (1) a spatial analysis of benthic communities at Pearl and Hermes Atoll, Northwestern Hawaiian Islands; (2) analysis of the diversity and abundance of marine algae at Gardner Pinnacles, Northwestern Hawaiian Islands; (3) a Pacific-wide study of the relative abundance of macroalgae based on rapid ecological assessment data; and (4) an analysis of the relative abundance of macroalgae in the islands of American Samoa. Algal research projects that are currently underway include: (1) an ecosystem-based analysis of Howland and Baker Islands, US Phoenix Islands; (2) description of a new brown algal species, *Sporochnus longiramosum*, from Maro Reef, Northwestern Hawaiian Islands; (3) analysis of benthic communities at Rose Atoll based on species-level percent cover data; (4) analysis of benthic communities at Lanai based on species-level percent cover data; (5) a comprehensive algal flora of Kingman Atoll and Jarvis Island; and (6) analysis of benthic communities at Palmyra Atoll based on species-level percent cover data.

Oceanography

Oceanographic monitoring and assessment continues throughout the NWHI, MHI, Guam, CNMI, American Samoa, and the Pacific Remote Island Areas (PRIAs). As of July 2008, there are 269 instruments deployed and 471 datasets available from past deployments. Datasets include various oceanographic and meteorological parameters including: sea surface and subsurface water temperature, salinity, current profiles, wave and tide data, photosynthetic active radiation, Ultraviolet-B (UV-B), air temperature, barometric pressure, and wind velocity in some combination at over 50 islands, atolls and banks around the Pacific Ocean. Remotely sensed and modeled products, including: sea surface temperature, ocean color, and open ocean wave heights, are used in tandem with in situ data to increase the spatial coverage and extend the temporal coverage of oceanographic monitoring conducted around the Pacific. These data allow comparison of instruments and calibration of satellite data. In October 2006 and 2007, for example, sea surface temperature around Guam exceeded the climatological mean, reaching and surpassing the bleaching threshold for a 10 day period in 2006 and approaching this threshold in 2007 (Figure 1).

Over 601 shallow water (30 m) conductivity, temperature, depth (CTD) casts were performed between January 2007 and July 2008 adding to the cumulative total of 4,170 casts. These casts provide depth profiles of salinity, temperature, density, and beam transmittance (water clarity) data at regularly spaced intervals (typically 1 km) around each of the atolls and islands visited during the RAMP cruises (Figure 2). At Guam, for example, the vertical structure show two distinct water masses; varying from relatively cooler (280-28.50 C), more saline, dense water on the north eastern coast, to warmer (290-300 C), lower salinity and density water along the eastern and southern sides of the island. These two water masses meet at a clear gradient between casts 16 and 17, located at the north east corner of the island (Figure 2). Deepwater (500 m) CTDs and shipboard acoustic Doppler current profiler (ADCP) transects were also conducted during research cruises providing important information about the large scale oceanographic conditions influencing the nearshore waters of island ecosystems.

Physical oceanographic data are complimented with in situ water samples of chlorophyll (chlorophyll a, pheopigments) and dissolved nutrient concentrations (phosphate, silicate, nitrate, nitrite), with over 800 chlorophyll and nutrient samples collected during the past year. In 2008 the project started collecting sea water carbonate chemistry data as part of the standard suite of monitoring products to add to the pilot project in American Samoa, as a collaborative effort with NOAA's Pacific Marine Environmental Laboratory. These data will be used to monitor changes in ocean acidification across the Pacific. These data are important for determining water masses and identifying unique oceanographic phenomena, and when compared with concurrently collected biological

