Annual Report for Fiscal Year 2005

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Introduction

The Joint Institute for Marine and Atmospheric Research (JIMAR) is a cooperative enterprise involving the National Oceanic and Atmospheric Administration (NOAA) and the University of Hawaii. JIMAR research spans six themes all aligned with the NOAA strategic Plan and the University's Indo-Pacific mission. The relevant themes are tsunamis and other long-period ocean waves, equatorial oceanography, climate, fisheries oceanography, tropical meteorology 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 NOAA interests. NOAA line offices collaborating in the JIMAR program include: the Environmental Research Laboratories (especially Pacific Marine Environmental Lab, PMEL; Atlantic Oceanic and Meteorological Lab, AOML; Forecast Systems Lab, FSL; and Climate Monitoring and Diagnostics Lab, CMDL), National Marine Fisheries Service (NMFS), National Weather Service (NWS), National Environmental Satellite and Data Information Service (NESDIS) and National Ocean Service (NOS). JIMAR also supports student development, outreach and 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 University of Hawaii School of Ocean and Earth Science and Technology.

Thomas Schroeder, Director

Our mission and vision statements are:

Mission: To conduct the research 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 2005 JIMAR continued to grow. At the same time we have begun to implement recommendations of the FY 2004 review conducted under the auspices of the NOAA Science Advisory Board SAB. These including expanding the number of Senior Fellows in fisheries research, addressing gender balance among the Senior Fellows and broadening our educational and outreach efforts. We have made progress in all of the above: new fisheries Senior Fellows have been added, we are in discussions with new female Fellows candidates and we have begun to work with the Hawaii Sea Grant program to broaden our outreach. Most of our outreach effort is embedded within thematic programs and include:

1. The Pacific International Training Desk (with the National Weather Service).
2. The Pelagic Fisheries Research Program (PFRP) Newsletter
3. Pacific ENSO Update (Pacific ENSO Applications Center (PEAC), with National Weather Service).
4. Monthly Audio Conference with Pacific Islands Meteorologists (PEAC, with National Weather Service).
5. JIMAR Fellows lectures (with Hawaii Sea Grant College Program - Hanauma Bay lecture series)
6. Collaboration with Hawaii Sea Grant on outreach newsletters on collaborative tsunami research.

We continue to support development of the graduate program in Coastal and Marine Resources (nee Graduate program in Tropical Fisheries and Aquaculture) a joint venture of NMFS, PFRP and the School of Ocean and Earth Science and Technology.

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. He 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 University of Hawaii has undergone a cumbersome reorganization revolving about reestablishment of a Manoa Chancellor. The President of the University has delegated his responsibilities as Chair of the Administrative Board to the Chancellor.

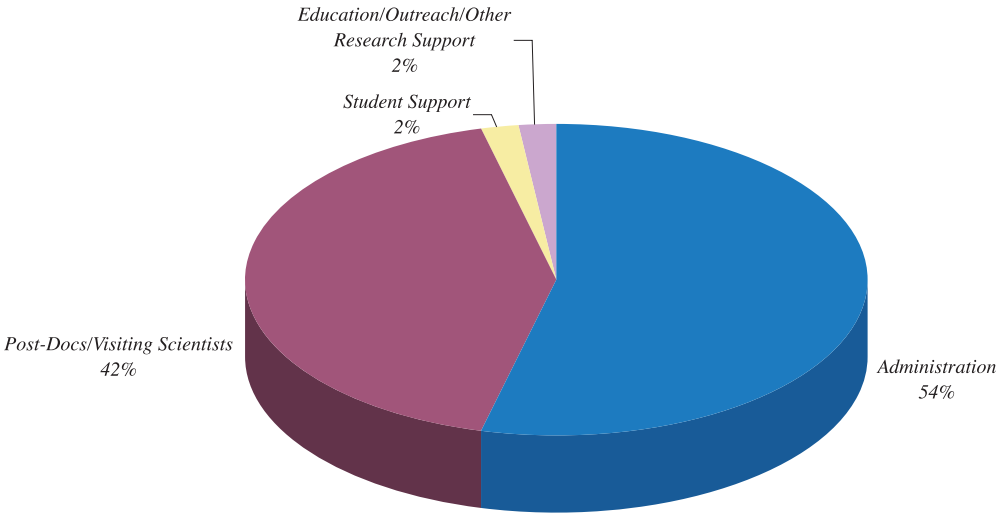
The Director manages day-to-day operations through the administrative staff (fully-supported by the Cooperative Agreement and returned indirect cost funds). Program managers (PFRP) or faculty PI/Directors (University of Hawaii Sea Level Center) lead some of the larger programs. A Council, elected among the Fellows, advises the Director on major expenditures on visiting scientists as well as selection of new and renewed Fellows. The list of current Fellows and Council members are provided below. In light of the current uncertainty over the future of JIMAR under the recompetition of the Joint Institutes we have decided to continue all existing Fellows for the next biennium and synchronize the appointment periods, which had been allowed to drift with arrivals and departures of individuals and development of new themes. Owing to the long-distance nature of the NOAA/JIMAR relationships, 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. Richard Brill (NMFS), Dr. Ed Harrison (PMEL), Dr. Gregory Johnson (PMEL), Dr. William Kessler (PMEL), Dr. Michael Laurs (NMFS), 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 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.

JIMAR's Task I is the base program of JIMAR. It provides research support for the visiting scientist and post-doctoral programs, and the administrative support for the Institute. The University of Hawaii contributes to this task by bearing all the indirect cost, and by paying the salary of the director. Percentages of funding by activity are exhibited in the following chart.

Distribution of JIMAR's Funding by Activity



JIMAR science comprises several dozen subprograms. Science news from JIMAR has been dominated by the Indian Ocean tsunami of December 26, 2004 and its aftermath.

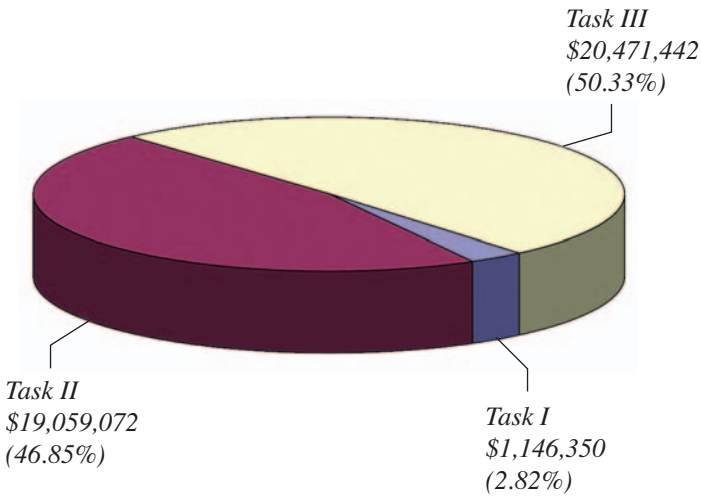
The UH Sea Level Center (UHSLC) maintains tide gages throughout the global tropics, primarily in support of climate research. However a number of these gages are capable of delivering near-real time high temporal

resolution information as well. The Pacific Tsunami Warning Center (PTWC) utilizes these data as part of its Pacific mission. On December 26 UHSLC gages did detect the catastrophic tsunami in the Indian Ocean. In a NOAA Research Hot Topic submission UHSLC/JIMAR presented analyses of some of the signals, demonstrating the efficacy of these gages in determining arrival times and differential structures of eastward- and westward-propagating portions of the tsunami. The global community has recognized the value of these "smart" tide gages and UHSLC personnel have been frequent attendees at International Planning Meetings for an Indian Ocean Tsunami Warning System. Several international organizations have approached JIMAR about developing smart tide gage capabilities for the Indian Ocean network. This technology complements the DART-buoy program developed at PMEL.

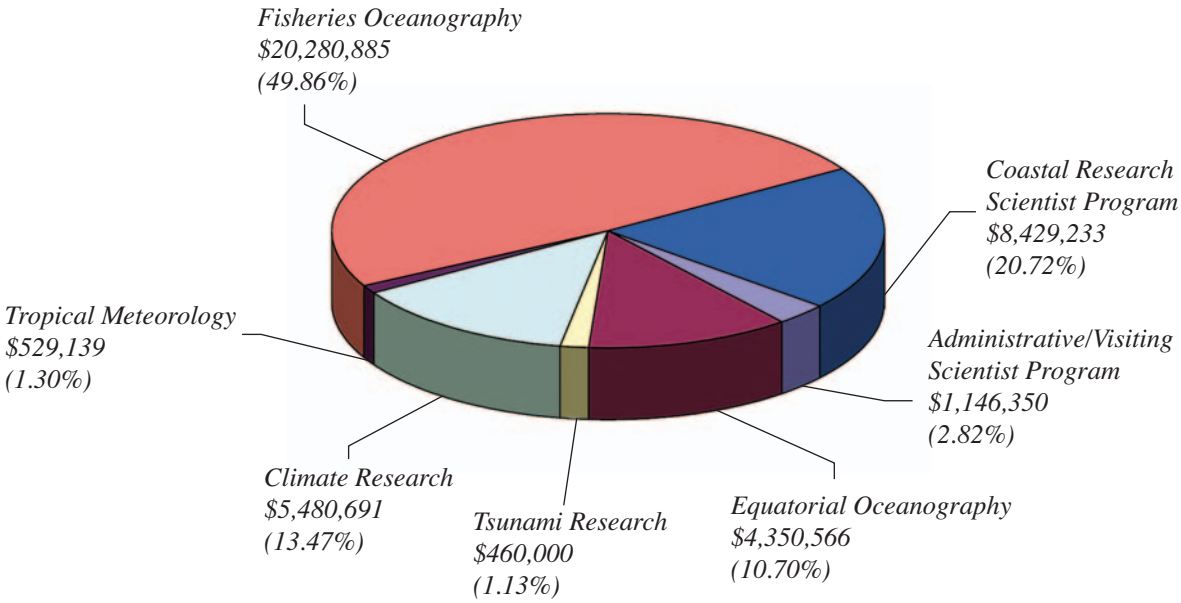
Other JIMAR programs have continued to make steady progress over the past year. The PFRP continues to work closely with NMFS on impacts of fishing gear and closures on Hawaiian-based fisheries. We recently have begun negotiations with the Western Pacific Fisheries Management Council and the State of Hawaii (Division of Aquatic Resources, Department of Land and Natural Resources) to undertake major portions of a federally funded fisheries disaster program. Our role would be to support industry research on alternative fisheries strategies and to provide educational and outreach programs for impacted fishermen and their families. Our cooperative programs with newly created Pacific Region of NMFS have grown as the region has faced a growing mission.

The Pacific ENSO Applications Center (PEAC) has been fully staffed for more than a year. The collaboration with the NWS has been strengthened and new research has been undertaken. On the outreach side, a monthly audio conference with meteorologists from U.S. Affiliated Pacific islands has been implemented with substantial impact. On the research side we have developed experimental sea-level forecasts which now appear in the quarterly *Pacific ENSO Update*. July 1 (actually start of FY2006) represented the 10th anniversary of the relocation of the Honolulu Weather Forecast Office to the University of Hawaii Manoa campus. This was recognized by special news releases and received excellent local news coverage.

Distribution of JIMAR's NOAA Funding by Task



Distribution of JIMAR's NOAA Funding by Theme



Accomplishments for Fiscal Year 2005

Equatorial Oceanography

JASMINE, The Joint Air-Sea Monsoon Interaction Experiment: Upper Ocean Survey

P.I.: Peter Hacker, Roger Lukas, and Eric Firing

NOAA Goal(s)

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

Purpose of the Project

JASMINE has been a collaborative pilot study of air-sea fluxes, convection and the upper ocean response to atmospheric forcing in the tropical eastern Indian Ocean. The purpose of the field work was to obtain high-quality upper ocean, air-sea flux and atmospheric data sets focusing on the onset phase of the southwest monsoon and its subsequent evolution over the seasonal cycle. The analysis phase has focused on documenting the role of intraseasonal processes.

Progress During FY 2005

In accord with project plans as the research nears completion, we have published a paper with our collaborators on the importance of atmospheric intraseasonal variability for driving the upper ocean circulation in the equatorial Indian Ocean and the resulting low-frequency rectification of equatorial surface currents and transport. A final activity is to use the JASMINE results to help plan and implement the sustained observations for the Indian Ocean via participation in the CLIVAR Indian Ocean Panel.

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 and Tsung-Hung Peng

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

Using the three-end-member mixing model on the complete set of newly synthesized and quality assured WOCE/JGOFS and NOAA global CO_2 survey data to re-evaluate the remineralization ratios throughout the whole ocean 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).Also developing 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 2005

The three-end-member mixing model of Li and Peng (2002) was applied to the WOCE data from Indian Ocean to obtain additional estimates on the remineralization ratios (P\N\Corg\-O_2) of organic matter in the oxygenated regions. The results show systematic changes of the remineralization ratios with latitude and depth in the Indian Ocean. The average remineralization ratios for Indian warm water masses (potential temperature q > ~10° C) are P\N\Corg\-O_2 = 1\(15.6±0.7)\(110±9)\(159±8). These are comparable to the traditional Redfield ratios (P\N\Corg\-

O_2 = 1\16\106\138), and are in good agreement with Anderson's (1995) values of P\N\Corg\-O_2 = 1\16\106\150 within the given uncertainties. Separation of nitrate deficits resulting from aerobic partial nitrification (dN) and anaerobic denitrification (dN") processes using empirical equations is shown to be useful and consistent with other observations. The dN maximum coincides with the phosphate and nitrate maximums, lies within the oxycline below the oxygen minimum zone, and is in contact with the continental slope sediments. The dN" maximum lies within the oxygen minimum zone with O_2 < ~2 mmol/kg, is in contact with shelf or upper slope sediments, and is always associated with a secondary nitrite maximum in the water column. The spatial extent of dN is much larger than that of dN". The low N/P remineralization ratio (<15) for deep waters (q < ~10°C) and the dN maximum in the lower oxycline can be best explained by the partial conversion of organic nitrogen into N_2, N_2O, and NO by yet unidentified bacteria during oxidation of organic matter. These bacteria may have evolved in a low oxygen and high nitrate environment to utilize both oxygen and nitrate as terminal electron acceptors during oxidation of organic matter (i.e. the partial nitrification hypothesis). Direct proof is urgently needed.

University of Hawaii Sea Level Center

P.I.: Mark Merrifield

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 UHSLC works through international collaborations to promote the development and continued operation of tide gauges for global sea level observations in support of climate research. In particular, the UHSLC is concerned with those stations that contribute to the Global Climate Observation System (GCOS). The center coordinates its activities with the Intergovernmental Oceanographic Commission (IOC) Global Sea Level Observing System (GLOSS). The center is an end-to-end provider of sea level information, taking part in data collection, processing, distribution, scientific analysis, and public outreach.

Progress During FY 2005

The UHSLC plays a direct role in operating and maintaining over 40 international tide gauge stations. During FY2005, UHSLC installed 3 new stations in the GCOS network (Colombo, Sri Lanka; Mar Del Plata, Argentina; Salvador, Brazil). In response to the 2004 Sumatra Earthquake, the UHSLC has been involved in expanding the capabilities of GLOSS tide gauge stations to support multiple use applications, including tsunami monitoring. The UHSLC upgraded 3 stations in accordance with tsunami monitoring recommendations put forward by the IOC and installed a new station at Sibolga, Indonesia. We accomplished most of our technical goals for the year, with the exception of a planned station at Minicoy Island, India, for which host country support has not been forthcoming.

Research during FY05 focused on extreme events, interdecadal fluctuations, and sea level rise in the mid-Pacific Ocean. A description of the 2004 Indian Ocean tsunami as measured by tide gauges was also published.

Tsunami Research

Archiving and Analysis of High-Resolution Sea Level Data from the Hawaiian Islands

P.I.: Douglas S. Luther

NOAA Goal(s)

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

Purpose of the Project

Our purpose is to acquire and archive, in an electronically accessible location, a database of high quality, rapidly-sampled sea level observations from existing Hawaiian shoreline gauges maintained by NOAA agencies. This sea level dataset is publicly available, via a web site on the Internet, for both practical applications and research. The archive was originally established in 1997 to ensure a consistent repository for rapidly-sampled sea

level in the Hawaiian Islands for the study of even very weak tsunamis and related infragravity wave signals at periods of 1-10 minutes. Additional research topics either in progress or currently contemplated with this dataset include 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. Sea level data from the large majority of the gauges we access would otherwise be lost without this archiving activity; that is, the data is not saved by the agency 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 studies of the phenomena listed above.

Progress During FY 2005

The Archive of Rapidly-Sampled Hawaiian Sea Level (ARSHSL) is being 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-sponsored UH Sea Level Center. Data have been automatically and, if necessary, manually downloaded daily, via Internet and telephone links, from 6 NOS and 15 PTWC gauges dispersed around the five main islands of Hawaii in 17 harbors (some harbors have multiple 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 quality control check and elimination of extreme outliers. Access to the web site is unrestricted, with 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. 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 maintained on the web site for each station.

This past fiscal year has seen the biggest changes in archiving procedures since the establishment of the archive. Current low rates for inter-island long-distance telephone calls mitigate the need to maintain modems at computers on islands other than Oahu. Modem maintenance was problematic, with frequent communications interruptions, on both Kauai and Hawaii Islands, and these modems have been de-commissioned (per the plan in last year's report). Of the 15 PTWC gauges, all but two are functioning well under PTWC's vigorous maintenance program. Only one gauge (at Lahaina, Maui) represents a significant loss, however, since the other gauge (at Kapoho, Hawaii) is redundant. Repair of these gauges is expected in the near future. As of the end of June, 2005, NOS finished an upgrade of its 6 gauges in Hawaii, including installation of new communications systems to improve the efficiency of the delivery of data by NOS's Center for Operational Oceanographic Products and Services (Co-Ops). The new communications systems prohibit dialup downloading of data such as we've been performing, so the 1-minute data from 3 gauges and 6-minute data from all 6 gauges is no longer directly available to us, but the latter is now available through the Co-Ops web site (http://tidesandcurrents.noaa.gov/). We are working with Co-Ops personnel to acquire the 1-minute data from these stations indirectly (e.g., delayed-mode CD's). The bonus to our program may be that we could have access to 1-minute data from all 6 NOS gauges where before we could only get it from 3. For studying tsunami signals, the sampling rate should be no more than 2 minutes.

Climate Research

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 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

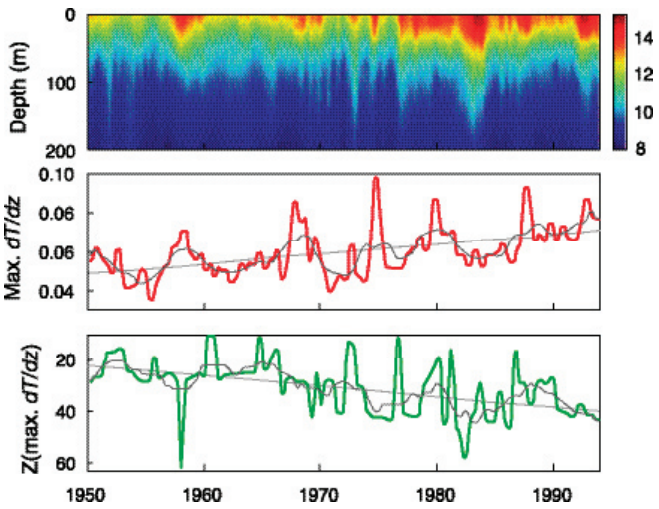
Purpose of the Project

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 bases 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. These research efforts are being 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 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.

Progress During FY 2005

In FY05, this project entered a new phase of research to characterize the linkages between basin-scale climate variability and local responses in mesoscale ocean circulation and structure. It is on these local scales where climate change will impact marine populations, ecosystem structure and productivity, and species interactions. We are working with a diverse group of investigators from several Federal and academic institutions, who represent expertise in various aspects of climate-mesoscale interactions. This collaboration will foster the development of metrics based on multiple data sets spanning a large spectrum of space and time scales, and provide robust indicators of the response of marine populations to climate change, a useful tool for resource assessment and management.



(a) Monthly time series of 0-200 m temperatures from a 1° box centered at 36.5°N, 123.5°W in the California Current. Monthly time series of (b) maximum dT/dz (°C m^{-1}) and (c) depth of the maximum dT/dz (m). Temperatures are modeled trend component from a state-space decomposition of observed temperatures from the World Ocean Database (Palacios et al., 2004). Colored curves in (b) and (c) are the monthly series, dark gray curves are the 37-point running averages, and thin gray lines are the regression of each variable on year.

All research objectives for this project for FY05 were met this year. The project continued statistical analyses of global climate indices and teleconnection patterns, which have improved our understanding of the impacts of global climate on disparate marine ecosystems, and on the consequences of long-term climate trends on interannual to decadal variability. Development of biologically relevant indices for the California Current System, by compiling a large data set of historical observations of nutrient concentrations, are being used to develop statistical models of nutrient availability and primary production, and ultimately leading indicators of ecosystem production. Research was initiated into the oceanographic characteristics and biological utilization of "hot spots" for migratory and top predator species in the North Pacific. Processing and analyses of satellite data was completed on a project detailing mesoscale eddy demographics in the California Current System. This 'eddy census' will provide a better quantification of the mean and time-varying pelagic fishery habitat for the California Current ecosystem. Field operations for the salmon electronic archival tagging project were completed, and all archival tag data are available via Live Access Server at http://www.pfeg.noaa.gov/products/ las/salmon_tag_data.htm. A salmon habitat index has been developed from these data, which allows annual estimates of the coastal ocean Chinook salmon habitat from satellite SST data. We also initiated a project with the Monterey Bay National Marine Sanctuary (MBNMS) to characterize the spatial and temporal variability of upwelling off Central California from satellite data products. These are being used by the MBNMS in their deliberations on the formation of marine protected areas.

Dynamics of Pacific Decadal Climate Variability and ENSO Modulation

P.I.: Fei-Fei Jin

NOAA Goal(s)

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

Purpose of the Project

The aim of this proposed research focuses on the roles of the tropical ocean-atmosphere interaction in the decadal climate variations of the tropical Pacific and decadal modulations of ENSO. We examine the relevance

of the decadal modes of tropical ocean dynamics to the decadal climate variability of the tropic Pacific. We study the interaction of coupled decadal modes with ENSO and explore nonlinear scenarios that allow large amplitude modulations of ENSO. We will also explore the implications to the regime predictability of the ENSO activity.

Progress During FY 2005

We investigate why El Niños are often stronger than La Niña . We have recently made a significant progress on the origin of Quasi-biennial variability. Our recent study showed El Niño and La Niña cycles may result from the coexistence of at least two leading modes with distinct periods of nearly 4-6 and 2-3 years. This multiplicity of modes also makes the El Niño phenomena very sensitive to climate changes from either natural or anthropogenic causes. A manuscript to report these new findings is to be submitted to Science for publication.

We have investigated the predictability of ENSO using nonlinear dynamical system approach. This work is reported at EGU 2005 meeting.

Effects of the Andes on Eastern Pacific Climate

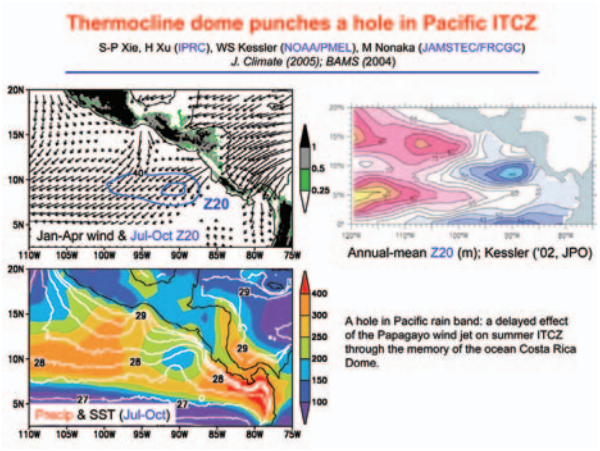
P.I.: Shang-Ping Xie and Yuqing Wang

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.



New satellite observations reveal a clear effect of an ocean thermocline dome on summer precipitation in the eastern Pacific ITCZ. The thermocline dome itself is an oceanic response to intense wind jets through Central American mountain gaps that are strongest in winter.

Progress During FY 2005

New satellite observations reveal a clear effect of an ocean thermocline dome on summer precipitation in the eastern Pacific ITCZ. The thermocline dome itself is an ocean response to intense wind jets through Central American mountain gaps. We also carried out numerical experiments to study the effects of Central American mountains on winter climate over the eastern Pacific.

We have developed a regional coupled ocean-atmospheric model over the eastern tropical Pacific. The simulation skills have recently improved significantly. In particular, the model captures the latitudinal asymmetry in sea surface temperature and atmospheric convection as well the annual cycle in equatorial SST and wind, features that many state-of-the-art global climate models have difficulty reproducing.

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

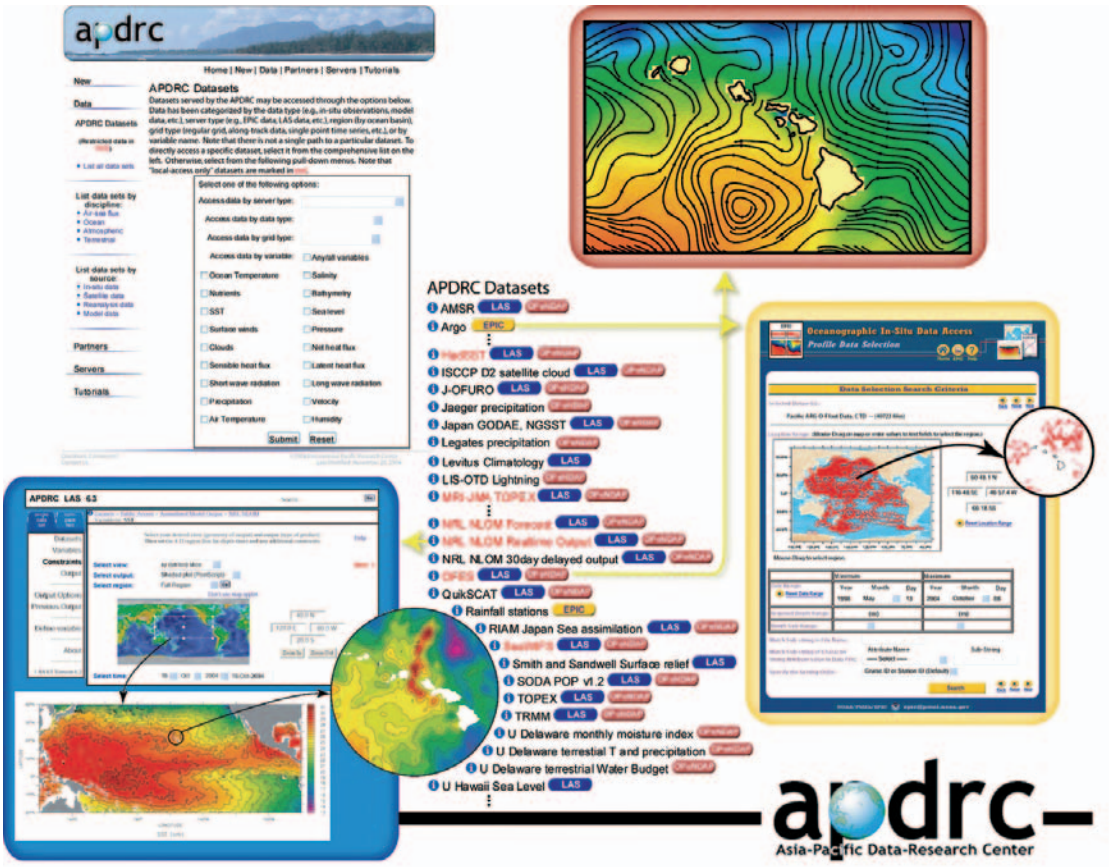
P.I.: Julian P. McCreary, Jr., Peter Hacker

NOAA Goal(s)

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

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 vision of the APDRC is to link data



Components of the APDRC website. Shown at the top left is the search utility, which has direct links to the data archive. A sample listing of datasets, shown in the center of the figure, gives the name of the dataset followed by an icon indicating the server type (OPeNDAP, LAS or EPIC) on which the dataset is available. Shown also is a sample output from each server, the yellow arrows indicating the datasets from which the outputs are derived.

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. The project is, in part, a collaboration with NOAA/PMEL and NOAA/GFDL (Geophysical Fluid Dynamics Laboratory) to implement infrastructure in support of the Global Ocean Data Assimilation Experiment (GODAE).

We have operated and upgraded our DSS in collaboration with our national and international partners. The data archive has been substantially increased with focus on atmospheric and satellite-derived products. In addition, the web-based data management tools have been substantially upgraded to allow easy access to metadata, product information, and product search capability. Value-added activities include: the completion of the quality control of the historic upper ocean thermal profile data set for the Indian Ocean through a partnership with the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia; and quality control of the historic ocean temperature and salinity data base with the Woods Hole Oceanographic Institution. 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. A major accomplishment has been the continuous serving of the global Navy Research Laboratory Layered Ocean Model (NLOM) products (both near-real-time and forecasts). Just over a year ago, we began the implementation of a high-resolution model for downscaling operational models in the Hawaiian Islands region; the model is currently being tested with various spatial resolutions and atmospheric forcing fields. In a new activity, we have participated in several Atmospheric

Brown Cloud meetings to help that community develop a data management strategy and future plans. We have also initiated activities for the PRIDE (Pacific Region Integrated Data Enterprise) program to jump-start integrated product development and coordination between the participating groups. The above activities are done in coordination and collaboration with our national (PMEL, GFDL and others) and international (Australia, India, Japan) partners on the implementation of a distributed and linked climate data server network.

Progress During FY 2005

The project expanded its scope to six major activities at the APDRC in accord with the project's objectives: operate and continue the development of the Data Server System (DSS); provide a global data archive and necessary data management for climate data and products; conduct value-added activities that produce needed data products; serve as a GODAE Product Server for a broad range of research and applications users with focus on satellite and model-derived products; implement a high-resolution model for downscaling operational models in the Pacific Islands regions; and assess and develop APDRC plans for the data management needs of the Atmospheric Brown Cloud (ABC) project.

Impacts of Warm Pool and Extratropical Processes on ENSO

P.I.: Bin Wang

NOAA Goal(s)

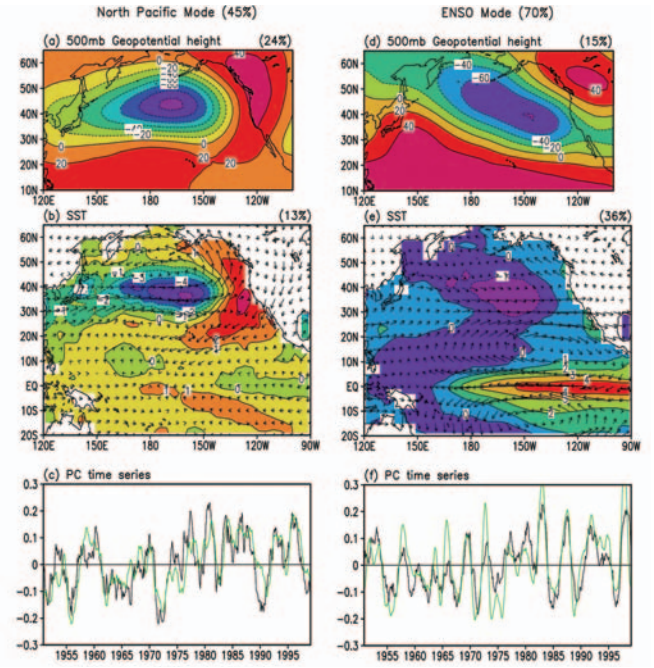
- To understand climate variability and change to enhance society's ability to plan and respond

Purpose of the Project

The purposes of this project are to address how the mid-latitude atmospheric variability influences the tropical Pacific and what roles the Indo-Pacific warm pool processes play in generating ENSO irregularity and biennial variability.

Progress During FY 2005

This project is in its second year (October 2004-September 2005). The paper of An, S.-I, and B. Wang, (2005) entitled "The forced and intrinsic low-frequency modes in the North Pacific" has been published in J. Climate. This paper distinguished the externally forced and the intrinsic interdecadal modes in the North Pacific by using the conditional maximum covariance analysis. Their differences between the two modes are elaborated.



