JIMAR

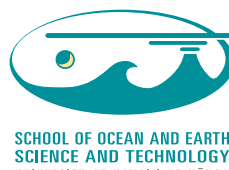**Joint Institute for Marine and Atmospheric Research**

JIMAR

Annual Report for Fiscal Year 2012

**For Cooperative Agreements
NA09OAR4320075 and NA08OAR4320910**

Mark A. Merrifield, PhD
Director

SCHOOL OF OCEAN AND EARTH
SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

Annual Report for Fiscal Year 2012

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Joint Institute for Marine and

Atmospheric Research

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Introduction

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

Mark A. Merrifield, Director

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

Our mission and vision statements are:

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

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

FY 2012 marked the first year of JIMAR's five- year term as NOAA's Cooperative Institute for the Pacific Island Region. Under the new cooperative agreement, JIMAR will continue to serve as an active partner with NOAA in meteorology, oceanography, and ocean engineering research, drawing upon the considerable resources of SOEST and other schools and institutes at the University of Hawaii. Building on 35 years of experience in basic and applied research from regional to global scale, JIMAR will expand to include new research theme areas in ecosystem forecasting, monitoring, and management, in close collaboration with partners at the NMFS Pacific Islands Fisheries Science Center (PIFSC) and the Pacific Island Regional Office (PIRO).

FY 2012 also was the first year under the directorship of Dr. Mark Merrifield from the UH Department of Oceanography, who succeeded Dr. Tom Schroeder upon his retirement from the Department of Meteorology. Under Dr. Schroeder's leadership, the JIMAR program expanded significantly in scope and breadth, particularly in the areas of fisheries and climate research. Dr. Merrifield served as a JIMAR Senior Fellow for a number of years and has had close ties with the JIMAR administration through his role as director of the University of Hawaii Sea Level Center, one of the long-standing programs in the institute. His research interests include global and regional sea level rise and variability, coastal circulation of island environments, and nearshore wave-driven processes on island shorelines, particularly associated with coral reefs.

In an effort to promote scientific engagement between UH, NOAA, and JIMAR scientists, a one-day JIMAR/PIFSC symposium hosted by JIMAR Deputy Director Jeffrey Hare was held in February 2012. Sessions on fisheries, protected species, and coral reef research were led off by keynote lectures by UH leaders in the respective fields. JIMAR researchers were able to share recent findings and to highlight new research directions through

oral and poster presentations. The success of the symposium has encouraged us to make this annual event, with different theme areas of JIMAR highlighted each year.

The Visiting Scientist program remains an important component of JIMAR. Eminent visitors during FY 2012 included Professor Bob Guza from the Scripps Institution of Oceanography who gave a seminar on nearshore processes and interacted with students on thesis research projects, Dr. Yi Chao from the Jet Propulsion Lab of the California Institute of Technology who gave the keynote address at the Annual Pelagic Fisheries Research Program meeting, Dr. Rui-Xin Huang from the Woods Hole Oceanographic Institute who collaborated with UH researchers on ocean circulation dynamics and coastal sea level variability studies in the Pacific, and Dr. Noel Davidson from the Australian Bureau of Meteorology who gave a seminar and participated in discussions on tropical cyclone research.

The Pacific Island Ocean Observing System (PacIOOS) came under the JIMAR administrative umbrella during the past year. The PacIOOS program offers a number of ocean products and services that support existing JIMAR research theme areas. For example, ocean circulation and wave models developed under PacIOOS are important tools for ecosystem modeling and forecasting. Further synergistic research projects involving PacIOOS and JIMAR researchers are anticipated over the coming year.

JIMAR researchers continued to excel during FY 2012. Some of the individual and team highlights include the following.
- Meagan Sundberg - PIFSC Team Member of the Year
- Kathryn Dennis - PIFSC Team Member of the Year
- Daniel Luers - PIRO Team Member of the Year
- Marine Debris Team (Kyle Koyanagi, Marie Ferguson, Russell Reardon, Mark Manuel, Kevin O'Brien, Max Sudnovsky) - RCUH Employee of the Year Nominees
- Vikram Khurana - RCUH Employee of the Year Nominee
- Hui-Hua Lee - NOAA Team Member of the Month (July 2011)
- Dios Gonzales - 15 years at RCUH
- Donald Hawn - 10 years at RCUH
- Melanie Abecassis - earned a PhD
- Mark Manuel, Mary Donovan, Jessie Lopez, and Alexanra Bayless - all earned MS degrees
- Liz Kashinsky - earned a MA degree

Research highlights during the past year, which are described in detail in the following sections, include the following.
- As part of the Fisheries Research and Monitoring Division's Bycatch Reduction Team, Dr. John Wang is working to reduce turtle and shark bycatch through innovative engineering of fishing gear. In mid-2011, John was part of a team (along with Ocean Discovery Institute) that was awarded a Runner-up designation from the World Wildlife Fund's "SmartGear" competition. The title of their submission was 'Turtle Lights for Gillnets'.
- In the Human Dimensions project (part of the Socioeconomics Group in PIFSC), JIMAR staff Dawn Kotowicz and Laurie Richmond interviewed fishing industry participants, including retailers and wholesalers, at the Honolulu Fish Action to determine impacts of a possible bigeye tuna fishery closure. In November 2011, Congress amended the law to permit US-flagged vessels to attribute their catch to American Samoa under certain conditions, thus permitting the fleet to remain active through to the end of the calendar year. The JIMAR Human Dimensions team then quickly refocused their efforts to related concerns of pelagic fish distribution in Honolulu, including investigation of impacts and non-economic sociocultural influences of policy and management decisions.
- Eliott Hazen led a study that predicts a large northward geographic shift in top predator biodiversity in the North Pacific based on previous estimates of species-habitat relationships and climate model projections from the GFDL Earth System Model.
- Kelvin Richards, Claire Paris, and graduate student Ana Vaz considered larval dispersal patterns of yellowfin tuna in the Hawaiian Region using a regional ocean circulation model and an individual-based submodel that simulates adult spawning strategies, larval development, behavior, and dispersal. The PFRP-funded study illustrates connections between island ecosystems that are under investigation.
- Jeff Drazen, Brian Bopp and graduate student Anela Choy are examining middle trophic level organisms in the pelagic food web for waters surrounding the Hawaiian Islands using multiple chemical analyses and stomach content analyses.

- At the March 2012 meeting of the Western and Central Pacific Fisheries Commission (WCPFC) in Guam, a Conservation and Management Measure (CMM) for oceanic whitetip sharks was adopted by consensus. The oceanic whitetip shark is an apex predator traditionally considered to be among the most abundant of oceanic pelagic sharks, but in many locales, catch rates appear to be declining. The scientific information integral to the conservation measure was generated primarily by Dr. Shelly Clarke, of the Oceanic Fisheries Programme of the Secretariat of the Pacific Community located in New Caledonia, and JIMAR Researcher Dr. William Walsh, who works in the NOAA PIFSC. Dr. Walsh's work was partially supported through JIMAR's Pelagic Fisheries Research Program (PFRP), and Clarke and Walsh were lead authors of a series of working papers documenting large declines in standardized catch rates for oceanic whitetip sharks over the last two decades across the Pacific basin.
- John Sibert and colleagues published a PNAS paper showing that closure of the high seas areas of the western Pacific would not solve overfishing of key pelagic fish resources.
- Kevin Weng and graduate student Gen Del Raye developed a model of fish cardiac and hematological physiology to investigate temperature-acidification-deoxygenation effects on fish performance.