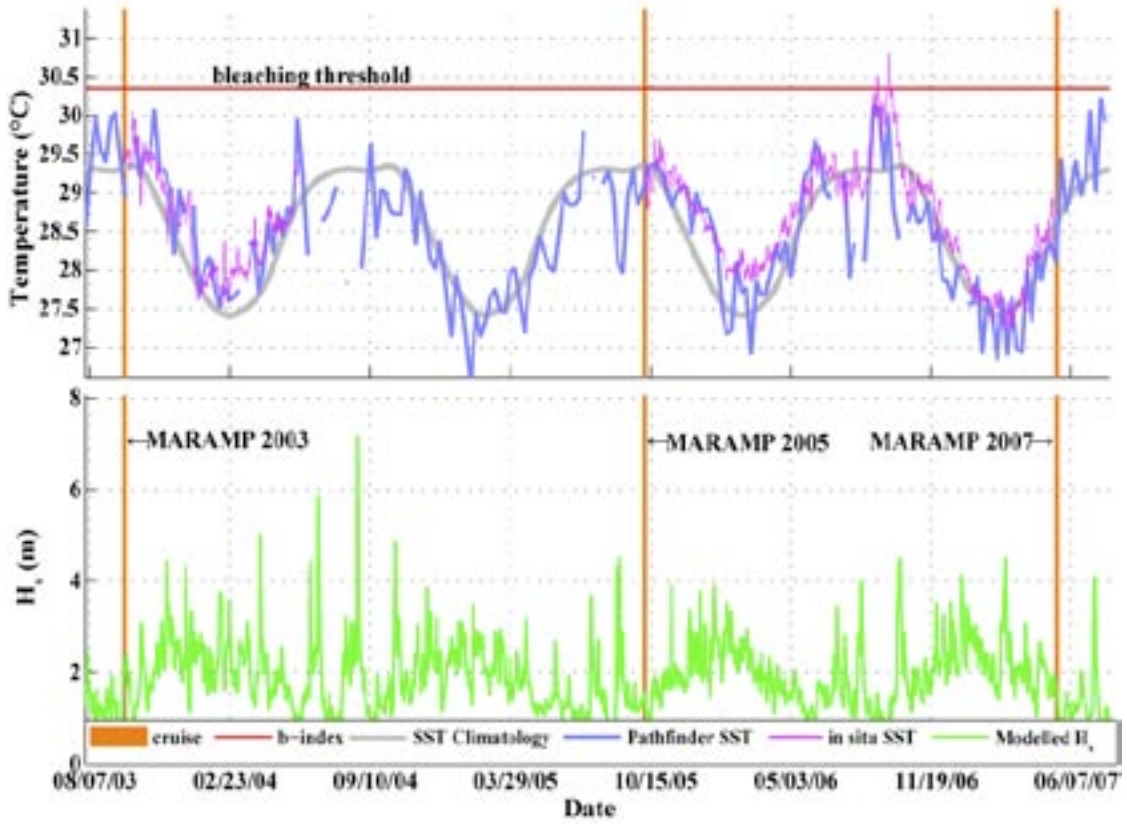


Figure 1. Time series of in situ sea surface temperature (SST), remotely sensed Pathfinder SST, Climatology and modeled wave height from Guam. Note the sea surface temperature around Guam exceeded the climatological mean, reaching and surpassing the bleaching threshold for a 10 day period in October of 2006.

data, aids in the understanding of the interactions between the physical environment and biological processes.

Ecological Acoustic Recorders (EARs) are passive acoustic listening devices used to monitor the temporal and spatial patterns of changes in the ambient sound field at remote coral reef ecosystem locations. The program uses EARs to monitor a variety of sounds, including those produced by snapping shrimp, fish, marine mammals and vessels. In 2007-2008 the program deployed or re-deployed 21 EAR units across the Pacific Island Region. Of these, four are located in the Northwestern Hawaiian Islands, four in the Main Hawaiian Islands, one at Johnston Atoll, five in American Samoa, one at Jarvis Island, one at Palmyra Atoll, one at Kingman Reef, one at Wake Atoll, one in Guam and two in Saipan. In addition, 21 other units were deployed in collaborative efforts with partners at the Northwest Fisheries Science Center, the National Marine Mammal Laboratory, the Alaska Sea Life Center, the Alaska Beluga Whale Commission, and the University of the Azores.

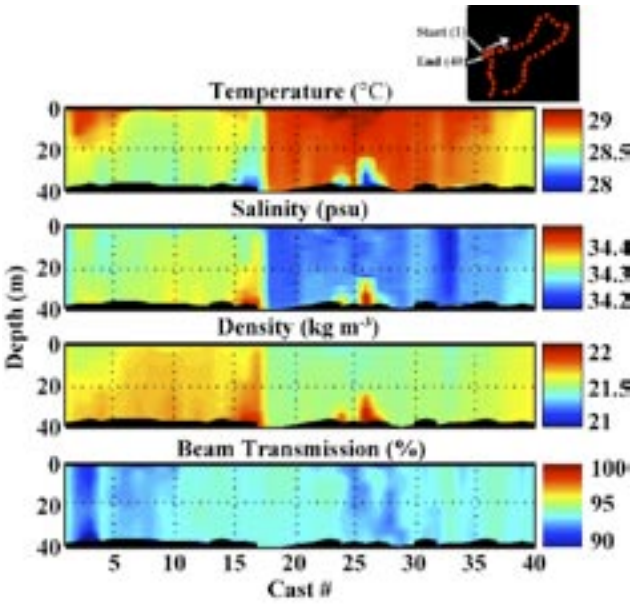


Figure 2. Temperature, Salinity, Density and Beam Transmission from 40 shallow water CTD casts around the Island of Guam, 2007.

EAR deployments have revealed several findings to date. Among these, the occurrence of a deep water chorus off Penguin Bank, Molokai, possibly tied to the mesopelagic boundary community. This chorus begins shortly after sunset and may be produced by myctophid fish, which are an important prey species for both pelagic and demersal fish as well as cetaceans. This phenomenon is being investigated in more detail. Another recent finding is the presence of humpback whale song at French Frigate Shoals. Data obtained by the EAR reveal that humpback whales appear to use French Frigate Shoals as a wintering ground in a similar way as in the Main Hawaiian Islands. Finally, EARs are revealing a variety of diel and seasonal trends in the acoustic activity of many species of reef fish and also snapping shrimp. These trends will be useful in gauging the long-term stability of the ecosystems in which the sounds occur.