Distributions of the first CMCA (conditional Maximum Covariance Analysis) mode associated with (a) 500 mb geopotential height, (b) SST and (c) the corresponding PC time series associated with SST (green line) and 500 mb (black line), when ENSO signals are removed. (d-f) As in (a-c) but the North Pacific mode's signals are removed. The covariance (the percentage ratio of the covariance explained by a pair of the eigenvectors to the total covariance between two fields) and variance fractions (the percentage ratio of the variance explained by the first eigenvector to the total variance) are indicated in the upper right-hand corner of each map. Linear regressions of 200mb winds against the PC time series of North Pacific and ENSO modes are overlapped over each SST pattern.

The paper of Wang et al. (2005) entitled "Fundamental challenges in simulation and prediction of summer monsoon rainfall" has recently been published in the journal *Geophysical Research Letters*. This paper questioned the scientific basis for two-tier climate prediction that lies in the predictability determined by the ocean and land surface conditions. We showed that the state-of-the-art atmospheric general circulation models (AGCMs), when forced by observed sea surface temperature (SST), are unable to simulate properly Asian-Pacific summer monsoon rainfall. All models yield positive SST-rainfall correlations in the summer monsoon that are at odds with observations. The observed lag correlations between

SST and rainfall suggest that treating monsoon as a slave results in the models' failure. We demonstrate that an AGCM, coupled with an ocean model, simulates realistic SST-rainfall relationships; however, the same AGCM fails when forced by the same SSTs that are generated in its coupled run, suggesting that the coupled ocean-atmosphere processes are crucial in the monsoon regions where atmospheric feedback on SST is critical. The present finding calls for reshaping of current strategies for monsoon seasonal prediction. The notion that climate can be modeled and predicted by prescribing the lower boundary conditions is inadequate for validating models and predicting summer monsoon rainfall.

Names of Students Graduating with MS or PhD Degrees During FY 2005

Zhuo Wang, Ph D

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

P.I.: John E. Barnes

NOAA Goal(s)

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

Purpose of the Project

Airborne mercury sampling equipment at Mauna Loa Observatory.

Three staff positions are funded to perform a variety of functions at Mauna Loa Observatory. All of the work is directly related to climate research. One position concentrates on a joint program with the Environmental Protection Agency to measure background mercury levels in the atmosphere. Mercury is measured in the gas phase as well as in particulates both day and night. A second position concentrates on particulate measurements in the upper atmosphere with a laser radar (lidar). This position also services an elemental carbon program started by Professor Barry Huebert (UH). The third technician position is for general maintenance of the observatory facilities.

Progress During FY 2005

The mercury measurements have continued and the range of measurements have expanded. New sampling procedures required the JIMAR chemist to travel to EPA headquarters for additional training. The laser radar program has also expanded with a new technique using a wide-angle camera to image the laser beam. The JIMAR worker has been the primary developer of the analysis software for this program. The technician has completed several project in preparation for the coming 50th year anniversary of the observatory.

Profiling CTD Float Array Implementation, Delayed-Mode Salinity Adjustments, and Ocean Climate Research

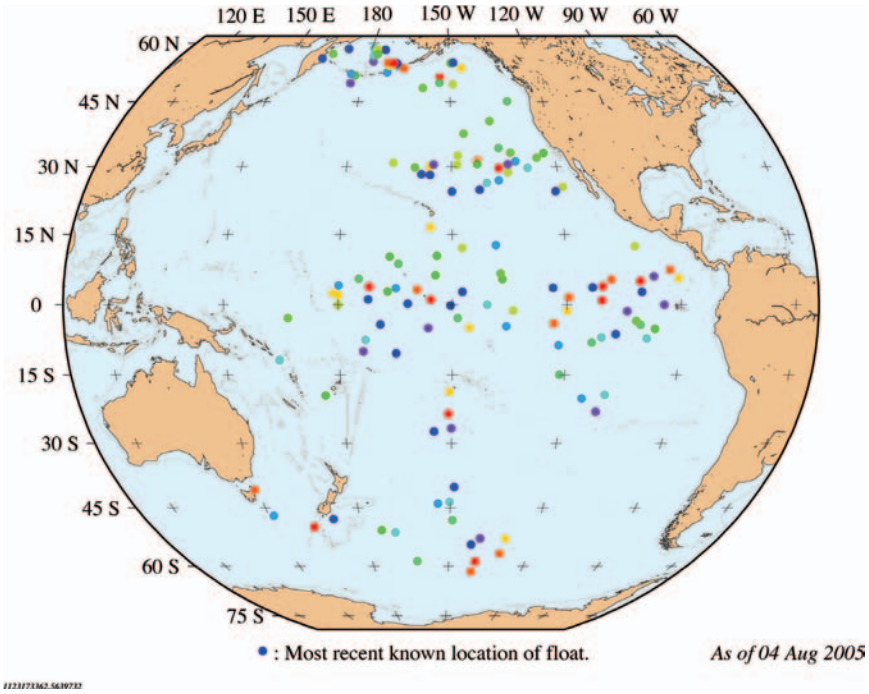
P.I.: Thomas A. Schroeder/Gregory C. Johnson

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

JIMAR works with U.S. and International Argo Project partners, especially NOAA/PMEL, on three aspects of



Most recent locations as of August 4, 2005 for Argo floats deployed through JIMAR and PMEL efforts.

the Argo Program. The first component involves float testing, deployment, and data/engineering evaluation. The second component involves delayed-mode quality control of U.S. Argo float salinity data and international Argo data management. The third component involves climate research using data from Argo floats.

Progress During FY 2005

E. Steffen worked on testing 94 floats (detecting and fixing 11 serious problems). She worked to ship 84 floats and deployed 82 in FY2005. She upgraded 43 floats from Alkaline to Lithium batteries. She also helped to monitored float performance and kept up with float registrations. She visited the California Maritime Academy and trained enthusiastic students in float deployment. She went on two deployment cruises and deployed 17 floats (some in boxes, some on a line). Stated goals were met.

A. Wong performed salinity drift evaluation for US Argo floats. She assisted the SIO Argo PI's in setting up a salinity drift evaluation system in-house. She worked with the WHOI Argo PI to modify the salinity calibration system for calibration in oceanographically complicated regions. She co-chaired the First Argo Delayed-Mode QC Workshop in San Diego in April 2005. She also undertook a study on the mean state of intermediate-depth water masses in the South Indian Ocean, which is now in press.

Role of Ocean-Atmosphere Interaction in Seasonal and Interannual Variations of the Atlantic ITCZ

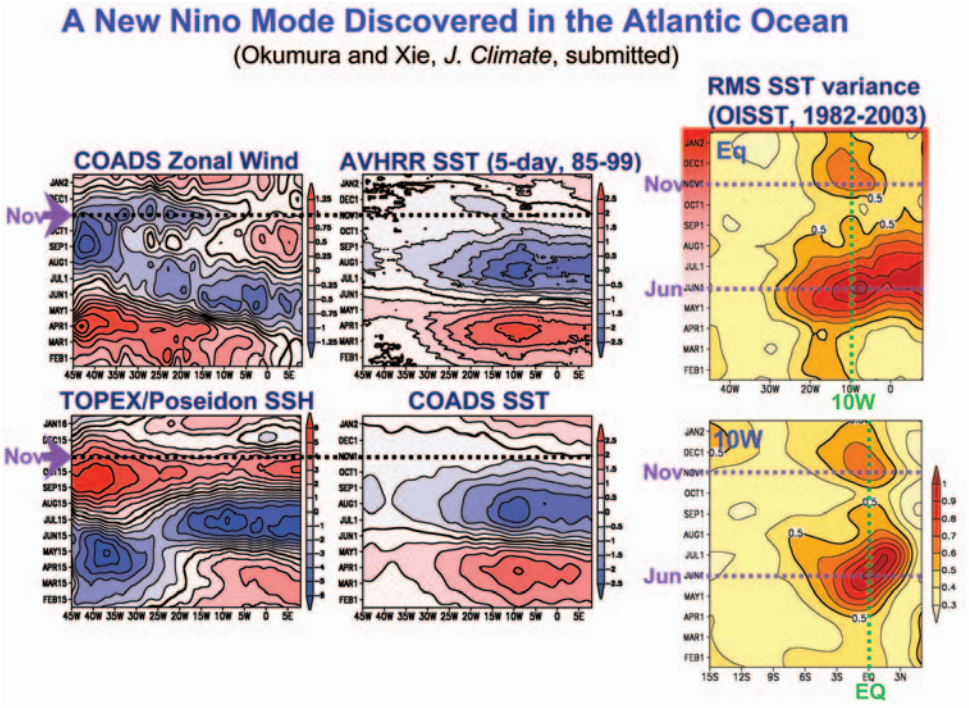
P.I.: Shang-Ping Xie

NOAA Goal(s)

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

Purpose of the Project

To study processes and mechanisms important for seasonal and interannual variations of the Atlantic ITCZ, with an emphasis on air-sea interaction, using a state-of-art regional atmospheric model (RAM) and observational diagnosis.



A suite of observational datasets are used to study seasonal and interannual variations in the equatorial Atlantic Ocean. Our analysis reveals a previously unknown feature of the sea surface temperature (SST) seasonal cycle: besides a major cooling in June-August, there is a secondary cooling in November-December in association with an acceleration of the easterly winds and shoaling thermocline (left and middle panels). The intensified winds and shoaling thermocline enhance the ocean-atmosphere coupling, leading to a Nino-like phenomenon during November-December (right panels).

Progress During FY 2005

A suite of observational datasets is used to study seasonal and interannual variations in the equatorial Atlantic Ocean. Our analysis reveals a previously unknown feature of the sea surface temperature (SST) seasonal cycle: besides a major cooling in June-August, there is a secondary cooling in November-December in association with an acceleration of the easterly winds and shoaling thermocline. The intensified winds and shoaling thermocline enhance the ocean-atmosphere coupling, leading to a Niño-like phenomenon during November-December. This new mode of equatorial air-sea interaction affects rainfall on the west coast of south Africa and over Brazil's Nordest.

Temporal Variability in Surface pCO2 at the Hawaii Ocean Time-Series Station ALOHA

P.I.: David M. Karl

NOAA Goal(s)

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

Purpose of the Project

To install and maintain a remote measurement system on the MOSEAN deep ocean mooring for the purpose of observing the partial pressure of carbon dioxide at the air-sea interface. To make the data sets publicly available through the Hawaii Ocean Time-series website.

Progress During FY 2005

The MOSEAN-HALE ALOHA mooring off Hawaii has been designed, fabricated and deployed successfully three times (August 2004, November 2004 and May 2005). HALE ALOHA mooring users have been identified and we conducted several planning meetings to discuss logistics (e.g., instrumentation, identification and location

and support requirements) and other operational details. All three deployments and two recoveries were successful in terms of operational objectives and instrumentation/data return. NSF-supported staff here in Hawaii have also supported the shore-based and at-sea logistics of a number of ancillary investigators who have added instruments to complement the MOSEAN - HALE ALOHA data set. The pCO2 system, supported by NOAA, has performed well and is currently returning well-calibrated data sets.

Transition from Experimental Climate Prediction to Operational Climate Forecasting and Information Services for the U.S.-Affiliated Pacific Islands

P.I.: Thomas A. Schroeder

NOAA Goal(s)

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

Purpose of the Project

To develop experimental climate services for the U.S. Affiliated Pacific Islands. This is achieved through development of the Pacific El Niño/Southern Oscillation (ENSO) Applications Center (PEAC). The ultimate goal is transition of these products and office to the National Weather Service Pacific Region.

Progress During FY 2005

FY 2005 is first-year in which we have been fully staffed. Since January 2005, PEAC has been conducting a monthly audio conference with representatives of WERI-University of Guam, NOAA's Climate Prediction Center (CPC), International Research Institute for Climate Prediction, NWS WFO Honolulu, NWS WFO Guam, WSO Pago Pago, WSO Yap, WSO Koror, WSO Chuuk, WSO Pohnpei and WSO Majuro. During this conference we discuss the previous month's climate in the Pacific, the current ENSO situation and various rainfall forecast model predictions for the next three months. This audio conference has improved the education and awareness of seasonal climate variability in the USAPI and helped empower the regional Weather Service Offices as climate information providers within their respective jurisdictions.

We are working with the International Pacific Research Center (IPRC) and NOAA's Climate Prediction Center to create a consolidated ensemble forecast for the U.S. Affiliated Pacific Islands. This consolidated forecast will combine three models from CPC. We have also developed an experimental seasonal sea-level forecast, based on a canonical correlation analysis (CCA) model. The product has been included in our quarterly newsletter (see below) and a manuscript submitted for review.

We continue to distribute the quarterly Pacific ENSO Update both in hard copy and electronic format. During the last year e-mail subscriber enrollment has doubled. As a result of customer feedback, a new online newsletter was created for low bandwidth customers.

Warm Pool Dynamics in the Interaction Between Asian Summer Monsoon and ENSO

P.I.: H. Annamalai

NOAA Goal(s)

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

Purpose of the Project

The goals of the proposed research are to understand the interactive nature between the Asian Summer Monsoon (ASM) and ENSO and to assess the contributions of the warm-pool dynamics to this interaction. Our approach is through data analysis and a suite of atmospheric and ocean model experiments. The project is based on the following hypothesis: During its evolution, the ASM-related convection moves north/northwestward from the equatorial Indo-Pacific regions whereas the ENSO-related convection/heat source moves eastward along the equator in the Pacific. In effect, during the boreal summer of El Niño years, the single major heat source (monsoon in the warm pool) is partitioned into two separate pieces (monsoon and El Niño). These two heat sources subsequently interact leading to changes in the thermally direct circulations which in turn modulate the convection and SST in the warm

pool leading to local air-sea interaction. These changes in regional air-sea interaction can directly interact with the ASM and subsequently affect the ENSO evolution.

Progress During FY 2005

In continuance of the last year research, during FY2005 two scientific articles were written and are in press now.

(i) Effect of preconditioning on the extreme climate events in the tropical Indian Ocean (Annamalai et al., 2005b): SST observations in the eastern equatorial Indian Ocean during the period 1950-2001 indicate that strong IODZM events are clustered in two decades, namely, the 1960s and 1990s. In this paper, we investigated possible reasons for this clustering. Specifically, we explored the hypothesis that Pacific Decadal Variability is an important factor in determining the clustering, primarily through atmospheric teleconnections to the Indian-Ocean equatorial wind field. This hypothesis was investigated using atmospheric reanalysis products in conjunction with output from an ocean model.

(ii) Southwest Indian Ocean SST Variability: Its local effect and remote influence on Asian monsoons (Annamalai et al., 2005c): Having recognized that SWIO SST anomalies during El Niño years, are large-scale and persist for more than a season, from a suite of experiments with ECHAM5-AGCM, we demonstrate that the changes in the Indian-Ocean Walker circulation suppress precipitation over the tropical west Pacific-Maritime Continent. Subsequently, the persisting circulation anomalies over that region increase the precipitation along the East Asian winter monsoon. Further, the persistence of SST anomalies in spring delays the northward migration of the vertically integrated moisture, causing a delay in the monsoon onset over India in June by 6-7 days.

Tropical Meteorology

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

Compilation, Digitization, and Use of Hawaii State Rainfall Records

P.I.: Pao-Shin Chu

NOAA Goal(s)

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

Purpose of the Project

To compile and digitize historical, monthly rainfall records from the Hawaii State Climate Office (HSCO) in the Department of Meteorology, School of Ocean and Earth Science and Technology, University of Hawaii. The state data come from numerous volunteer observers such as sugar plantations, pineapple companies, individuals, and others. The state data are unrelated to the NOAA/NCDC network. Metadata describing changes in the way the observations are taken from the handwritten records will be codumented. All digitized data will be entered onto the spreadsheets and be provided to the funding agency

Progress During FY 2005

We have compiled the state rain gages with more than 10 years of records for six major islands (Hawaii, Maui, Molokai, Lanai, Oahu, and Kauai). In all, 429 gages are compiled and digitized. Also included are the state key number, name, observer name, latitude, longitude, and elevation for each gage. Out of these 429 gages, there are 103 gages with more than 50 years of records, offering opportunity for documenting long-term climate change and variability in the tropical Pacific. In addition, we are updating the historical rainfall stations for the County of Kauai, including the index of stations (i.e., period of records, elevation), the station location maps, and rainfall contour maps. We are in the process of making a GIS map of current active stations as well as a map of

inactive stations so users will have a better knowledge regarding the location of existing stations, data format, data durations, and station history

National Weather Service Pacific International Training Desk

P.I.: Thomas A. Schroeder

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

To provide specialized training in U.S. National Weather Service techniques and technology to interns from meteorological services in World Meteorological Organization (WMO) Region V. This is achieved by bringing interns to the Honolulu Weather Forecast Office on the University of Hawaii Manoa campus. There they work with a JIMAR training specialist and have access to the facilities and programs of the University's department of Meteorology as well as JIMAR and the School of Ocean and Earth Science and Technology.

Progress During FY 2005

For FY 2005 we entertained interns from Samoa, the Philippines, the Cook Islands, Vanuatu and Niue. We plan to place a new WMO announcement of opportunity in FY 2006.

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 Southwest Fisheries Laboratory, La Jolla, CA and the Western Pacific Regional Fisheries Management Council.

A General Model for Protected Species

P.I.: Mark Maunder (Simon Hoyle)

NOAA Goal(s)

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

Purpose of the Project

Managing wildlife-human interactions is increasingly important as human influence on natural habitats grows. Effective management requires defined objectives and reliable information about the likely consequences of management actions, or lack of such actions. These requirements are general across all taxonomic groups and management issues. Integrated Bayesian population modeling is a method for estimating population dynamics and decision analysis that is generally applicable, extremely flexible, uses data efficiently, and gives answers in a format that can be directly measured against management objectives.

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. Methods will also be developed to estimate the effect of the management measures on both the protected species and the fisheries. We will apply the framework to several protected species populations.

Progress During FY 2005

The present report reviews the activity under this contract from March 2004 to February 2005. The research was delayed due to staffing changes. The work to date has consisted of 4 main lines of activity:

- Development of an integrated model for dolphins
- Development of an integrated model for Albatross
- Development of general modeling framework for protected species
- Other applications

These topics are briefly reviewed below.

Development of an Integrated Model for Dolphins
- This project has been completed and a paper describing the research has been published

Albatross Modeling
- The albatross mark-recapture database has been finalized by the Patuxent Environmental Research Centre, USGS, and received by the research team.
- Paul Doherty of the Department of Fishery and Wildlife Biology, Colorado State University, visited the IATTC to discuss the albatross mark-recapture database and analysis of the data.
- Sophie Veran of the Centre d'Ecologie Fonctionnelle et Evolutive, visited the IATTC and collaborated on the analysis of adult survival rate from Tern Island mark-recapture data.
- SH continued the use of an individual-based model of albatross population dynamics and capture probability to investigating lack of fit in mark-recapture models and in particular the problems with the Tern Island population of black footed albatross data.
- Goodness of fit has been an ongoing problem for modeling the mark-recapture data. Sophie Veran visited Hawaii in late 2004 and updated the mark-recapture database. These more recent data were sampled differently from the earlier data that gave serious problems with goodness-of-fit. They considerably improve prospects for mark-recapture modeling. However, some problems remain with goodness of fit, and the integrated analysis will not be carried out until they are resolved – the goodness-of-fit work is being carried out in Montpellier.
- SH worked with Sophie Veran to continue the investigation of the effect of widowing in albatross.
- Fishery effort time series and albatross bycatch rates for integration into a model of albatross interactions with fisheries were obtained from most of the available sources including Hawaiian, Californian, Alaskan, and non-US longline fisheries and Japanese, Taiwanese and Korean pelagic squid and large-mesh driftnet fisheries. There have also been difficulties obtaining Pacific-wide time series of detailed effort data and bycatch data for the numerous fisheries potentially taking black-footed albatross bycatch. We hope to obtain additional data within the next few weeks.
- SH visited Niall Broekhuizen of NIWA in New Zealand to discuss albatross modeling.

Development of a General Modeling Framework for Protected Species

A number of steps were taken towards developing and extending a general approach for modeling protected species.
- MM submitted a paper titled "A review and comparison of Bayesian and likelihood methods" to the journal Ecology that describes several aspects of the general framework.
- MM and SH developed a course titled "An introduction to ecological modeling and programming using AD Model Builder" and taught the course twice in the US and once in New Zealand. The course contains many aspects of the general framework and has been approved for 1.2 Continuing Education Units by the American Fisheries Society.
- MM collaborated with Panagiotis T. Besbeas of University of Kent to develop methods to approximate likelihoods and integrate the information into statistical models. This method can be used in the general framework to integrate prior information or reduce the computational demands of the analysis.
- MM gave several presentations on aspects of the general framework.

Other Applications
- SH visited Milani Chaloupka at the University of Queensland and Col Limpus at the Queensland Environmental Protection Agency to discuss data and possible collaborations in preparation for applying the Bayesian integrated modeling approach to a turtle population.
- Jaume Forcada, Biological Sciences Division NERC, British Antarctic Survey, visited the IATTC and collaborated with MM and SH to develop an integrated model based on the general framework for Antarctic penguin populations.

Addition of Multi-Species Capability, Sex Structure and Other Enhancements to the Length-Based, Age Structured Modeling Software MULTIFAN-CL

P.I.: John Hampton and Pierre Kleiber

NOAA Goal(s)

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

Purpose of the Project

MULTIFAN-CL (Fournier et al. 1998[1]) is a spatially-explicit, length-based, age-structured model, which uses time-series of catch, effort, length-frequency and tagging data to obtain estimates of various population parameters, including: recruitment and biomass time-series, natural mortality rates, selectivity and catchability coefficients for defined fisheries, growth parameters and movement rates. The software is now routinely used for tuna stock assessments reported each year to the Standing Committee on Tuna and Billfish (SCTB). Several applications to Pacific pelagic fisheries have been reported in the scientific literature (Hampton and Fournier 2001[2]; Kleiber et al. 2003[3]; www.multifan-cl.org).

In collaboration with agencies involved with the scientific work of the SCTB, this PFRP project provides support for further development of MULTIFAN-CL to enhance its assessments of tuna stocks in the western and central Pacific Ocean and elsewhere, and to extend its applicability to species having biological characteristics and data support different than tunas. The proposed software enhancements are:

1. Incorporation of enhanced parallel processing capability
2. Incorporation of a modified size-frequency likelihood function
3. Addition of alternative parameterizations of fishery selectivity
4. Formalization of a population projection procedure
5. Addition of sex structure
6. Addition of multi-species capability

[1] Fournier, D.A., Hampton, J., and Sibert, J.R. 1998. MULTIFAN-CL: a length-based, age-structured model for fisheries stock assessment, with application to South Pacific albacore, *Thunnus alalunga*. *Can. J. Fish. Aquat. Sci.* **55**: 2105-2116.

[2] Hampton, J., and Fournier, D. 2001. A spatially-disaggregated, length-based, age-structured population model of yellowfin tuna (*Thunnus albacares*) in the western and central Pacific Ocean. *Mar. Freshw. Res.* **52**: 937-963.

[3] Kleiber, P., Hinton, M., and Uozumi, Y. 2003. Stock assessment of blue marlin (*Makaira nigricans*) in the Pacific using MULTIFAN-CL. *Mar. Freshw. Res.* **54**: 349-360.

Progress During FY 2005

During FY 2005 significant progress was made on the first four items above. The first objective, parallel processing, is being incorporated to improve the efficiency of the software to fill the demand for more intense computation as complicating factors are added, such as the last two items above. Some parts of the model can now function as parallel processes, and more possibilities for parallelizing remain. Items 2 and 3 implement alternative formulations of the model and have been undertaken with a view also to improved computational efficiency as well as stability of the fitting process. The results of these changes are now being evaluated. The fourth item has been undertaken in answer to demands from the new Western and Central Pacific Fishery Commission (WCPFC), which wishes to consider various management measures for dealing with evident overfishing in recent years of bigeye tuna. Population abundance and catches by various fleets can now be projected into the future with uncertainty bounds under various hypothetical management regimes so that the efficacy and possible side effects can be evaluated.

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

P.I.: John Sibert, Judith R. Amesbury, and Rosalind Hunter-Anderson

NOAA Goal(s)

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

Purpose of the Project

MARS will produce a report on the long-term data concerning fisheries for pelagic species in both Guam and the Northern Mariana Islands. The report will be based mainly on archival review. However, we are also conducting interviews with fishermen on each of the four major islands (Guam, Rota, Tinian, and Saipan), and we will have one or more collections of archaeological fish bones analyzed to add to the data from the Prehistoric Period.

Progress During FY 2005

We expect that our report will consist of four chapters. The first will be an overview of the prehistory and history of the Mariana Islands as it pertains to pelagic fishing. The second chapter will cover the Prehistoric Period; the third chapter will cover the Spanish Period; and the fourth chapter will cover the Twentieth Century. Hunter-Anderson has almost completed the first chapter, and Amesbury is working on the fourth chapter. We have interviewed ten fishermen in Saipan and Tinian. We had planned to interview 12 fishermen, three on each of the four major islands—Guam, Rota, Tinian, and Saipan. We still need to interview the Guam and Rota fishermen. We have obtained the Mangilao Golf Course faunal remains from the Guam Museum, but we have not yet sorted out the fishbone to send to New Zealand for analysis.

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

P.I.: Selina Heppell (Oregon State University), Molly Lutcavage (University of New Hampshire), and John Sibert (University of Hawaii, JIMAR)

NOAA Goal(s)

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

Purpose of the Project

We propose to run quantitative and qualitative analyses of existing data on the ecology, distribution and fishery interactions of leatherback and loggerhead sea turtles in both 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, where fisheries interactions are common, appear to be stable or increasing, while populations of the same species in the Pacific are declining. Because of great concerns for their 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 worldwide take patterns in pelagic and inshore fisheries, and impacts on stock rebuilding, is incomplete, at best.

Progress During FY 2005

We received our funding in January 2005. Our objectives for FY2005 fall into 3 phases.

Data Acquisition

1. Compile published and unpublished data on the life history, at-sea distribution, pelagic and coastal fisheries interactions, and history of direct exploitation for loggerhead and leatherback sea turtle populations in the North Pacific and North Atlantic oceans.

To date, we have created a database for collection and sorting of biological information, fishery data, and oceanographic data relevant to sea turtles in the Pacific and Atlantic basins. We are constructing a GIS-based assessment tool for a spatial evaluation of temporal changes in nesting beach numbers, fishery interactions (based on density of effort in sea turtle habitat), and conservation actions such as egg protection. Our database and map will be populated with published data from a variety of sources, and serve as a framework for hypothesis testing. In addition, spatial and oceanographic analyses of Atlantic leatherback sea turtle movements are underway by Lutcavage and colleagues, and these results will be used to test hypotheses related to movements and spatial and temporal depiction of habitat.

Hypothesis Formulation

2. Identify and evaluate alternative hypotheses for population change for each species in each ocean basin,

by postulating the changes in abundance, distribution, genetic composition or size distributions that would be anticipated from these hypotheses.

The PIs have been in contact with a number of sea turtle researchers, oceanographers and federal sea turtle working groups to discuss possible causes for population recovery (Atlantic) and declines (Pacific). We will finalize a list of invitees for our September workshop in Honolulu by May 1.

Model Building and Hypothesis Testing

3. Compare expected distributions of loggerhead and leatherback turtles in each ocean basin based on habitat preferences and oceanographic regimes.

Graduate student Abigail McCarthy has completed an initial analysis of loggerhead turtle habitat preferences using General Additive Models of sea turtle bycatch records from the Atlantic. The predicted distribution of turtles from this model will be tested for Atlantic and Pacific using additional bycatch records and data from satellite telemetry. The results will also be compared with previous studies that utilize different methods. Ms. McCarthy will complete her thesis in December 2005.

4. Develop a modeling framework for assessment of population-level impacts of pelagic fisheries on sea turtle populations that are subject to multiple stressors.

PI Selina Heppell and contractor Rebecca Lewison have developed and evaluated a series of age-structured models to predict time lags and magnitude of trends in sea turtle populations that are expected following a natural or man-made perturbation. We are also examining more traditional production models for leatherbacks, as nesting beaches in the Atlantic provide a range of population sizes and recovery rates that can help determine appropriate stock-recruitment parameters. We are also investigating the potential for evaluation of stock status through size distributions; this may be possible with loggerheads, but is unlikely to work for leatherbacks due to extreme variability in size at age observed by Snover and Avens at the SEFSC.

Comparisons of Catch Rates for Target and Incidentally Taken Fishes in Widely Separated Areas of the Pacific Ocean

P.I.: William Walsh and Keith A. Bigelow

NOAA Goal(s)

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

Purpose of the Project

This project has continued and expanded upon an earlier Pelagic Fisheries Research Program project (Distributions, Histories, and Recent Catch Trends with Six Fish Taxa Taken as Incidental Catch by the Hawai'i-based Commercial Longline Fishery, by William A. Walsh and Samuel G. Pooley). It has two general aims: the practical goal is to assess and improve the accuracy of longline logbook data for several pelagic fishes (e.g., striped marlin, shortbill spearfish, albacore, bigeye tuna, wahoo), while the more conceptual goal is to elucidate variation in catch per unit effort (CPUE) for these fishes across wide spatial scales in the Pacific Ocean. Regarding the latter, the specific intention is to determine whether, and if so, to what extent, intra- and interspecific CPUE values for the several species are correlated throughout the Pacific Ocean. The work has entailed (or will entail) analyses and comparisons of fish catch and operational data gathered by the Hawai'i Longline Observer Program of the National Marine Fisheries Service (NMFS), longline logbook records submitted by the Hawai'i-based fleet, data from mainland US fisheries and US possessions, and western Pacific fisheries.

Progress During FY 2005

This project was initially funded in November 2002, with a scheduled two-year duration. There have not been any specific conceptual problems per se. Although this project has not yet yielded peer-reviewed publications, there has been substantial progress toward its practical goals. Generalized additive models have been fitted to observer data for both striped marlin and shortbill spearfish. This represents a logical succession to previous work with blue marlin, with improvements. Specifically, these models have fewer degrees of freedom allotted to predictor variables that appeared to exert minor effects on catch rates; as a result, the likelihood of overparameterization has been reduced with little loss of explanatory power. In addition, substitution of an overdispersed Poisson distribution for an ordinary Poisson distribution as the error structure has improved the fit of these models, which

were then applied to logbook data to identify likely errors and thereby improve accuracy. In this context, logbook data for black marlin and sailfish have also been examined and corrected because the billfishes catch data from the Hawaii-based longline fishery tend to exhibit "intermingled" patterns of misidentifications. Thus, it was considered appropriate to evaluate the four remaining istiophorid species together.

This project has also contributed to improvements in both the electronic archival of logbook data at the Pacific Islands Fisheries Science Center and the linkage between logbook data and fish auction sales records provided by the United Fishing Agency, Ltd., Honolulu, HI. Concerning the former, a corrected 100-month data set for blue marlin (March 1994-June 2002) is presently in the ORACLE electronic archive, and corrected data for black marlin and sailfish will be ready for inclusion therein in the very near future (within approximately one month). In this context, Ms. Karen Sender of the Pacific Islands Fisheries Science Center Information Technology Program and Mr. Lee Weinberger from the Southeast Fisheries Center have been very helpful and informative. It is their professional judgment that the availability of these corrected data sets should permit whatever "fine-tuning" may prove necessary to enhance the usefulness and accuracy of the logbook data archived at the Pacific Islands Fisheries Science Center. Improved linkage between logbook and auction data is important because the latter have been used extensively to verify statistical results and thereby correct billfish catch data. Mr. Dios Gonzales of the Pacific Islands Fisheries Science Center Fishery Monitoring and Economic Performance Division has been most helpful in this regard.

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.: Jeffrey Polovina and Michael Seki

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

To describe the vertical habitat and horizontal movements of bigeye and albacore tunas 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.

A pop-up archival transmitting tag is attached to an albacore tuna in American Samoa waters, March 2004.