The Director of JIMAR is a regular member of the University of Hawaii faculty and is appointed through joint decisions by leaders of the University and NOAA Research. The Director reports to an Administrative Board composed of University and NOAA officials. As both NOAA Research and University research ventures have grown, both agencies have delegated more responsibilities to the field. The Director of NOAA Research has delegated most decision-making authority to the Director of PMEL. The President of the University has delegated his responsibilities as Chair of the Administrative Board to the Chancellor of the Manoa campus. The Director manages day-to-day operations through the administrative staff (fully-supported by the Cooperative Agreement and returned indirect cost funds), Program Managers (Pelagic Fisheries Research Program [PFRP]), and faculty PI/Directors (University of Hawaii Sea Level Center [UHSLC]). A Council, elected among the Fellows, advises the Director on major expenditures on visiting scientists and the selection of new and renewed Fellows. The list of current Fellows and Council members are provided. We renewed the appointments of all current Fellows so that all appointments are synchronized. Owing to the long-distance nature of the NOAA/JIMAR relationship, no single meeting of all Fellows is possible. Business of both the Fellows and the Council are done via e-mail and by visits of the Director to NOAA facilities and professional meetings.

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

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

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

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

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

Distribution of JIMAR's Task I NOAA Funding by Activity

Education/
Outreach/Other
Research Support
1%

Student Support
1%

Post-Doc/Visiting
Scientists
31%

Administration
61%
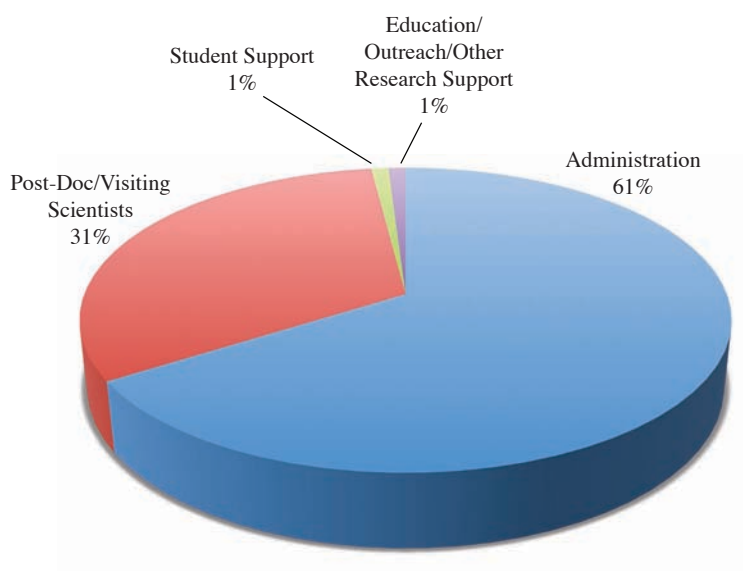
Distribution of NOAA Funding by Task
(FY 2009-2012)

Task I
$461,640
(1.13%)

Task III
$15,304,514
(37.30%)

Task II
$25,264,099
(61.57%)
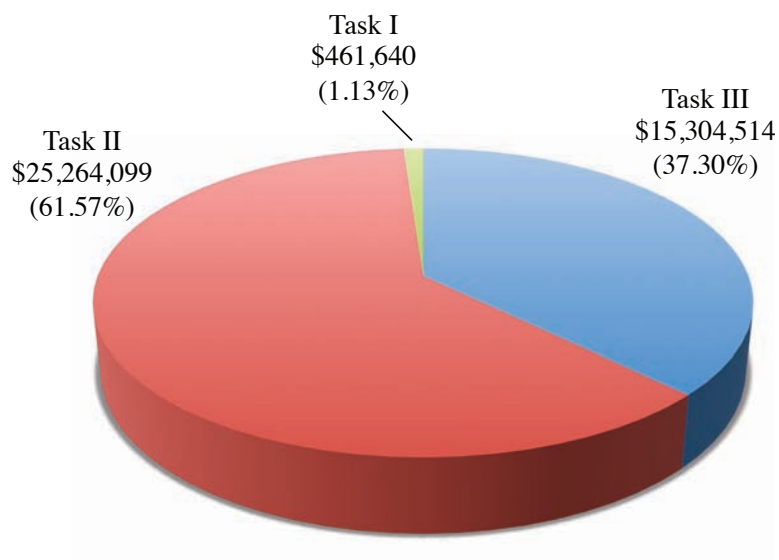
Distribution of NOAA Funding by Theme
(FY 2009-2012)

Administrative/
Visiting Scientist
Program
1.13%

Tropical
Meteorology
1.97%

Equatorial
Oceanography
11.24%

Fisheries
Oceanography
44.49%

Climate
Research
17.03%

Coastal Research
Program
24.14%
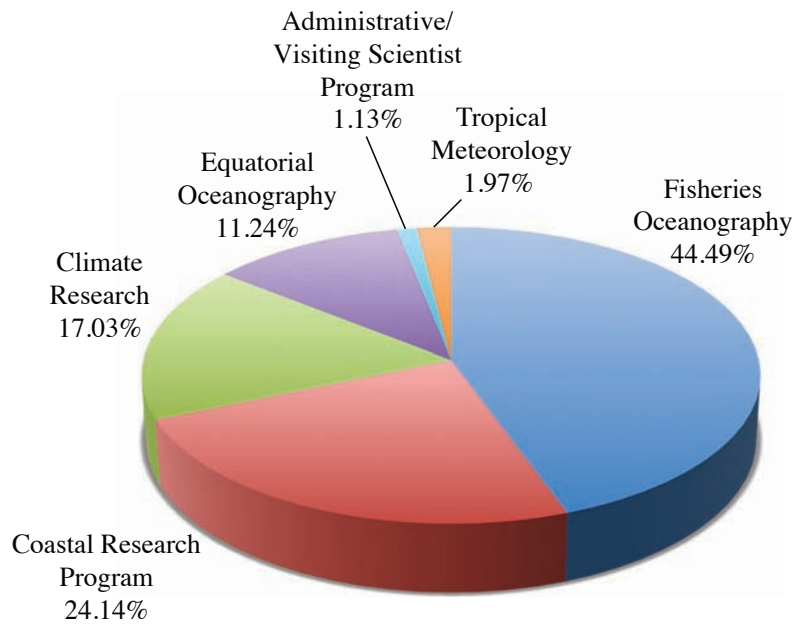
Accomplishments for Fiscal Year 2012

Equatorial Oceanography

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

University of Hawaii Sea Level Center

P.I.: Mark A. Merrifield

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

NOAA Sponsor: David Legler

NOAA Goal(s)

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

Purpose of the Project

The purpose of the UHSLC is to ensure that tide gauge data from around the world are collected, quality assessed, and archived for climate and oceanographic research. In addition, the center seeks to implement a global tide gauge observing system as defined by the Intergovernmental Oceanographic Commission Global Sea Level Observing System (GLOSS) and the Global Climate Observing System (GCOS). The center focuses on high frequency measurements that are available in near-real time as a complement to the Permanent Service for Mean Sea Level (PSMSL), which is the primary archive for delayed mode monthly-averaged sea level time series. In collaboration with NODC, the UHSLC maintains the Joint Archive for Sea Level (JASL), a research quality dataset for high frequency tide gauge observations. The UHSLC acquires tide gauge data from ~ 450 stations maintained by 65 international agencies, and the UHSLC collaborates directly with international partners to maintain 75 high profile stations that are important for the global observing system. The UHSLC collaborates with the Pacific GPS Facility to install and maintain continuous GPS capabilities for the assessment of ground motion at ~10 GCOS/GLOSS tide gauge stations. The UHSLC is an active participant in the operational and scientific oversight of GLOSS through the GLOSS Group of Experts. UHSLC datasets are used in conjunction with operational numerical models, for the calibration of satellite altimeter data, the production of oceanographic products, and research on interannual to decadal climate fluctuations and short-term extreme events. UHSLC station data also are made available via satellite to the Pacific Tsunami Warning Center, the West Coast/Alaska Tsunami Warning Center, and international centers for tsunami monitoring. Over the years the UHSLC has participated in international scientific programs including NORPAX, TOGA, WOCE, GODAE, CLIVAR, and the TOPEX/POSEIDON and Jason Science Working Teams.