In an ongoing study led by collaborators from SOEST, University of Hawaii, the bottomfish camera station (BotCam) is being utilized to evaluate the effectiveness of restricted fishing areas for improving the bottomfish fishery in the Main Hawaiian Islands. Data is being analyzed from over 330 (and counting) successful BotCam deployments in and around restricted fishing areas at Niihau, Kaena, Makapuu, Penguin, Pailolo, and Hilo.

The BotCam station, initially developed by the program, is a non-extractive method to monitor exploited bottomfish populations and other important deep water species, visually assess habitat, and study ecological linkages to more shallow water ecosystems. Optical measurement tools represent an underutilized non-extractive method for collecting ecosystem observations of habitat and population parameters.

Benthic Habitat Mapping

The benthic habitat mapping group has been surveying in U.S. affiliated Pacific islands since 2001 in order to create maps of all coral reef habitats as an essential part of the JIMAR Sustaining Healthy Coastal Ecosystems program. Using bottom cameras, diver surveys, and single-beam echosounders, over 53,000 km2 of seafloor have been mapped and over 500 camera sled tows for optical validation were conducted.

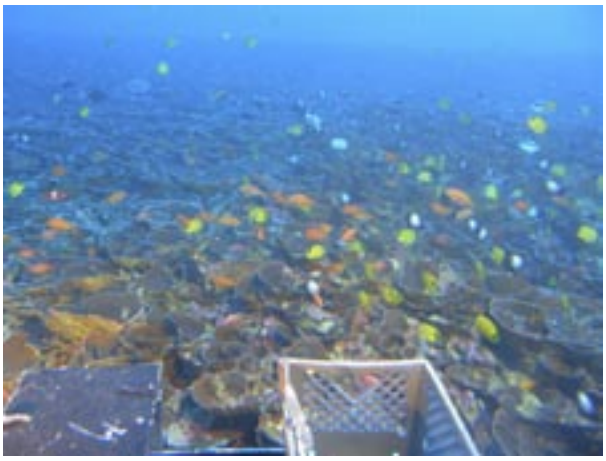
Mapping data were collected on three cruises this year. In December 2007 a member of the mapping group participated in a cruise aboard the *R/V Ka'imikai-o-Kanaloa* on an externally funded project with partners from the Bishop Museum, several departments at the University of Hawaii and the State of Hawaii Department of Aquatic Resources.

Table 1. A summary of all mapping operations as of June 30, 2008.

	Total # Tows	**Total Multibeam sq. km**
Main Hawaiian Islands	32	2,668
Northwestern Hawaiian Islands	226	45,519
CNMI & Guam	113	13,236
American Samoa	127	1,385
U.S. Phoenix and Line Islands	37	3,793

The project is investigating mesophotic coral reefs (defined as scleractinian coral reefs at depths between 50 m and 100 m) in the Auau Channel. Coral samples were collected and sent to taxonomic experts for identification. Video imagery was also collected during ROV and submersible dives. These as well as videos from previous work done in the area were analyzed by the project's mapping specialists and incorporated into a map that is being used as the primary planning tool for instrument deployments and other research later in 2008.

In February 2008 a team of 5 scientists conducted small boat based operations around the insular shelf of Tutuila, American Samoa. During these surveys approximately 100 hours of underwater video were collected to map the distribution and nature of benthic substrates and communities. These data include 38 tows, over 80 km in length, at depths between approxi-



Mesophotic coral reef in the Au'au Channel and reef fish communities utilizing this habitat (photo by Max Creamer, HURL)

mately 20 m-150 m. Extensive and previously undocumented scleractinian coral reef assemblages were found. Preliminary results were relayed to partners at the American Samoa Department of Marine and Wildlife Resources and further analyses of the data are ongoing.

Divers groundtruthing backscatter data on a sandy seafloor at French Frigate Shoals (photo by Kerry Grimshaw)

In May 2008, multibeam and optical mapping data were collected on a 28 day dedicated mapping cruise aboard the NOAA Ship *Hi'ialakai*. Surveys were conducted at French Frigate Shoals and surrounding banks, including Necker and the Brooks Banks. Two scientists from the Biogeography branch of NOAA's National Centers for Coastal Ocean Science located in Silver Spring, Maryland participated in this cruise in order to collaborate on optical data collection techniques. New equipment configurations were successfully used including a dedicated winch, new lights, a Track Link USBL underwater navigation system, and the Biogeography team's camera sled. A total of 35 tows including 100.3 hrs. of optical data covering 159.8 linear kilometers of seafloor were collected for mapping benthic habitats and habitat utilization. Four days of data collection were lost during transit back to Main Hawaiian Islands to replace sonar processor and exchange safeboat HI-2 with HI-1. A total of approximately 3297 km^2 and 145 km^2 of multibeam data were successfully collected aboard the NOAA Ship *Hi'ialakai* and *R/V AHI* respectively. 28 scuba dives were also conducted and proved to be a valuable addition to mapping methodologies as a tool for validating backscatter data interpretation.