Progress During FY 2005

Analyses of the acoustic data collected on the American Samoa cruise in March 2004 have been completed. Analyses of the temperature and depth occupied by two albacore tagged in waters around American Samoan with Pop-up Archival Transmitting (PAT) tags has been completed. These data were presented at the PFRP PIs meeting in December 2004. Results will also be presented at the Tuna Conference in May 2005. Bigeye movement data around Hawaii based on PAT tags was computed using light and SST-based geolocation. These results will be presented at the Tuna Conference in May 2005. A March 2005 tagging cruise was conducted to deploy more PAT tags on bigeye around Hawaii.

Development of a Hierarchical Model to Estimate Sea Turtle Rookery Contributions to Mixed Stocks in Foraging Habitats

P.I.: Benjamin Bolker

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 develop general methods for incorporating ecological covariates in genetic stock analysis models. Stock analysis attempts to estimate the proportion of the individuals in a mixed population that come from each of a number of possible source populations: for example, comparing data from breeding grounds and an open-ocean population that combines individuals from many breeding grounds to figure out the importance of particular breeding grounds to the overall population. In the past, stock analysis has been based only on individual morphological or genetic measurements, such as the mitochondrial DNA haplotypes of individuals found in rookeries and in mixed-stock foraging grounds. Other ecological information such as the size of the breeding population or the distance from the breeding population to the foraging ground is often available (and ignored). We are using stock analysis of Atlantic sea turtle populations (loggerhead and green turtles) to test and develop models that include ecological covariates such as rookery size and location, and drawing initial conclusions about the more powerful or different conclusions that come from incorporating this information. In particular, we are developing hierarchical Bayesian models, which are a flexible but rigorous way to add rookery size and geographic location to stock analysis methods that have traditionally used only genetic data to try to infer the contributions from each rookery. We are also developing important auxiliary statistical tools, such as model selection methods that can determine whether adding particular ecological covariates to an analysis actually increases the precision and accuracy of our estimates, or whether (if we mistakenly try to add irrelevant information to the model) it actually dilutes the power of the analysis; these tools are necessary before one can confidently start using hierarchical Bayesian methods as a general tool to add information to stock analyses. We are building software tools that implement these methods and that can be used by a broader audience of researchers. Finally, we hope to apply these general methods to some broader questions in stock analysis: for example, where should we define boundaries between populations for the purpose of stock analysis? How do we know when we have enough information to justify analysis at a very fine spatial scale or using very detailed genetic differences, and when should we be satisfied with analyses on a coarser scale?

Progress During FY 2005

- We have continued to develop our methods for estimating contributions in a "many-to-many" stock analysis situation, where data are available from many sources (rookeries) and many destinations. In this case, we can incorporate rookery and feeding-ground size directly (rather than hierarchically, although we are also exploring hierarchical versions of this model), and we can express contributions in either a "rookery-centric" way—percentages of individuals leaving each rookery for different foraging grounds—or in the more traditional "foraging ground-centric" way—percentages of individuals in each foraging ground coming from different rookeries. We found that approaching this problem naively and running a series of separate stock analyses for each foraging ground gives misleading answers. In addition to our paper in Molecular Ecology applying this technique to stranding data, we have applied these techniques to green turtle data from the Atlantic and have a manuscript in prep. (also for submission to Molecular Ecology).
- We will continue to work to make the procedures we have developed robust and to incorporate them into a relatively user-friendly package running on top of the R programming environment (and possibly tying in the BUGS statistical estimation package as well). (An initial version of the package is available at http://www.zoo.ufl.edu/bolker/turtle.)
- We have continued (and will continue) to develop and support our R package for stock analysis, available from http://www.zoo.ufl.edu/bolker/R/windows.

Development of Oceanographic Atlases for Pelagic and Insular Fisheries and Resource Management of the Pacific Basin

P.I.: Russell E. Brainard, John Sibert and Dave Foley

NOAA Goal(s)

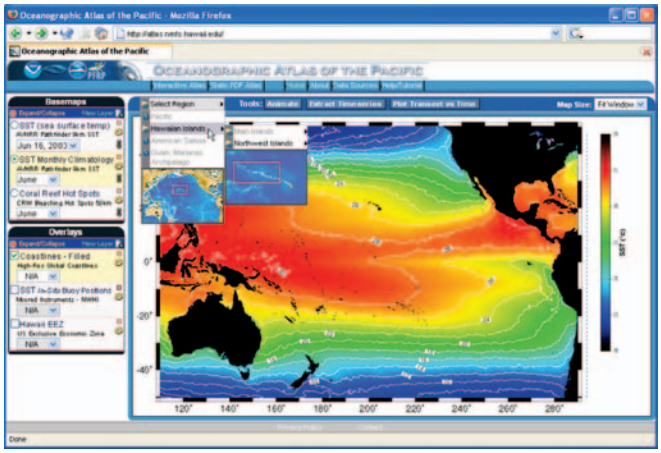
- To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management
- To understand climate variability and change to enhance society's ability to plan and respond
- To serve society's needs for weather and water information

Purpose of the Project

A broad range of oceanographic and environmental conditions and processes influences marine ecosystems and fisheries. The development of broad-based ecosystem approaches to fisheries management is hindered by the bewildering array of unsynthesized oceanographic information currently available. Additionally, there is no consistent coding or formatting standards, and each data source may require different software for access. The Oceanographic Atlas of the Pacific is designed to provide a single point of access to environmental data from a variety of platforms (satellite, shipboard, moorings, and numerical models) in forms that are useful and accessible to both non-expert and expert users. This will be accomplished through a series of oceanographic atlases for all of the U.S. Pacific Island exclusive economic zones (EEZ) and regions of the Pacific basin important for pelagic and highly migratory species fisheries management. Data coverage will be provided at basin-wide and regional scales as well as for various biogeophysical sub-regions and, contingent upon data availability, individual islands, banks, or reefs. Distribution of the full data sets will be conducted primarily over the Internet using an interactive web interface that allows users to customize various aspects of data selection and display. Both CD-ROM and limited print versions will also be made available for resource managers and researchers in those areas lacking the resources for large Internet transfers.

Progress During FY 2005

As in FY04, current work has focused mostly on the development of the Atlas data delivery mechanism rather than research into and development of novel and highly derived data products. As the flagship Atlas product, the website is designed to be a sophisticated yet easy to use interface to in situ, satellite, and model data. The strength of this system is its ability to let users combine and compare any data available through the Atlas by selecting combinations of basemaps and overlays in a manner similar to many GIS applications. In FY05, a homepage for the Atlas was created, collecting e-mail addresses for an Atlas-update mailing list and providing a place for future Atlas tools to reside. For the interactive mapping interface, the structure of the interface has been implemented with a set of GIS-like tools and features, including map zooming and panning, region selection, and query definition. This HTML/Javascript interface relies upon a suite of backend tools that handle metadata management, data processing, data aggregation, and visualization. An application written in Python acts as a web-service for the browser client. When the user requests a map visualization, the web-service runs assorted code modules that find the necessary source data, reprocess it, slice the dataset along the appropriate dimensions, and create plots of multiple overlaid datasets that are returned to the client as images with associated metadata. Raw data queries are handled similarly but result in the return of data values as either ASCII or netCDF files rather than images.



The Oceanographic Atlas of the Pacific, making marine environmental data accessible on the web and in print.

Work is currently being done to make the Atlas compatible with OPeNDAP enabled distributed archives of oceanographic data. An OPeNDAP server and Live-Access-Server (LAS) have also been installed on the Atlas webserver to help facilitate interoperability. The OPeNDAP server will allow the Atlas to share its local data holdings with partners elsewhere on the Internet. As the adopted standard for the Integrated Observing System efforts around the world, OPeNDAP will allow the Atlas to integrate emerging oceanographic data streams.

Data Sets

Remote Sensing Data and Model Output. The development of science-quality historical time series and climatologies is one of the fundamental goals of the project. The Atlas project has been working with the National Oceanographic Data Center (NODC) Satellite Oceanography Group to derive climatologies from the best available remote sensing and other wide-coverage gridded oceanographic datasets. Pathfinder 5.0 4km sea-surface temperature, ocean color (SeaWiFS/MODIS chlorophyll a, PAR), wind speed and stress, salinity, and dissolved oxygen at 100m climatologies have been produced for the Atlas so far, and the original time series data is also available. Other data sets in the Atlas holdings include variables such as sea surface height and currents.

Many datasets needed for the Atlas are provided in near real time on an operational basis by the Hawaii CoastWatch node. Many others are available from other sources and are being archived separate from the CoastWatch data.

Model output from OGCMs provides an important component of the Atlas. Due to the limitation of satellite measurements to surface waters and the extremely sparse spatial and temporal distribution of *in situ* and shipboard measurements, models must provide many estimates of subsurface dynamics. Several model outputs are available via OPeNDAP through the International Pacific Research Center (IPRC) Asia Pacific Data Research Center (APDRC), including surface level data from NRL's Navy Layered Ocean Model (NLOM).

In Situ Data. While large *in situ* oceanographic data sets, such as COADS and Levitus/World Ocean Atlas, provide "highly refined" products that can adequately provide the larger scale context within which finer scale information, when available, can be more effectively analyzed. The Atlas has acquired several collections of publicly available *in situ* measurements, including the World Ocean Database, as well as near real time data from NMFS Coral Reef Ecosystem Division moorings and drifters in the northwest Hawaiian archipelago and other US Pacific Island EEZs. Through a geographical query process on the Atlas web interface, users can see locations where in-situ measurements are available and then access profiles and time series as graphs and raw data. Currently, only the CRED instruments are queryable, though work is being done to convert the thousands of WOD profiles into a relational database format.

Diet Dynamics and Trophic Relations of Laysan and Black-Footed Albatrosses

P.I.: Thomas A. Schroeder [Stewart Allen]

NOAA Goal(s)

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

Purpose of the Project

Laysan and Black-footed albatrosses experienced drastic declines in their breeding populations at their most important colonies but have recently stabilized. Pelagic longline fishing has been implicated as a possible contributor to the declines. It is also possible that food availability regulates reproduction. Because of their scavenging nature, the diet of these albatrosses may to some extent be dependant on drift net and pelagic longline fisheries as sources of food. We are investigating the relationship between two North Pacific albatrosses and these two types of fisheries by analyzing the digestive tract contents and stable isotopes of albatrosses salvaged recently from the Hawaii longline fishery and breeding colonies of the Northwest Hawaiian Islands. We will compare our results to similar data collected from albatrosses salvaged from the squid and large-mesh drift net fishery a little over 10 years ago. Understanding the relationship between these seabirds and fisheries is essential to the conservation and management of both the albatrosses and fisheries.

Progress During FY 2005

Salvage Efforts

Total Black-footed Albatrosses salvaged include 24 from the Pacific Islands Region longline observer program, 5 from the Hawaii longline bycatch reduction experiments, 9 from the Southwest Region longline observer

program, 1 from French Frigate Shoals, and 1 from Kure. Total Laysan Albatrosses salvaged include 21 from the Pacific Islands Region longline observer program, 49 from the Hawaii longline bycatch reduction experiments, 3 from the Southwest Region longline observer program, 20 from Kure and 6 from Midway. Fewer albatrosses were salvaged than expected potentially because of changes in fishing effort and mitigation requirements. Nevertheless, several overall objects have been met.

Preliminary Results

We found that all but 1 of the Black-footed Albatrosses and all of the Laysan Albatrosses were breeding age adults, the exception being a pre-breeding adult exhibiting breeding plumage. From our stable isotope analysis of breeding age adults only, we found no significant decline in trophic position for either of the albatross species interacting with the fisheries since the demise of drift-gill-netting. Black-footed albatrosses had significantly higher trophic positions than Laysan albatrosses, but Black-footed albatrosses associated with swordfish fishing had significantly higher trophic positions than those associated with tuna fishing. Differences in trophic position between Black-footed and Laysan albatrosses may potentially be driven by habitat preferences that render the Black-footed albatrosses more likely to interact with swordfish fishing, assuming swordfish fishing provides higher trophic level food sources. Despite any potential effect on the diet of fishery interacting individuals, the trophic positions of Laysan albatrosses salvaged from the North Western Hawaiian Islands were significantly lower than longline associating albatrosses suggesting there is no population level effect.

Analysis of the digestive tract contents of longline associated albatrosses is nearly complete. All of the gut contents have been identified, enumerated and weighed. Bait comprised a large proportion of the diet, though the majority of the food items identified were mesopelagic squid. We are still in the process of analyzing the prey tables to determine the overall importance of each prey type, and finding suitable materials for prey isotopic analysis.

Distributions, Histories, and Recent Catch Trends with Six Fish Taxa Taken as Incidental Catch by the Hawaii-Based Commercial Longline Fishery

P.I.: William Walsh and Keith A. Bigelow

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 was designed to provide corrected catch rates for blue shark, blue marlin, mahimahi, wahoo, opah, and pomfrets taken by the Hawaii-based longline fishery. It has entailed development of statistical models from observer data with subsequent application to the logbook data from unobserved sets as comparison standards. This project is also contributing to improved linkage of data gathered by the NMFS Observer Program, the logbook program, and auction data from the United Fishing Agency, Ltd., Honolulu, Hawaii.

Progress During FY 2005

Recent work conducted for this project has been devoted to completing a manuscript that presents corrected catch rates and describes logbook data accuracy for blue marlin in the Hawaii-based longline fishery from March 1994 through June 2002. The manuscript has been revised after review and is in press at Fisheries Research (a peer-reviewed journal).

There were no specific new problems encountered in FY 2005. The usual difficulty with the evaluation of data quality is that it tends to be laborious and time-consuming. The blue marlin analysis, for example, required detailed checks on and correction of the catches from approximately 500 fishing trips since 1994.

The marlins project has contributed to improve linkage between observer, logbook, and auction data, in the sense that the work was conducted as an integrated analysis predicated upon use of the fishery observer data to develop a statistical model, application of its coefficients to logbook data as a comparison standard, and use of sales data to verify analytical results. The corrected blue marlin logbook catch data generated by these analyses have been incorporated into the ORACLE database at the Pacific Islands Fisheries Science Center.

Work conducted under this and an earlier, related project has been recognized and incorporated into agency-level planning at NOAA Fisheries. "Evaluating Bycatch: A National Approach to Standardized Bycatch Monitoring Programs," published by the NMFS in June 2003, cited Walsh (2000) ("Comparisons of fish catches

reported by fishery observers and in logbooks of Hawaii-based longline vessels"; Southwest Fisheries Science Center Administrative Report H-00-07) and Walsh et al. (2002) ("Comparison of logbook reports of incidental blue shark catch rates by Hawaii-based longline vessels to fishery observer data by application of a generalized additive model"; Fisheries Research 58:79-94) in relation to the accuracy of both observer and logbook data and characterization of forms of bias in logbooks.

Economic Fieldwork on Pelagic Fisheries in Hawaii

P.I.: Minling Pan

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 objective of this multi-year project is to provide detailed economic information (especially cost of operation) on Hawaii-based domestic pelagic fishing vessels: longliners, trollers and handliners, and charter boats. Cost-earnings reports (published as JIMAR/SOEST reports) on each of these fisheries were prepared since the project began in 1994. The data from these studies have been used in a variety of economic and social analyses of these fisheries both within the project, by other PFRP projects, and by the National Marine Fisheries Service, supporting fishery management in the Western Pacific Islands Region.

There are three main tasks under this project within FY2005.

A. Wrapping up the longline cost-earnings research (received funds from PFRP 2003)
B. Blue marine evaluation (received funds from PFRP 2003)
C. Technological changes and the impact on fishing effort in the Hawaii-based longline fishery (expected funds from PFRP 2005)

Progress During FY 2005

A. During FY2005, a study on imported frozen tuna treated with tasteless smoke (CO) and its impact on Hawaii fresh tuna market was conducted (assisted by summer intern Timothy Ming). Based on industrial observations, Hawaii has recently seen an increase in imported tuna, which competes directly with the local fishing industry. Many supermarket chains in Hawaii sell imported tuna, which could be previously frozen and treated with CO, as "ahi poke." This is the same name used for local fresh tuna but the CO treated tuna is sold at a much lower price. The local fishing industry is concerned that the ongoing increase in imported tuna may threaten the livelihood of the local industry. This is especially true for the pelagic fishery, which is the largest fishery in Hawaii. The Pelagic Plan Team recommended a study on imported tuna and the impacts on the local market. A pilot study on the subject was completed in FY05.

B. Based on PFRP steering committee and reviewers' comments, the research proposal was revised and re-submitted to PFRP for FY06 funding. David Itano is serving as co-PI for this project. The revised research proposal has been approved and funds for this project are expected later this year.

Economic Value of Pacific Blue Marlin in the Hawaii Recreational Fishery

P.I.: Thomas A. Schroeder [Stewart Allen]

NOAA Goal(s)

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

Purpose of the Project

A potential upcoming issue in local fisheries management is allocation of blue marlin catch among the various components of the Hawaii fishery (i.e., recreational vs. commercial effort). A recent dissertation clearly identified a trade-off between commercial and recreational fishing. However, that study examined commercial and recreational tradeoffs using a model that did not value the recreational trip explicitly nor the value of individual species, e.g., blue marlin. The purpose of this project is to identify the specific economic values associated

with the species (blue marlin). These values could then be compiled with previous research findings into a comprehensive analysis of economic values that would support regulatory development.

Progress During FY 2005

Objective 1. Estimate the non-market value of blue marlin to Hawaii recreational anglers (including charter boat clients).

Objective 2. Compare market and non-market values of blue marlin in Hawaii.

Progress toward these goals in FY2005 included the following:

- JIMAR funding will be used to pay a natural resource economist to assist with the project. As such, developed background and scope of work for RFP for the contractor. Worked with JIMAR and RCUH to identify the appropriate vehicle (i.e., RFP or RFQ) for the contract. Worked with JIMAR to refine the contract vehicle pursuant to comments from RCUH.
- Identified required qualifications for the contractor. Researched potential contractor candidates and selected three who are qualified to perform the tasks in the scope of work, to whom the RFP/RFQ will be sent, and from whom bids will be solicited.
- Discussed with the Hawaii Division of Aquatic Resources (HDAR) the possibility of administering the survey to elicit blue marlin values using protocols and resources already present in existing HDAR projects. Specifically, discussions involved determining whether survey administration could be achieved by adding questions to the existing Hawaii Marine Recreational Fishing Statistics Survey (HMRFSS) or, alternatively, by sampling fishers who had participated previously in the HMRFSS survey (i.e, by obtaining names and contact information for those fishers and conducting an independent survey).
- Discussed with NOAA headquarters staff the possibility of adding questions to the economics add-on associated with the survey instrument used in nationwide MRFSS efforts.

Evaluation of Data Quality for Catches of Several Pelagic Management Unit Species by Hawaii-based Longline Vessels and Exploratory Analyses of Historical Catch Records from Japanese Longline Vessels

P.I.: William Walsh and Keith A. Bigelow

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 continues and expands upon two earlier Pelagic Fisheries Research Program project (Distributions, Histories, and Recent Catch Trends with Six Fish Taxa Taken as Incidental Catch by the Hawai'i-based Commercial Longline Fishery, by William A. Walsh and Samuel G. Pooley; Comparisons of Catch Rates for Target and Incidentally Taken Fishes in Widely Separated Areas of the Pacific Ocean, by William A. Walsh and Samuel G. Pooley). In general, the project is intended to provide well-documented and verified data sets for use in multispecies modeling in the context of ecosystem-based management. There are two specific intentions. The first is to conduct data quality control studies akin to those in the previous projects with those pelagic management unit (PMU) species that have not yet been so evaluated. The underlying premise for this task is that catch trends for all species, not only the targets or those taken with regularity as incidental catch, should be considered in relation to ecosystem-based management. The second specific intention is to conduct exploratory analyses of catch data collected in the post-World War II era by Bureau of Commercial Fisheries observers stationed aboard Japanese longline vessels. The reason for including historical work is to provide background information that could prove useful in assessing the effects of industrialized fishing in the Pacific Ocean over a time scale of several decades.

Progress During FY 2005

This project was funded in November 2004, with a scheduled two-year duration. Progress was achieved during FY 2005 on the basis of its continuity with earlier work. Specifically, the logbook data quality control studies

with blue marlin, striped marlin, and shortbill spearfish revealed that all of these species are involved in species misidentifications that at times include black marlin or sailfish, which were listed among the species of interest for this project. These patterns of misidentifications, which have greatly inflated the nominal catches of black marlin and sailfish, have occurred despite the fact that they are considered rare (black marlin) or not common (sailfish) in the catch of the Hawaii-based fishery. Because the misidentifications represent a "tangled web," the logbook quality control work for black marlin and sailfish is being conducted along with that for striped marlin and sailfish. Moreover, because these species are rare or not common, the quality control work is being conducted by direct comparisons to auction sales records, rather than by the residuals analyses being used with striped marlin and shortbill spearfish. The considerable upward bias for the black marlin catch is demonstrated by the fact that correction of 0.8% of the longline sets by the Hawaii-based fleet during the study period, all of which were deployed on trips that logged multiple black marlin, resulted in a 34% decrease from the nominal black marlin catch. Similar, though less marked, results are expected with sailfish. The additional logbook data corrections to be based upon residuals analyses with striped marlin and shortbill spearfish are expected to lead to further, substantial reductions in the estimated catches of these species.

Fisheries Oceanography: Marine Mammal Research Program

P.I.: Thomas A. Schroeder [George A. Antonelis]

NOAA Goal(s)

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

Purpose of the Project

The main purpose of the Marine Mammal Research Program (MMRP) is to study the relationship between environmental/oceanographic parameters and demographic trends of the endangered Hawaiian monk seal and cetaceans in the Pacific Islands Region (PIR). Monk seals and cetaceans are apex predators and represent important components of the marine ecosystem. Much is known about monk seal population dynamics, and monitoring programs are in currently place. MMRP has recently begun developing a comprehensive plan to collect 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. JIMAR personnel are integrated in virtually all aspects of MMRP activities and contribute significantly in administrative support, logistic coordination, technical computer oversight, data collection and storage, field research, and report writing.

Juvenile monk seal sleeping on the beach at Pearl and Hermes Reef (image courtesy of Maire Cahoon).

Progress During FY 2005

In FY2004, MMRP planned to conduct ongoing monk seal projects that include population monitoring and assessment, characterization of foraging ecology, and evaluation of health and disease. Also, cetacean studies were planned to begin in collaboration with scientists from the Southwest Fisheries Science Center, National Humpback Whale Sanctuary, and non-government organizations.

In FY2005, ongoing Hawaiian monk seal studies involved documenting monk seal demography, as well as factors influencing population trends. Population trends were variable at the six main reproductive subpopulations in the Northwestern Hawaiian Islands (NWHI), and in recent years overall pup production and juvenile survival decreased at most sites. The largest subpopulation is at French Frigate Shoals, where counts of non-pups dropped by 60% since 1989, and the age distribution became severely inverted due to high juvenile mortality over the last decade.

Future abundance trends will likely depend upon whether predicted losses at French Frigate Shoals are countered by gains at other locations. Further, recent investigations indicate that oceanographic changes have a direct (e.g., loss of optimal parturition habitat) and indirect (e.g., variation in productivity and prey availability) influence on juvenile monk seal survival and thus, contributed to the recent lack of growth in monk seal numbers. Disease does not appear to have influenced recent population declines, while necropsies have revealed that emaciation is the most common cause of death for juveniles.

Two recently weaned pups rest together on the beach at French Frigate Shoals (image courtesy of NMFS-Suzanne Canja).

More than 20 cetacean species are known to occur in the Pacific Islands Region, which encompasses the U.S. Exclusive Economic Zone (i.e., waters out to 200 nmi from shore) around the entire Hawaiian archipelago, Johnston Atoll, Kingman Reef and Palmyra Atoll, Baker and Howland Islands, Jarvis Island, American Samoa, Wake Island, Guam, and the Commonwealth of the Northern Marianas Islands, totaling some 1.7 million sq. nmi of ocean. Many cetacean species present are poorly studied throughout their range, and are virtually unstudied in large portions of the PIR. As an initial step in the pursuit of its cetacean research and assessment mandate, from 22-24 June 2005 the MMRP convened a workshop of experts and stakeholders to review and assess what is known about cetaceans in the PIR, identify important gaps in knowledge, and provide direction for future research. During FY2005, MMRP also facilitated research with a PhD student at the University of Hawaii involving skin sampling of spinner dolphins (*Stenella longirostris*) at French Frigate Shoals in the Northwestern Hawaiian Islands to genetically assess the population structure of spinner dolphins throughout the Hawaiian Archipelago. MMRP collaborated with other PIFSC scientists on the deployment of a high-frequency autonomous acoustic recording package (HARP) on the seafloor at the summit of Cross Seamount to detect and record cetacean vocalizations in the region and to better understand seasonal and diurnal changes in cetacean occurrence in relation to oceanographic and fisheries acoustic data. Finally, MMRP facilitated a novel application of mark-recapture methods to assess the abundance of false killer whales (*Pseudorca crassidens*) in the main Hawaiian Islands and to refine population estimates for this strategic stock (Marine Mammal Protection Act designation).

Fisheries Oceanography—Protected Species—Marine Turtle Research Program

P.I.: Thomas A. Schroeder [George H. Balazs]

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 includes nine discrete elements that consist of: 1) research to reduce or mitigate high-seas and coastal fishery by-catch 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 population trends for stock assessments; 4) simulation modeling of long term datasets to better understand population dynamics; 5) health assessments and disease investigations with focus on sea turtle fibropapilloma tumor disease; 6) conduction of a 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 research results; and 9) experimentation with remote viewing digital imagery for sea turtle monitoring and research.

Progress During FY 2005

As planned in FY2004, JIMAR staff assisted NOAA Fisheries staff in research on fibropapilloma disease. In May 2005, in collaboration with veterinarian Dr. Robert Morris, a small study was initiated to test the next-generation formulation of a tumor-dissolving compound called Dermex. Initial work with this experimental therapy had shown

promise in captive trials conducted by PIFSC in 2002. However, at that time, the manufacturer was unable to resolve certain problems in coarseness of the solution that made it unsuitable to treat many fibropapilloma tumors in stranded turtles in Hawaii. In FY2005, the study is testing the reformulated Dermex compound for effectiveness.

Fibropapilloma is a tumor forming, debilitating and sometimes fatal disease of sea turtles that has emerged in the past 20 years as a potentially serious threat to populations worldwide. Mouth tumors and mouth and eye tumors in combination are highly prevalent in stranded turtles, and their frequency has increased since 1990.

On May 4, 2005, JIMAR staff assisted NOAA Fisheries staff in successfully releasing forty 2-year old juvenile loggerhead turtles with small satellite-linked tags attached in pelagic waters near the International Dateline at 32°N, 176°E. This project continues program research goals articulated in FY2004, i.e., to study the pelagic ecology and movements of sea turtles to develop management strategies to reduce fisheries bycatch. This important first-of-its kind event took place from the Aichi Maru, the training ship of the Miya Fisheries High School located in Gamagori, Japan. Caretaker specialist Mr. Hitoshi Nakamura of the Port of Nagoya Public Aquarium accompanied the turtles. JIMAR staff prepared the initial satellite tracking maps for these turtles in early June and will continue to update the maps as new data are received.

Also in pursuit of FY2004 goals, a total of 22 scientists from the Hawaiian Islands, California, American Samoa, Palau, the Federated States of Micronesia, Guam, the Commonwealth of the Northern Mariana Islands, Taiwan and Japan participated in sea turtle collaboration research and training conducted by the PIFSC Marine Turtle Research Program (including JIMAR staff) between July 2004 and June 2005.

Fisheries Oceanography: Research Aimed to Reduce Sea Turtle-Longline Interactions

P.I.: Thomas A. Schroeder [Yonat Swimmer]

NOAA Goal(s)

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

Leatherback sea turtle brought on board a Brazilian fishing vessel during experiment to identify means to reduce the incidence of sea turtle entanglement in longline fishing gear.

Purpose of the Project

A collaborative investigation is currently underway to characterize vision, hearing, and chemoreception in sea turtles so that a comprehensive assessment of potential sensory attractants and repellents may be made. The ultimate goal is to develop modified longline gear or bait that will be effective for catching fish but either undetectable or repellent to sea turtles. Use of such bait could potentially decrease the rate of sea turtle injury and mortality due to fisheries interactions. Research has focused specifically on the chemosensory capabilities and use of olfaction and vision in detecting food sources.

Progress During FY 2005

Goals articulated in FY2004 and associated progress made in FY2005 are discussed below.

1) In fall 2004, at the NOAA Sea Turtle Facility in Galveston, TX, conduct behavioral experiments with chemicals that are likely to either mask odors (e.g., 2-phenylethanol) or serve as repellents (e.g., tiger shark homogenates). This work was conducted primarily by JIMAR researcher Dr. Amanda Southwood during September to October 2004. Tiger shark mucus (collected from tiger sharks captured off Oahu) and other repellents were tested at the stated facility and the work provided valuable insight into sea turtles' use of olfaction in attracting

them to fishing gear. The resulting publication is currently under review as part of a NOAA Tech Memo.

2) Conduct research on captive sea turtles in Brazil to determine potentially repellent odors. This work was done collaboratively with researchers from Brazil's Projeto TAMAR. Lianne McNaughton, a JIMAR research associate, assisted in this project. In addition, a collaboration with investigators from Aquatic Adventures (San Diego and Mexico) implemented captive turtle behavioral experiments to test turtles' responses to light sticks of different colors and different types of baits.

Loggerhead sea turtle maintained at the NOAA Sea Turtle Facility in Galveston, TX. This juvenile was used in experiments to determine turtles' chemosensory capabilities and their reliance upon vision and olfaction in attracting them to fishing gear.

3) Continue collaborative research with Costa Rican, Brazilian, and Ecuadorian scientists to conduct field trials to determine the efficacy of a proposed mitigation measures (e.g. large circle hooks); collect blood samples from incidentally-caught turtles in order to analyze biochemical parameters associated with stress. In collaboration with PRETOMA, trials were successfully conducted to determine the effects of a 10 deg offset in fishing hooks on turtle capture rates in longline fishing off the coast of Costa Rica. Michael Musyl, a JIMAR employee, assisted in this research by going out on a longline fishing trip during January 2005. In Brazil and Ecuador, our colleagues in country as well as colleagues with the IATTC have taken the lead in conducting research to determine the impact of larger circle hooks on rates of capture and probability of survival of sea turtles interacting with fishing gear. Regarding the work to determine biochemical parameters associated with stress of capture, JIMAR researcher Dr. Amanda Southwood took the lead in writing letters to management agencies in the U.S., Brazil, Costa Rica and Ecuador to acquire permission to collect blood samples for this purpose. Amanda also requested permits through CITES for this work. However, due to a variety of permitting complexities, this work was not completed during this past year; it is anticipated that this work will occur during the upcoming year.

4) Host a meeting on the sensory physiology of marine turtles, specifically in relation to their attraction to longline fishing gear. A PI meeting and special session for the Sensory Physiology Working Group was hosted at the Sea Turtle Symposium in Savannah Georgia in Jan. 2005. In addition, a PI meeting was hosted for the newly-established sensory and mechanical working group in North Carolina in Spring 2005. For the latter meeting, Dr. Amanda Southwood was instrumental or organizing the logistics involved in coordinated a group of scientists to exchange ideas at a remote site.

Fisheries Oceanography—Swordfish Research

P.I.: Thomas A. Schroeder [Karen Sender]

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 support the population assessment of North Pacific swordfish and other highly migratory species. Specifically, database development (InPort and LODS) will be used to inventory and document fisheries-dependent data holdings and to provide PIFSC scientists and fisheries managers the information required to understand our fisheries data. This project also supports fulfillment of U.S. obligations for the Interim-Scientific Committee for Research on Tuna and Tuna-like Species in the North Pacific

Progress During FY 2005

During FY2005, JIMAR funds were used to purchase contractor support for programming and database development. Progress on goals, as articulated in the FY2004 JIMAR annual report, was made as follows:

- Continued implementation of the InPort metadata catalog and migration to HQ—JIMAR contractors developed the InPort system and it is in final acceptance testing. This initial version of InPort is scheduled to migrate to NMFS ST6 (HQ) before the end of calendar year 2005; however, that date is dependent on resources to be made available at ST6.
- Continued development of Data Management tools and techniques—JIMAR contractors developed a database naming standard, which was submitted to the national Fisheries Information System at NMFS HQ. Contractors also designed an internet-based tool for online data access and a procedure for implementing database history tracking, which is in review. These tools will be used to make improvements to existing information systems both at PIFSC and at other fisheries offices.
- JIMAR contractors assisted in designing the Economic Data Management Module and building the back-end database structure. However, the user interface for data entry will need to be completed in the next funding year. The full integration of the Economics Data Management Module with the existing Longline Observer Data System (LODS) will facilitate data entry, data validation, and integration with related fisheries and vessel information required to support socio-economic science at PIFSC. Other enhancements to LODS were made to accommodate the re-opening of the Pacific swordfish fishery.