Figure 1. Observed western Pacific Sea Level from tide gauges (black) compared to reconstructions based on the PDO (red) and the SOI (red dash) with global mean sea level included (black dash). The PDO index (blue) and scaled SOI (green) are shown for comparison. (Merrifield et al., 2012).

Progress during FY 2012

UHSLC analysts continue to maintain the Fast Delivery Database, the primary source for quality assessed, near-real time sea level data available to the research community, and the JASL database of research quality, delayed mode, high frequency tide gauge data. UHSLC accomplishments for data management met objectives during FY 2012 in that the core function of each database was maintained, and both databases were expanded to take on new station installations as they become available. In terms of station maintenance, another objective was
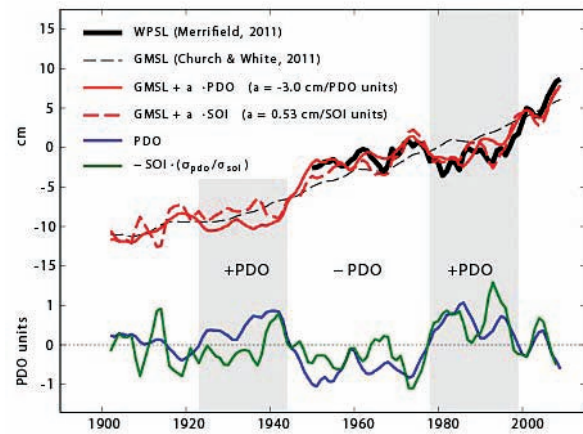
to conduct 6 field trips during FY2011. The project was able to accomplish 7 field trips and serviced 18 stations. Continuous GPS was installed at 2 stations (Gan and Male, Maldives).

Various metrics describing the status of the global sea level monitoring effort based on tide gauges were considered. The project's first metric is an estimate of globally-averaged sea level based on tide gauge data, with the metric being the uncertainty of that estimate. The level of uncertainty associated with the network will decrease as the number of independent tide gauge stations increases, and as land motion corrections are taken into account with GPS monitoring. The second metric takes into account the reliability of the network. It simply is a measure of data return across the global array. The third metric is a measure of coverage. It is a measure of the percentage of ocean surface area that the tide gauge network has some predictive skill in hindcasting, as determined by correlations studies versus overlapping altimeter time series.

UHSLC research efforts were focused on multidecadal sea level variability and extreme sea level events and climate variations. Multidecadal sea level variability in the Pacific has been related to significant changes in the Pacific trade winds (Merrifield and Maltrud, 2011; Merrifield et al., 2012). The possibility of a low frequency variation in global sea level was considered based on tide gauge observations (Chambers et al., 2012). Changes in storm variability in the central Pacific on climate timescales has been inferred from tide gauge records at Midway Atoll (Aucan et al., 2012). The project took part in the OCO contribution to the BAMS State of the Climate report, describing global and regional sea level change during 2012.
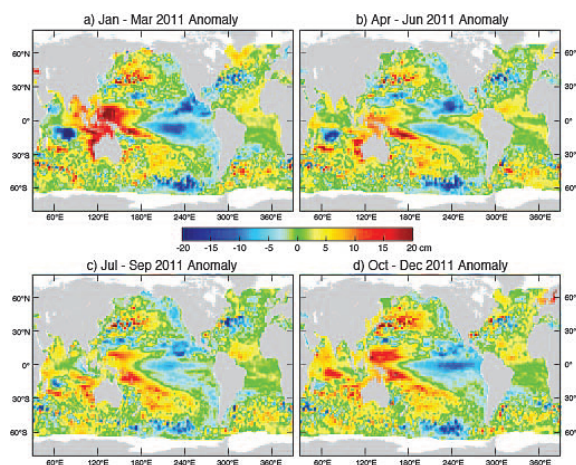

Figure 2. Seasonal sea surface height anomalies for 2011 relative to the 1993-2011 baseline average are obtained using the multimission gridded sea surface height altimeter product produced by Ssalto/Duacs and distributed by Aviso, with support from CNES (www.aviso.oceanobs.com). Units are in centimeters.

WHOI Hawaii Ocean Timeseries Station (WHOTS)

P.I.: Mark A. Merrifield, Roger Lukas

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

NOAA Sponsor: David Goodrich

NOAA Goal(s):

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

Purpose of the Project

The WHOTS surface mooring and buoy is an element of the NOAA-funded Ocean Reference Stations network (R. Weller and A. Plueddemann, WHOI) aimed at providing state-of-the-art air-sea flux and near-surface ocean measurements to benchmark atmospheric reanalysis products in different regions. Through the Hawaii Ocean Time-series project funded by NSF, the upper ocean portion of the WHOTS mooring is instrumented to measure temperature, salinity and currents (R. Lukas, UH). The WHOTS ocean carbon measurements are funded by NOAA through PMEL (C. Sabine), and ocean color measurements are funded by NASA (S. Laney, WHOI).

Progress during FY 2011

During 2012, the WHOTS-8 buoy was recovered and the WHOTS-9 buoy was moored using the NOAA *R/V Hi`ialakai*. Intercomparison between shipboard and moored instruments provided the basis for calibration assessment and ultimate correction of instruments on the mooring. Cross-comparison between new and old buoys was conducted for three days.

After substantial methods development, the subsurface temperature, salinity and velocity measurements from WHOTS-1 through WHOTS-7 were final-quality controlled, transmitted to NODC and OceanSITES, and made

widely available via our HOT and WHOTS websites, accessible via the Station ALOHA portal http://aloha.manoa.hawaii.edu.

Tsunami Research

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

Archive of Rapidly Sampled Hawaiian Sea Level

P.I.: Douglas S. Luther

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

NOAA Sponsor: Christopher Sabine

NOAA Goal(s)

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

Purpose of the Project

The Archive of Rapidly Sampled Hawaiian Sea Level (ARSHSL) provides an electronically accessible database of rapidly-sampled ($\Delta t \leq 6$ minutes) sea level observations from existing Hawaiian coastal sea level gauges maintained by NOAA agencies (NOS and PTWC). The sea level data in ARSHSL is publicly available online for both practical applications and research. The archive was originally established with NOAA funding in 1997 to ensure a consistent repository for rapidly sampled sea level in the Hawaiian Islands for the study of weak tsunamis and related infragravity wave signals (including edge waves and harbor resonances) at periods of 2-40 minutes. The archive is maintained with funding by JIMAR. Beyond studies of the 2-40 minute gravity waves that impact commercial and private boating activities, the ARSHSL data is used by the NOAA-funded Pacific Islands Ocean Observing System (PacIOOS), and by investigators studying the dynamics of 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 interannual variability around the Hawaiian Islands. Sea level data from two-thirds of the gauges that the project accesses is not generally available to the public and research communities; that is, the data is not prepared and offered to the public by the agency (PTWC) responsible for maintaining the gauges because these activities are not part of the mission of that agency. Therefore, this data archiving and dissemination activity provides as complete a dataset as possible of sea level fluctuations at the coasts of the Hawaiian Islands for current and future research and practical applications.