Marine Debris Removal

The Marine Debris Team leads a successful multi-agency effort to remove derelict fishing gear from the reefs and beaches of the Hawaiian Archipelago. Since the inception of marine debris removal efforts in 1996, over 599 metric tons (MT) of derelict fishing gear have been removed from the NWHI and over 35 MT removed from the MHI. All derelict fishing gear removed since 2002 has been incinerated for Oahu energy production. The primary goals of the project are as follows: assess, document, and remove derelict fishing gear from the coral reef environments and islets of the NWHI and MHI; and monitor debris accumulation at specified NWHI reef sites to identify rates and patterns of ongoing accumulation.

Marine Debris Team remove huge hawser during the NWHI land clean-up days.

This year, the Marine Debris team continued its successful survey and targeted removal effort in the NWHI from the NOAA Ship *Oscar Elton Sette*. The Marine Debris team removed over 28 metric tons of derelict fishing gear from the NWHI in July-November, 2007.

The Marine Debris Team also

Marine Debris Team and USCG remove land debris from Midway

joined forces with the US Coast Guard and successfully removed 16 metric tons from Maro Reef and 12 metric tons from Midway's land debris. This was all completed in eight operational days in May-June, 2008.

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Appendix I List of Acronyms

A-AM system	Asian-Australian Monsoon System
ADCP	Acoustic Doppler Current Profiler
ADMB	AD Model Builder
AFS	American Fisheries Society
AIM	Ambient Ion Monitor
AMEMR Symposium	Advances in Marine Ecosystem Modeling Research Symposium
AMOC	Atlantic Meridional Overturning Circulation
APDRC	Asia-Pacific Data Research Center
APEC Climate Center	Asia-Pacific Economic Cooperation
APECOSM	Apex Predators Ecosystem Model
AR4	IPCC Fourth Assessment Report
ARSHSL	Archive of Rapidly-Sampled Hawaiian Sea Level
AVHRR	Advanced Very High Resolution Radiometer
B/C	Bycatch top Catch
BATS	Bermuda Atlantic Time-series
BCT	Business Card Tag
BET	Bigeye Tuna
BotCam	Bottomfish Camera
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CAM2	Community Atmospheric Model
CGPS	Collocated GPS
Chl-a	Chlorophyll-a
CICIMAR	Centro Interdisciplinario de Ciencias Marinas
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CLIOTOP	Climate Impacts on Oceanic Top Predators
CliPAS	Climate Prediction and it's Application to Society
CLS	Collecte Localisation Satelliete
CNMI	Commonwealth of the Northern Mariana Islands
CNRS	Centre National de la Recherche Scientifique
CPUE	Catch Per Unit Effort
CRED	Coral Reef Ecosystem Division
CREPT	Coral Reef Ecosystem Plan Team
CRH	Centre de Recherche Halieutique
CRMI	Coral Reef Management Initiative
CRP	Cetacean Research program
CSIA	Compound-Specific Isotope Analysis
CSIRO	Commonwealth Scientific and Industrial Research Organization
CTD	Condutivity, Temperature, Depth Casts
CTP	Central Tropical Pacific
CZCS	Coastal Zone Color Scanner
DDS	Data Server System
DJF	December-January-February

DLNR	Deparment of Land and Natural Resources
DNA	Deoxyribonucleic Acid
EA	Environmental Assessment
EARs	Ecological Acoustic Recorders
ECMWF	European Centre for Medium-Range Weather Forecasts
ECOTAP	Étude du comportement des thonidés par l'acoustique et la pêche en Polynésie française
ECOTAP-IRD	Étude du comportement des thonidés par l'acoustique et la pêche en Polynésie française - Institut de recherche pour le développement
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
ENF	El Nido Foundation
ENSO	El Niño/Southern Oscillation
EOD	Ecosystem and oceanography Division
EOFs	Empirical Orthogonal Functions
EPA	Environmental Protection Agency
ERA	ECMWF Re-Analysis
ERD	Environmental Research Division
ERDDAP	Environmental Research Division Data Access Program
ESA	Endangered Species Act
ESSIC	Earth System Science Interdisciplinary Center
ETP	Eastern Tropical Pacific
EwE	Ecopath with Ecosim
FAD	Fish Aggregation Device
FBSAD	Fisheries Biology and Stock Assessment Division
FFS	French Frigate Shoals
FLAS	Fisheries Local Action Strategy
FMP	Fishery Management Plan
FSWP	Fishery Statistics of the Western Pacific
FUS	Fisheries of the United States
FWS	Fish and Wildlife Service
GASEX-II	Gas Exchange Experiment II
GCM	General Circulation Model
GCM	General Circulation Model
GCOS	Global Climate Observing System
GEF	Global Environmental Facility
GLM	Generalized Linear Model
GLMMs	General Linear Mixed Models
GLOBEC	Global Ocean Ecosystems Dynamics
GMT	Geostationary Meteorological Satellite
GLOSS	Intergovernmental Oceanographic Commission Global Sea Level Observing System
GODAE	Global Ocean Data Assimilation Experiment
GOES	Geostationary Operational Environmental Satellite
GOOS	Global Ocean Observing System
GPS	Global Positioning System