Fishery Dynamics in the Samoan Archipelago

P.I.: Keith Bigelow (NMFS, PIFSC), Adam Langley (SPC), John Hampton (SPC), and John Sibert (UH, JIMAR, PFRP)

NOAA Goal(s)

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

Purpose of the Project

The immediate goal of the proposed research will be to quantify the spatial and temporal dynamics of longline fisheries in the Samoan archipelago. Local scale fishery impacts of catch levels on CPUE will be investigated within the A. Samoa and Samoa longline fisheries targeting albacore and compared to other albacore longline fisheries in the south Pacific. Detection of local fishery impacts on CPUE is a primary objective of the WPRFMC and other Pacific Island Management authorities and will assist in developing policy within these expanding island-based fisheries. The project will also seek to improve the regional south Pacific albacore stock assessment.

Progress During FY 2005

This project was funded in November 2004 with a scheduled two-year duration. A recruitment notice for a JIMAR fisheries research analyst was advertised in February and a shortlist was developed in April 2005. The spatial stratification of the MULTIFAN-CL south Pacific albacore assessment has been revised to investigate the impact of different structural assumptions of the model, including the assumptions regarding seasonal movement. The assessment now includes a separate fishery for the Samoan archipelago, thereby, enabling local scale trends in biomass to be examined relative to fisheries in adjacent areas.

Human Dimensions Analysis of Hawaii's Ika-Shibi Fishery

P.I.: Edward W. Glazier

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

Progress During FY 2005

This project was recently funded, and the University of Hawaii Committee on Human Subjects Research more recently granted project approval. For these reasons, only limited progress can be reported at this juncture.

We have thus far conducted a series of 15 preliminary interviews with Big Island residents who are knowledgeable of the ika-shibi fishery and environmental and economic factors associated with ahi fishing strategies along the

coast of the Big Island. Information gathered during these interviews will assist in development of research protocols to be used later in the project. The initial informants were also asked to identify other Big Island residents who are or have been avidly involved in the Big Island ika-shibi fishery. We have thus initiated our social network sampling methodology and preliminary substantive research, as described in the project proposal.

In keeping the scheduled activities noted in that proposal, we have also conducted extensive preliminary archival research for the project. On Oahu, this included identification of relevant secondary source materials and interviews with staff at the Japanese Cultural Center, University of Hawaii at Manoa libraries, and the Bishop Museum. Similar research was conducted at the University of Hawaii at Hilo.

Incorporating Oceanographic Data in Stock Assessments of Blue Sharks and Other Species Incidentally Caught in the Hawaii-Based Longline Fishery

P.I.: Pierre Kleiber and Hideki Nakano

NOAA Goal(s)

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

Purpose of the Project

Improve habitat-based standardization of longline effort by accounting for the affects of current shear and other oceanographic features on the depth distribution of longline hooks and the degree to which that distribution overlaps the depth distribution of particular fish species.

Progress During FY 2005

During FY 2005 a longline shoaling manuscript was submitted to *Fisheries Research* and is now in the hands of reviewers. Since then the project has shifted its sights to other possible oceanographic effects on longline than shoaling caused by current shear and is testing alternative methods of longline effort standardization in support of a renewed North Pacific blue shark assessment. The statistical habitat based effort standardization similar that employed regional and pacific wide bigeye and yellowfin stock assessments is being tested for blue sharks, and an alternate approach based on proximity to oceanographic fronts is also being tested.

In early FY05 the computer specialist supported by this project moved on to other pastures. The salary funds thus made available are being applied to further development of MULTIFAN-CL by way of a contract with Otter Research. Ltd., the designers of MULTIFAN-CL, which is the principal stock assessment model that is making use of standardized catch and effort data produced by this project. This project is thus joining forces with another PFRP project, *Addition of multi-species capability, sex structure and other enhancements to the length-based, age structured modeling software MULTIFAN-CL.* Incorporating sex specificity is an important enhancement to the model for fishes with sexually dimorphic growth and behavior such as blue sharks, marlins, and swordfish that are either targeted or incidentally caught by longliners.

Instrumental Buoys as Autonomous Observatories of Pelagic Ecosystems

P.I.: Kim Holland, Laurent Dagorn, David Itano

NOAA Goal(s)

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

Purpose of the Project

This report covers work accomplished in these two interrelated projects that are designed to explore the dynamics of aggregations of tuna when they associate with various man-made structures and to elucidate the underlying biology that results in these types of aggregation/association phenomena.

Progress During FY 2005

Significant advances were made in all facets of the program.

- Captive tuna facilities at Coconut Island have continued to produce important data concerning target strengths of both yellowfin tuna and mackerel scad. In the most recent round of experiments using a Simrad EK 60 unit (November 2004), the orientation of the individually insonnicated animals was confirmed by using an underwater camera focused on the target area. This allowed exact quantification of the angle of the incidence of the sonar beam on the target animal. These data are currently being analyzed. The acquisition of sonic data for mackerel scad is an important addition because this species is often found in large numbers around coastal FADs. Passive acoustic signatures were also acquired for yellowfin tuna and mackerel scad and these data are also being analyzed. Captive tuna are currently being raised to achieve sizes suitable for testing new types of electronic tags as part of the "ecology tags" component of this program (see below).
- Development of new types of electronic tags ("ecology tags"). Progress was made in investigation of three types of tag. A "bioacoustic probe" acquired on loan from Dr. William Burgess (Greenfield Technologies, Santa Barbara, CA) was successfully deployed through intraperitoneal implantation in a black tip reef shark. The subsequent retrieval of the tag revealed successful recording of many different types of pertinent acoustic signatures including those associated with feeding, the vocalizations of puffer fishes near the shark and the sound of motorized vessels operating in the vicinity of the shark lagoon. These data indicate that this approach holds promise for further development and arrangements have been made with Dr. Burgess to continue this testing. Stomach motility tags have been successfully tested with captive blacktip reef sharks with deployment periods ranging from a few days to two weeks. The resultant data show remarkably little stomach motility but there is evidence of diet changes in activity. The probe has been slightly redesigned and testing will continue. Progress is also being achieved in developing a stomach pH transmitter although there have been problems with the power supply for these units. They are currently under repair by the German manufacturer.
- Isotope/trophic status experiments. Experiments with captive yellowfin fed controlled diets of known isotopic composition were completed during this reporting period and the data are currently being analyzed and two papers are being prepared for publication. These data have been presented at several different symposia.
- Design of a "Smart FAD." All appropriate administrative tasks have been completed to formalize the interaction between University of Hawaii and Dr. Jules Jaffe (SIO) concerning the design and deployment of a prototype "Smart FAD" equipped with a 360-degree scanning sonar. The prototype has been designed and is currently under construction under Dr. Jaffe's supervision in La Jolla. Testing will occur in Spring/Summer 2005

Integrated Modeling for Hawaiian Albatross Populations

P.I.: Dan Goodman (Montana State University) and Jean-Dominique Lebreton (Centre d'Ecologie Fonctionnelle et Evolutive)

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 analyze available information concerning Black-footed (*Phoebastria nigripes*) and Laysan (*Phoebastria immutabilis*) albatross (BFAL and LAAL for the sake of brevity in what follows). These analyses aim at assessing the status of their populations in relation with the potential impact of longline fisheries. While BFAL population size is about one tenth of LAAL's, the ratio of by-catch by longline fishing is higher. This suggests a high impact of longline fishing on BFAL, with potential biologically significant consequences. Due to the uncertainty on population size (roughly 300 000 individuals), and the level of by-catch in the 90s (between 5 000 to 12 000 individuals), up to now the impact of by-catch on population dynamics and sustainability in BFAL remains unknown, although such a level is considered on general grounds as high enough to be detrimental. Furthermore, little is known about the demography and biology of both BFAL and LAAL, for example for what concerns age and rate of recruitment, adult and juvenile survival, rate of pair reformation after widowhood.

The project is divided in three main steps:

- Estimation of demographic parameters by capture-recapture analysis of existing data and analysis of census data
- Integration of these pieces of information in a matrix model, integrating as much biological specificities as possible, such as intermittent breeding, widowhood and time to repair…
- Last, development of integrated models, using in particular the Kalman filter and Bayesian approaches, to combine likelihoods for the various pieces of information available.

Progress During FY 2005

Compilation of Data

A large part of the year was used to finalize the compilation of information required for the analysis. This included updating capture-recapture data of BFAL and LAAL, getting data on fishing effort and on recoveries of ringed animals caught by Hawaiian fleet. We also met people from the Pacific Fish and Wildlife Service involved in albatrosses project, in order to obtain more details on study design and sampling methods.

Analyses of Capture Recapture

We started the analysis of capture-recapture data for adults BFA using models with heterogeneity in capture probability developed in our laboratory. Without the use of these models, the survival estimates are underestimated. As a first approach, we performed the analysis using a model where survival was constant over time. We confirmed the existence of heterogeneity in recapture probability (survival estimated at 0.903 in a classical model versus 0.92 when taking into account heterogeneity). All analyses were performed using software U-CARE and M-SURGE.

Estimation of By-Catch

A major source of uncertainty comes from the estimation of by-catch rate. Up to now, estimation of by-catch was direct, relying on counting the number of animals caught on boats with observers, extrapolating to American fleet and to other fleet. An important source of variance in the estimation of by-catch comes from the extrapolation to a large scale. We plan to estimate the by-catch rate using another method relying on the combination of capture-recapture and recoveries data. This estimate will be used for validating the former estimation method for obtaining more accurate estimates. It thus could be used in the future as a useful and powerful tool for the management of by-catch rate. In practice, we built a multi-state capture-recapture model that includes recoveries of caught birds by boats with NOAA observers.

Integrated Modeling

We collaborated with Mark Maunder and Simon Hoyle of the IATTC, involved in a PFRP project of "general Bayesian integrated population dynamics model for protected species". We established a common capture-recapture model and matrix model that we plan to use as a common framework for integrated modeling.

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

P.I. John Sibert

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.

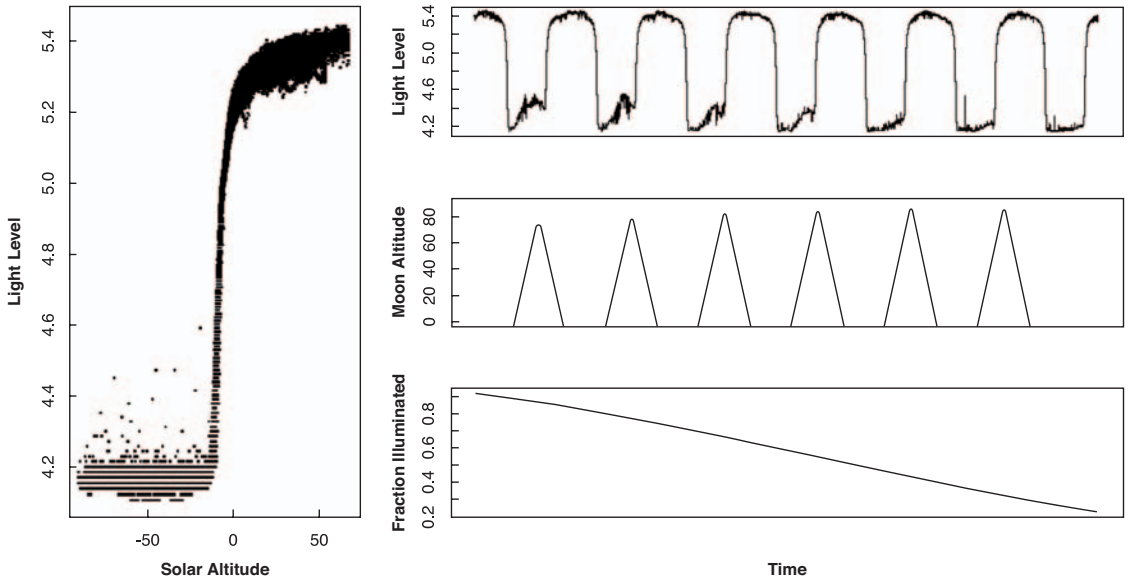
Progress During FY 2005

Progress on Goals from FY 2004

- Augment the analysis of Coral Sea bigeye tracking data by comparison with sea-surface temperature.

  An ad hoc polynomial latitude bias correction was included in the state-space Kalman filter mode. The estimated track agreed well with latitude estimation using SST data. The results were included in the report by Gunn et al. published by the Australian government.

- Analyze currently used light-based geolocation algorithms to identify and correct the source of the autocorrelated latitude bias.



Relationship between calculated solar altitude and light intensity (left panel) and representative 7-day period from the raw light record from a tag (top right). The reflected light from the moon is detectable by the tags. Data from tags deployed on a mooring in the Pacific Ocean at 24°N latitude.

The astronomical computations used for latitude estimation by measurement of the position of the sun were examined. The latitude bias found in the light-base algorithms used in most archival tags appear to be due to misspecification of the elevation of the sun at arbitrary light thresholds. The conclusion is that light-based geolocation algorithms need revision.

Dr. Anders Nielsen has joined the project as a post-doctoral fellow to begin development of a joint model for geolocation and track reconstruction. This work will construct a statistical sound approach to geolocation and reconstruction of tracks from tagged individuals. It will include the formulation and implementation of a joint model for the geolocation from light measurements and prediction of the most probable track from these measurements.

The initial work re-analyzes the source of the geolocation, raw light measurements from the tags, and describes these measurements as functions of the position on the globe and time. For this purpose archived mooring studies have proven very valuable. Early findings (refer to figure above) indicates that it is possible to estimate a strong relationship between the calculated solar altitude and the light intensity, and also that reflected light from the moon is detectable by the tags (at least when they are shallow).

This work involves close collaboration with other researchers in the PFRP, PIFSC and elsewhere to keep the focus of the developed methods on real practical problems.

- Refine the inclusion of temperature in the Kalman filter model.

  This work has been completed and a manuscript has been submitted to Fisheries Oceanography and accepted for publication after revisions. Nielsen, A., K. Bigelow, M. Musyl and J. Sibert. 2005. Improving light-based geolocation by including sea surface temperature.

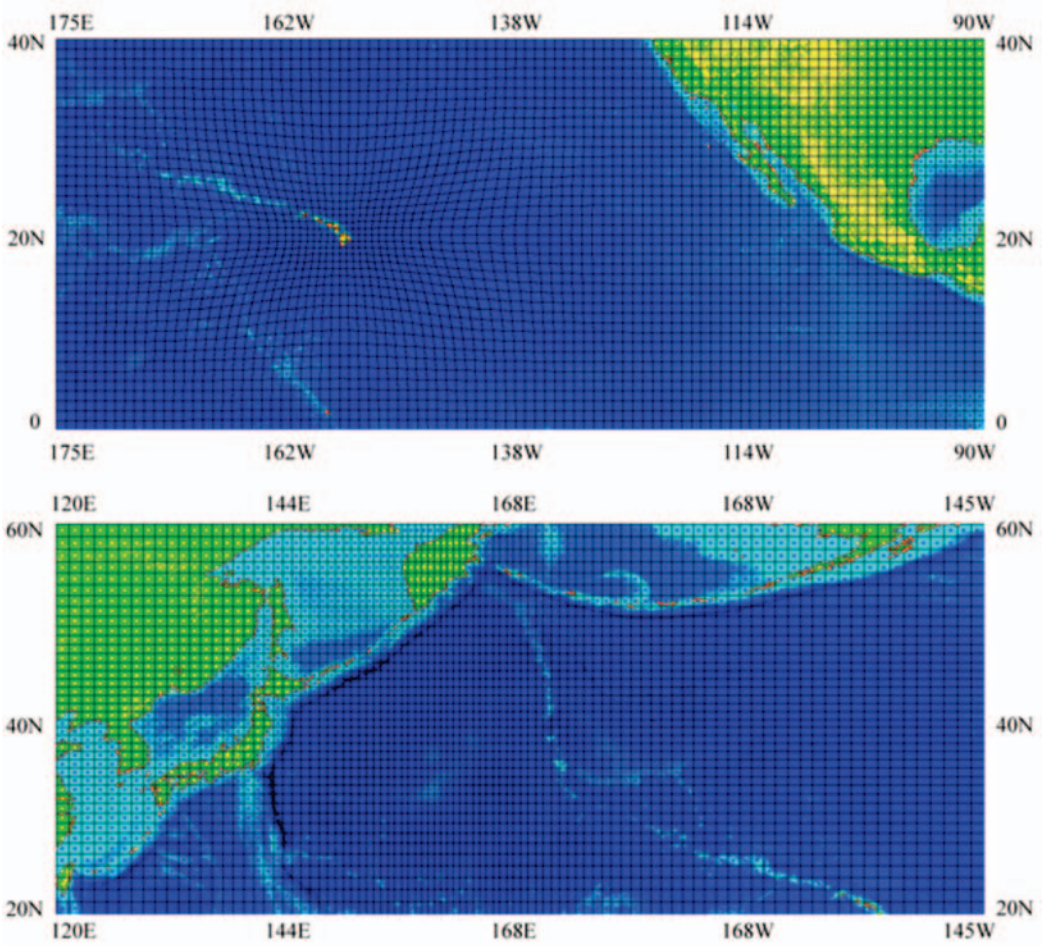
- Complete re-analysis of HTTP data using the ADRM.

  This work was not completed because these data have already been thoroughly analyzed by other methods.

Progress in Other Areas

- Creation of electronic tagging data repository.

  Collaborators from within the PFRP, CSIRO Division of Marine Research, and Secretariat of the Pacific Community Oceanic Fisheries Programme requested that the PFRP act as an “honest broker” for the exchange of data from electronic tags. Considerable effort was expended to determine an appropriate format for inclusion of metadata. A preliminary web site has been established using the metadata tools provided by the Knowledge Network for Biocomplexity project. Several problems were encountered with the software provided by the



Examples of mixed-resolution grid and generated mask (yellow dots—land, blue—ocean). On the upper graph two-dimensional transform of coordinates around Hawaiian islands is shown, below is the twice finer grid in the Kuroshio region, stretched along each direction separately.

KNB complicate creation of well-documented data objects. The "beta" version of the repository can be seen at http://shibi.soest.hawaii.edu:8080/knb.

- Comparison of MULTIFAN-CL with other sock assessment methods.

  The results of the Secretariat of the Pacific Community, Oceanic Fishery Programme, simulation exercise to evaluate stock assessment models are reanalyzed. Standardized bias is used to evaluate the discrepancy between simulation and estimation and to provide a quantitative expression of estimation skill. Seven assessment models were applied to forty realizations of five fishery scenarios of increasing complexity. Production models performed well because of the exclusion of uninformative data in complex scenarios. MULTIFANCL performed well when data were informative and natural mortality correctly specified. Simulation exercises of this complexity do not definitively address the question of assessment model reliability. The results were presented at the Seventeenth Meeting Of The Standing Committee On Tuna And Billfish, Majuro, Republic of Marshall Islands, August 9-18, 2004. SCTB17/MWG-4.

- Collaboration on the "Mixed-resolution models for investigating individual to population spatial dynamics of large pelagics" project.

  The progress on implementing a variable resolution finite difference grid is reported in the report from the mixed resolution model project. Dr. Senina is currently implementing adjoint methods to carry out maximum likelihood parameter optimization in the SEAPODYM model.

Investigation of Aggregation Behavior of FAD-Associated Small Yellowfin Tuna and Size-Dependant Vertical Stratification

P.I.: Kim Holland

NOAA Goal(s)

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

Purpose of the Project

The objectives of this project are two-fold but complimentary – first, to tag small (< 40cm) yellowfin to compare their FAD-associated aggregation behavior with that of larger fish tagged in previous experiments and second, to determine if yellowfin tuna of different sizes segregate vertically when they co-occur in aggregations of mixed size classes.

Progress During FY 2005

This project got off to a fast start due to a range of size classes of tunas becoming associated with various FADS around Oahu and our ability to capture these fish and apply the appropriate tags.

To date, 42 yellowfin tuna and one bigeye tuna of less than 40cm FL (32 - 40 cm, SD 2.54) have been tagged and released at FADs. Of these, 32 were tagged with pressure sensitive transmitters. In concert with these 32 releases, an additional 17 medium-sized (63-83 cm FL, SD 4.76) yellowfin were tagged with pressure sensitive tags and released at the same FADs. Thus, we have achieved the goal of telemetering a range of sizes of yellowfin tuna while they are simultaneously associated with a FAD. There have been four recaptures of the larger size class yellowfin. One sonic tag was recovered (V9P) and re-deployed in another yellowfin.

Initial results indicate that even the smallest sizes that were tagged survive the operation successfully and are subsequently detected for many days at their points of release. Also, there does indeed appear to be a difference in the range of depths utilized by different size classes – the smallest specimens show shallower depth distributions and a smaller range of vertical movements than larger specimens coexisting at the same FADs at the same time.

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

P.I.: Thomas A. Schroeder [Minling Pan]

NOAA Goal(s)

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

Purpose of the Project

The goal of this project is to provide an estimate of the value of commercial and recreational fisheries, updating and augmenting work initially completed under the Pelagic Fisheries Research Program. The project also investigates approaches to providing estimates of the economic value of protected species

Talking to fishermen about fishing technological changes and impact on capacity ([top] image courtesy of Adam Griemester; [bottom] Quang Nguyen).

conservation. These estimates would be used by the Western Pacific Regional Fishery Management Council in the development of Fisheries Management Plans (FMPs) to 1) estimate fishing effort associated with important target species in the commercial, charter, sports, semi-commercial (termed "expense fishing" in Hawaii), and recreational fishing sectors; and 2) estimate the cost-effectiveness and benefits of protected species conservation.

Progress During FY 2005

The specific objectives of this program in FY 2005 included:

1) Investigate technological changes and their impact on fishing capacity in the Hawaii-based longline fishery;
2) Study the costs of transshipping tuna and swordfish to the US Mainland and foreign countries;
3) Develop a continuous data collection system for Hawaii's main commercial fisheries.

Progress toward these objectives included:

1) Conducted an inventory of all of the changes in fishing technology in the Hawaii longline fishery during the past 20 years. Developed a questionnaire to survey vessel owners and operators regarding current uses of technology and historical technological changes. The survey fieldwork (i.e., interviewing of vessel owners and captains) has begun and approximately 30 vessels (owners and captains) have been interviewed.
2) Through JIMAR, hired a full-time employee in June 2005 to assist in the project. This project assistant's current research efforts are to complete the survey of industry representatives and to develop an approach to estimate the costs of exporting and transshipping tuna and swordfish from Hawaii to other areas.
3) In a joint effort with the PIRO observer program, successfully established a continuous economic data collection program through the observer program for the Hawaii longline fishery and NWHI bottomfish fishery. This "economic add-on" program was received positively by fishermen, especially the Hawaii longline fishermen. The data collection program promises to be both an efficient and cost-effective means to obtain high quality information on the costs associated with fishing. Between the project's inception in August 2004 through April 2005, information was collected for approximately 170 trips.

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

P.I.: Thomas A. Schroeder [Gerard DiNardo]

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 (spiny and slipper lobster stocks in the Northwestern Hawaiian Islands (NWHI)), and (3) the impact of fishing on these stocks. During a technical review of the NWHI lobster assessment procedures, it was recommended that collaborative research programs between industry, the National Marine Fisheries Service, Pacific Islands Fisheries Science Center (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.

Progress During FY 2005

The JIMAR FY2004 annual report outlined five goals for FY2005, including: 1) continuation of spiny lobster tagging experiments at Necker Island and slipper lobster tagging experiments at Maro Reef, 2) conduct the NWHI lobster resource survey in June 2005, 3) if feasible, expand the spatial scope of the NWHI lobster resource survey and tagging experiments to archipelago wide, 4) plan and participate in the Third Scientific Symposium on Resource Investigations in the NWHI scheduled for November 2004 at the Hawaii Convention Center, and 5) conduct a NWHI lobster stock assessment and continue population model development.

Of the goals articulated, the following were accomplished: 1) Lobster tagging. Two commercial fishing vessels were contracted (chartered) from September 2 to October 1, 2004 to conduct lobster-tagging experiments at

Necker Island and Maro Reef, and JIMAR staff provided oversight on all scientific elements of the experiments. The charters were a success; approximately 7,000 spiny lobsters at Necker Island and 5,000 slipper lobsters at Maro Reef were tagged and released. The same two vessels were contracted from July 16 to August 14, 2005 to continue the lobster tagging project. Current tagging data was analyzed to estimate spiny lobster growth and movement patterns, and these estimates compared to historical growth patterns. 2) NWHI lobster resource surveys. The 2005 NWHI lobster resource survey was conducted from June 6 to July 5, 2005 aboard the NOAA *R/V Oscar Elton Sette*. During the cruise both PIFSC and JIMAR scientists conducted a suite of experiments and data collection activities. Data from the survey are being edited and keypunched. In addition, bycatch associated with the NWHI annual lobster resource survey was analyzed to determine the utility of using these data to assess fishing impacts to the NWHI ecosystem. 3) Archipelago-wide lobster resource survey. Expanding the scope of the tagging experiments to archipelago wide, an FY2004 goal, did not occur in FY2005 because of insufficient funding. 4) Scientific Symposium. Three presentations were made at the Third NWHI Scientific Symposium in November 2004. In addition, JIMAR staff presented numerous presentations on the status of lobster research to the Western Pacific Regional Fisheries Management Council (WPRFMC) and at various international and national scientific conferences and symposia. 5) Stock assessment and population models. Significant progress on population model development and bycatch synthesis by JIMAR staff occurred in FY 2005. A spatially-explicit population model for spiny lobster that incorporates all available fishery-dependent and fishery-independent data was developed using MULTIFAN-CL. This is the first spatially structured population model for NWHI lobster populations, and represents a significant advancement in our understanding of local and regional dynamics. A second model is being developed in collaboration with scientists from the University of British Columbia, and both models will be reviewed at a lobster modeling workshop in September 2005. This workshop was originally scheduled for April 2005, but because of scheduling conflicts with participants, had to be rescheduled to September (FY2006). In addition, Dr. Shelley Clarke was contracted through JIMAR in January 2005 to conduct North Pacific blue shark and striped marlin assessments. Dr. Clarke is stationed at the National Research Institute of Far Seas Fisheries (NRIFSF) in Shimizu, Japan and will complete the blue shark assessment in August 2005. The striped marlin assessment is scheduled to be completed by March 2006.

Marine Resource Dynamics and Assessment Program (MARDAP): Pelagic Fisheries EFH Research Program

P.I.: Thomas A. Schroeder [Michael Parke]

NOAA Goal(s)

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

Purpose of the Project

Define essential fish habitats for Pelagic Management Unit Species for the Western Pacific Pelagic Fisheries Management Plan using spatially linked historical satellite data from the Coastwatch archives and historical longline logbook records for the longline fishery collected over the past 10 years. Utilize GIS to analyze and map the spatial patterns of pelagic fishery CPUE and environmental conditions using spatial overlays. Store the new data created by this analysis as part of the longline logbook data archive in the HL Oracle database. This analysis can easily be extended to include endangered species interactions.

Progress During FY 2005

Downloaded from Oracle software, consolidated, and organized all raw data required for the project on portable disk drive, to facilitate use by temporary programmer.

Marine Resource Dynamics Assessment Program Cooperative Research

P.I.: Thomas A. Schroeder [Christofer H. Boggs]

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.

Progress During FY 2005

Funds were used in FY 2005 to bring collaborator Steve Beverly to Hawaii to participate in a meeting on technical assistance for research on bycatch reduction in longline gear, and to send JIMAR-funded staff (M. Musyl) to a meeting on the development of shipboard computing systems for fisheries research. These activities supported the goal of testing new deep-set gear configurations on commercial fishing vessels and recording at sea reduction in incidences of epipelagic bycatch. At the workshop, Beverly presented his Birdlife International Award-winning gear design, which will be tested in Hawaii in the coming months. And Mike Musyl's analysis of the depth distribution of pelagic fishes and turtles from PSTAT tag data completed this year illustrates how Steve Beverly's gear design would reduce epipelagic species while increasing target catch rates for bigeye tuna.

Marine Resource Dynamics Assessment Program Research Support

P.I.: Thomas A. Schroeder [Susan Kamei]

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 continue to provide research support for fishery data monitoring and research operations as part of the ongoing research under the Marine Resource Dynamics Assessment Program (MARDAP).

Progress During FY 2005

Project funds supported ongoing research operations conducted at the Pacific Islands Fisheries Science Center on the University of Hawaii campus and at the Kewalo Research Facility. Funding was provided to fill needs in two major areas: Research Operations and Fishery Monitoring. The following is a summary of progress in each area:

Research Operations
Facilities Maintenance: In FY2004, funding was provided to support salary and related costs for a maintenance assistant. During FY2005, the maintenance assistant provided considerable logistical support of major facilities projects as identified as an objective in FY2004. These projects included roof replacement, bathroom renovations, and repaving of the parking lot. The maintenance assistant played a key role in working with contractors, coordinating movement of supplies to storage, and coordinating disposal of items including bulky items and hazardous materials.

Administrative Support: As planned in FY2004, funding was provided to support salary and related costs for an administrative secretary to support research staff in the areas of Fishery Monitoring and Socio-Economic research. This new position was filled as of May 2004. The addition of this position provided support to researchers in the areas of travel, procurement, and budget, as well as general clerical support to relieve scientific staff of these duties so more time could be spent on direct research and professional development.

IT Support: As identified in FY2004, in FY2005 additional resources were directed to website development. Funding was provided to support salary and related cost for a webmaster. This position was filled as of October 2004. Specific accomplishments include design and implementation of a new website, website maintenance, and ongoing research on best practices for use in periodic website upgrades. In addition, a number of projects are in progress including the implementation of an IT support service request tracking system, the implementation of an editorial publication management system, the upgrade of library web applications, and the implementation of an employee tracking system.

Fishery Monitoring

Funding was provided to support salary and related costs for a Fisheries Specialist. Progress in FY2004 included daily dock rounds, collection of federally mandatory logbooks, preliminary dockside checks of the logs followed by detailed checks, vessel monitoring, and maintenance of the current vessel inventory. Logbooks were collected from 1,391 trips last year, corresponding to approximately 16,000 longline sets. Although logbook compliance was generally very good, the Fishery Specialist did have to inform the proper authorities (i.e., NMFS Enforcement) on a small number of occasions (ca. 10) regarding questionable reporting. The vessel inventory is current.

In FY2005, the Fisheries Specialist began verifying dates and logbook page numbers on all observed trips. The specialist provided data requested by the debriefers in the NMFS Observer Program because of incomplete or questionable observer reports. As planned for FY2004, in FY2005 the specialist also worked closely with the Pacific Islands Regional Office whose mandate is to track and verify the longline shallow set certificates. He collected and reported the shallow set certificate usage on a trip-by-trip basis. The used certificates are then archived with the corresponding logbook pages. This data is fast tracked into Longline logbook system for timely use by management. The establishment of a procedure in FY2004 for reconciliation of the trip data between agencies on a daily basis has been working well.

The Science Center in conjunction with the Western Pacific Regional Fishery Management Council continues to pursue the formalization of an electronic longline logbook to provide a more accurate alternative to paper logs. In FY2005, a number of issues arose which unfortunately temporarily delayed the formalization of the official acceptance of electronic logbooks in Hawaii and American Samoa. The Pilot Program remains in place.

As the liaison with longline fishermen, the Fishery Specialist has maintained a close working relationship with the longliners. Discussions with the fishers address topics such as catch rates and composition; fish prices; and expenses, including ice, certificates, and especially fuel, the cost of which has risen considerably. The specialist also provides copies of reports, regulations, current information regarding protected species, and sea surface temperature maps to the captains; the latter, in particular, seem to be greatly appreciated. On some occasions, the specialist has been able to collect specimens (small swordfish) and tags from longliners, as well as some bottom fish from bottom fish boats for use by research staff.