Progress during FY 2012

Per the plans for this past year, the ARSHSL has been maintained online (http://www.soest.hawaii.edu/oceanography/dluther/arshsl.html) by M. Luther and D. Luther, in collaboration with the NOAA-funded UH Sea Level Center (M. Merrifield, Director). One-minute and six-minute data from six NOS gauges are retrieved from NOAA's Tides and Currents website (http://tidesandcurrents.noaa.gov/), rather than through the special communications pathways originally established for ARSHSL. PTWC sea level gauge data (1-second or 2-minute samples, depending on the gauge) have been automatically or, if necessary, manually downloaded daily via Internet and telephone links from up to 14 PTWC gauges in 12 harbors. All the sea level data, as originally sampled from a total of 17 harbors (some harbors have multiple gauges and, over time, some gauges have been decommissioned) dispersed around the five main islands of Hawaii, are stored on the ARSHSL website, usually after both a low-level quality control check and elimination of extreme outliers. Access to the website is unrestricted, with past users ranging from UH graduate students to government civil engineers, and even PTWC. The applications have ranged from hydrogeology to gravity wave studies to dock design. Predominant users in the past year focused on infragravity waves at periods of 2 minutes to several hours in support of the development of both harbor surge

and beach flooding nowcasts and forecasts for the PacIOOS. JIMAR and PacIOOS have continued supporting a graduate student, Assaf Azouri, who is analyzing the 13 years of PTWC sea level data from Haleiwa Harbor in ARSHSL to determine the relationships between Haleiwa's suite of infragravity wave fluctuations and their many forcing pathways (e.g., wind-generated swell directly forcing harbor infragravity waves; versus, swell forcing coastal infragravity waves that then force harbor infragravity waves). Azouri is working with PacIOOS product developers (especially, Martin Guiles) to create a product for PacIOOS that will predict the occurrence of potentially damaging infragravity wave currents in Haleiwa Harbor up to a few days into the future. This work will be extended to other harbors, using the archived high-resolution sea level data in ARSHSL to establish the initial set of parameters of the transfer function from swell to harbor infragravity waves.

A technical report on the ARSHSL was prepared in January 1998, and is periodically updated on the website. Logs of all data holdings and processing activity are being maintained on the website for each station. As expected, archiving activities required most of the budgeted effort this past year. Per the plans stated in last year's report, an additional "value added" activity accomplished this past year was the updating of files of concatenated, quality-controlled, hourly-averaged sea level data for studies of low-frequency phenomena, especially to aid modeling and prediction of sea level inundation hazards around Oahu for NOAA's PacIOOS

Sea Level (SL) data from the ARSHSL are enabling the development of a public information product that will forecast the occurrence of strong currents due to infragravity (IG) waves in otherwise protected harbors. Such surge currents in Hawaii, caused primarily by storm-generated gravity wave swell (3-30 second periods), have been responsible for damage to boats and harbor infrastructure. The figure displays a sequence of analyses employed to determine which characteristics of the offshore swell would be the better predictor. The abscissae are the swell wave characteristics and the ordinates are the IG wave power spectral densities (PSDs) in Haleiwa Harbor on the north shore of Oahu. The swell characteristics were determined from a year of observations from the permanent Waimea wave buoy about 8 km northwest of the north shore of Oahu. The IG wave PSDs were determined from the high-resolution (2-minute samples) sea level observations stored in ARSHSL. Each row of the figure is for a single IG wave period band: at the top is 4-10 minutes; at the middle is 10-15 minutes; and, at the bottom is 15-40 minutes. Each column has a single predictor (abscissae): for the left column it's swell energy (Es); in the middle it's swell PSD (called PDlp) which emphasizes the longer periods in the swell band; and on the right it's swell PSD propagating toward the shore (called PDlpCos). Energy and PSD estimates were made for each 3-hour time period, of which there were 2640 in 2002 (840 hours had gaps in the swell data and were thus not considered). The estimates were binned along the abscissae into groups of 80 estimates and averaged, resulting in 33 values plotted in each frame. The standard error, in each dimension, for each point plotted is always smaller than the diameter of the symbol. The red curves are the result of a least-squares determination of the 'best fit' 3rd-order polynomial. The root mean square difference (not shown) between the observed IG PSD and the predicted IG PSD monotonically decreases in each row from the left frame to the right frame, indicating that the most accurate of the three predictors is swell PSD propagating toward the shore.

Modeling of Uncertainties in Flood Hazard Mapping

P.I.: Mark A. Merrifield [Kwok Fai Cheung]

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

NOAA Sponsor: Gordon Grau

NOAA Goal(s)

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

Purpose of the Project

Tsunami inundation maps are typically based on historical events or postulated worst-case scenarios with unknown occurrence probabilities. The information is intended for emergency management, but might not be suitable for land-use planning and engineering design. The purpose of the project is to implement a recently developed probabilistic method for inundation mapping and flood hazard assessment. The specific objectives are to implement the method to produce probabilistic tsunami inundation maps and develop metrics to measure the efficacy and merits of the proposed probabilistic method in relation to conventional approaches.

Progress during FY 2012

The project has selected American Samoa as the site for development of probabilistic tsunami inundation maps. American Samoa is a suitable site for the demonstration study because of its proximity to an active subduction zone and experience with a recent destructive tsunami. The project has a separate contract to develop deterministic tsunami inundation maps for American Samoa. This will provide an opportunity to compare deterministic and probabilistic approaches for tsunami inundation mapping.

The project is currently compiling a digital elevation model (DEM) for the southwest Pacific along the Tonga Trench and collecting seismic and paleotsunami data in the region. The recent aerial LiDAR survey of Tutuila conducted by NOAA will greatly augment the DEM for inundation modeling. The project has finalized the source mechanism for the 2009 Samoa earthquake and is in the process of modeling the tsunami for validation of the computed inundation.