GTS	Global Telecommunications System
HABs	Harmful Algal Blooms
HAMER	Hawaii Archipelago Marine Ecosystem Research
HARP	High Frequency Recording package
HCD	Habitat Conservation Division
HI-OOIS	Hawaii Ocean Observing and Information System
HLA	Hawaii Longline Association
HMS	Highly Migratory Species
HMSRP	Hawaiian Monk Seal Research Program
HPLC	High Performance Liquid Chromatography
HRPT	High Resolution Picture Transmission
HURL	Hawaii Undersea Research Laboratory
HYCOM	Hybrid Coordinate Ocean Model
IATTC	Inter-American Tropical Tuna Commission
IBMs	Individual Based Models
ICESS	Institute for Computational Earth System Sciences
ICG/IOTWS WG2	Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System
ICG/PTWS-XXII	Intergovernmental Coordination Group of the Pacific Tsunami Warning System
ICWL	International Conference and Workshop on Lobster Biology and Management
IDEA	NOAA's "Integrated Data and Environmental Applications" Center
IFD	International Fisheries Division
IFP	International Fisheries Program
IIFET	International Institute of Fisheries Economics and Trade
IOOS	Integrated Ocean Observing System
IPCC	Intergovernmental Panel on Climate Change
IPRC	International Pacific Research Center
IPSL	Institut Pierre Simon Laplace
IRD	Institut de recherche pour le développement
ISC	International Scientific Committee
ITCZ	Intertropical Convergence Zone
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
JIMAR	Joint Institute for Marine & Atmospheric Research
KUR	Kure Atoll
LAS	Live Access Server
LAS	Local Action Strategy
LIHU	GPS site located at the Lihue NWS office
LLDS	Hawaii Longline Logbook Data System
LODS	Hawaii Longline Observer Data System
LTJG	Lieutenant, junior grade
MANOVA	Multivariate Analysis of Variance
MARDAP	Marine Resource Dynamics & Asssessment Program
MERIS	Medium Resolution Imaging Spectrometer

MHI	Main Hawaiian Islands
MHIBF	Main Hawaiian Islands Bottomfish
MJO	Madden-Julian Oscillation
MLO	Mauna Loa Observatory
MMPA	Marine Mammal Protection Act
MMRN	Marine Mammal Response Network
MMRP	Marine Mammal Research Program
MODIS	Moderate Imaging Spectrometer
MPAs	Marine Protected Areas
MSU	Montana State University
MT	Metric Tons
MTRP	Marine Turtle Research Program
MULTIFAN-CL	A length-based, age and spatially-structured statistical model for fisheries stock assessment
NCAR	National Center for Atmospheric Research
NCCOS	National Centers for Coastal Ocean Science
NCDC	National Climate Data Center
NCEP	National Centers for Environmental Prediction
NCOM	Navy Costal Ocean Model
NEPA	National Environmental Policy Act
NFA	National Fisheries Authority
NFRDI	National Fisheries Research and Development Institute
NGCC	New Guinea Coastal Current
NLOM	Navy Layered Ocean Model
NMFS	National Marine Fisheries Service
NMFS PIFSC	National Marine Fisheries Service, Pacific Islands Fisheries Science Center
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
PTWC	Pacific Tsunami Warning Center
NRIFSF	National Research Institute of Far Seas Fisheries
NRL	Navy Research Laboratory
NWHI	Northwestern Hawaiian Islands
NWS	National Weather Service
OCO	Office of Climate Observations
OPeNDAP	Open-Source Project for a Network Data Access Protocol
openMPI	Open Message Passing Interface
OWCP	Ocean Watch
PASTA	Pacific-Atlantic Sea Turtle Assessment project
PISCES	Pelagic Interaction Scheme for Carbon Ecosystem Studies
PC	Principal Component
PEAC	Pacific ENSO Applications Center
PFAD	Private FAD
PFRP	Pelagic Fisheries Research Program
PHR	Pearl and Hermes Reef or acronym
PI	Principal Investigator