Marine Resource Dynamics Assessment Program: Sociocultural Profile of Pacific Island Fishing Communities

P.I.: Thomas A. Schroeder [Stewart Allen]

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 part of the ongoing research under the Marine Resource Dynamics Assessment Program (MARDAP). The purpose of this project is to develop a social and cultural data base of fishing ports and associated communities in Hawaii, Guam, Commonwealth of the Northern Marianas, and American Samoa. The goal of this effort 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.

Progress During FY 2005

Objective 1. Develop a data base structure that is consistent with existing port profiles being used in other parts of the country, while adding elements relevant to the Western Pacific. In FY2005, a database structure consisting of 35 variables and 15 cases (different units of analysis for Western Pacific fishing communities) was developed. Many of the variables consist of trend data, such as changes in population size by decade.

Objective 2. Collect and add to the data base variables available from existing sources. In FY2005, a wide range of existing data sources was used to populate the database, including the U.S. Census, State of Hawaii/

territory/commonwealth government agency data, the Hawaii Marine Recreational Fishing Survey, and Hawaii Department of Aquatic Resources commercial marine license reporting and registration forms.

Objective 3. Develop a protocol for collecting port information not already available and begin collecting the highest priority information. The project's technical report describing the data base and major findings, which will be available in draft during October 2005, identifies gaps in the data and methods of addressing those gaps. One information need—patterns of fishing dependency at smaller scales—has already been identified. Work on Guam to address this data gap is proceeding under a pending contract from NOAA to a consultant. Another identified need is for GIS analyses to enable linking of fishermen's residences to fishing ports. To address this need, an FTE GIS specialist is coming temporarily to the PIFSC via rotational assignment.

Mixed-Resolution Models for Investigating Individual to Population Spatial Dynamics of Large Pelagics

P.I.: Patrick Lehodey

NOAA Goal(s)

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

Purpose of the Project

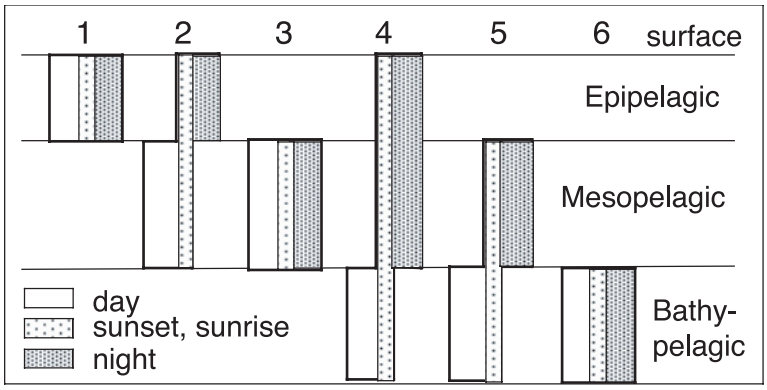
This project addresses ways to improve upon two classes of models: Individual Based Models (IBMs) and Advection Diffusion Reaction Models (ADRMs) that would help to model from ocean basin to individual scale. Both these types of models have been successfully applied to predicting tuna behaviors; IBMs at the very fine scale and ADRMs at the population level. The two classes of models can provide complimentary approaches to investigating the problems of scale integration when going from individual to the population level and from individual movements to advection-diffusion patterns. However, the approach needs a unifying framework combining large and small spatio-temporal scales i.e., the mixed resolutions in a same model domain. Mixed resolution models use a stretched grid system with greater resolution at one of multiple locations of the model domain. Therefore, the project proposes mathematical and programming developments in movement and spatial population dynamics models including a post-doctoral grant devoted to the development of an individual-based model (IBM). Though not included in the budget, a second post-doctoral study is closely associated to this project, as it will develop technics of local stretching for a grid generator that will be embedded into the coupled physical-biogeochemical model (ESSIC, University of Maryland) and the spatial ecosystem model (SEAPODYM, SPC) that will be used for predicting the oceanic environment of tuna and the large scale dynamics of their populations. The ESSIC model (co-P.I. R. Murtugudde, University of Maryland) will provide fields of predicted data (currents, temperature, primary production and zooplankton biomass) with several areas of focus at higher resolution. These predicted data will serve as input in SEAPODYM that will provide predicted distributions of tuna forage (~micronekton) and tuna (skipjack, albacore, yellowfin, bigeye) biomass. The IBM will use the oceanic environment predicted by both ESSIC and SEAPODYM models. Behavior of tuna or other large pelagics predicted with the IBM will be compared to observed movements of individuals marked with electronic tags in selected study areas, and to spatial patterns generated by ADRMs.

Progress During FY 2005

Planned research activities for FY 2005 as listed in FY 2004 report were:

- Simulations at different time and space resolutions based on predicted fields from the coupled physical-biogeochemical model (ESSIC, Univ. Maryland) and the model SEAPODYM (SPC).
- Evaluation of the predicted biomass distribution of the three forage components in SEAPODYM.
- Development of a multi-grid technique to be used in ESSIC and SEAPODYM models.
- Analyses of bigeye tuna habitat predicted from SEAPODYM against observed tuna behavior from archival tag data
- Development of the IBM model and first simulations using the predicted environment from ESSIC and SEAPODYM.

Dr. R. Murtugudde provided to the PI a second set of predicted fields from the coupled biogeochemical model for the period 1950-2002 at an enhanced spatio-temporal resolution of ½ degree and 10 days. In relation with the



The different daily vertical distribution patterns of the micronekton in the tropical pelagic ecosystem used to model the intermediate trophic levels in SEAPODYM. 1, epipelagic; 2, migrant mesopelagic; 3, non-migrant mesopelagic; 4, highly-migrant bathypelagic; 5, migrant bathypelagic; 6, non-migrant bathypelagic.

new developments in SEAPODYM to more realistically describe the dynamics of intermediate trophic levels, the model requires oceanic variables averaged over three vertical layers: epipelagic, mesopelagic and bathypelagic. This is an important evolution to allow comparisons between individual vertical tuna behavior as observed from archival tagging and model predictions. The classification of the micronekton (forage) components is based on their vertical distributions that control their relationships with (and accessibility to) top predators, with both groups showing daily migrations to the upper layers during the night. A 3-layer, 6-forage component conceptual model was developed on the basis of a literature review. Several parameterizations of energy transfer from primary production to the 6 forage components were tested and the outputs compared to some available observation in the literature.

The enhanced resolution with the large basin-scale simulation allows prediction of realistic mesoscale patterns in the equatorial region but seems to have difficulties to reproducing mesoscale dynamics in the higher latitudes, especially in the Kuroshio extension. To have realistic oceanic input in the model, it may be necessary to combine several simulation outputs from different model configurations. This could be an evolution of the "grid and mask builder" (GMB) software developed in parallel to this project for designing the spatial grid of the model and interpolating input fields along the selected grid.

Dr Inna Senina, who has been recruited at the PFRP for developing the 'multi-grid' numerical scheme has now included the stretching techniques in both GMB software and SEAPODYM. Non-regularity of the grid is circumscribed by analytical functions, which transfer either two-dimensionally stretched (refer to figure at right, upper graph) or one-dimensionally stretched coordinates (right, lower graph) into constant step grid coordinates. It allows us to introduce variable resolution into numerical scheme by using only derivatives of stretching functions. Within this approach the number of nodes as well as the cost for numerical computations remains the same. The GMB software is developed accordingly to allow the use to create different types of variable resolution grids, build mask according to topography maps (2 minute resolution elevation data) and to interpolate SEAPODYM data onto constructed grids.

While a reference version of the SEAPODYM code was placed on a server accessible through the internet by authorized members, a new version is being developed separately and will become the new reference once fully tested. Code management software (SVN) is used to manage access to the code, and to document all changes. This is particularly useful when several persons are working on the same code. The mixed-resolution with SEAPODYM is working and I. Senina is now running the test phase.

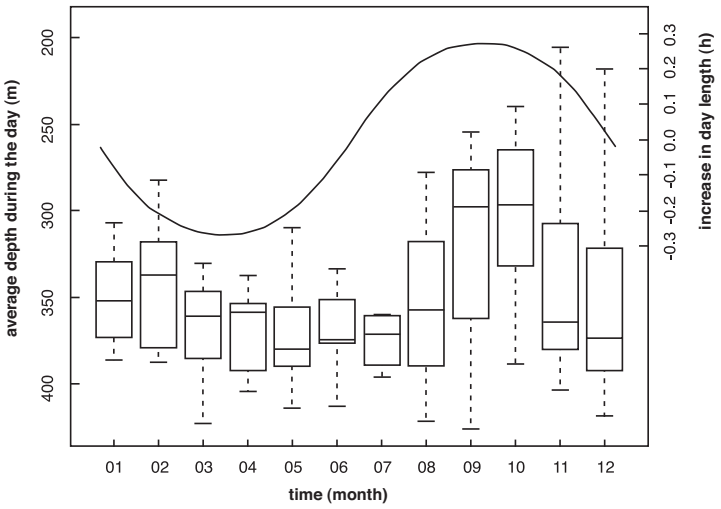
In relation with the changes in the forage modelling in SEAPODYM, it was also necessary to reconsider the approach to link the dynamics of the predators (tuna) to these different prey populations. Several other changes have been introduced; in particular, the possibility to have seasonal behavior for the reproduction. The dynamics of the tuna species is constrained by the definition of two habitat indices. The adult habitat that constrains the movement is based on accessibility coefficients to each forage component, depending on the temperature and oxygen affinities of the species (and age). The spawning habitat constrains the tuna recruitment to environmental conditions (temperature, food and predators). Spawning seasonality is introduced by shifting the conditions of the adult habitat toward those of the spawning habitat in relation to the seasonal cycle of day-length (with a peak at maximum gradient). Indeed, results of the archival tagging data analysis by G. Allain could confirm this approach.

Gwenhael Allain started his post-doc at SPC, Noumea, New Caledonia, on 15 May 2004. The objective of his work is to investigate the influence of the environment on bigeye tuna movements in order to develop a rule-based IBM where fish will be able to 'swim through' environmental data for the simulation of spatial dynamics

from individual to population scale. Two types of data were available: archival tag records and ocean model outputs, including space-time forage biomass estimations from SEAPODYM. First, G. Allain is *investigating the relationships between tagging and model data* on a common scale. The results of this exploratory analysis will be used to develop a rule-based IBM, in order to validate the parameterization of fish behavior in relation to environmental variability used in SEAPODYM and to validate theoretical mechanistic IBMs for tuna behavior including more physiology.

Horizontal movements. Since October 1999, more than 180 archival tags have been deployed on bigeye tuna in the Coral Sea under a joint CSIRO/SPC project; so far 17 have been recovered. Light records were processed by CSIRO using Wildlife Computers 'Global Position Estimator' software to estimate longitude and latitude. Most probable horizontal movements were then estimated from the geolocation data using Kalman filter analysis (Kftrack R Package by J. Sibert and A. Nielsen). Two individual tag records clearly exhibit eastward migration to New Caledonian waters at the same period of the year (Oct–Apr). The monthly evolution of predicted sea surface temperature and forage biomass from Jan 1999 to Dec 2002 in the area delimited by the supposed migration route (148°E–165°E, 16°S–22°S) suggest that this is a time of seasonal warming and peak biomass of epipelagic and migrant mesopelagic forage.

Vertical movements. Bigeye tunas exhibited four types of vertical behavior: the 'classic' or W-shaped one with typical depths of 300-500 m during the day and 0-200 m during the night (74 % of total time), the 'surface' one with depth continuously <100 m during day and night (1 % of total), the 'mixed' one with only short dives under 200 m during the day (24 %) and the 'deep dive' one consisting in short-duration dives <600 m (1 %). The relationships between the type of behavior and the environment encountered along the tracks were investigated using Generalized Additive Models.



Average depth (m) during the day (boxplots, red line) inhabited by tagged bigeye tuna in relation to the month of the year (x-axis) showing a seasonal change in the vertical behavior with a good match with the seasonal cycle of gradient in day length (here at latitude 25°S).

The dependent variable was the average depth during the day during a 10-day archival tag record. The covariates were the 10-day period of the year, temperature in the three layers (0-200 m, 200-500 m, >500 m) during this period, dissolved oxygen concentration in the three layers, primary production over the water column and forage biomass estimated during the day for the three layers. The 'best' model according to these criterions had the three following covariates: 10-day period of the year, 'forage biomass in the deep layer (>500m) during the day' and 'forage biomass in the middle layer (200-500m) during the day.

The seasonal trend shown by the "10-day period of the year" covariate is common to all individual bigeye tunas tagged. Average depth during the day is closer to the surface from August to November (see figure at right)). Therefore the data sample was split in two parts (August to November / December to July) that would separate two major seasonal behaviors. GAMs were adjusted to these two sets of data. From August to November, the average depth during the day increase with the increase of forage biomass in the surface layer (0-200 m), *i.e. during this period tunas would prefer to move to surface waters that are poor in forage*. From December to July, the positive relationship with deep forage abundance was predominant and the 'classic' behavior was rather invariant (90 % of time spent in the layer 200-500 m during the day, 98 % of time spent in the layer 0-200 m during the night).

All tagged tuna were supposed to be mature given their sizes at release/recapture and it is tempting to relate this seasonal change in behavior to a spawning behavior, when tuna would target waters with low forage abundance (i.e., low predator density of their larvae). The "classical" behavior would be the feeding behavior observed most

of the time, in which the dive depth during the day would be related to the estimated biomass of bathypelagic and mesopelagic forage.

Modeling Longline Effort Dynamics and Protected Species Interaction

P.I.: PingSun Leung, Naresh Pradhan, and Sam Pooley

NOAA Goal(s)

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

Purpose of the Project

The general aim of the proposed study is to refine and extend the existing fleet dynamic model, and the specific objectives and tasks are as follows:

- Extend the longline trip level time-series data set to 2002.
- Re-estimate the technical and economic interrelationships among different species landed; and the entry/stay/exit behavior.
- Estimate the catch-effort relationships for each species and for each fleet.
- Analyze the factors, rate, and degree of protected species interaction (e.g., turtles, and seabirds) with longline fishing activities.
- The information generated above will be incorporated into the existing fleet dynamic model in maximizing fishery welfare and fishing effort considering broader implications on protected species and stock conditions.

Progress During FY 2005

The following summarizes the major activities:

1) Modification and improvement of the existing fleet effort dynamic model in maximizing fishery welfare by incorporating protected species as well as the newly estimated catch-effort relationships has been completed. An abstract of the work (submitted to *Ecological Modeling*) is presented as below:
There has been a growing concern about the interactions of endangered sea turtles with Hawaii longline fishery very recently. Some tougher measures including swordfish harvest ban have been put into effect since 2000 to protect these species. Accounting for protected species interactions by fishery management has, therefore, become equally important policy goal recently. A multi-objective programming model has been extended to incorporate sea turtle interactions as one of the fishery management goal. The model results indicate that there is a tradeoff between fleet-wide profit and turtle interactions, and a significantly higher profit and reduced turtle interactions possibility by reconfiguring fishing efforts compared to the base scenario. However, the current fishery policy related to sea turtle interaction disallows the tapping of all the potential efficiency gain as illustrated from the model results, as the number of turtles allowed to get interacted severely curtails swordfish targeted longline fishing activities that use the conventional technologies. Banning longline activities is also not costless, as the average shadow price per turtle in terms of lost profit is about $9,120 and in terms of lost revenue is about $56,060. Adaptation to 'turtle-friendly' fishing technologies is among the many strategies that would allow for higher optimal fishing efforts leading to higher overall welfare.

2) A distance function approach has been adopted to model sea turtle interaction as an undesirable output in Hawaii's longline fishery. This approach provides a method of calculating temporal and trip-specific cost of sea turtle bycatch reduction without assuming any policy intervention. The major component of this analysis is a parametric input distance function that incorporates both desirable and undesirable catches. Using a duality argument, the cost-related shadow price for sea turtle bycatch can be derived from the estimated distance function. The major finding of this analysis is that the average shadow price of sea turtle bycatch from the period 1991-1999 is about $32,561 (expressed in 1991 dollars). Empirically, this method also provides temporal estimates of the average shadow price of sea turtle bycatch by trip characteristics, such as catch season, trip type and location. Such information can be useful in analyzing tradeoffs between number of incidental takes of sea turtles and the marginal cost of sea turtle bycatch. A paper documenting this analysis and its results is being finalized at this time.

3) A more detailed analysis of catch and effort relationship for each species in each trip type than the one used in (1) above is current underway. Stock indices will be created using CPUE standardization method, and will

be integrated into a system of catch-effort regressions to account for the interactions between trip types in the Hawaii's longline fishery. Preliminary results are under evaluation at this time.

4) Two presentations reporting the preliminary results of (a) the distance function estimation and (b) incorporating sea turtle interactions in a multi-objective programming model for Hawaii longline fishery have been made at the November PFRP PI meeting.

5) Two journal papers from the current project are under peer review and one manuscript is in the final stage of preparation for journal submission (please see the publication list below). In addition, two journal papers related to the project are in press.

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

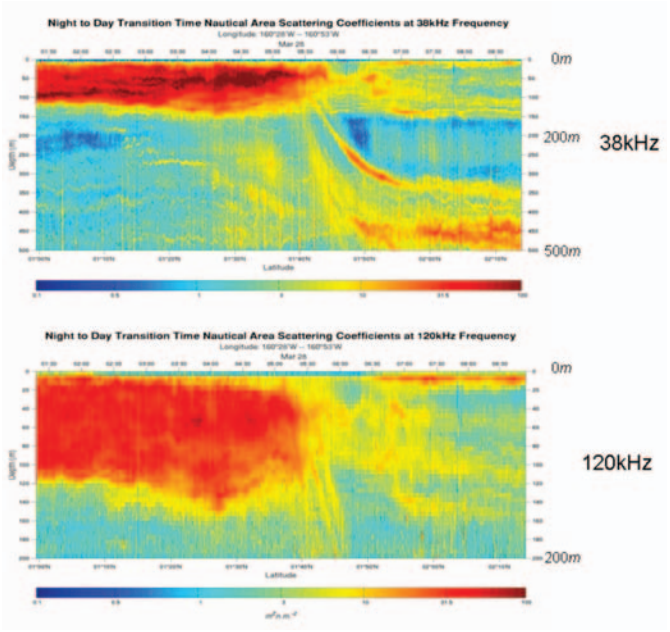
P.I.: Michael P. Seki and Jeffrey J. Polovina

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 (>50 ft. in length) that have fueled a fivefold increase in fishing effort and landings from 1999 to 2001. Prior to the sudden expansion, most longline fishing around American Samoa were accomplished through a fleet of smaller, 30-ft, open-decked catamarans known as *alia*. To illustrate the expansion, over 50 boats actively participated in the fishery during 2001 deploying 4,690 sets (over 5 million hooks) resulting in catch rates of about 40 fish/1000 hooks. By comparison, only 23 vessels made up the fishery in 1999, making 2,102 sets (ca. 912,742 hooks) yielding 32.38 fish/1000 hooks. Albacore tuna, *Thunnus alalunga* is the target species in the fishery and dominates the catch.



Nautical Area Scattering Coefficients (NASC, $m^2 \bullet nmi^{-2}$) from shipboard Simrad EK-60 echosounder measurements (38 and 120 kHz GPTs) aboard the NOAA ship *Oscar Elton Sette*, March 2004.

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 will be fishery information to develop a functional understanding of the spatial and temporal occupation and movement tendencies of large South Pacific albacore 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 2005

Analysis of all data sets collected for the assessment of physical processes affecting the American Samoa fishing grounds, as well as albacore distribution and longline performance, have been completed. Data used for this project included sea surface height along with derived geostorphic currents from Jason satellite data, American Samoa longline fishing logs, temperature-depth recorders (TDRs) attached to longline sets, popup satellite tags (PATs) (see PFRP albacore vertical movement project by Polovina and Seki), and bioacoustic and CTD data (temperature, salinity, dissolved oxygen, and chloropigments) collected during an oceanographic survey aboard the NOAA ship *Oscar Elton Sette* in March 2004.

Results of the study thus far identifies the American Samoa fishing grounds as a dynamic region with strong mesoscale eddy activity that shows temporal variability on scales of less than 1 week. In addition, the South Equatorial Counter Current (SECC)—a strong, eastward flowing jet with a pronounced intra-annual signature that traverses the northern section of the American Samoa Exclusive Economic Zone (EEZ)—creates strong horizontal shear at its boundary regions with the westward flowing South Equatorial Current (SEC), resulting in dynamic instability which contributes further to the formation of eddies and meanders within the northern section of the EEZ on a seasonal scale. Longline albacore catch seem to be influenced by both the mesoscale eddy and intra-annual SECC variability; year round catch tended to be located at the eddy periphery while albacore catch per effort (CPUE) showed intra-annual variability with high CPUE during May through August relative to that during September through April. Further, during the May-August period, CPUE tended to be significantly higher in the northern half relative to the southern half of the American Samoa EEZ. This intra-annual variability in CPUE lags that of the SECC by about two months.

Vertical distribution information from PAT instrumented albacore within the EEZ show that the fish spend most of their time between 150-250m depth, corresponding to 25°-21°C, with depths (temperatures) between 150 -300m (25°-18°C) during the day and 0-200m (30°-24°C) during the night. These daytime and nighttime depths of ~150 and ~250m correspond to depths of relatively high biomass—as estimated from acoustic backscatter—as well as to strong temperature and salinity gradients. TDRs attached to longline sets show that the American Samoa longline fleet targets the 150-250m depth well.

The most prominent feature of the acoustic backscatter is the diurnal patterns of the vertical migrating sonic scattering layer (SSL) (top, right). The SSL exhibited strongest scattering between 20-120 m during the nighttime and between 400-700 m during the day. While the nighttime 38 kHz backscatter (vertically integrated over the upper 200 m) show greater values than that acquired with the 120 kHz transducer, the daytime 200 m integrated 120kHz backscatter tend to be higher than the 38 kHz suggesting that the diurnal vertical migratory pattern is predominantly due to relatively larger organisms (≥5-10cm); i.e., micronekton. Further, acoustic backscatter strength tended to increase toward the north at both 38 kHz and 120 kHz frequencies on a larger scale while showing some correlation of higher backscatter with eddy boundaries (bottom, right). Between two meridional transects positioned 1.5° longitude apart from each other within the EEZ, the western transect had higher backscatter and corresponded to lower dissolved oxygen and higher chloropigments measurements than the eastern transect at both frequencies. Dissolved oxygen and chloropigments along both meridional transects exhibited a northward decrease and increase, respectively, although temperature and salinity profiles were relatively uniform from south to north. The results of this work continue to be prepared for publication.

Ocean Remote Sensing

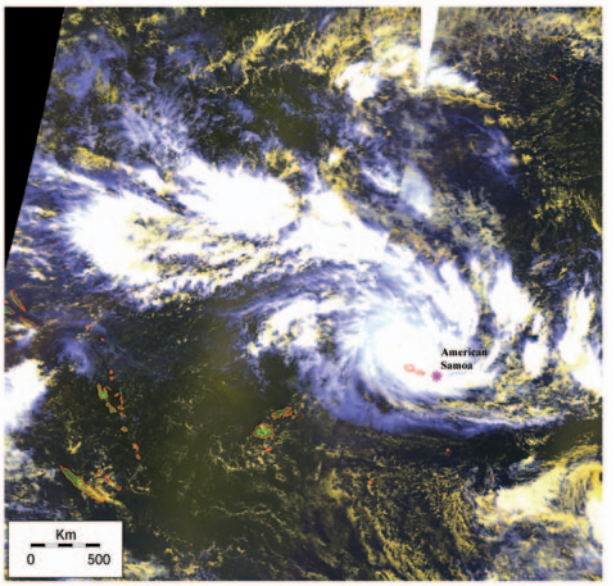
P.I.: Thomas A. Schroeder [Jeffrey Polovina]

NOAA Goal(s)

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

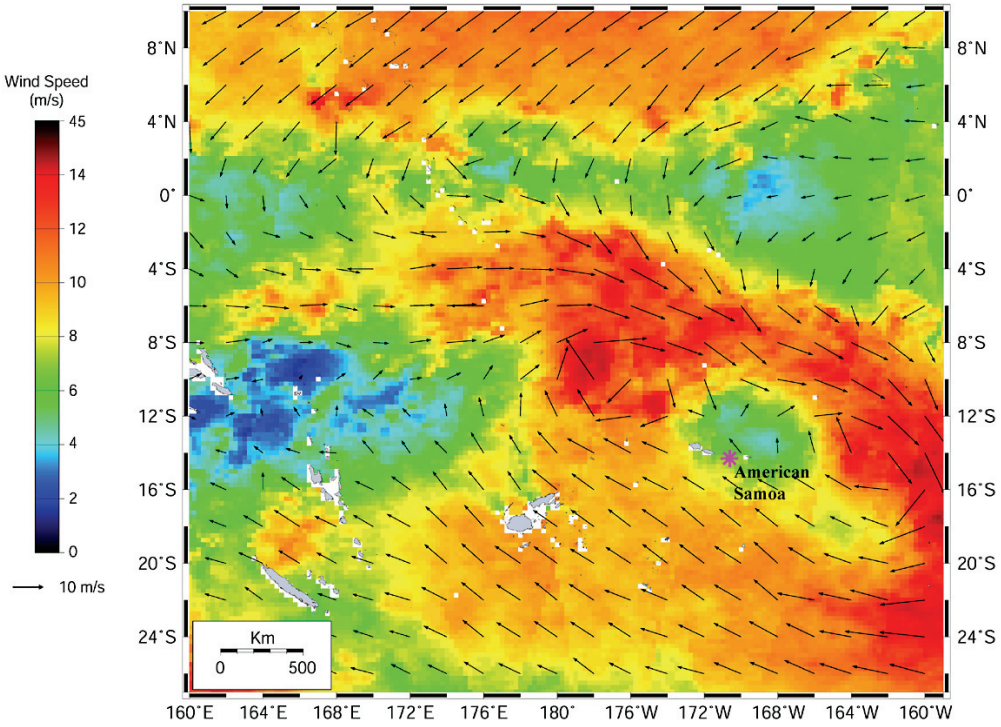
Purpose of the Project

This project develops and maintains a data base of satellite oceanographic data including sea surface temperature, surface wind characteristics, sea surface height, and ocean color covering the central and North Pacific. Staff collaborate with fisheries researchers to use satellite remotely-sensed oceanographic data in fisheries and protected species research. The project develops and maintains a web site http://coastwatch.nmfs.hawaii.edu/ to display satellite remotely sensed data.



Color composite from the NOAA Advanced Very High Resolution Radiometer acquired on 15 February, 2005 at 2031 and 2212 UTC. The observed cloud structures comprising Cyclone Olaf denote its clockwise air circulation pattern.

Color composite from the NOAA AVHRR, 15 February 2005, showing the cloud pattern associated with Cyclone Olaf.



QuikSCAT surface winds 3-day composite for 13-15 February, 2005. Cyclone Olaf is seen as it passes over the Samoa Islands.

QuikSCAT surface winds 3-day composite for 13-15 February 12005. Cyclone Olaf is seen as it passes over the Samoa Islands.

Progress During FY 2005

FY05 was a period of expansion for Coastwatch from providing central Pacific data coverage to Oceanwatch that provides the same data for the entire Pacific. A new website is now located at http://oceanwatch.pifsc.noaa.gov/. Our oceanographic data, including Modis ocean color, has been provided to support several NOAA research cruises and used in a range of research projects. Regional indicators based on empirical orthogonal functions are also provided based on satellite altimetry. All salaries and travel as well as most of the supplies and equipment for Oceanwatch are funded with JIMAR funds.

In our FY04 annual report we indicated that for 2005 we proposed to access and provide near real time Modis ocean color data and to work with researchers to develop ecosystem indicators based on satellite data to monitor the North Pacific. We did accomplish both these goals this year.

Names of Students Graduating with MS or PhD Degrees During FY 2005

Lucas Moxey, MS Geology

Pelagic Fisheries Research Program—Management

P.I.: John Sibert

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 2005

- Work closely with the PIFSC to improve budgetary arrangements and coordination of research programming.

  Communications with PIFSC have greatly improved. For the first time in its history the PFRP has received notification in advance of the budget for the new appropriation and a detailed briefing on new NOAA contracting and online application procedures. The NEPA requirements may be overly strict.

- Facilitate international collaboration in research on pelagic fisheries.

  The PFRP remains active in international tuna research and management. The PFRP Program Manager was a member of the United States Delegation to the third (and final) meeting of the Science Coordinating Group of Preparatory Conference for the Commission for the Conservation and Management of Highly Migratory Fish Stocks in Western and Central Pacific (WCPFC). Several PFRP scientists made presentations to the seventeenth (and final) meeting of the Standing committee on Tuna and Billfish in Majuro, Republic of Marshall Islands, August 9-18, 2004. The PRFP Program Manager is Chair of the SCTB Methods Working Group and has completed evaluation of stock assessment methods and specific stock assessment results. PFRP Researcher David Itano is Chair of the SCTB Fishing Technology Working Group. The PFRP hosted meetings of three working groups of the new GLOBEC project, CLIOTOP (Climate Impacts on Oceanic Top Predators) in conjunction with annual PFRP Principal Investigators workshop. The first meetings of CLIOTOP working groups 2 (Physiology, behavior and distribution), 4 (Synthesis and modeling) and 5 (Socio-economic aspects and management strategies) in December 1-3 in Honolulu. GLOBEC invited the PFRP Program Manager to serve on the CLIOTOP Steering Committee.

- Education and training

  The PFRP actively promotes graduate education in fisheries. The PRFP Program Manager assisted in creating the proposal for a new Coastal and Marine Resources (CMR) graduate degree program. Unfortunately, the University of Hawaii's Graduate Division did not see fit to approve the proposal and asked for revisions. The CMR curriculum coordinator, funded from the PFRP Management budget, suffered serious health problems which interfered with his ability to perform his duties. It is not clear when the CMR program will accept its first students.

  The PFRP currently supports one graduate research assistants. Brittany Graham, a PhD candidate in the Oceanography Department, continues to be a productive member of the pelagic food web project, "Trophic structure and tuna movement in the cold tongue-warm pool pelagic ecosystem of the equatorial Pacific". Richard Hall, a Masters candidate in the Geography Department, has completed his tenure with the PFRP.

Protected Resources Environmental Compliance Initiative

P.I.: Thomas Schroeder, Ph.D./Karnella/Faris

NOAA Goal(s)

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

Purpose of the Project

The Protected Species Environmental Compliance Initiative (PRECI), begun in FY 2003, seeks to enhance the management of protected resources throughout the U.S. Pacific Islands. The goal of the PRECI is to establish and maintain enhanced management based on science for protected resources within the jurisdiction of the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries Service) Pacific Islands Regional Office (PIRO), Protected Resources Division (PRD). The PRECI directly supports the Joint Institute for Marine and Atmospheric Research (JIMAR) theme of achieving a sustainable balance between the forces of coastal development and conservation/preservation goals. Information obtained during the course of the PRECI will be used to assist resource managers in decision making and directing further investigation in habitat and protected species investigation, enhance interagency cooperation, and help to investigate the compatibility of new technologies and protected species conservation and recovery. A major focus of this initiative is to investigate and implement approaches to fulfilling mandates under the Endangered Species Act, the Marine Mammal Protection Act, the Magnuson-Stevens Fishery Conservation and Management Act, and other federal statutes to ensure the conservation and recovery of protected species in the central and western Pacific region. Several projects within the

initiative will focus on program-specific goals and will enhance management capabilities as well as assisting in other programs to achieve the broader goals of resource conservation and cooperative management. The PRECI will be closely coordinated with a number of existing programs. These include liaison and coordination with the NOAA Fisheries Pacific Islands Fisheries Science Center, NOAA National Ocean Service Sanctuaries Programs, State of Hawaii, the Western Pacific Regional Fishery Management Council, Territory of American Samoa, Territory of Guam, and the Commonwealth of the Northern Mariana Islands.

JIMAR resource management liaison employee, Jeffrey Mangel, assisting with transport of stranded humpback whale calf to necropsy site. February 9, 2005. Barbers Point Oahu.

Develop and implement strategies to further recover marine species protected under the Endangered Species Act and/or the Marine Mammal Protection Act. Conduct section 7 consultations under the Endangered Species Act. Revise and maintain the marine mammal stranding program to fulfill mandates of the Marine Mammal Protection Act. Assist in the analysis and procedural requirements to manage federal fisheries in compliance with the Endangered Species Act and the Marine Mammal Protection Act. Project provides supplementary staff to augment federal employees assigned to this mission.