University of Hawaii Sea Level Center–Tsunami Research

P.I.: Mark A. Merrifield

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

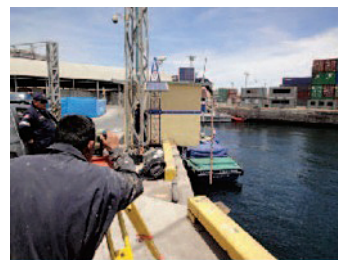### NOAA Sponsor: Michael Angove

NOAA Goal(s)

- 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
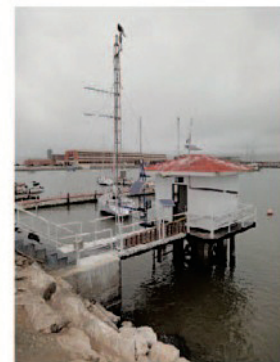
Purpose of the Project

The UHSLC is taking part in the installation and ongoing maintenance of ten water level stations in the Caribbean Sea and twelve water level stations in the Pacific Ocean in support of regional tsunami warning and sea level monitoring. The Caribbean portion of the project is in collaboration with Dr. Victor Huerfano, the Director of the Puerto Rico Seismic Network (PRSN). UHSLC oversees the installation of the stations and provides training for a PRSN technician on the operation and maintenance of the stations. The UHSLC also has provided ongoing technical support, and data processing and quality assessment services. The Pacific portion of the project is primarily focused on the maintenance of tsunami water level stations previously maintained by the Pacific Tsunami Warning Center (PTWC). UHSLC is working with PTWS and the West Coast and Alaska Tsunami Warning Center (WCATWC) on network priorities and station selection. UHSLC involvement ensures that the water level stations will comply with global sea level observing system requirements for oceanographic and climate research.

MATARANI, PERU

CALLAO, PERU

LA LIBERTAD, ECUADOR

Progress during FY 2012

For the Pacific Ocean, three stations were upgraded (Matarani and Callao, Peru and La Libertad, Ecuador) as planned. Maintenance visits were conducted at 3 stations as planned (Quepos, Costa Rica, Acajutla, El Salvador and Legaspi, Philippines). Equipment has been shipped to UHSLC's partner agency in Peru for the eventual upgrade at the Atico station. The Peru agency will be responsible for installing that station and

Figure 1. Tsunami water level stations upgraded in the Pacific Ocean include Matarani and Callao, Peru and La Libertad, Ecuador.

Figure 2. *Tsunami water level stations upgraded in the Caribbean include El Porvenir, Panama; Santa Marta and San Andres, Colombia.*

UHSLC is working with them on the installation date. The project hopes to complete this within the next 6 months. UHSLC had proposed to visit Tern Island during FY 2012, however, was unable to get transit aboard a NOAA vessel to this remote site. The project hopes to schedule that trip in the coming year. UHSLC has also removed Niue and Soccoro Island from the list of eventual installation/upgrades due to budget cuts.

For the Caribbean, the project installed three stations of the four planned during FY 2012 (El Porvenir, Panama; Santa Marta and San Andres, Colombia). Maintenance work at 3 stations (Limon, Costa Rica, and Puerto Plata and Punta Cana, Dominican Republic) was completed as planned. Budget cuts have necessitated the removal of Grand Turk, Bahamas from the list of proposed station upgrades.

Climate Research

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

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

P.I.: Axel Timmermann

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

NOAA Sponsor: Chris Miller

NOAA Goal(s)

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

Purpose of the Project

The main goal of this project was to separate the naturally occurring changes in the behavior of ENSO from those that are externally forced and to identify the respective underlying mechanisms. The conducted research reassesses existing paleo-ENSO proxy data, develops new combined ENSO variance reconstructions and provides rigorous uncertainty estimates.

Separating externally forced signals in tropical Pacific climate reconstructions and model simulations from the signals generated by internal instabilities is a fundamental problem. Using several existing climate model

simulations of the last 500-1000 years and combining different paleo-proxy records for ENSO, we will elucidate the physical mechanisms responsible for long-term changes of tropical Pacific climate during the last millennium. Questions to be addressed specifically are: 1) what is the degree of consistency between different paleo-ENSO reconstructions during the last millennium; 2) what is the range of internally generated ENSO variability on decadal and centennial timescales in comparison with the externally-induced low-frequency modulation of ENSO; and 3) what are the mechanisms of internally generated and externally-induced long-term changes of ENSO? These questions will be addressed by a careful statistical analysis of existing paleo-proxy data for ENSO and by using coupled-atmosphere ocean general circulation model simulations for the last 500-1000 years. Our proposed research will reassess existing paleo-proxy data, provide rigorous uncertainty estimates, and might eventually contribute to a better understanding of ENSO's sensitivity to climate change, with important implications for society.
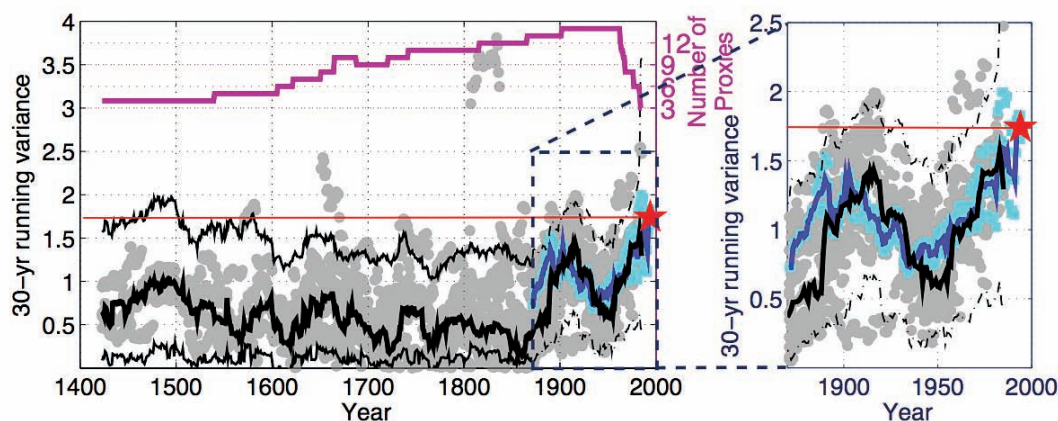
The 30-yr running variance (grey dots) of each of the 14 high-pass filtered (HPF, 10-year cutoff) ENSO reconstructions overlaid with the ensemble median running variance (thick black line). At any point in time prior to the observation period the thin black lines represent the widest median running variance signal error bars of the two types of error analysis detailed in the methods text. Inside the window of instrumental data these error bars change to thin black dash-dot lines as there is a direct measurement of ENSOs variance. The width of each of these two error bar estimates varies depending on the number of ENSO variance proxies available (see purple line at top of panel). Cyan dots indicate the 30-yr running variance of the 4 observed HPF Niño 3.4 SST anomalies, while the blue line represents the observed ensemble median running variance. The red star indicates the most recent value of the ensemble median 30-yr running variance of the 4 observed HPF Niño 3.4 SST anomalies (1979-2009), while the thin red line just extends this most recent value back through time for comparison with the ensemble median proxy running variance and its error bars.

Progress during FY 2012

Characterizing ENSO's long-term changes in frequency, magnitude and duration has been hampered by the fact that reliable instrumental records only cover a period of less than 150 years. Multi-century paleoclimate reconstructions derived from monthly to annually resolved tree rings, ice cores, lake sediments and coral records can be used to extend the observational record and to further quantify and constrain ENSO's uncertain response to external climate perturbations, such as greenhouse warming, in the context of its naturally occurring variability. Numerous attempts have been made to reconstruct past ENSO variability using a variety of proxy archives. However, the multi-decadal to centennial-scale ENSO variance changes from these reconstructions differ considerably. The project conducted a combined variance analysis of 14 pre-selected ENSO proxies (with correlation between proxy and instrumental data > 0.5), some of which extend back prior to 1400 AD. The project focused on the interannual ENSO frequency by high-pass filtering (HPF, 10-yr cutoff period) each of the 14 ENSO reconstructions. The project analysis reveals that the observed ENSO variance in the most recent 30-yr period was higher than at any time during the preceding 600-year record (see figure). The large variance estimate error bars for the period prior to 1600 CE act to reduce the statistical confidence in the variance differences between the pre-1600 period and the most recent 30-yr period. Accounting for these time-varying uncertainty ranges, the project concluded with high statistical confidence that the increased ENSO variance of the most recent 30-yr period of the 20th century is larger than at any time during at least the last ~400 years (exceeding the 95% confidence level). A paper with these results has just been submitted.