PICTs	Pacific Island Countries and Territories
PIFSC	Pacific Islands Fisheries Science Center
PIR	Pacific Islands Region
PIRO	Pacific Islands Regional Office
PIT	Passive Integrated Transponder
PLA	Participatory, Learning, and Action
PMEL	Pacific Marine Environmental Laboratory
PMNM	Papahanaumokuakea Marine National Monument
PNG	Papua New Guinea
POFI	Pacific Ocean Fish and Invert project
PRD	Protected Resources Division
PRECI	Protected Resources Environmental Compliance Initiative
PRIA	Pacific Remote Island Area
PRIDE	Pacific Region Integrated Data Enterprise
PRIWG	Pacific Region Interagency Coral Reef Mitigation Working Group
PSATs	Pop-up Satellite Archival Tags
PSD	Protected Species Division
PSMSL	Permanent Service for Mean Sea Level
PTTs	Platform Terminal Transmitters
PTWC	Pacific Tsunami Warning Center
QBO	Quasi-Biennial Oscillation
QDFA	Quadratic Discriminant Function Analysis
R/V AHI	Research Vessel Acoustic Habitat Investigator
R/V	Research Vessel
RA	Research Assistant
RAs	Regional Associations
RAMP	Reef Assessment and Monitoring Program
RCUH	Research Corporation of the University of Hawaii
REA	Rapid Ecological Assessment
RFP	Request for Proposal
RGM	Reactive Gaseous Mercury
RMI	Republic of the Marshall Islands
ROAM	Regional Ocean-Atmosphere Model
ROV	Remotely Operated Vehicle
SAS	Statistical Analysis System
SAT	Surface air temperature
SEAFACTS-ICES Symposium	Symposium on the Ecosystem Approach with Fisheries Acoustics and Complementary Technologies (SEAFACTS) International Council for the Exploration of the Sea (ICES)
SEAPODYM	Spatial Ecosystem and Populations Dynamics Model
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SECC	South Equatorial Counter Current
S-EOF	Season-Reliant Empirical Orthogonal function
SFI	Sustainable Fisheries Initiative
SLA SD	Sea Level anomaly standard deviation

SOEST	School of Ocean & Earth Science & Technology
SOI	Southern Oscillation Index
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
SSH	Sea Surface Height
SST	Sea Surface Temperature
STA	Service Target Agreement
SWFSC	Southwest Fisheries Science Center
TDRs	Time Depth Temperature Recorders
TEDs	Turtle Excluder Devices
THREDDS	Thematic Real-time Environmental Distributed Data Services
THREDDS/OPeNDAP	Thematic Real-time Environmental Distributed Data Services/ Open-source Project for a Network Data Access Protocol
TL	Total Length
TL	Trophic Level
TZCF	Transition Zone Chlorophyll Front
UC	University of California
UCLA	University of California, Los Angeles
UH	University of Hawaii
UHDAS	University of Hawaii Data Acquisition System
UHSLC	University of Hawaii Sea Level Center
ULB	Free University of Brussels
ULT	Ultra-Low Temperature
USAPI	U.S.-Affiliated Pacific Islands
USBL	Ultra Short Baseline
USCG	United States Coast Guard
USFWS	US Fish and Wildlife Service
USGS	U.S. Geological Survey
UV-B	Ultraviolet Light B
VIMS	Virginia Institute of Marine Science
WCPF	Western and Central Pacific Fisheries
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean
WCRN	West Coast Regional Node
WOCE/JGOFS	World Ocean Circulation Experiment/Joint Global Ocean Flux Study
WPacFIN	Western Pacific Fisheries Information Network Project
WPRFMC	Western Pacific Regional Fisheries Management Council
WPSARP	Western Pacific Stock Assessment Review Process

Appendix II Visiting Scientists

DATE	NAME/AFFILIATION	PURPOSE OF VISIT
08/12/07-08/20/07	Milani Chaloupka Director Ecological Modeling Services P/L University of Queensland St. Lucia, Australia	Attend and present research at the WCPFC Annual Science Meeting.
08/14/07-08/17/07	Jerald S. Ault Professor Rosenstiel School of Marine & Atmospheric Science University of Miami	Evaluate the HAMER (Hawaii Archipelago Marine Ecosystem Research) Program.
08/14/07-08/17/07	Tim Essington Associate Professor University of Washington School of Aquatic & Fishery Science	Evaluate HAMER (Hawaii Archipelago Marine Ecosystem Research) Program.
08/14/07-08/17/07	David Fluharty Professor University of Washington School of Marine Affairs	Evaluate HAMER (Hawaii Archipelago Marine Ecosystem Research) Program.
09/08/07-09/22/07	Minoru Kanaiwa Assistant Professor Hokkaido, Japan	Collaborate with Dr. Keith Bigellow to develop multispecies statistical habitat-based model for CPUE standardization in Pacific pelagic fisheries. Tokyo University of Agriculture
10/07/07-10/08/07	Craig Kawamura Private Citizen Award recipient and contact person for NOAA's Barbless Circle Hook Project	Participate in 2nd Annual Fishing and Seafood Festival 10/07/07. Attend meeting 10/08/07 to establish working relationship and facilitate 2008 planning between NOAA and Hilo Casting Club.
10/15/07-10/18/07	Charles Jones Researcher ICESS UC Santa Barbara	Collaborate with Yi-Leng Chen on MM5 output and fire weather modeling. Attend PRIDE investigators meetings. Collaborate with Joshua Fu and other IPRC members on Madden-Julian Oscillation. Present seminar on Madden-Julian Oscillation.
10/15/07-10/26/07	Bryan Manly Statistician Western Ecosystems Technology Inc	Attend workshop, statistical consultation. Review bycatch estimates and give course on assessing bycatch with NMFS PIFSC (National Marine Fisheries Service, Pacific Islands Fisheries Science Center).