Progress During FY 2005

During FY2005, the following were accomplished: an average of three employees continued to work with the State of Hawaii and local agency representatives on fishing interactions and protected species interactions. Staff assisted by protecting monk seals during lactation periods, assembling gear for marine mammal stranding response, drafting a synopsis summarizing marine mammal stranding responses in the main Hawaiian Islands in the past five years, reviewing federal project proposals and advising on ways to avoid, minimize, or mitigate impacts to marine protected species. The PRECI has been successful in reaching a variety of its goals that it proposed in 2002-2005. In September 2004, Resource Management Specialist Five (RMS V) was hired to ensure international turtle conservation management projects are provided adequate administrative and technical support. Project monitoring site visits were carried out by RMS V in Papua New Guinea, Guam, the Commonwealth of the Northern Mariana Islands, American Samoa, Yap (Federated States of Micronesia), Palau and Indonesia. The RMS V participated in the Twenty-fifth Annual Symposium on Sea Turtle Biology and Conservation in Savannah, Georgia and the Melanesian Marine Turtles Conservation Forum in the Solomon Islands. The RMS V was an invited speaker at both the Marine Turtle Workshop in Palau and at the first public consultation between the Indonesian longline fishing industry and World Wildlife Fund in Bali, Indonesia. In addition, the RMS V has provided considerable administrative and technical assistance with JIMAR and NOAA Fisheries Service supported marine turtle projects on-going at the above-mentioned locations. The following subcontracts for sea-turtle investigations are on-going and will be completed by the end of FY 2006: Guam, American Samoa, the Northern Mariana Islands, Federated States of Micronesia and the Marshall Islands. Some delays in these projects were a result of the longer than expected time to acquire USFWS/NMFS marine turtle research permits and required training for marine turtle research field techniques.

The objectives established for this period included: 1) Maintain two employees to liaison with community and local governments regarding the management and uses of coastal resources and their impact on protected marine species; 2) draft informal section 7 consultation responses to other federal agencies in response to their submissions of project plans and permit applications; 3) support federal personnel to respond to stranded marine mammal events in the main Hawaiian Islands; 4) provide administrative support to federal and JIMAR project staff in the Protected Resources Division; 5) purchase equipment for new and/or existing hires (computers, cameras, outdoor gear); 6) assist educational mission by designing, publishing, and distributing outreach materials.

Regulatory Impact Analysis Framework for Hawaii Pelagic Fishery Management: A Multilevel and Multiobjective Programming Model

P.I.: Minling Pan and Keiichi Nemoto

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 this project is to enhance the multi-level multi-objective programming model for the Hawaii fisheries that was developed under PFRP Project #2066/2113. This involves making the basic model structure more tractable for regulatory analysis. It should allow more flexible time-area specification and facilitate updating the underlying data. The updated model focuses on the Hawaii-based longline fishery.

Progress During FY 2005

The project was wrapped up during FY05. A non-linear programming model, updated in previous years and implemented by General Algebraic Modeling System (GAMS), was used for a policy simulation to analyze the recent policy for recent (2004) reopening the Hawaii swordfish fishery. A technical report has been completed as a JIMAR publication in 2005 and titled in "Regulatory Impact Analysis for Pelagic Fisheries Management in Hawaii: A Spatially Disaggregated Nonlinear Programming Model," by Keiichi Nemoto, SOEST 05-01, JIMAR Contribution 04-353.

The Role of Oceanography in Aggregation and Vulnerability of Bigeye Tuna in the Hawaii Longline Fishery from Satellite, Moored and Shipboard Time Series

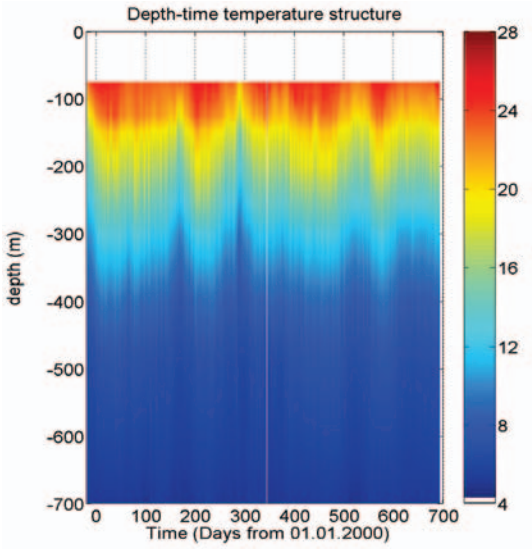
P.I.: Russell E Brainard, Jeffrey J Polovina, Michael P Seki, Bo Qui and Pierre Flament

NOAA Goal(s)

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

Purpose of the Project

Stock assessment of Bigeye tuna is generally based on long-line catch-per-unit-effort (CPUE) as an index of abundance of stock assessment. Unfortunately, fishery-dependant CPUE does not necessarily reflect abundance of stock but rather the catchability, which is in turn dependant on variable oceanographic conditions. Preferential habitat appears to be the 8-15 C waters near the base of the thermocline so variability of thermocline depth could affect concentration. According to work by Boggs, Brill and others Bigeye tend to remain in the upper 10-90m at night and repetitively migrate vertically between 350-500m and 50-150m during the day. However, a recent paper in the southern Pacific by Schaefer and Fuller (2002) suggests on rare occasions they can exceed 1000m in depth (and thus can not be physiologically oxygen limited to 350m in their dive profiles). This behavior suggests that at times when the thermal structure is depressed, tuna may be less aggregated and vice-versa. Likewise horizontal and vertical shears have a profound effect on catchabilities and we would like to consider whether wave activity could also be a factor effecting catchability.



Depth time temperature slice (year 1& 2 with time in days from 01 01 2000.

Progress During FY 2005

Bigeye Mooring Data Return: For the year 3 mooring seven out of eleven SeaBird SBE39 temperature recorders returned with data. The recorders where at the following depths: surface, 25 m, 125 m, 200 m, 250 m, 300 m, 400 m, and 700 m. The Seabirds recorded temperature data every 300 sec.

The upward and downward looking acoustic Doppler profilers (ADPs) had start times which were shifted by 30 minutes to avoid interference between the two instruments. Data collection parameters were set to record for 20 min, with 70 pings, with twenty 8 meter bins, with a 4m blanking interval at the top and bottom. Full data coverage for the year was recorded.

The third instrument deployed was an Aanderra RCM9 current meter at 350m. The deployment parameters were 8 channels, wide temperature and conductivity ranges. The instrument was also equipped with a dissolved oxygen sensor.

A generalized additive model was used to predict the effects of oceanography in the Palmyra Atoll region on bigeye CPUE from Hawaii Longline logbook entries. It was found that bigeye CPUE was higher in El Niño years around Palmyra Atoll and predictions of higher CPUE were made for the 2005 winter months.

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

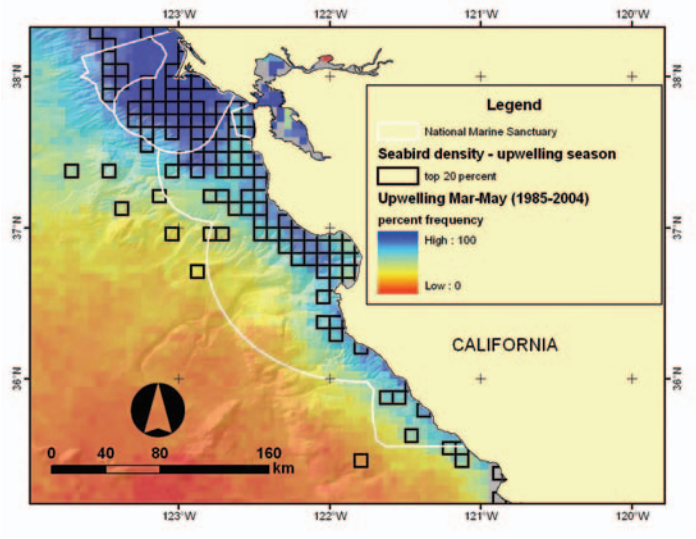
P.I.: Thomas Schroeder [Franklin B. Schwing]

NOAA Goal(s)

- To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management
- To understand climate variability and change to enhance society's ability to plan and respond
- To serve society's needs for weather and water information
- To support the nation's commerce with information for safe, efficient, and environmentally sound transportation

Purpose of the Project

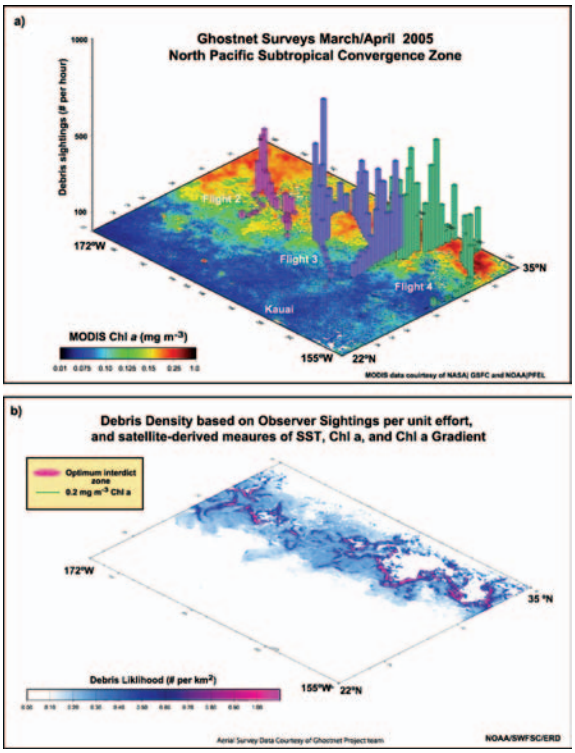
The purpose of this project is to conduct research and provide satellite data in support of the emerging west coast regional associations of the Integrated Ocean Observing System (IOOS). These efforts are undertaken to: 1) improve understanding of marine environmental variability and its impacts on living 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.



Sample image from the Sanctuary Information and Monitoring Network (SiMON) GIS. Images like this allow decision makers to include spatial maps of persistent oceanic features (such as upwelling, shown here) in the process of designating Marine Protected Areas within the Monterey Bay National Marine Sanctuary. This map also included regions Analogous near real time products are also made available to assist in the monitoring that is required for an established region.

Progress During FY 2005

This year has been very productive for the Satellite Remote Sensing project, with all goals met or exceeded. It was anticipated that much of the effort in FY05 would be dedicated to the establishment of basic infrastructure and communication systems; this work was completed ahead of schedule. Consequently, a number of satellite data applications were established that relate directly to NOAA missions, above and beyond the more basic goal of supplying oceanographic data sets as the West Coast regional node (WCRN) of the NOAA CoastWatch program has done for the past 13 years.



a) Map of debris sighting density for Ghostnet 2005 aerial surveys in the subtropical convergence zone overlaid on chlorophyll a concentration measured from the MODIS sensor carried aboard NASA's Aqua spacecraft. Each bar represents the number of sightings during a six minute increment of flight on the NOAA P-3 Orion aircraft. b) Predicted debris density based on probability distribution functions of environmental data sampled from satellites at locations of sightings. Maps like these will be used in 2006 surveys, which may also include experimental at-sea interdiction.

Climate and Ecosystems: NOAA has established a team to develop a plan for the transition of satellite measurements of SSH, surface vector winds and ocean color from NASA research into NOAA operations. The objective is to show clear progress towards providing better products and services with these data. The effective management and dissemination of satellite data and derived products to a variety of customers internal and external to NOAA is a crucial component of this transition. The variables chosen reflect the requirements designated by fisheries researchers and managers. A proposal funded by NESDIS to the NOAA Fisheries Service, Southwest Fisheries Science Center, Environmental Research Division (ERD) will provide a demonstration project for the management and dissemination of satellite data, expanding the current OceanWatch LAS at SWFSC/ERD to provide time series of ocean surface currents and primary productivity. Both have immediate application to fisheries research and management, ecosystem-based management, coastal ocean management, and monitoring the global carbon cycle.

Marine Protected Areas: SWFSC/ERD and NOAA Satellite and Information's CoastWatch Program have begun a project in cooperation with the Monterey Bay National Marine Sanctuary (MBNMS) Marine Protected Area (MPA) work group to map habitat categories based on oceanographic criteria. The work group, established by the NOAA Ocean Service, is composed of Federal, state, municipal, fishing, and conservation representatives seeking to evaluate potential locations for MPAs. The state of California has legislated, through the Marine Life Protection Act, the selection of MPAs, and will use this information in their process as well. This cooperative work supports NOAA, state, and local entities seeking to manage living marine resources conservatively for the benefit of our constituents, and will ultimately be a model for defining and mapping ocean habitats in other regions. This work is scheduled for inclusion in the new Cooperative Conservation Program.

Protected Species and Navigation Hazards: Derelict fishing nets and other gear adrift in the central Pacific is a serious navigation hazard and poses entanglement threats to protected species such as turtles, Hawaiian Monk Seals, and the coral reefs of the Hawaiian Archipelago. The Ghostnet project, initiated by NASA in 2001 and funded in FY2005 by NOAA Fisheries Service, uses a variety of satellite and aircraft-borne sensors to identify, track, and survey regions where derelict fishing gear and other marine debris are likely to accumulate, with the intent of guiding interdiction efforts to intercept and recover the nets at sea. In FY05, the WCRN began delivery of a suite of near real-time satellite data products (SST, SSH, winds and color) that NESDIS used in planning the 2005 Ghostnet aerial surveys of the Subtropical Transition Zone. The project covered areas that a survey crew member described as "so dense, you could walk across it". These debris sightings have been used in conjunction with satellite-based measurements to produce predictive maps to help optimize recovery operations. Additionally, tracks of drifters attached to nets will be used to optimize circulation models that indicate debris "hot spots", or regions of high accumulation. ERD will support future Ghostnet surveys, as well as extensive outreach efforts coordinated by the Sea Grant Colleges of Hawaii, Alaska, and Oregon.

Sociological Baseline of Hawaii-Based Longline Fishery: Extension and Expansion of Scope

P.I.: Stewart Allen, Ph.D. (PIFSC), John Sibert (UH, JIMAR, PFRP)

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 understanding 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. For example, due to a lack of data, the 2001 pelagics fishery Environmental Impact Statement (EIS) was forced to cite a study of workers laid off from the sugar industry on the island of Hawaii to describe the range of possible effects of closure of the swordfish fishery. 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

Project researchers are conducting in-person interviews and, as needed, focus groups with longline captains, owners, crews, and family members, as well as key individuals in associated shoreside businesses (including the auction, fishing supply and support industries, wholesale and retail seafood dealers. Deliverables will include a database of responses from the Hawaii longline fishing community and a series of reports summarizing those data and providing contextual information. Although some of these data will be confidential due to the sensitivity and potentially statutorily confidential nature of these responses, a research database to be shared with other researchers will be constructed as well. These deliverables, to be updated on a regular basis, will constitute the baseline for subsequent NEPA analyses.

Progress During FY 2005

Researchers have conducted interviews with longline captains, owners, crew, family members, and local fishing supplier businesses. Interviewees provide information about their background, how they came to be involved in the fishery, the nature of their job, what they like most and least about their work, perceptions of the industry, and their community. The interviewees' knowledge regarding fishing regulations and management and their adequacy is explored. Information is also collected on interviewees' social networks, particularly regarding social and community ties to Hawai'i's industry. The interviews are really oral histories, with the interviewee determining the focus of the conversation. There is no survey form or questionnaire, although we attempt to cover similar content areas with each person. University of Hawaii (RCUH) personnel conducted interviews under a research plan approved by the University's Committee on Human Subjects.

The interviewer was typically accompanied by an appropriate interpreter/community liaison. Even in situations where interpretation was not essential, this person served to make the interviewees more comfortable and to allow expression of some terms in a native language. In many cases multiple conversations with an individual may have occurred before an actual interview was completed, allowing an individual to develop trust with the interviewee and interpreter. Similarly, in many cases an interview was followed up with a series of multiple discussions over time, increasing the accuracy of the responses. The interviewer and interpreters also utilized participant observation as a study method, and over time have been come to be perceived as part of the longline community.

Sampling is opportunistic, although researchers are careful to include representations of the various ethnicities present among the diverse industry participants, as well as any distinct social networks within those ethnic groups. For owners and captains this means samples of Vietnamese-American, Korean-American, and Caucasian industry participants; among crewmen this has ensured adequate crew representation of Filipino and local crew. Vessels are concentrated in three distinct locations within the Port of Honolulu, and researchers also plan to analyze differences across these three locations.

Interviews have been conducted with 234 individuals including vessel owners, captains, and crew from a total of 79 vessels. We estimate that this number reflects roughly 50% of owners and captains present in the Hawaii

longline industry; as well as 45% of crew involved in the industry. Although an occasional additional interview may be conducted, data collection for the producer side of the industry is essentially complete. Information from the 234 interviews has been captured in qualitative and quantitative data bases and preliminary analyses are underway.

Preliminary Characterizations

Owners and Captains: In October, 2004 there were approximately 44 Vietnamese-American operated vessels in Hawai'i, owned by an estimated 35 families. Researchers spoke with 28 family members involved with a Hawai'i based longline vessel, including owners, owner/suppliers, ex-owners, captains, and wives), along with 12 Vietnamese crew (or ex-crew). Together, these individuals reflected an estimated 34 vessels. All of the Vietnamese-owned vessels docked at Pier 17, space permitting; however some respondents had relocated to California's swordfishery at the time of their interview. A total of 18 of the 44 vessels had, at some time between 2002-2004, fished for swordfish in California. Of the 28 owner/captains interviewed, 8 individuals worked in California's swordfishery. All have since returned to Hawai'i's longline industry.

In October, 2004 there were 33 Korean operated vessels in Hawaii, owned by roughly 26 families. Researchers spoke with 19 individuals, reflecting an estimated 23 vessels. Virtually all of Korean-owned vessels dock at Kewalo Basin. However, like the Vietnamese owned vessels, they have recently begun to dock at Pier 38 when off-loading fish and preparing to depart.

In October, 2004 there were roughly 35 Caucasian operated vessels owned by an estimated 25 families. Researchers interviewed 17 owners and captains. In addition, there were 3 owners/captains of 'other' ethnic affiliations, but who interacted as part of the Caucasian Hawai'i based longline community. When these individuals were added to the Caucasian owner responses, there were a total of 20 owners/captains in this network, reflecting a total of 25 vessels. At the time of interviews, a majority of Caucasian-owned vessels docked at Pier 35-38, with a few vessels docking at Kewalo basin, and even fewer at Pier 17. In late 2004, with the move of the United Fishing Agency's auction to Pier 38, most of the Caucasians also moved their vessels to Pier 35-38.

Basic demographic characteristics for owners, owner captains, and captains have been analyzed by ethnicity (Table 1). Notable differences included the slightly higher average age of Korean owners and captains, the slightly lower number of years fishing of the Vietnamese owners and captains, the high frequency of Vietnamese owners and captains who did not finish high school, and the marital status of Caucasian owners and captains.

Table 1.	Vietnamese	Korean	Caucasian
Average age	47	53	48
Average # years commercial fishing	19	29	27
From fishing family	81%	56%	41%
Didn't finish high school	74%	7%	0%
Currently married	86%	68%	33%
Family dependent on longline	71%	58%	50%

Vessel owners also exhibited differences across in job satisfaction, problems faced, and opinions of their own financial situation (Table 2). For example 90% of Caucasian owners reported making a profit in the previous year, while only 14% and 12% of Vietnamese and Korean owners/captains respectively reported such earnings. Similarly, when asked about the types of problems an individual faced, there were different problems noted among different ethnic groups. However, all ethnic groups reported problems associated with manning a vessel and with National Marine Fisheries Service policies, regulations, and enforcement.

Table 2.	Vietnamese	Korean	Caucasian
Reported making profit	15%	12%	90%
Would quit fishing for higher income	31%	53%	19%
Auction monopoly is major problem	46%	67%	27%
Biggest problems facing industry	Swordfish ban, NMFS, Manning vessel	NMFS, Manning vessel, Market	Manning vessel, NMFS

Crew: In October, 2004, there were roughly 112 active vessels in the Hawaii-based fleet. Researchers interviewed 166 crewmen from a total of 64 vessels. In many cases, follow up interviews were conducted with an interviewee who may have transferred to work on a different vessel. Most vessels use 4 working crewmen at sea, however considering the difficulty in obtaining labor it is uncommon for all vessels to be completely manned at any given

time. Vessel owners hire local laborers from a very small pool of workers who work a number of vessels on a transitional basis. Because of the difficulty in obtaining local labor, Hawai'i longline vessel owners frequently employ foreign laborers from the Philippines, Indonesia, Republic of Kiribati, and other regions.

In October, 2004 we estimate that there were roughly 250 foreign laborers present in the Hawai'i longline industry, mostly from the Philippines. Researchers interviewed 145 Filipino crew; including 71 Filipino laborers working on Vietnamese operated vessels, 42 working on Korean operated vessels, and 32 working on Caucasian operated vessels.

In addition to foreign laborers, researchers also interviewed 19 local crew or x-crew; reflecting 12 Vietnamese, 5 Caucasian, 1 Micronesian, and 1 other. In early 2004 there was an influx of approximately 50 crewmen from the Republic of Kiribati arriving predominately on Korean operated vessels. However, due to an initially high return rate, only an estimated 20 individuals remained by the end of 2004. These individuals were not interviewed as part of the study. Additionally, there was a large influx of Indonesian crewmen arriving in late 2004. Two of these individuals were interviewed and it is possible that the number of Indonesian crewmen working on Hawai'i longline vessels may increase. Together, all 165 crew (foreign, local and x-crewmen) constituted 82 individuals working on Vietnamese operated vessels, 46 working on Korean operated vessels, and 37 working on Caucasian vessels.

With the dominant source of labor in Hawaii's longline industry being that of foreign crew, analyses were conducted to explore the desirability, characteristics, and satisfaction of these workers. Vessel owners considered Filipino laborers a valuable source of labor because many Filipino workers were experienced fishermen with trade skills; almost all had completed high school and nearly half had attended or completed some form of tertiary education. Additionally, because Filipino crewmen visa status in Hawaii requires that they remain on board the vessel, owners reported savings in repairs, maintenance, and increased security for the vessel. Similarly, having crew reside on board the vessel provided vessel owners with a reliable and consistent crew. Finally, vessel owners reported that foreign labor might be cheaper than hiring local crew, who have traditionally been paid in shares.

Analyses to date have covered basic information about Filipino crew. Among Filipino crew respondents there was a considerably high level of job satisfaction (Table 3). When asked specifically about problems relating to living conditions, working conditions, and income, a strong majority reported having no such problems. A majority of Filipino crewmen said they would return to the industry for future employment (assuming they were able to do so). However, crewmen were more reluctant to encourage their children to seek employment working as a crewman in Hawaii's longline industry; only about one-third reported that they would.

Table 3.	
Made reasonable income	79%
Level of job satisfaction is high or very high	67%
Reported no problem with workload	77%
Reported no problem with living conditions	80%
Reported they would get involved again	71%
Reported they would encourage children to get involved	35%

Although job satisfaction was high, a small proportion of Filipino crewmen did mention some issues such as problems with supervisors, immigration restrictions, personal or family problems, and unstable incomes. Other concerns voiced by fewer individuals included problems with the agency with whom their employment is contracted, lack of solidarity among foreign laborers, and ironically, other foreign labor taking their jobs.

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

P.I.: Minling Pan and Michael Parke

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 this project is to incorporate a time/area closure model previously developed to estimate sea turtle takes (Kobayshi-Polovina, 2001a, 2001b) into a multi-level and multi-objective programming model

developed in previous PFRP projects (Pan et al. 2001, and Nemoto, 2005). This updated model will then be used to estimate economic returns and incidental takes of sea turtles over space and time under existing and potential regulatory policies. Ideally, this model should enable regulators and fishers to develop policies that would direct fishing effort to areas and times that will maximize economic return and minimize protected species interactions.

Progress During FY 2005

This project started in September 2004. The project made limited progress due to the resignation of the original PI (Keiichi Nemoto) in January 2005. Minling Pan, NMFS economist, took over the project and currently serves as the project PI. A full-time research associate for this project is currently being recruited. A qualified applicant has been selected and the new staff member is expected on board soon. The project is expected to speed up after the full-time research associate comes onboard.

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

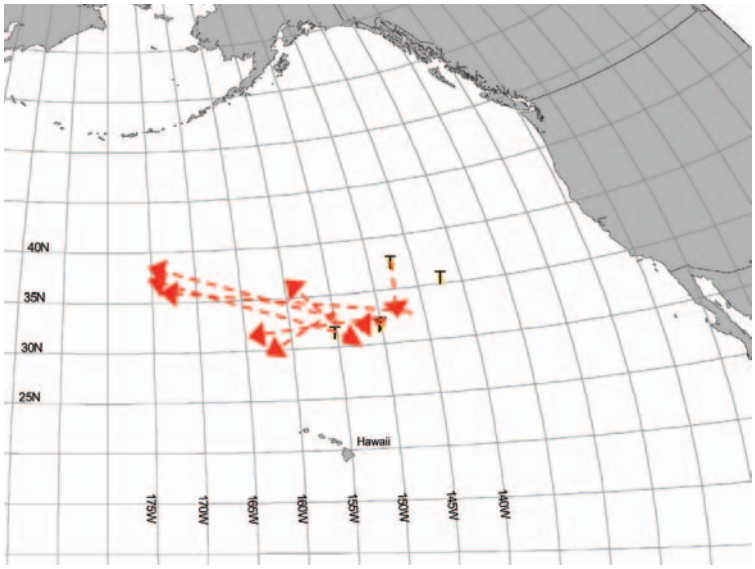
P.I.: Yonat Swimmer, Mike Musyl, Lianne McNaughton, Rich Brill

NOAA Goal(s)

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

Purpose of the Project

The objectives of this project are two-fold: 1) to provide estimates of delayed mortality and morbidity 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've deployed pop-up satellite archival tags (PSATs) on longline-caught and free-swimming hard-shelled turtles in the Eastern Tropical Pacific, the North Pacific, and the South Atlantic Oceans.



Deployment locations (yellow triangles) and start and end points of turtle tracks (red dashed line) from 13 loggerhead turtles tagged after their capture and release from longline fishing gear in a swordfish-style fishery in the North Pacific Ocean. Average number of days tracked for 8 deeply hooked turtles was 136.

Progress During FY 2005

PSATs Deployed in the North Pacific Ocean

California-based observers have deployed 13 PSATs on incidentally caught loggerhead turtles in the North Pacific Ocean swordfish fishery since 2002. Of these, turtles that were "deeply" hooked" (hooked in mouth) were successfully tracked for an average of 136 days (n=8), while turtles that were "lightly" hooked (in flipper), were tracked an average of 55 days (n=1). Four of the 13 tags failed to report, and the majority of tags failed to transmit any appreciable depth and temperature data. It appeared that a single mortality case was observed 6 months post-release from fishing gear. Turtles' start and end points are graphed in the figure above.

PSATs Deployed in the South Atlantic Ocean

Since January 2004, 5 loggerhead turtles have been tracked with PSATs after their interaction with longline fishing gear. Of these, data have been received for one tag, which chronicled the turtle's movements for 76 days after which the tag was apparently shed. Three PSATs are currently reporting data and these data will become

Deployment locations (yellow triangles) and start and end points of a track (red dashed line) from 5 loggerhead turtles tagged after their capture and release from longline fishing gear in a swordfish-style fishery off Brazil.

available to us in the coming weeks. We had anticipated the CPUE of turtles to be higher thereby enabling the deployment of additional PSATs. Turtles' start and end points are graphed in the figure at right (top of page).

Turtles' most probable tracks are currently being determined via the Kalman-filter modeling approach. We continue to work with Anders Nielsen to refine these estimates based on incorporation of sea surface temperature data. However, this has been problematical due to the paucity of temperature data downloaded from some of the PSATs. Overall, we are disappointed with the quantity of data received from PSATs. To help decipher these low data reporting rates, we are closely working with Michael Musyl on another PFRP project to determine the relative performance characteristics of PSATs. PSAT reporting rates and possible explanatory factors have been added to a meta database which will incorporate PSAT information from a number of different researchers (*i.e.* Musyl, Brill, Swimmer, Lutcavage, Wilson, *et al.*) on many different species to explore for patterns and commonalities (*e.g.* comparing serial numbers of non-reporting tags, *etc.*). Lastly, with our "team" of PSAT collaborators (Oceanographic Correlations: Mike Laurs, Dave Foley, Keith Bigelow; Data Analysis and PSAT function: Molly Lutcavage, Yonat Swimmer; Physiological Modeling: Hans Malte, Christina Larsen; Biochemical Correlates of Delayed Mortality: Chris Moyes; Kalman Filter Development: John Sibert, Anders Nielsen; Habitat Based Models and Stock Assessments: Pierre Kleiber, Keith Bigelow; Visual Capability of Pelagic Fishes: Eric Warrant, Kerstin Fritsches) we intend to explore many different avenues of investigation that may help explain vertical and horizontal movement patterns of turtles that may uncover vertical and thermal niche partitioning in the pelagic ecosystem.

Sustainable Fisheries Initiative

P.I.: Thomas A. Schroeder/Alvin Katekaru/John Kelly/Charles Karnella

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 Sustainable Fisheries Initiative (SFI) is a project intended to foster sustained optimal use of fishery resources and provide for maximum protection of marine endangered and threatened species of the State of Hawaii and other U.S. flag islands in the western Pacific region. As mandated under the Magneson-Stevens Fishery Conservation and Management Act (Magneson-Stevens Act), fishery conservation and management actions must be based on the best scientific information available. SFI endeavors to collect and analyze scientific data, including socio-economic information, and as appropriate, apply them to fisheries management activities. The desired outcome of SFI is to help increase food supply, enhance the economy, and maximize commercial and recreational fishing opportunities in the State. The major focus of this initiative is to develop, investigate and implement fisheries conservation and management programs consistent with the Magneson-Stevens Act, and other applicable laws such as, to fulfilling several objectives of the Endangered Species Act, Marine Mammal Protection Act, National Environmental Policy Act, and various Executive Orders. The study also entails analysis of biological, environmental, and economic issues such as, protected species interaction mitigation, including fishermen education and data collection/ monitoring in domestic and international fisheries. Researchers (Fisheries Specialists) will closely coordinate and collaborate with several existing organizations. These include the NOAA Pacific Islands Fisheries Science Center, NOAA National Ocean Service, Western Pacific Fisheries Management Council, State of Hawaii Department of Land and Natural Resources, UH Sea Grant Program, National Fisheries Authority (NFA) of Papua New Guinea (PNG), Marshall Islands Marine Resources Authority, Territory of American Samoa, Territory of Guam, and the Commonwealth of the Northern Mariana Islands.

Sustainable Fisheries: Sustainable Fisheries Division provides outreach and education for fishermen from commercial longline and bottomfish vessels in the Pacific Islands Region. Sustainable Fisheries works closely with the Observer Program, to provide information and instruction on protected species mitigation (sea turtles and seabirds) for commercial longline and bottomfish vessels based in Hawaii.

The Sustainable Fisheries outreach specialist demonstrating dehooking techniques in Micronesia.

Observer Program: 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 and bottomfish vessels based in Hawaii. The data are collected at sea by fisheries observers. The debriefers/data surveyors' primary purpose is to train observers and ensure the quality and integrity of data collected by the observers through debriefing observers and data editing.

Progress During FY 2005

The Marshall Islands Sea Turtle-Fisheries Interaction and Outreach Education Project was completed in December 2004. It is believed that changes in attitudes held towards turtles as incidental catch in longline fisheries will be reflected by increased attention of observers to this incidental catch and their release as a result of training received during project. The Marshall Islands Sea Turtle-Fisheries Interaction Outreach Education Project Phase II will take place in November 2005 in coordination with observer training by the Secretariat of the Pacific Community (SPC). The Papua New Guinea Sea Turtle Interaction Mitigation and Outreach Program Phase I was completed in January 2005. During that phase, a contractor worked with the National Fisheries Authority to train fishery observers on marine turtle handling and dehooking techniques. Also during that time frame, turtle excluder devices (TEDs) were introduced to the Gulf of Papua fishing industry by a contracted prawn trawl expert and were favorably received. Papua New Guinea Sea Turtle Interaction Mitigation and Outreach Program Phase II has been moved to August 2005 and as a result was not completed in FY 2005. Schedule changes with the National Fisheries Authority's observer trainings caused a postponement of the observer training covered under this project. The prawn trawl TED trial portion of this project has also been delayed because of

unexpectedly slow communications between the prawn trawl expert and engineers designing the TED frames. Expected implementation for the TED trial is August 2005. For the subcontract, Solomon Islands Sea Turtle-Fisheries Interaction Outreach Education Project, during April 27-May 1 a pre-project implementation site visit was carried out to determine the suitability of a project aimed at mitigating adverse consequences of sea turtle interactions with commercial fisheries. Such a project was determined to be suitable to the Solomon Islands, although, a date has yet to be scheduled for implementation.