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

P.I.: Hariharasubramanian Annamalai

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

NOAA Sponsor: Jin Huang

NOAA Goal(s)

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

Purpose of the Project

The primary goal is to develop and transition a dynamical precipitation prediction system for all U.S. Affiliated Pacific Islands (USAPI) based on the Climate Forecast System (CFS). For the target regions over the USAPI, the current operational seasonal precipitation prediction system is based on empirical methods (e.g., Canonical Correlation Analysis or CCA). In the CCA prediction tool sea surface temperature (SST) provides the most reliable predictive information, and high prediction skill is obtained for ENSO winters. For non-ENSO years and also for weak to moderate ENSO events, although significant seasonal rainfall anomalies are observed over the USAPI, precipitation forecast skill by the empirical model is low. Reasons may be manifold including: a) nonlinear relationship between ENSO SST and precipitation is not incorporated; b) details in the space-time evolution of SST during different flavors of ENSO are not properly accounted for; and c) SST anomalies other than ENSO may be responsible for rainfall variations. A prediction system based on a fully coupled dynamical model may overcome some of the above limitations.

Progress during FY 2012

The 24-member ensemble hindcast performed with CFSv2 has been examined to document the skill scores over the USAPI, and to assess its improvements compared to CFSv1. It is expected that higher horizontal resolution employed in CFSv2 capture the details in regional precipitation over the USAPI, particularly the orographic induced rainfall over the Hawaiian Islands. Relevant observational and reanalysis products were regridded to the model (CFSv2) grid for validation purposes.

First, to be consistent with the previous results with CFSv1 (Sooraj et al. 2012) the project examined the skill scores over all the target regions. The initial results for boreal winter rainfall anomalies at 0-month lead over the USPAI are encouraging. Due to the coarse resolution employed in CFSv1, the target regions cover the adjoining oceanic regions of the USAPI. When examined at this spatial level, at 0-month lead the DJF rainfall anomaly hindcasts in both versions are comparable but CFSv2 shows some improvements at various leads.

To understand the added benefit of higher resolution in CFSv2, the project reexamined the skill scores at various leads and for all the four standard seasons over regions covering the land points of the USAPI. It is quite remarkable that during the local rainy seasons the deterministic skill score is high at leads 3-4 months over USPAI, which seems to be an improvement compared to CFSv1. To underscore if the model's success is for correct reasons, the project examined the ability of the model to represent the circulation features that influence the regional rainfall anomalies over the USAPI. A full manuscript with all the details is being written up.

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

P.I.: Kevin Hamilton

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

NOAA Sponsor: Howard Diamond

NOAA Goal(s)

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

Purpose of the Project

This project enhances activities at the Asia-Pacific Data-Research Center (APDRC) as well as climate research within the International Pacific Research Center (IPRC) at the University of Hawaii. The project's overall goals are: (i) to meet critical regional needs for ocean, climate and ecosystem information; (ii) to enhance activities in support of the Global Earth Observation System of Systems (GEOSS) and the NOAA Integrated Data and Environmental Applications (IDEA) Center; (iii) to provide infrastructure in support of follow-on activities to the Global Ocean Data Assimilation Experiment (GODAE); and (iv) to conduct research to enhance understanding of climate variability and change in the Asia-Pacific region. The vision of the APDRC is to link data management and preparation activities to 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 public. The APDRC is organized around three main goals: providing integrated data server and management systems for climate data and products; developing and serving new climate-related products for research and applications users; and conducting climate research in support of the IPRC and NOAA research goals.
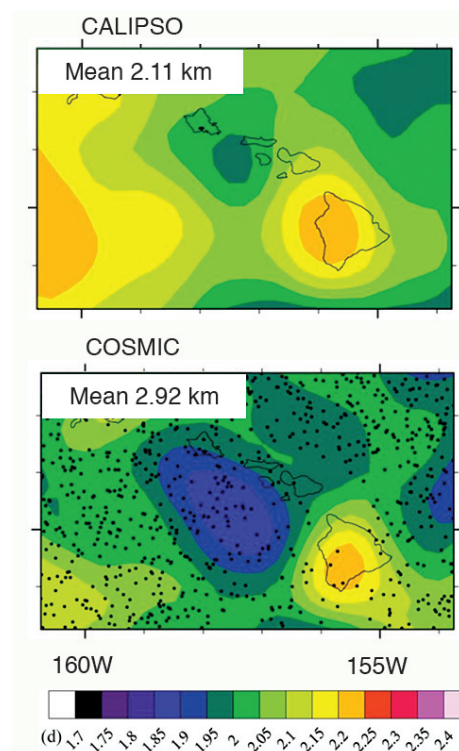
Progress during FY 2012

There are two main components to this activity: Data Management (DM) and Data Server Systems (DSS). The DM group identifies important datasets from each of three sub-disciplines: oceanographic data, atmospheric data and air-sea flux data. Moreover, the group ensures that on-line data is up-to-date, well documented, and to a certain extent, quality controlled. Members in the activities also compile research results that have evaluated the data products in some way. Finally, the group also makes recommendations on how to make the data more useful to clients—the value-added component. An additional activity included under data management

Comparison of annual mean height of trade wind cloud layer in the Hawaiian region determined from satellite-based lidar observations from the CALIPSO instrument with the annual mean height of the Trade Wind inversion determined from satellite radio-occultation measurements from COSMIC (values in km). The dots show locations of individual COSMIC soundings that are available (see Zhang et al., 2012, for details).

is user interface development. The user-interface activity focuses on providing an interface between users and the data archives, including maintaining the APDRC web presence. The group makes sure the web pages are user-friendly and up-to-date and also handles specific, specialized data requests (*e.g.*, email requests) by notifying the appropriate activity within the data management group. Finally, this group fosters co-operation with data serving groups outside the APDRC by providing links to their sites.

The DSS component then ensures the data and products are properly served to the community via the APDRC system. A software-server manager, in collaboration with the IPRC computing facility, maintains all the software programs that comprise the APDRC data server systems. The group installs and upgrades all the server software, ensuring that programs are up-to-date, and makes sure that the APDRC web links are active and accurate. The group also oversees the day-to-day operation of the server machines and provides all upgrades to these machines. The server management group keeps up-to-date on new advances in technology, including both hardware and software, by attending meetings and workshops and through dialogue with other groups to provide future direction and recommendations for the APDRC computing infrastructure. The group also teams with the IPRC Parallel Computing Facility (PCF) to provide technical support to users.

The APDRC maintains a wide suite of data transport and discovery servers including: OPeNDAP-based THREDDS DODS Server (TDS), GrADS DODS Server (GDS), and DAPPER; a Live Access Server (LAS); and DCHART. These servers continue to be maintained and there were no dramatic changes to these services in the past year.