10/22/07-10/26/07	Soon Song Kim Fisheries Scientist NFRDI (National Fisheries Research & Development Institute) Busan, Korea	Collaborate with NOAA Fisheries scientists on experiment analysis for reduction of sea turtle bycatch in tuna longline fisheries.
10/26/07-11/20/07	Erin Brendan Roark Researcher Stanford University	Participate in KOK cruise 10/28/07-01/20/07 to collect deep-sea corals for radiocarbon dating.
11/11/07-11/15/07	Jean Deneubourg Professor ULB (Free University of Brussels) Brussels, Belgium	Invited presenter at the PFRP Principal Investigators Workshop 11/11/07 to 11/15/07. Modeling collaboration.
11/13/07-11/15/07	Simon Nichol Principal Fisheries Scientist Secretariat of the Pacific Community Noumea, New Caledonia	Invited presenter at the PFRP Principal Investigators Workshop 11/13/07 to 11/14/07. Conduct research work with Itano and others.
11/13/07-11/15/07	Takayuki Matsumoto Researcher National Research Institute of Far Seas Fisheries Shizuoka, Japan	Invited presenter at the PFRP Principal Investigators Workshop 11/13/07-11/14/07. Research collaboration with PFRP PIs 11/15/07.
11/29/07-12/03/07	Tenaya Norris Research Assistant The Marine Mammal Center	Attend 17th Biennial Conference on the Biology of Marine Mammals. Present 2006-2007 data on Hawaiian Monk Seal Captive Care Project in Cape Town, South Africa.
12/04/07-12/08/07	Jun-ichi Yano Director of Research CNRS Toulouse Cedex, France	Visit JIMAR and present seminar to JIMAR community.
12/07/07-12/10/07	Andrew Halford Research Associate University of Guam Ipan, Guam	Consultant for workshop on Kona wharf expansion.
12/07/07-12/10/07	Alexander Kerr Biologist University of Guam Mangilao, Guam	Participate in Apra Harbor/Kio Wharf Monitoring Protocols Workshop 12/07/07-12/10/07.
12/07/07-12/10/07	Jerald S. Ault Professor University of Miami, Rosenstiel School of Marine and Atmospheric Science	Participate in Apra Harbor/Kilo Wharf Monitoring Protocols Workshop 12/07/07 to 12/10/07.

12/07/07-12/10/07	Steven G. Smith Research Scientist University of Miami	Participate in Apra Harbor/Kilo Wharf Monitoring Protocols Workshop 12/07/07 to 12/10/07.
12/07/07-12/10/07	Tom Schils Assistant Professor University of Guam, Marine Laboratory Mangilao, Guam	Participate in Apra Harbor/ Kilo Wharf Monitoring Protocols Workshop 12/07/07 to 12/10/07.
12/10/07-12/13/07	Steven Railsback Environmental Scientist Lang Railsback and Association	Present seminar. Conduct introductory lecture/tutorial. Meet researchers on campus and at NOAA (National Marine Fisheries) to explore collaborative research options.
12/30/07-02/15/08	In-Sik Kang Professor Seoul National University Seoul, Korea	Deliver lectures at Monsoon Institute. Carry out cooperative research related to climate changes in East Asia, intraseasonal predictability, seasonal prediction and future plans for CliPAS.
01/03/08-01/06/08	Yongkang Xue Professor UCLA	Attend Institute on "The Monsoon System: Prediction of Change and Variability" 01/02/08-01/12/08. Invited to be faculty member and keynote lecturer at Institute.
01/05/08-01/11/08	R.H. Kripalani Deputy Director Indian Institute of Tropical Meteorology Pune, India	Attend Institute on "The Monsoon System: Prediction of Change and Variability" 01/02/08 to 01/12/08.
01/06/08-01/10/08	Akio Kito Director Meteorological Research Institute Ibaraki, Japan	Attend Institute on "The Monsoon System: Prediction of Change and Variability" 01/02/08 to 01/12/08.
01/06/08-01/09/08	Duane Waliser Scientist Jet Propulsion Laboratory California Institute of Technology	Attend Institute on "The Monsoon System: Prediction of Change and Variability 01/02/08 to 01/12/08. Invited to be faculty member and keynote lecturer at Institute.
01/08/08-01/12/08	Ashok Karumuri Senior Research Scientist APEC Climate Center Busan, Korea	Attend Institute on "The Monsoon System: Prediction of Change and Variability" 01/02/08 to 01/12/08.
01/08/08-01/09/08	Gregory Skomal Senior Marine Fisheries Biologist MA Marine Fisheries	Participate in "Shark Predation on Hawaiian Monk Seals" Workshop 01/08/08 to 01/09/08.