During FY 2005, progress was made in areas of protected species interaction mitigation, data collection and monitoring, and keeping objectives consistent with the MSA, ESA, NEPA, and various Executive Orders.

Sustainable Fisheries: The outreach specialist continued her sea turtle dehooking program that instructs fishermen in the proper ways to use dehooking tools to release hooked and entangled sea turtles. She has trained 95 observers and all Hawaii longline vessel operators in sea turtle dehooking techniques. Through the outreach program an interactive DVD on sea turtle and seabird mitigation techniques was developed for longline fishermen. Also developed were an informative brochure on side-setting of longline gear, an identification guide of Hawaiian seabirds for recreational fishermen, and 26 Public Service Announcements for "Let's Go Fishing". The outreach specialist has also presented turtle handling procedures at the Technical Assistance Workshop in Hawaii and at the observer training workshop in Micronesia.

A support associate for Sustainable Fisheries was hired to assist with administrative work, as well as special projects. She has assisted and helped to coordinate many seabird related management actions, including Environmental Impact Statements, regulatory amendments and rule packages.

Observer Program: From July 2004 through June 2005, 416 observer trips were debriefed. Of the 416 observed trips, 260 were completed through the final data editing stage. This combined with the previous deficit of 40 trips from the previous year puts the observer program approximately 200 trips behind in the final data editing stage for observer data. This year the observer program has had an increase of approximately 150 observed trips more than the previous year. This increase and a shortage of debriefing staff are the major reasons for not meeting our objectives this year. However, we have since hired a full compliment of staff and we expect to meet our objectives for 2006.

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

P.I.: Valerie Allain, Robert Olson, Felipe Galván-Magaña, and Brian Popp (Brian Fry, Brittany Graham)

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

Recent modeling suggests that tuna productivity in the western and central Pacific Ocean is tied to upwelling along the equator in the central and eastern Pacific. The project proposes to test this hypothesis by combining diet analysis, stable isotopic analyses, and food-web modeling to study trophic-level variation and tuna movements in the equatorial Pacific. Our hypothesis predicts that tunas that reside near equatorial upwelling regions feed at relatively low trophic levels. Opposite trends are expected in equatorial regions with little upwelling, such as the warm pool of the western Pacific, where tunas are expected to feed at higher trophic levels and move extensively, searching for less-abundant prey. The main objectives of the project are 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 modeling of the equatorial Pacific Ocean.

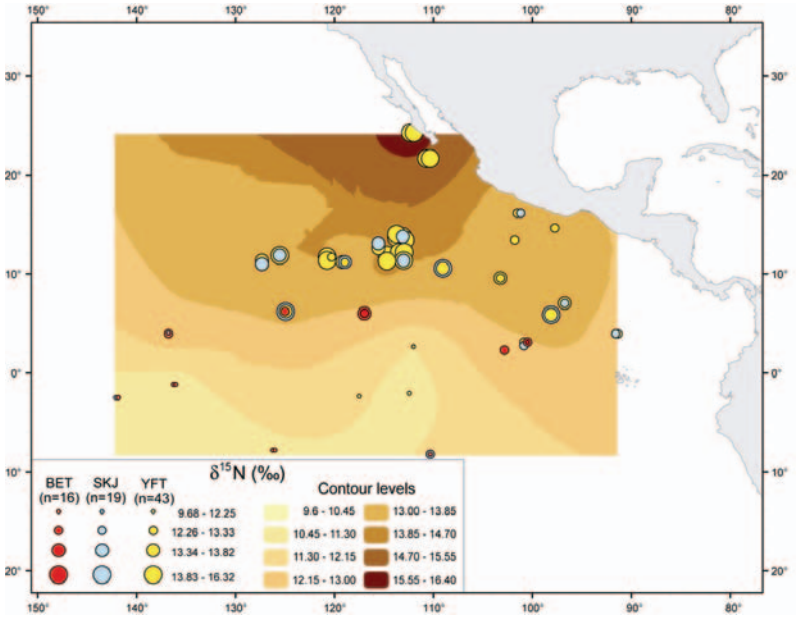
Progress During FY 2005

Sampling: In the western and central Pacific, 29 sampling trips on tuna fishing vessels have been completed. Of the 2513 stomachs collected so far from 60 species, 1605 have been examined in the laboratory. The diet data for albacore, yellowfin, and bigeye tuna have been partially analyzed. Zooplankton samples were collected during a scientific cruise in the western Pacific. In the central Pacific, an area that was previously underrepresented in

our collection efforts, 550 tissues samples from 18 pelagic organisms were collected during 2 recent NOAA oceanographic cruises. During the second cruise, a TAO/Triton-buoy cruise, water samples were also collected along a N-S transect across the equator, which will enable us to couple physical and chemical oceanographic conditions to the isotope ecology of tunas. In the eastern Pacific, 31 sampling trips on tuna purse-seine vessels were completed during this annual report period. Samples of stomachs and tissues have been collected from more than 8800 specimens of about 41 taxa. The majority of the stomach samples have been partially or completely analyzed in the laboratory, and the diet data for about 30 predator species caught in 41 purse seine sets have been analyzed by a student at CICIMAR, Mexico. Ten zooplankton samples and 17 POM samples were collected on a NOAA shark research cruise in the eastern Pacific.

In the cold tongue-warm pool pelagic ecosystem, we have documented that different regions have different isotope compositions. However, very little in the ocean is stationary enough or has a suitable lifespan to incorporate a permanent regional isotopic signal at the base of the food chain. To overcome these spatial and temporal hurdles, we predict that long-term isotopic values will be captured in the tissues of barnacles living on the stationary TAO-buoys. We recently collected barnacles from 10 different buoys in the central Pacific and have established collaborations with NOAA scientists to continue collecting barnacles from other TAO buoys. Once we have determined the regional isotope compositions of these primary consumers, we can better track movement patterns of mobile pelagic fishes.

Stable Isotope and Mercury Analyses: We analyzed samples for stable isotope analysis of (1) eastern Pacific yellowfin tuna, bigeye tuna, flying fishes, and mycotophid fishes, (2) western Pacific pelagic fish tissue samples, (3) tunas from throughout the equatorial Pacific to incorporate into our isotope biogeographic maps. (1) One-hundred and eighty-nine samples (composites of several individuals) from the eastern Pacific have been analyzed. The nitrogen isotope ratios of the yellowfin, skipjack, bigeye, myctophids, and flying fishes were incorporated into regional isotope biogeographic maps. (2) Three-hundred and twenty samples from the western Pacific have been analyzed. Focusing on just yellowfin tuna, the isotope values indicated that the fish have different diets in different areas. Samples from Micronesia in the warm pool are much different than samples from New Caledonia and French Polynesia, south and east of the warm pool, respectively. (3) After considerable effort to analyze samples from throughout the equatorial Pacific, we have developed our first basin-wide isotope biogeography maps. These maps are more robust for the eastern Pacific, where the geographical coverage of the samples is of high resolution. The maps demonstrate that the isotope values of the tunas are not homogenous, which would be expected if they moved and mixed extensively. Our maps illustrate strong patterns, both basin-wide (between the western and eastern Pacific) and regionally (within the eastern Pacific), suggesting little movement.



Nitrogen stable isotope ratios, $\delta^{15}N$ (‰), in the white muscle of yellowfin, skipjack, and bigeye tunas caught in the eastern Pacific Ocean. A significant trend of higher $\delta^{15}N$ values at higher latitudes is apparent.

Seventy-one samples were analyzed for methyl mercury concentrations. The results for the tunas indicated that methyl mercury concentrations increase with fish size. Our complete data set, which includes skipjack, wahoo, mahi mahi, oilfish, prey species, and others, indicates that methyl mercury contents increased with depth of foraging. Accordingly, we intend to couple the Hg and isotope data sets to examine foraging depth by pelagic fishes.

Modeling and Diet Analyses: Progress has been made to develop a new ecosystem model, based on Ecopath with Ecosim (EwE), for the western Pacific. Efforts were focused on obtaining better diet data for the model. Instead of taxonomic prey components, we are considering classifying the main prey according to their depth distribution and vertical migratory behavior. Hence, the prey found in the stomach contents was classified into 6 categories (epipelagic, non-migrant mesopelagic, surface migrant mesopelagic, non-migrant bathypelagic, surface migrant bathypelagic, and intermediate migrant bathypelagic). The diets of the main predators are now examined according to these classes, and we are in the process of gathering the data to formulate a new Ecopath model. The current EwE model for the pelagic ecosystem of the eastern Pacific will be reformulated based on new diet and stable isotope data from this project. These data are being compiled as more samples are analyzed.

A comparative study has been carried out using diet data for yellowfin tuna in the eastern and western Pacific. This preliminary study shows important differences between the food habits in the two regions, probably linked to the depth of the thermocline, to the depth of the oxygen-minimum zone in the eastern Pacific, and to the presence of numerous coral islands in the western Pacific. A detailed analysis of the data for the western Pacific highlights differences in the diets among yellowfin from New Caledonia (epi- and mesopelagic fishes), Polynesia (epipelagic fishes and crustaceans, juvenile reef fishes), and PNG-Solomon (epipelagic fishes and crustaceans, juvenile reef fishes). Differences are also observed in the isotope data, but more samples need to be analyzed to link the diet data and the isotope data of the tunas.

Western Pacific Fisheries Information Network

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

NOAA Goal(s)

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

Purpose of the Project

WPacFIN's ongoing goal is to improve the availability of accessible, timely, and high-quality fisheries data needed for research and fisheries management. The WPacFIN Program improves the data processing and management capabilities of fisheries scientists, researchers, and managers at JIMAR, UH, NMFS, and the Western Pacific Regional Fisheries Management Council. It also gives technical support to participating WPacFIN fisheries agencies in American Samoa, Hawai'i, Guam, and the Commonwealth of Northern Mariana Islands, with JIMAR staff providing the major support for American Samoa and Hawai'i. WPacFIN integrates local and federal data, shares it through WPacFIN data share agreements, and manages it locally on a central computer at PIFSC. It provides direct access to the data for qualified users and fulfills numerous data requests for researchers throughout the year. The JIMAR staff provides most support for producing the routine annual report products of "Fisheries of the United States" (FUS) and "Fishery Statistics of the Western Pacific" (FSWP), and status reports for the Bottomfish and Pelagics Fishery Management Plans for American Samoa and Hawai'i. In addition, the JIMAR staff provides the main support for maintaining the WPacFIN Website at the PIFSC that provides public access to non-confidential fisheries data, charts, various reports, and general information on related fisheries and island agencies

Progress During FY 2005

Objectives for FY 2005: The overall goal of the WPacFIN project is to continue providing the wide range of technical and data processing support needed to continue improving fisheries data collection, fisheries monitoring, management, and research programs throughout the Western Pacific. Systems development efforts are ongoing in each of the Pacific island areas and JIMAR staff play a major role in developing systems for American Samoa and Hawai'i. WPacFIN JIMAR staff will develop new and robust data integration algorithms for HDAR (Hawaii Department of Aquatic Resources) data to improve creation of "best available" statistics from the various data sets (e.g. integrating dealer- and fisherman-reported data), data quality control (QC) and reporting modules for HDAR's new aquarium fish reporting system. They will also design, program, and implement a Tutuila-based inshore creel survey system for American Samoa's DMWR (Department of Marine and Wildlife Resources). Reports are also a priority for the WPacFIN project, and related goals include 1) completing the design, programming, and implementation of automated annual report module generators for the Bottomfish and Pelagics Plan Teams for Hawai'i; 2) designing, programming, and implementing processes for generating summary statistics and

graphical outputs for use by the Coral Reef Ecosystem Plan Team (CREPT) to produce this FMP's first annual report for American Samoa and Hawai'i fisheries agencies (note: this is a continuing project because the CREPT only recently developed specifications for the report); and 3) continuing the development and improvement of automated production software for "Fisheries of the United States" and "Fishery Statistics of the Western Pacific" for Guam, CNMI, American Samoa, and Hawai'i. The WPacFIN website will continue to be upgraded and maintained by WPacFIN JIMAR staff. Likewise, DIAS implementation and form archival procedures will be improved, expanded, and standardized where possible in American Samoa and Hawai'i.

Progress to Date: WPacFIN JIMAR projects have made very significant progress in providing technical support and applications development. Many complex computer programs have been written, and implemented in the island agencies and in the central WPacFIN office to process the wide range of data collected by fishery dependent data collection programs in the island agencies and to make these data available to users. More specifically, this past year's most notable accomplishments include: 1) improving data quality control (QC), processing, and reporting modules for HDAR's general Fishermen Reporting System and Dealer Reporting System; 2) developing and implementing new applications for Northwest Hawaiian Islands (NWHI) bottomfishing and the Aquarium Fish Reporting System; 3) studying and analyzing data integration algorithms for HDAR data to improve creation of "best available" statistics from the various data sets; 4) improving and standardizing American Samoa inshore data collection methodology; 5) making significant progress on improving the automated production of annual Plan Team reports for American Samoa and Hawai'i and the production of FSWP and FUS reports ("how to" documentation on producing these reports were also in progress); 6) successfully implementing the Document Imaging and Archival System (DIAS) in American Samoa DMWR (it was implemented in HDAR during previous year); 7) significantly upgrading and modifying the WPacFIN Website; and 8) upgrading the processing power and operating systems of all PC's in WPacFIN-associated island agencies.

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 Northwest Hawaiian Island as a national refuge. To date, JIMAR research has been directed at issues related to coral reefs, a major component of the coastal zones of Hawaii and U.S.-affiliated Pacific Islands.

Coral Reef Management Initiative

P.I.: Alan Everson, John Naughton

NOAA Goal(s)

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

Purpose of the Project

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 develop 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 reef.

Progress During FY 2005

Staff continued participation in the Hawaii Coral Reef Mitigation Working Group, conducted surveys of mitigation projects in Palau, Saipan, Hawaii and American Samoa, conducted biological assessments in Hawaii and USAKA, Republic of the Marshall Islands. Also provided on-site technical advice and assistance to Yap State EPA in dredge project assessment activities and Yap State MRMD in Ulithi turtle assessments and satellite tag application. In addition, staff located in American Samoa, CNMI and Hawaii coordinated Local Action Strategies for inshore coral reef fisheries management. These activities included revising the action plans, presiding over planning meetings and ensuring the goals and objectives of the various plans are met. Also responsible for budget planning and other funding issues. Organized and participated in 3 Fishery Forums, one in Saipan, one in Rota and one in Tinian in collaboration with the Western Pacific Regional Management Fisheries Council and the CNMI Division of Fish and Wildlife (DFW). In addition, several workshops were planned and implemented by field staff.

JIMAR staff also responded to two vessel groundings in Hawaii, one on Oahu (M/V Cape Flattery) and the other on Pearl and Hermes reef in the Northwestern Hawaiian Islands (M/V Casitas). For the Oahu vessel grounding the staff performed essential damage pre-assessment work as well as leading the efforts in coral reef restoration and is planning to start the actual damage assessment work in August. Staff have also been participating in the pre-assessment planning phase for the recent grounding off of Pearl and Hermes reef and is slated to start the damage pre-assessment in August. All of these efforts support the initiatives to protect and restore coastal resources. In addition staff provided GIS products for the restoration and damage assessment of the M/V Cape Flattery and M/V Casitas. Continued participation in the interagency habitat mapping efforts on research vessels in the NWHI (M/V Hi'ialakai) and Main Hawaiian Islands (M/V Kilo Moana) and met with regional GIS coordinators within the NMFS for the purpose of streamlining and standardizing GIS efforts. Also participated in workshops on GIS as it relates to coral reefs, habitat restoration, climate change and coral reef bleaching, coral reefs and land-based pollution, and marine mammals.

National Environmental Policy Act (NEPA) Initiative

P.I.: Thomas A. Schroeder/Charles Karnella

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

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 environment, stimulate health and welfare of man and enrich understanding of ecological systems and natural resources important to the Nation. The major focus of this initiative is to obtain technical assistance on an activity- and project-specific basis to ensure timely and legally sufficient agency compliance with applicable NEPA requirements. This initiative is comprised of two components, both addressing critical NEPA requirements. One component addresses NOAA Fisheries Service's NEPA compliance associated with a State of Hawaii conservation project. Key tasks for this component are: 1) managing NOAA Fisheries' NEPA compliance activities associated with oversight of the State's project, and 2) assisting the State in its development of the conservation project by providing marine resource expertise and input on structuring and implementing the project. The second component of this initiative addresses similar issues in international waters. This component of 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 other arenas, namely State and local projects and international projects.

Information and lessons learned from these two components of this NEPA Initiative will be evaluated and applied to future NEPA actions. NEPA focused hires under this initiative will closely coordinate and collaborate with several existing organizations with marine resource protection mandates. These include, but are not limited to: NOAA Pacific Islands Region Fisheries Science Center, NOAA National Ocean Service, NOAA and NOAA Fisheries Service headquarters components, the Western Pacific Fishery Management Council, and the State of Hawaii Department of Land and Natural Resources.

The purpose is the development of a NEPA Analysis for the Western and Central Pacific Fisheries Commission (WCPFC) and its implementing statute and regulatory regime. The position of International NEPA Project Manager will serve as NEPA project manager for the development of the NEPA analysis for the WCPFC. The position of International NEPA Project Analyst will serve as NEPA Project Analyst and will support development of a NEPA analysis for the WCPFC.

Progress During FY 2005

Hired International NEPA Project Analyst. Recruiting for International NEPA Project Manager and NEPA Administrative Assistant.

Sustaining Healthy Coastal Ecosystems

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

NOAA Goal(s)

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

Purpose of the Project

To address concerns about the deterioration of coral reef ecosystems around the globe, this project supports multi-disciplinary efforts to assess, monitor, map, restore, and protect coral reef ecosystems of the U.S. Pacific Islands. The goals of this program 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 2005

Program Overview: The JIMAR Sustaining Healthy Coastal Ecosystems program is funded by NOAA Coral Reef Conservation Program and is staffed by over 50 researchers, support personnel, and graduate students. This includes 42 full-time personnel and 9 U.H. graduate students that are employed through the Joint Institute of Marine and Atmospheric Research (JIMAR). 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).

During 2004-2005, the JIMAR Sustaining Healthy Coastal Ecosystems program conducted multi-disciplinary research cruises to conduct 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 (NWHI), the Main Hawaiian Islands (MHI), and Saipan in the Commonwealth of the Northern Mariana Islands (CNMI). 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. Program activities that evaluate and reduce adverse impacts to coral reef ecosystems, included marine debris removal efforts in the NWHI and MHI, mass

coral bleaching studies in the NWHI, and damage assessment and restoration efforts related to the grounding of the Flattery off Barber's Point.

In November 2004, more than a dozen JIMAR scientists delivered presentations representing work accomplished through PIFSC's Coral Reef Ecosystem Division (CRED) at the Northwestern Hawaiian Islands Third Scientific Symposium in Honolulu. Attended by more than 150 scientists, managers, and policy makers, this Symposium was conceived to provide a forum for the review and synthesis of recent research, as well as a mechanism for identifying knowledge gaps and delineating future research needs. Fourteen oral presentations and nine poster presentations were made by JIMAR scientists on coral reef ecosystem research in the NWHI.

Ecological Assessment—Fish: Ecological assessments of reef fish were conducted on NOAA Ship *Hi'ialakai* cruise to the NWHI in the fall of 2004 (09/13/04 – 10/17/04) and on the NOAA Ship *Oscar Elton Sette* cruise to the MHI in the spring of 2005 (2/24/25 – 03/06/05).

Resurveying of fish at 60 historical stations throughout the NWHI (9 reefs) in September-October 2004 confirmed the continued presence of high standing biomass fish assemblages dominated by carangid (jack) and shark apex predators. Fish assemblages continued to be numerically dominated by medium-bodied herbivores (primarily acanthurids) and by large numbers of small-bodied planktivores (primarily pomacentrids, but also chaetodontids and anthiine basslets). Endemic Hawaiian species rarely encountered on shallow reefs in the main Hawaiian Islands (e.g. *Genicanthus personatus, Epinephelus quernus*) were regularly seen at the northern three atolls. Species representing faunal links to southern Japan, including *Centrypyge interrupta*, were observed at the northern three atolls but were not recorded during transects.

Fish REA surveys on the first CRED cruise in the MHI (mostly around Maui and Hawaii) were conducted in February—March 2005. Large apex predators such as sharks and jacks were rarely encountered and only several small jacks (30-40cm) were observed, in contrast to the NWHI. Small snappers such as *Aphareus furca* and *Lutjanus kasmira* and the grouper *Cephalopholis argus* were common predators in the MHI. Fish assemblages were numerically dominated by acanthurids, pomacentrids and chaetodontids. Towed-diver surveys assessed large fish (>50 cm Total Length [TL]) along ~ 110 km of coastal habitat. The redlip parrotfish (*Scarus rubroviolaceus)* and the spectacled parrotfish (*Chlorurus perspicillatus*) were common large fish at all islands and habitat types. Fish predator densities were low at all islands. Only one whitetip reef shark (*Triaenodon obesus*) and four giant trevally (*Caranx ignobilis*) were observed. The most common jack was the bluefin trevally (*Caranx melampygus*), while mostly <50 cm TL. The finescale triggerfish (*Balistes polylepis* was frequently observed along the south of Hawaii. The spotted knifejaw (*Oplegnathus punctatus*) was seen multiple times. Only one tiger shark (*Galeocerdo cuvier*) was seen. Hawaiian green sea turtles (*Chelonia mydas*) were observed during many surveys and were especially abundant along the southeast coasts of Hawaii. Four hawksbill turtles (*Eretmochelys imbricata*) were observed along the southeast coast of the island of Hawaii.

Throughout the year, analysis continued on the growing datasets for Pacific reef fish assemblages. Six peer-reviewed manuscripts have been published or submitted for publication from this work. Contributions were also made to *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005*, in Chapters 11 (American Samoa,), 15 (CNMI), and 16 (Guam).

Ecological Assessment—Corals: In November 2004, more than a dozen JIMAR scientists delivered oral or poster presentations representing work accomplished through Pacific Islands Fisheries Science Center's Coral Reef Ecosystem Division (CRED) at the Northwestern Hawaiian Islands Third Scientific Symposium in Honolulu. Two JIMAR presentations focused on the mass coral bleaching event that affected the Northwestern Hawaiian Islands in late summer 2002, and the local scientific community was introduced to data freshly collected September 2004 that documented a second episode of mass coral bleaching. An additional JIMAR poster presentation at the NWHI Symposium focused on the first two years of data generated from larval recruitment plates that are annually deployed and retrieved at six locations throughout the NWHI.

A second year of surveying long-term monitoring sites in the NWHI that were selected by a multi-disciplinary team in 2003 was conducted onboard the NOAA vessel *Hi'ialakai* in September/October 2004. This was the first scientific expedition undertaken by the *Hi'ialakai* since she was refurbished for Pacific reef studies, and JIMAR scientists worked cooperatively with scientists from the NWHI Coral Reef Ecosystem Reserve, Bishop Museum, and University of Hawaii in a productive partnership. Highlights of the expedition, in addition to documenting a second episode of mass coral bleaching, included observations of the progression of disease tumors in *Acropora* populations at French Frigate Shoals, and the discovery by JIMAR Marine Debris Specialists of a shipwreck at Pearl & Hermes Atoll which is likely one of the namesakes of that reef.

Soon after the grounding of the 555-foot bulk carrier Cape Flattery off Barber's Point, Oahu in February 2005, JIMAR scientists at Pacific Islands Fisheries Science Center (PIFSC) were requested by NOAA's Pacific Area Regional Office (PIRO) to conduct an assessment of damage to the benthic environment using CRED's unique towed-diver survey methodology. Four such surveys were conducted in mid-February, after which JIMAR Marine Ecologist Dr. Jean Kenyon conducted a detailed, georeferenced analysis of the digital imagery recorded during the tows using sophisticated protocols developed within CRED. The report subsequently presented to PIRO and Hawaii Department of Aquatic Resources (DAR) following approval for release by NOAA Fisheries Pacific Islands Fisheries Science Center stands as an unbiased quantitative assessment of the benthic damage resulting from this grounding incident.

Ecological Assessment—Algae: Since summer of 2004, seven peer-reviewed manuscripts incorporating data collected by the CRED phycology lab have been published or accepted for publication. An additional two manuscripts are in review. Five of these manuscripts focus on the Northwestern Hawaiian Islands. The detailed analysis of benthic cover at French Frigate Shoals that was discussed in last year's annual report has spawned 3 manuscripts: a qualitative assessment of algal species, a quantitative assessment of benthic cover, and a qualitative assessment of scleractinian coral species. An additional manuscript looking at relative abundance of macroalgae across the entire Northwestern Hawaiian Island archipelago based on in situ observations will be published in the proceedings of the Northwestern Hawaiian Islands' 3rd Scientific Symposium. One new species of red algae, named *Dasya atropurpurea*, was described from Pearl and Hermes Atoll.

Algal manuscripts from outside the Northwestern Hawaiian Islands include the description and molecular characterization of *Halimeda kanaloana* from Maui Nui. Analysis of algal data collected from the Mariana archipelago was combined with sea turtle observations to produce 2 manuscripts trying to link turtle abundance with foraging patterns. Finally, a Pacific-wide study of benthic functional groups revealed that most healthy tropical reefs in the Pacific are dominated by algal functional groups rather than coral communities. In additional to these peer-reviewed manuscripts, the CRED phycology lab has provided data from the Northwestern Hawaiian Islands and US Pacific Remote Island Areas integral to completing sections in 2 recent volumes: *Status of Coral Reefs of the World: 2004* and *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005*. Algal presentations were given at the Northwestern Hawaiian Islands' 3rd Scientific Symposium in Honolulu during November 2004 and at the XVIII International Seaweed Symposium in Bergen, Norway in June 2004.

A new species, Dasya atropurpurea *sp. nov., is a deep water red algae that was found in the Northwestern Hawaiian Islands (photo by Peter Vroom).*

Ecological Assessment—Invertebrates: The non-coral marine invertebrate component is conducted through a partnership between the Coral Reef Ecosystem Division (CRED) of the NOAA Pacific Islands Fisheries Center and the Hawaii Biological Survey and Pacific Biological Survey of the Bishop Museum, both based in Hawaii. In the variety of locations in which surveys have been conducted, a set of target organisms are enumerated with quantitative techniques for the purpose of monitoring. In conjunction with the regular monitoring activities the species richness of the various habitats present is gradually being assessed through the collection and identification of various taxonomic groups from these research cruises. With the addition of 2004-2005 survey results, the preliminary totals for species richness are: 885 species from 12 phyla for the (NWHI), 396 species from 4 phyla for the Pacific Remote Island Areas (PRIA), and 507 species from 4 phyla for American Samoa. In FY2005 there were 2 new records for the Hawaiian Archipelago: Trapezid crabs *Tetralia glaberrima* and *Tetralia muta*. Also,

a new species of hermit crab from the genus Dardanus was identified from Howland and Baker Islands in the PRIA. Only a fraction of material collected for identification has been completed and the values reported here will increase greatly. These efforts also allow for alien species surveys to be conducted in these remote habitats. Data from the CRED efforts have been combined with other surveys to compile records for alien species (marine invertebrates only). The current results for FY2005 are as follows: 7 species from 3 phyla for the NWHI, 13 species from 6 phyla for the PRIA and 26 species from 8 phyla for American Samoa.

Oceanography: Oceanographic monitoring and assessment continues throughout the Northwestern Hawaiian Islands (NWHI), Guam and the Commonwealth of the Northern Marianas Islands (CNMI), American Samoa, and the U.S. Line and Phoenix Islands. Over the last year, 51 new instruments have been deployed, expanding CRED's existing long-term monitoring network to 132 stations measuring various oceanographic and meteorological conditions at 44 islands and banks around the Pacific Ocean. 447 closely-spaced shallow water (30 m) conductivity, temperature, depth casts (CTDs), approximately 50 shipboard deepwater (50 m) CTDs, and thousands of kilometers of acoustic doppler current profiler (ADCP) transects have also been collected over the past year, expanding CRED's existing oceanographic assessment data. New for this year, oceanographic assessments are being complimented with *in-situ* water samples of chlorophyll and dissolved nutrient concentrations, with over 65 sampling locations visited over the last year. Other variables, such as dissolved inorganic carbon (DIC) and colored dissolved organic matter (CDOM) are also being measured at certain locations as part of a collaborative effort with NOAA's Pacific Marine Environmental Laboratory (PMEL) and Atlantic Oceanographic and Meteorological Center (AOML).

Ocean circulation and archipelago connectivity studies have also moved forward. CRED continues to monitor satellite tracked oceanic drifters (SVPs) and has established a partnership with the International Pacific Research Center (IPRC) this year to develop a numerical circulation model for the greater Hawaiian Archipelago.

Over the past year, great strides have also been made in standardizing CRED's oceanographic data and data collection procedures. A substantial portion of the data has been documented with Coral Reef Information System (CoRIS) and prepared for dissemination to stakeholders. Data collaboration has been formed with NOAA National Weather Service (NWS) and it is likely than CRED's telemetered time series observations will be incorporated into NWS observations within the next year. Current efforts are centered on data processing, completing reference guides on data collection protocols and processing methodology, and finalizing a spatially searchable database accessible via the Web.

The greater standardization and CRED's multidisciplinary approach to coral reef ecosystem research and continued expansion of oceanographic data collection has resulted in the publication of four oceanographic manuscripts currently in press, two in review, and an additional two in preparation.

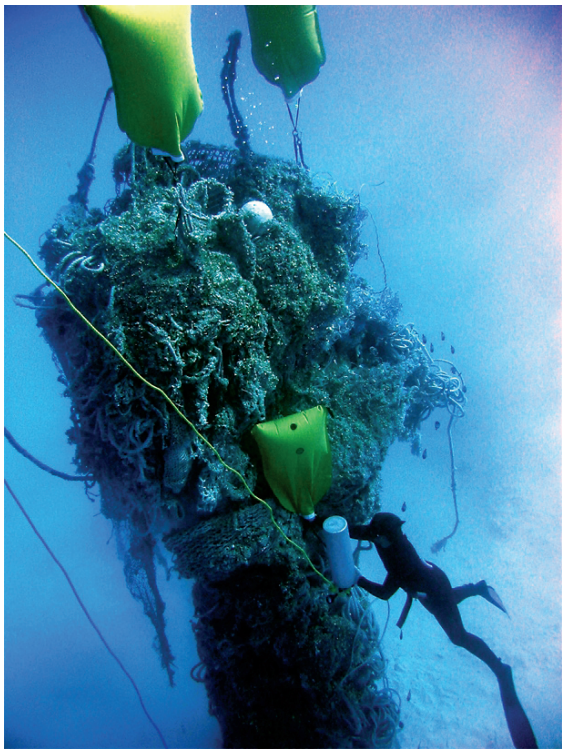
Benthic Habitat Mapping: Benthic habitat mapping of coral reefs is an important part of the JIMAR Sustaining Healthy Coastal Ecosystems work. Since 2001 surveys have been conducted in U.S.-affiliated Pacific Islands using bottom cameras, towed diver surveys, and single-beam echosounders. In FY 2003 a significant new mapping capability was added to this program with the delivery of a 25-ft survey launch, R/V AHI, which is equipped with a 240-kHz multi-beam sonar. Extensive mapping (755 km2 surveyed) was conducted in 2003/2004 at Midway; at Saipan, Marpi Bank, Tinian, Tatsumi Reef, and Rota in the Commonwealth of the Northern Mariana Islands; in Guam; and at Tutuila, Ofu, Olosega, and Ta'u Islands in American Samoa. In 2004/2005 data sets and metadata for all of these locations were submitted to the National Geophysical Data Center, and grids were made available through the website, http://www.pifsc.noaa.gov/cred/hmapping/.