The APDRC data archives increased in size mainly due to a large acquisition of OFES output, daily downloads of high-resolution, global ocean model output from the Navy Layered Ocean Model (NLOM) and Navy Coastal Ocean Model (NCOM), and local implementation of the Hybrid Ocean Coordinate Model (HYCOM). In addition,

the APDRC staff has been instrumental in assembling coupled climate model output from CMIP-5 runs for local research activities. Daily downloads of various operational models continue. One these is output from a regional atmospheric model (run at UH) that is used by a wide variety of users, and the APDRC now has a long archive. In all, the APDRC has archived about 130 TB of data: 55% of this is output from the Earth Simulator (OFES/AFES); coupled climate model output from various sources occupy about 23%; the remaining 22% covers all the other data sets. Upgrades to the APDRC web pages include new additions to the projects page that lists a brief description of the projects that the ADPRC supports, along with direct links to these projects (http://apdrc.soest.hawaii.edu/projects). All tasks and projects were completed on time and within budget.

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

P.I.: Mark A. Merrifield

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

NOAA Sponsor: Winston Luke [Darryl T. Kuniyuki]

NOAA Goal(s)

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

Purpose of the Project

Primary Task—Collection of atmospheric mercury speciation data. The project collects and analyzes semi-continuous high altitude (11,400 feet) measurements of Hg^0, RGM, and Hg^p at the Mauna Loa Observatory (MLO), Hawaii. The objectives of this task will be to accumulate a long-term record of ambient Hg^0, RGM, and Hg^p chemistry to (i) support atmospheric mercury chemistry research, (ii) establish a baseline mercury measurement station, and (iii) investigate the long range transport of mercury from South East Asia across the Pacific. In addition to this primary task, other data is measured and collected which may affect the transport and transformation mechanisms of atmospheric mercury. This includes measurements of aerosol particulates, semi-continuous ozone, sulfur dioxide, elemental carbon, and meteorology measurements. All of the data is to be organized and archived in a database. Some data and theories will be placed on the MLO website and other types of media for outreach purposes.

Figure 1. (L to R) Winston Luke, Paul Kelly, and Xinrong Ren.

Progress during FY 2012

Semi-continuous measurements of Hg^0, RGM, and Hg^p were conducted at MLO, Hawaii. The data was archived and added to the long-term record of ambient Hg^0, RGM, and Hg^p record. The Hg data is currently being analyzed and compared with the measurements of aerosol particulates, semi-continuous ozone, sulfur dioxide, elemental carbon, and meteorology measurements. A scientific paper presenting the transport and transformation
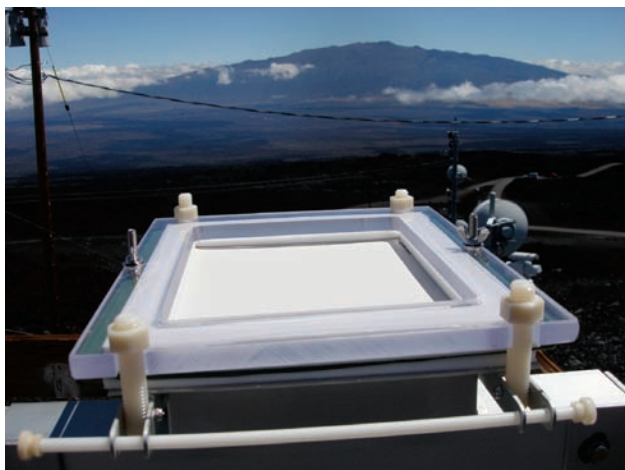
Figure 2. Hi Vol Sampler filter.

mechanisms of atmospheric mercury at MLO is currently being written and scheduled for publication later this year. Funding from EPA ended in 2010, but the project was picked up by Dr. Winston Luke of NOAA's Air Resources Laboratories (ARL).

Multi-Model Ensemble Forecast of MJO

P.I.: Bin Wang

NOAA Office (of the primary technical contact): MAPP

NOAA Sponsor: Annarita Mariotti

NOAA Goal(s)

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

Purpose of the Project

The purpose of the proposed research is to develop a Multi-Model Ensemble (MME) methodology, based on coupled models, for the operational prediction of the Madden-Julian Oscillation (MJO) and associated N. American impacts during boreal winter. The proposed objectives consist of the following: 1) construct a coordinated hindcast experiment using seven coupled global models that can be utilized for MJO forecast assessment (e.g., predictability) and development (e.g., MME); 2) use the hindcast experiment to assess the predictability and prediction skill of the MJO and related N. American impacts during boreal winter; 3) examine the prediction skill sensitivity to aspects of initialization; 4) use the hindcast experiment to develop an MME technique suitable for MJO prediction and assess improvements in MJO prediction skill; 5) combine the MME and the US CLIVAR MJO Working Group multi-model MJO forecast currently available at the Climate Prediction Center (CPC) to deliver an MME forecast methodology suitable for implementation at
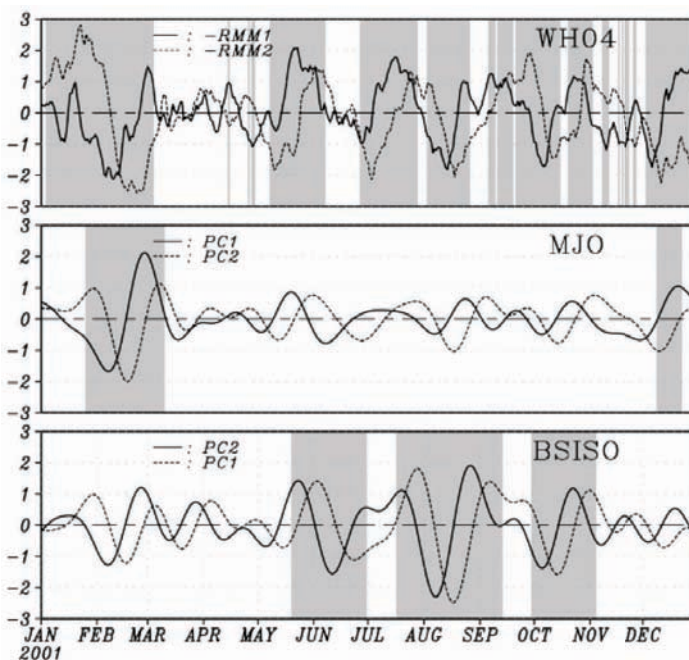

Figure 1. A comparison of the ISO index between the WH04 (upper), the MJO (middle), and the BSISO (lower) for the year 2001. Note that each PC is normalized by one standard deviation of the corresponding PCs during the period each EEOF analysis was performed to obtain the EEOFs. Significant ISO events are shaded in the background.

National Center for Environmental Prediction (NCEP); and 6) using historical data combined with the multi-model hindcast to develop composite maps of the N. America weather/climate response to the life-cycle of the MJO.