01/08/08-01/09/08	Eric Stroud Principal Chemist Syvax Inc./ Shark Defense	Participate in and present at "Shark Predation on Hawaiian Monk Seals" Workshop 01/08/08 to 01/09/08.
01/08/08-01/09/08	Ralph Grubbs Assistant Scholar Scientist Florida State University Costal and Marine Lab	Participate in "Shark Predation on Hawaiian Monk Seals" Workshop 01/08/08 to 01/09/08.
02/16/08-04/15/08	Haiming Xu Professor Nanjing University of Information Science & Technology Jiansu Province, China	Visit IPRC (International Pacific Research Center). Collaborate with Yuqing Wang and other IPRC members on regional climate modeling in Eastern Pacific and South China Sea.
04/10/08-04/11/08	Stephen Kajiura Assistant Professor Florida Atlantic University	Participate in "Shark Deterrent and Incidental Capture" Workshop 04/10/08 to 04/11/08 in Boston, Massachusetts.
04/10/08-04/11/08	Tallack, Michelle Associate Research Scientist Gulf of Maine Research Institute	Participate in "Shark Deterrent and Incidental Capture" Workshop 04/10/08 to 04/11/08 in Boston, Massachusetts.
04/28/08-04/30/08	Xiaopei Lin Associate Professor Ocean University of China Qingdao, China	Collaborate with Professor Shang-Ping Xie on ocean climate variability. Present seminar at IPRC (International Pacific Research Center).

Appendix III Workshops and Meetings Hosted by JIMAR

Albatross Modeling Workshop
November 7-9, 2007
Kamehameha Room, Imin Conference Center, UH-Manoa

Carlos Alvarez
Sarah Converse
Katherine Cousins
Paul Doherty
Kelly Finn
Beth Flint
Daniel Goodman
Simon Hoyle
William Kendall
Pierre Kleiber
Jean-Dominique Lebreton
Rebecca Lewison
Mark Maunder
Maura Naughton
Marc Romano
Karen Rosa
John Sibert
Paul Sievert
Sophie Veran

PFRP Principal Investigators Workshop
November 13-14, 2007
Asia Room, Imin Conference Center, UH-Manoa

Melanie Abecassis
Stewart Allen
Johnoel Ancheta
Paul Bartram
Keith Bigelow
Anela Choy
Laurent Dagorn
Jeffrey Dambacher
Lisa De Forest
Jean-Louis Deneubourg
Reka Domokos
Mathieu Doray
Jeffrey Drazen
Tim Essington
Bridget Ferris
Ed Glazier
Marcia Hamilton
Donald Hawn
Kim Holland
Justin Hospital
Simon Hoyle
David Itano
Melissa Iwamoto
John Kaneko
Marco Kienzle
Bert Kikkawa
Pierre Kleiber
Dodie Lau
Shichao Li
Joe Liddle
Takayuki Matsumoto
Nicole Milne
Michael Musyl
Simon Nicol
Anders Nielsen
Minling Pan
Jeffrey Polovina
Sam Pooley
Brian Popp
Janna Shackerhoff
Alexander Shor
John Sibert
Bill Walsh

Appendix IV JIMAR Personnel

Information as of June 30, 2008

Category	Number	High School	Associates	Bachelors	Masters	Ph.D.
Research Scientists	20	0	0	0	0	20
Visiting Scientists	0	0	0	0	0	0
Postdoctoral Fellows	6	0	0	0	0	6
Research Support Staff	101	3	4	54	34	6
Administrative	13	2	0	10	1	0
Undergraduate Students	24	24	0	0	0	0
Graduate Students	15	0	0	12	3	0
Received less than 50% NOAA support	3	0	0	1	1	1
Total	**182**	**29**	**4**	**77**	**39**	**33**
Located at Lab (include name of lab)	ESRL: 7 NWS: 1 PFEL: 7 PIFSC: 88 PIRO: 17 PMEL: 2					
Obtained NOAA employment within the last year	2					
Postdoctoral Fellows and Students from Subgrantees	Postdocs: 1 Students: 3					

Appendix V Awards

Krista Graham
NOAA Fisheries Team Member of the Year

Kevin Higaki
NOAA Fisheries Team Member of the Year

Kyle Koyanagi
Nominated for 2007 RCUH Outstanding Employee of the Year

Licia (Dodie) Lau
Nominated for 2007 RCUH Outstanding Employee of the Year

Megan Moews
NOAA Fisheries Team Member of the Year

Lucas Moxey
NOAA Fisheries Team Member of the Year

Lynne Nakamura
NOAA Fisheries Team Member of the Year

Quang Nguyen
Honorable Mention for one of three dissertation essays, "Do Fishermen Have Different Attitude Toward Risk? An Application of Prospect Theory to the Study of Vietnamese Fisher"—the IIFET 2008 Vietnam Best Student Paper Award

Naomi Yamamoto
2007 RCUH Outstanding Employee of the Year, 2nd Place

Michelle Yuen
NOAA Fisheries Team Member of the Year

Kay Zukeran
Nominated for 2007 RCUH Outstanding Employee of the Year

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	FY03	FY04	FY05	FY06	FY07	FY08	FY03	FY04	FY05	FY06	FY07	FY08
Peer-Reviewed	18	36	50	36	32	31	33	22	26	20	26	25	20	30	26	28	43	51
Non-Peer-Reviewed	16	39	31	24	11	18	10	17	14	16	18	8	14	21	17	17	20	17