Working with the U.S. Navy, scientists returned to CNMI in November 2004 to collect additional ground truth data in the Saipan Anchorage; a 45-page report "Characterization of Benthic Habitats for Saipan Anchorage Commonwealth of Northern Mariana Islands" was submitted to the Navy in May 2005. The NOAA Ship *Hi'ialakai* with two multibeam sonars (30 and 300 kHz) started operations in the Hawaiian Archipelago in early 2005, and over 100 days of seafloor mapping operations were conducted on 5 cruises. In the NWHI, boundary mapping was conducted at Nihoa, Kure and Pearl and Hermes; 90 per cent of the western bank of French Frigate Shoals was completed; and limited areas were mapped at Necker, Maro, and Midway. In the MHI, Ni'ihau Island was mapped in water depths from 20-200m, and approximately 50 per cent of Penguin Banks and 90 per cent of the north shore of Molokai were mapped in 15-150m depths. On the island of Oahu, 46 km^2 at depths between 20 m and 100 m was mapped in the vicinity of Kahuku Pt. Ground truth data were also collected at Ni'ihau, Kauai, Oahu and Penguin Bank in the MHI. Data processing and preparation of metadata is underway for all multibeam and ground truth data collected.

Marine Debris Removal: The Marine Debris Removal Program of CRED leads an immensely successful multi-agency effort to remove and recycle derelict fishing gear from the reefs and beaches of the NWHI. Since the inception of marine debris removal efforts in 1996, over 456 metric tons of derelict fishing gear have been removed from the NWHI. The four primary goals are:

- To assess, document and remove derelict fishing gear from the coral reef environment of the NWHI.
- To remove derelict fishing gear from the beaches and islands of the NWHI.
- To monitor debris accumulation in two areas, the High Entanglement Risk Zones (HERZ) for Hawaiian monk seals (*Monachus schauinslandi*) and specified derelict fishing gear accumulation rate study sites.
- To expand the net analysis database.

Marine debris survey and collection activities from 1996-2005 were conducted at Kure Atoll, Midway Atoll, Pearl and Hermes Atoll, Lisianski Island, Laysan Island, and French Frigate Shoals. The 2004 summer field season was marked by the unexpected discovery of several unique shipwrecks sites at Pearl and Hermes Atoll. The shipwrecks are thought to possibly be the whaling vessels Pearl and Hermes who reportedly ran aground on the reef in 1822. Although no live entanglements were witnessed this year, divers did find a fully intact loggerhead turtle skeleton and partially decomposed small cetacean carcass in entangled in net.



A diver from the Marine Debris Program utilizes liftbags to raise a large conglomerate of derelict fishing gear to the surface for removal at Pearl and Hermes Atoll, NWHI (photo by Amy Hall).

Debris removed by island or atoll for 2004:

Laysan Island: 3040 kg
Lisianski Island: 2799 kg
Kure Atoll: 2667 kg
Maro Reef: 46740 kg
Pearl and Hermes Atoll: 54538 kg
French Frigate Shoals: 1402 kg
Total: 111, 803 kg

The 2005 summer field season started on June 8th with the departure of the M/V Casitas and 16 marine debris divers. A total of 14, 200 kg (14.2 metric tons) were removed from the coral reefs and beaches of the NWHI in the month of June.

Debris removed by island or atoll for 2005:

Laysan Island: 1084 kg
Lisianski Island: 1170 kg
Kure Atoll: 2245 kg
Midway Atoll: 4899 kg
Pearl and Hermes Atoll: 4914 kg
Total: 14, 312 kg

The 2005 summer marine debris season was scheduled for 120 days, but ended early on July 1 when the M/V Casitas ran hard aground at Pearl and Hermes Atoll. All marine debris divers safely evacuated the ship and spent two days at North Island within Pearl and Hermes Atoll. The NOAA Ship *Sette* picked up all personnel on July 3rd and moved them to Midway Atoll, where the Coast Guard C-130 flew everyone back to Honolulu on the morning of the July 6.

The ecological research projects that were implemented and conducted during the 2004/2005 (FY05) marine debris field season include:

- A baseline population study of the black-lipped pearl oyster (*Pinctada margaritifera*) and the crown-of-thorns sea star (*Acanthaster planci*),
- A derelict fishing gear accumulation rate study at Kure and Pearl and Hermes Atolls.

In November of 2004, the marine debris team in coordination with NOAA's Pacific Islands Regional Office (PIRO), the State of Hawaii's Division of Land and Natural Resources (DLNR), and the U.H. Hawaii Institute of Marine Biology (HIMB), removed a large derelict net, weighing over 4,536 kg from Kaneohe Bay, Oahu. This was the largest net removal in the main Hawaiian Islands; over 20 personnel from various organizations participated and much media recognition was garnered.

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Appendix I List of Acronyms

ABC	Atmospheric Brown Cloud
ADCP	Acoustic Doppler Current Profiler
ADP	Acoustic Doppler Profiler
ADRM	Advection Diffusion Reaction Model
AGCMs	Atmospheric General Circulation Models
AOML	Atlantic Oceanographic and Meteorological Center
APDRC	Asia Pacific Data Research Center
ARSHSL	Archival of Rapidly-Sampled Hawaiian Sea Level
ASCII	American Standard Code for Information Interchange
ASM	Asian Summer Monsoon
BFAL	Black-footed Albatross
BUGS	Bayesian Inference Using Gibbs Sampling software
CCA	Canonical Correlation Analysis
CDOM	Colored Dissolved Organic Matter
CICIMAR	Centro Interdisciplinario De Ciencias Marinas
CITES	Convention on International Trade and Endangered Species
CLIOTOP	Climate Impacts on Oceanic Top Predators
CMR	Coastal and Marine Resources
CNMI	Commonwealth of the Northern Mariana Islands
COADS	Comprehensive Ocean Atmosphere Data Set Project
Co-Ops	Center for Operational Oceanographic Products and Services
CoRIS	Coral Reef Information System
CPC	Climate Prediction Center
CPUE	Catch Per Unit Effort
CRED	Coral Reef Ecosystem Division
CREPT	Coral Reef Ecosystem Plan Team
CRMI	Coral Reef Management Initiative
CSIRO	Commonwealth Scientific and Industrial Research Organization
CTDs	Conductivity Temperature Depth casts
DAR	Department of Aquatic Resources
DART	Deep-Ocean Assessment and Reporting of Tsunamis
DFW	Department of Fish and Wildlife
DIAS	Document Imaging and Archival System
DIC	Dissolved Inorganic Carbon
DLNR	Division of Land and Natural Resources
DMWR	Department of Marine and Wildlife Resources
DSS	Data Server System
ECHAM5	European Center Hamburg Atmospheric Model 5
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
ENSO	El Nino/Southern Oscillation
EPA	Environmental Protection Agency
ERD	Environmental Research Division
ESA	Endangered Species Act
ESSIC	Earth System Science Interdisciplinary Center
EwE	Ecopath with Ecoism
FADs	Fish Aggregation Devices
FMP	Fisheries Management Plan
FSWP	Fishery Statistics of the Western Pacific
FTE GIS	Full Time Employment Geographic Information System
FUS	Fisheries of the United States
GAMS	General Algebraic Modeling System

GCOS	Global Climate Observation System
GFDL	Global Fluid Dynamics Laboratory
GIS	Global Ionospheric Studies
GLOBEC	Global Ocean Ecosystem Dynamics
GLOSS	Global Sea Level Observing System
GMB	Grid and Mask Builder
GODAE	Global Ocean Data Assimilation Experiment
HARP	High-frequency Autonomous Acoustic Recording Package
HCD	Habitat Conservation Division
HDAR	Hawaii Division of Aquatic Resources
HERZ	High Entanglement Risk Zones
HIMB	Hawaii Institute of Marine Biology
HMRFSS	Hawaii Marine Recreational Fishing Statistics Survey
HSCO	Hawaii State Climate Office
HTTP	Hyper Text Transport Protocol
IATTC	Inter-American Tropical Tuna Commission
IOC	Intergovernmental Oceanographic Commission
IODZM	Indian Ocean Dipole Zonal Mode
IOOS	Integrated Ocean Observing System
IPRC	International Pacific Research Center
ITCZ	Intertropical Convergence zone
JGOFS	Joint Global Ocean Flux Study
JIMAR	Joint Institute for Marine & Atmospheric Research
KNB	Knowledge Network for Biocomplexity
LAAL	Laysan Albatross
LAS	Live Access Server
LODS	Longline Observer Data System
MARDAP	Marine Resource Dynamics Assessment Program
MARS	Micronesian Archaeological Research Services
MBNMS	Monterey Bay National Marine Sanctuary
MHI	Main Hawaiian Islands
MMPA	Marine Mammal Protection Act
MMRP	Marine Mammal Research Program
MOSEAN-HALE ALOHA	Multi-Disciplinary Ocean Sensors for Environmental Analyses and Network Hawaii Air-Sea Logging Experiment A Long Term Oligotrophic Habitat Assessment
MPA	Marine Protected Area
MRMD	Marine Resources Management Division
MSA	Magneson Stevens Fisheries Conservation Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
M-SURGE	Multistate Survival Generalized Estimation software
MULTIFANCL	a length-based, age and spatially-structured statistical model for fisheries stock assessment
NASA	National Aeronautics and Space Administration
NCDC	National Climate Data Center
NEPA	National Environmental Policy Act
NERC	National Environment Research Council
NESDIS	National Environmental Satellite, Data, and Information Service
netCDF	Network Common Data Format
NFA	National Fisheries Authority
NIWA	National Institute for Water and Atmosphere, New Zealand
NLOM	Navy Layered Ocean Model
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

NODC	National Oceanographic Data Center
NOS	National Ocean Service
NRIFSF	National Research Institute of Far Seas Fisheries
NRL	Naval Research Laboratory
NWHI	Northwestern Hawaiian Islands
NWS	National Weather Service
OACES	Ocean Atmosphere Carbon Exchange Study
OGCM	Ocean General Circulation Model
OPeNDAP	Open Source Project for a Network Data Access Protocol
ORACLE	relational database management system software
PAT	Pop-up Archival Transmitting
PC	Precious Coral
PEAC	Pacific ENSO Applications Center
PFADs	Private Fish Aggregating Device
PFRP	Pelagic Fisheries Research Program
PI	Principle Investigator
PIFSC	Pacific Islands Fisheries Science Center
PIR	Pacific Islands Region
PIRO	Pacific Islands Regional Office
PMEL	Pacific Marine Environmental Laboratory
PMU	Pelagic Management Unit
PNG	Papua New Guinea
POM	Princeton Ocean Model
PRETOMA	Programa Restauracion de Tortugas Marinas
PRIA	Pacific Remote Island Areas
PRIDE	Pacific Region Integrated Data Enterprise
PSATs	Pop-up Satellite Archival Tags
PSTAT	Pop-up Satellite Transmitting Archival Tag
PTWC	Pacific Tsunami Warning Center
QC	Quality Control
RAM	Regional Atmospheric Model
RCUH	Research Corporation of the University of Hawaii
RFP	Request for Proposals
RFQ	Request for Quotations
SCTB	Standing Committee on Tuna and Billfish
SEAPODYM	Spatial Ecosystem and Populations Dynamics Model
SEC	South Equatorial Current
SECC	South Equatorial Counter Current
SEFSC	Southeast Fisheries Science Center, National Marine Fisheries Service
SFI	Sustainable Fisheries Initiative
SIO	Scripps Institution of Oceanography
SOEST	School of Ocean & Earth Science & Technology
SPC	Secretariat of the Pacific Community
SSH	Sea Surface Height
SSL	Sonic Scattering Layer
SST	Sea Surface Temperature
SVN	Subversion code management software
SVPs	Surface Velocity Programs
SWFSC	Southwest Fisheries Science Center
SWIO	Southwest Indian Ocean
TAO	Tropical Ocean-Atmosphere
TDR	Temperature-Depth Recorders
TEDs	Turtle Excluder Devices
U-CARE	Utilities-Capture-Recapture software

UH	University of Hawaii
UHSLC	University of Hawaii Sea Level Center
USAKA	United States Army Kwajalein Atoll
USAPI	United States Affiliated Pacific Islands
USGS	United States Geological Survey
WPacFIN	Western Pacific Fishery Information
WCPFC	Western and Central Pacific Fishery Commission
WCRN	West Coast Regional Node
WERI	Water and Energy Research Institute
WFO	Weather Forecast Office
WHOI	Woods Hole Oceanographic Institution
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WOD	World Ocean Database
WPRFMC	Western Pacific Regional Fisheries Management Council
WSO	Weather Service Office

Appendix II Visiting Scientists

DATE	NAME/AFFILIATION	PURPOSE OF VISIT
07/05/04-07/10/04	Garry Day	Provide knowledge and expertise in the area of turtle excluder devices (TEDs) to Papua New Guinea
08/05/04-08/16/04	William Emery University of Colorado at Boulder	Collaborate with Dr. Mark Merrifield and Dr. Bo Qiu on joint research interest in surface current mapping
08/07/04-08/22/04	Shaun Johnston Scripps Institution of Oceanography University of California, San Diego	Participant in HOME project meeting and work on papers from ONR funded projects “Adaptive Ocean Sampling Network (AOSN)” and “Layered Organization in the Coastal Ocean (LOCO)”
08/29/04-09/03/04	Chih Chang Naval Postgraduate School Monterey, CA	Attend Ms. Zhou Wang’s defense and final examination of her dissertation after serving on Ms. Wang’s PhD committee for 3 years.
09/20/04-10/05/04	Kyler Abernathy National Geographic TV and Film	Participant in the study of monk seal foraging behavior in the main Hawaiian Islands
09/20/04-10/05/04	Patrick Greene National Geographic	Participant in the study of monk seal foraging behavior in the main Hawaiian Islands
09/27/05-09/30/04	Timothy Ming Wheaton College, Illinois	Presentation at Pelagics Plan Team Meeting
10/16/04-10/26/04	Dana Caccamise Ohio State University	Assist with preparing the GPS equipment for two upcoming tide gauge maintenance trips and the training of the staff with regards to future GPS operators
11/14/04-12/04/04	Kenneth Sperber Lawrence Livermore National Lab Livermore, CA	Collaborate with Hanna Annamalai and other IPRC researchers to work on monsoon modeling papers
11/16/04-11/23/04	Christopher Jones Marine Science Institute University of California, Santa Barbara	Assisted PFRP staff with development of the PFRP electronic tagging data base per Dr. John Sibert’s request
11/24/04-12/07/04	Laurent Dagorn IRD Victoria, Seychelles	Collaborate with PFRP scientists and attend PI meetings

11/27/04-12/06/04	Olivier Guyader French Research Institute for Exploitation of the Sea	Attend and participate in the CLIOTOP working group 5 meeting 12/01/04 to 12/03/04 and collaboration work
11/28/04-12/02/04	Bruce Robison Monterey Bay Aquarium Research Institute (MBARI)	Invited speaker at the annual PFRP Principal Investigator's workshop 11/29/04 to 12/01/04
11/28/04-12/03/04	Hikaru Watanabe National Research Institute for Far Sea Fisheries, Ocean Squid Section Shimizu, Japan	Invited speaker at the annual PFRP Principal Investigator's workshop 11/29/04 to 12/01/04
11/29/04-12/03/04	Hazel Oxenford Centre for Resource Management & Environmental Studies University of the West Indies	Invited speaker at the annual PFRP Principal Investigator's workshop 11/29/04 to 12/01/04 and attend sessions at the CLIOTOP Working Group meetings 12/01/04-12/03/04
11/29/04-12/03/04	Jock Young CSIRO Marine Labs Australia	Invited speaker at the annual PFRP Principal Investigator's workshop 11/29/04 to 12/01/04 and attend sessions at the CLIOTOP Working Group meetings 12/01/04-12/03/04
11/29/04-12/03/04	Gabriel Vecchi UCAR Princeton, NJ	Attend Indian Ocean Coupled Modeling Workshop 11/29/04-12/03/04
11/29/04-12/03/04	Debasis Sengupta Indian Institute of Science Centre for Atmospheric & Ocean Sciences India	Attend Indian Ocean Coupled Modeling Workshop 11/29/04-12/03/04
11/29/04-12/03/04	Harry Hendon BMRC Australia	Attend Indian Ocean Coupled Modeling Workshop 11/29/04-12/03/04
11/29/04-12/03/04	David Anderson ECMWF Shinfield Park, England	Attend Indian Ocean Coupled Modeling Workshop 11/29/04-12/03/04
11/30/04-12/03/04	Peter Jacques University of Central Florida	Invited speaker at the CLIOTOP Working Group 5 meeting 12/01/04-12/03/04
12/28/04-02/27/05	In-Sik Kang Department of Atmospheric Sciences Seoul National University Seoul, Korea	Collaborate with Dr. Bin Wang and other IPRC scientists on climate variability and changes in Korea and East Asia

01/19/05-01/23/05	Fernando Giannini Mix Industria de Produtos Alimenticos LTDA Brazil	Attend the Sea Turtle Symposium in Savannah, GA 01/19/05-01/21/05
01/27/05-02/06/05	Charles Werner Gamma Remote Sensing Ag Switzerland	Begin collaboration on vertical land motion in the vicinity of tide gauges
02/20/05-02/28/05	Jagadish Shukla George Mason University Fairfax, VA	Collaborate with fellow scientists on climate research
03/05/05-03/09/05	Ian Boyd Sea Mammal Research Unit University of St. Andrews United Kingdom	Attend Pre Workshop Data Analysis Meeting, two day Hawaiian Monk Seal Foraging Workshop, and Post Workshop Report Planning 03/06/05-03/09/05
03/06/05-03/09/05	Lloyd Lowry US Marine Mammal Commission Kailua-Kona, HI	Attend Pre Workshop Data Analysis Meeting, two day Hawaiian Monk Seal Foraging Workshop, and Post Workshop Report Planning 03/06/05-03/09/05
03/06/05-03/09/05	Don Bowfin Bedford Institute of Oceanography Nova Scotia	Attend Pre Workshop Data Analysis Meeting, two day Hawaiian Monk Seal Foraging Workshop, and Post Workshop Report Planning 03/06/05-03/09/05
03/06/05-03/09/05	Sara Iverson Dalhousie University Halifax, Nova Scotia	Attend Pre Workshop Data Analysis Meeting, two day Hawaiian Monk Seal Foraging Workshop, and Post Workshop Report Planning 03/06/05-03/09/05
03/06/05-03/09/05	Albert Harting Harting Biological Consulting	Attend Pre Workshop Data Analysis Meeting, two day Hawaiian Monk Seal Foraging Workshop, and Post Workshop Report Planning 03/06/05-03/09/05
03/06/05-03/09/05	Corey Bradshaw Charles Darwin University Australia	Attend Pre Workshop Data Analysis Meeting, two day Hawaiian Monk Seal Foraging Workshop, and Post Workshop Report Planning 03/06/05-03/09/05
03/31/05-05/01/05	Elliot Hazen Duke University Beaufort, NC	Participate on research cruise on NOAA vessel O.E.Sette around the Hawaiian Archipelago 04/08/05-05/01/05
04/17/05-05/01/05	Erwan Josse IRD Centre de Bretagne France	Participate on research cruise on NOAA vessel O.E.Sette around the Hawaiian Archipelago 04/18/05-05/01/05
05/21/05-05/28/05	Marco Kienzle Fisheries Research Service United Kingdom	Collaborate with colleagues at JIMAR and NOAA Fisheries

Appendix III Seminar List

DATE	NAME/AFFILIATION	PURPOSE OF VISIT
07/05/04-07/10/04	Garry Day	Provide knowledge and expertise in the area of turtle excluder devices (TEDs) to Papua New Guinea
08/05/04-08/16/04	William Emery University of Colorado at Boulder	Collaborate with Dr. Mark Merrifield and Dr. Bo Qiu on joint research interest in surface current mapping
08/07/04-08/22/04	Shaun Johnston Scripps Institution of Oceanography University of California, San Diego	Participant in HOME project meeting and work on papers from ONR funded projects "Adaptive Ocean Sampling Network (AOSN)" and "Layered Organization in the Coastal Ocean (LOCO)"
08/29/04-09/03/04	Chih Chang Naval Postgraduate School Monterey, CA	Attend Ms. Zhou Wang's defense and final examination of her dissertation after serving on Ms. Wang's PhD committee for 3 years.
09/20/04-10/05/04	Kyler Abernathy National Geographic TV and Film	Participant in the study of monk seal foraging behavior in the main Hawaiian Islands
09/20/04-10/05/04	Patrick Greene National Geographic	Participant in the study of monk seal foraging behavior in the main Hawaiian Islands
09/27/05-09/30/04	Timothy Ming Wheaton College, Illinois	Presentation at Pelagics Plan Team Meeting
10/16/04-10/26/04	Dana Caccamise Ohio State University	Assist with preparing the GPS equipment for two upcoming tide gauge maintenance trips and the training of the staff with regards to future GPS operators
10/31/04-11/15/04	Jami Johnson National Marine Fisheries Service	Present analysis at the 3rd annual NWHI Scientific Symposium
11/14/04-12/04/04	Kenneth Sperber Lawrence Livermore National Lab Livermore, CA	Collaborate with Hanna Annamalai and other IPRC researchers to work on monsoon modeling papers
11/16/04-11/23/04	Christopher Jones Marine Science Institute University of California, Santa Barbara	Assisted PFRP staff with development of the PFRP electronic tagging data base per Dr. John Sibert's request
11/24/04-12/07/04	Laurent Dagorn IRD Victoria, Seychelles	Collaborate with PFRP scientists and attend PI meetings

11/27/04-12/06/04	Olivier Guyader French Research Institute for Exploitation of the Sea	Attend and participate in the CLIOTOP working group 5 meeting 12/01/04 to 12/03/04 and collaboration work
11/28/04-12/02/04	Bruce Robison Monterey Bay Aquarium Research Institute (MBARI)	Invited speaker at the annual PFRP Principal Investigator's workshop 11/29/04 to 12/01/04
11/28/04-12/03/04	Hikaru Watanabe National Research Institute for Far Sea Fisheries, Ocean Squid Section Shimizu, Japan	Invited speaker at the annual PFRP Principal Investigator's workshop 11/29/04 to 12/01/04
11/29/04-12/03/04	Hazel Oxenford Centre for Resource Management & Environmental Studies University of the West Indies	Invited speaker at the annual PFRP Principal Investigator's workshop 11/29/04 to 12/01/04 and attend sessions at the CLIOTOP Working Group meetings 12/01/04-12/03/04
11/29/04-12/03/04	Jock Young CSIRO Marine Labs Australia	Invited speaker at the annual PFRP Principal Investigator's workshop 11/29/04 to 12/01/04 and attend sessions at the CLIOTOP Working Group meetings 12/01/04-12/03/04
11/29/04-12/03/04	Gabriel Vecchi UCAR Princeton, NJ	Attend Indian Ocean Coupled Modeling Workshop 11/29/04-12/03/04
11/29/04-12/03/04	Debasis Sengupta Indian Institute of Science Centre for Atmospheric & Ocean Sciences India	Attend Indian Ocean Coupled Modeling Workshop 11/29/04-12/03/04
11/29/04-12/03/04	Harry Hendon BMRC Australia	Attend Indian Ocean Coupled Modeling Workshop 11/29/04-12/03/04
11/29/04-12/03/04	David Anderson ECMWF Shinfield Park, England	Attend Indian Ocean Coupled Modeling Workshop 11/29/04-12/03/04
11/30/04-12/03/04	Peter Jacques University of Central Florida	Invited speaker at the CLIOTOP Working Group 5 meeting 12/01/04-12/03/04
12/28/04-02/27/05	In-Sik Kang Department of Atmospheric Sciences Seoul National University Seoul, Korea	Collaborate with Dr. Bin Wang and other IPRC scientists on climate variability and changes in Korea and East Asia
1/3/05	Seema Balwani	Participate in Strategic Planning Meeting to provide insight to government grants 01/05/05-01/06/05

01/19/05-01/23/05	Fernando Giannini Mix Industria de Produtos Alimenticos LTDA Brazil	Attend the Sea Turtle Symposium in Savannah, GA 01/19/05-01/21/05
01/27/05-02/06/05	Charles Werner Gamma Remote Sensing Ag Switzerland	Begin collaboration on vertical land motion in the vicinity of tide gauges
02/20/05-02/28/05	Jagadish Shukla George Mason University Fairfax, VA	Collaborate with fellow scientists on climate research
03/05/05-03/09/05	Ian Boyd Sea Mammal Research Unit University of St. Andrews United Kingdom	Attend Pre Workshop Data Analysis Meeting, two day Hawaiian Monk Seal Foraging Workshop, and Post Workshop Report Planning 03/06/05-03/09/05
03/06/05-03/09/05	Lloyd Lowry US Marine Mammal Commission Kailua-Kona, HI	Attend Pre Workshop Data Analysis Meeting, two day Hawaiian Monk Seal Foraging Workshop, and Post Workshop Report Planning 03/06/05-03/09/05
03/06/05-03/09/05	Don Bowfin Bedford Institute of Oceanography Nova Scotia	Attend Pre Workshop Data Analysis Meeting, two day Hawaiian Monk Seal Foraging Workshop, and Post Workshop Report Planning 03/06/05-03/09/05
03/06/05-03/09/05	Sara Iverson Dalhousie University Halifax, Nova Scotia	Attend Pre Workshop Data Analysis Meeting, two day Hawaiian Monk Seal Foraging Workshop, and Post Workshop Report Planning 03/06/05-03/09/05
03/06/05-03/09/05	Albert Harting Harting Biological Consulting	Attend Pre Workshop Data Analysis Meeting, two day Hawaiian Monk Seal Foraging Workshop, and Post Workshop Report Planning 03/06/05-03/09/05
03/06/05-03/09/05	Corey Bradshaw Charles Darwin University Australia	Attend Pre Workshop Data Analysis Meeting, two day Hawaiian Monk Seal Foraging Workshop, and Post Workshop Report Planning 03/06/05-03/09/05
03/31/05-05/01/05	Elliot Hazen Duke University Beaufort, NC	Participate on research cruise on NOAA vessel O.E.Sette around the Hawaiian Archipelago 04/08/05-05/01/05
04/17/05-05/01/05	Erwan Josse IRD Centre de Bretagne France	Participate on research cruise on NOAA vessel O.E.Sette around the Hawaiian Archipelago 04/18/05-05/01/05
05/21/05-05/28/05	Marco Kienzle Fisheries Research Service United Kingdom	Collaborate with colleagues at JIMAR and NOAA Fisheries

Appendix IV Workshops and Meetings Hosted By JIMAR

Pelagic Fisheries Research Program Principal Investigators Workshop

November 29 – December 1, 2004

Allain, Gwenhael
Allain, Valerie
Allen, Stewart
Bartram, Paul
Bidesi, Vina Ram
Bigelowe, Keith
Bisson, Jeremy
Brill, Richard
Burnell, Andy
Dagorn, Laurent
Dalzell, Paul
Domokos, Reka
Duffy, David
Galvan-Magaña, Felipe
Glazier, Ed
Graham, Brittany
Grubbs, Dean
Hawn, Donald
Heppell, Selina
Holland, Kim
Howell, Evan
Huang, Hui
Humphreys, Robert
Itano, David
Jantz, Lesley
Josse, Erwan
Kaneko, John
Kinan, Irene
Kirby, David
Kleiber, Pierre
Laurs, Michael
Lebreton, Jean-Dominique
Lehodey, Patrick
Leung, PingSun
Lindstrom, Daniel
Lutcavage, Molly
Marsac, Francis
Maury, Olivier
McCarthy, Abigail
McKelvey, Robert
McNaughton, Lianne
Moffitt, Russell
Morioka, Roy
Moyes, Chris
Musyl, Michael
Nemoto, Keiichi
O'Flaherty, Padraic
Olson, Robert
Opheim, Signe
Ortiz De Zarate, Victoria
Osherenko, Gail
Oxenford, Hazel
Pan, Minling
Papastamatiou, Yannis
Parry, Matthew
Polovina, Jeffrey
Pooley, Sam
Popp, Brian
Pradhan, Naresh
Robison, Bruce
Seki, Michael
Senina, Inna
Snover, Melissa
Southwood, Amanda
Stender, Yuko
Swimmer, Yonat
Veran, Sophie
Walsh, William A.
Watanabe, Hikaru
Watters, George
Young, Jock

PFRP staff:
Ancheta, Johnoel
Lau, Dodie
Sibert, John

CLIOTOP Working Group Meetings

December 1-3, 2004

Valerie Allain
Stewart Allen
Vina Ram Bidesi
Richard Brill
Laurence Cordonnery
Dan Costa
Heidi Dewar
Peter Jacques
David Kirby
Denise Konan
Patrick Lehodey
Ping Sun Leung
Francis Marsac
Ruba Marshood
Ollivier Maury
Robert McKelvey
Kathleen Miller
Rémi Mongruel
Keiichi Nemoto
Gail Osherenko
Minling Pan
Jeffrey Polovina
Heileen Shea
John Sibert
Hernan Villagran
George Watters
DG Webster
Jock Young
Frank Alcock
Lee Anderson
Sandy Argue
Haritz Arrizabalaga
Olivier Aumont
Pascal Bach
Andy Bakun
Manual Barange
Francois-Xavier Bard
Trond Bjorndal
Barbara Block
Kenneth Broad
Liam Campling
Ratana Chuenpagdee
Robert K. Cowen
Jose Miguel de la Serra
Mike Domeier
Josh Eagle
Tim Essington
Alain Fonteneau
Jean-Marc Fromentin
Daniel Gaertner
Alberto Garcia
Philippe Gaspar
John Gunn
Olivier Guyader
Jean-Pierre Hallier
Alistair Hobday
Denzo Inagake
Uehara Kazuyuki
Molly Lutcavage
Jacek Majkowski
Frederic Ménard
Arthur Miller
Ronald Mitchell
Keisuke Mizuno
Patrick Monfray
Raghu Murtugudde
Robert Olson
Anthony Patt
Renaud Pianet
Roger Pulwarty
Evgueny Romanov
Francois Royer
Kurt Schaefer
Gary Sharp
Robert Skillman
Rashid Sumaila
Chi-Lu Sun
Ziro Suzuki
Daniel Talhelm
Akira Taniguchi
Gary Thomas
Heidi Weiskel
Francisco Werner

Appendix V JIMAR Personnel

Information as of June 30, 2005

Category	Number	Unknown	High School	Associates	Bachelors	Masters	Ph.D.
Research Scientist	21	0	0	0	0	1	20
Visiting Scientist	1	0	0	0	0	0	1
Postdoctoral Fellow	2	0	0	0	0	0	2
Research Support Staff	91	0	2	5	57	23	4
Administrative	12	0	1	0	10	1	0
Undergraduate Students	18	0	18	0	0	0	0
Graduate Students*	19	0	0	0	12	5	2
Received less than 50% NOAA support	10	0	0	0	3	1	6
Total	**174**	**0**	**21**	**5**	**82**	**31**	**35**
Located at Lab (include name of lab)	PMEL = 2 PFEL = 8 PIRO = 16 PIFSC = 80 CMDL = 3 NWS = 1						
Obtained NOAA employment within the last year	4						
Postdoctoral Fellows and Students from Subgrantees	12						

*2 Graduate Students pursuing another Ph.D. degree.

Appendix VI 2005 Awards

2005 Awards

Brittany Graham
SOEST's Lenoida Fisheries Scholarship

Cindy Bessey
2004 Robert L. Kendall Transactions of the American Fisheries Society Best Paper Award

Edison Gica
AGU Outstanding Student Paper Award (Dec. 2004)

Appendix VII Publication Summary

The table below shows the total count of publications for the reporting period and previous periods categorized by NOAA lead author or institute (or subgrantee) lead author and whether it was peer-reviewed or non-peer-reviewed.

	JI Lead Author				NOAA Lead Author				Other Lead Author			
	FY02	FY03	FY04	FY05	FY02	FY03	FY04	FY05	FY02	FY03	FY04	FY05
Peer -Reviewed	19	18	36	50	7	33	22	26	17	20	30	26
Non-Peer-Reviewed	15	16	39	31	15	10	17	14	10	14	21	17