Progress during FY 2012

The first objective has been accomplished and the intraseasonal variability hindcast experiment (ISVHE) has been executed. Ten models' hindcast have been collected from Europe, United States, Japan, Australia, Korea, and Canada. Objective 2 has been partially conducted and the prediction skills of the models have been analyzed. In addition, research work on objective 3, to examine the prediction skill sensitivity to aspects of initialization, has obtained important results. Objective 4 is in progress; Boreal summer intraseasonal oscillation (ISO) evaluation metrics have been designed. Next year objective 5 will be completed: the evaluation and MME. For objective 6, the boreal summer ISO teleconnection pattern has been studied. For boreal winter, the MJO teleconnection pattern has been developed. In particular a schematic for how MJO impacts US winter snow storm has been developed (Moon et al.).
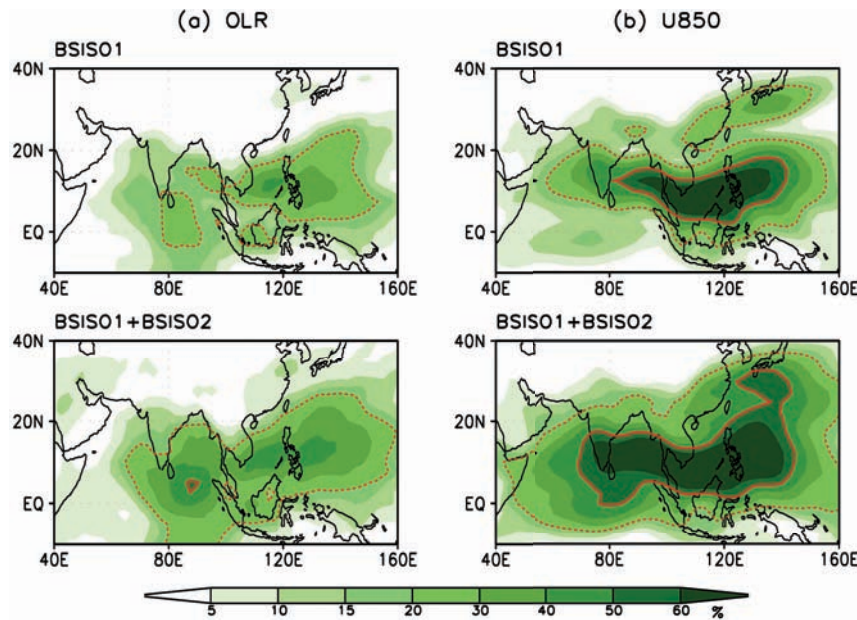
Figure 2. Spatial distribution of the fractional variances of pentad (a) OLR and (b) U850, that are accounted for by the first BSISO mode (upper panels), and the first two BSISO modes (lower).

Pacific ENSO Applications Climate Center

P.I.: Mark A. Merrifield

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

NOAA Sponsor: Jeffrey LaDouce

NOAA Goal(s)

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

Purpose of the Project

The purpose of the Pacific ENSO Applications Climate (PEAC) Center is to conduct research and develop information products specific to the US-Affiliated Pacific Islands (USAPI) on El Niño–Southern Oscillation (ENSO) climate cycles, the latest long-term forecasts of ENSO conditions, and the historical ENSO impacts on rainfall, sea level variability and change, and tropical cyclone activity. PEAC products support planning and management activities in such climate-sensitive sectors as water resource management, fisheries, agriculture, civil defense, public utilities, coastal zone management, and other important economic and environmental sectors of the USAPI.
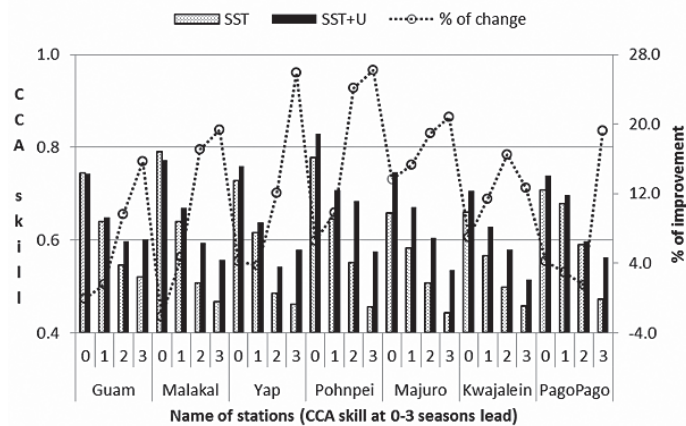

Figure 1. Four seasons' average values of CCA cross-validation hindcast skills for all U.S-Affiliated Pacific Islands (USAPI) from 0 to 3 seasons lead time. As compared to SST-based forecasts, the percentage of improvement by SST and wind (SST+U) based forecasts is shown by dotted line.

Progress during FY 2012

The recent 2010-11 La Niña is one of the largest on record, with a Southern Oscillation Index that would rank this event as the second largest over the past century. The sea level rise at island locations (Yap, Pohnpei, and Kapingamarangi) was considerably higher (50 to 125 mm) than during previous La Niña years, which raised immediate concern for all of the island communities. A contributing factor for the anomalously high sea levels is the recent trend of enhanced trade winds west of the dateline. Several new findings suggest that the recent trend of enhanced trade winds west of the dateline is partly responsible for rapid sea level rise in the USAPI region. Whether these enhanced trade winds are a short-term variation or part of a longer-term trend remains an open question.
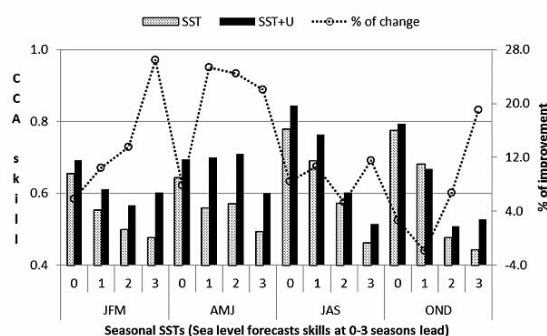

Figure 2. Average (for seven USAPI stations) forecasts skills at 0 to 3 seasons lead time based on SST and SST+U for JFM, AMJ, JAS, and OND seasons. Percentage of improvement is shown by dotted line.

The project has revised the operational canonical correlation analysis (CCA) statistical model for sea level forecasts, which was developed in large part on ENSO conditions and tropical Pacific sea-surface temperature (SST) during the period prior to the recent trade wind intensification. Therefore this year, wind forcing has been added in addition to SST as a new variable to forecast sea level variability on seasonal time scales. The initial CCA findings are very encouraging, as the SST and trade wind based forecasts are more skillful than those based on SST alone, particularly for longer time scale forecasts (e.g., 6-12 month lead-times). The improved long-term forecasts provide clients in the USAPI region with the opportunity to develop more efficient response plans for hazard management.

Pacific RISA Integrated Climate Program Support

P.I.: Cheryl L. Anderson

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

NOAA Sponsor: Caitlin Simpson

NOAA Goal(s)

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

Purpose of the Project

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

Progress during FY 2012

There were three activities covered in this project. The first activity was to build capacity in the development, analysis, and delivery of climate information tailored to the needs of disaster management communities. The project will use the Climate Information Delivery and Decision Support System (CLIDDSS) as the technical platform for data portfolio management to support the distribution of information through newsletter formats to multi-sector disaster managers about their climate-related risks. The intent was to work through the State Hazard Mitigation Forum and to work with the county disaster managers. Unfortunately, major shifts in personnel and new planning requirements from the Federal Emergency Management Agency (FEMA) have overwhelmed the disaster management community. Additional delays came from the collaborating team, since they have been involved extensively in the National Climate Assessment process, which has diverted resources and key personnel to pressing national issues.

To respond to the objectives of the project, despite delays in both disaster management and climate risk communities in Hawaii, the University of Hawaii (UH) conducted key informant interviews and a small survey on the need for and use of climate information in the disaster management. The disaster managers were unaware of new websites and portals to display and discuss information. The work required to develop the Pacific Islands Regional Climate Assessment (PIRCA) involved evaluation of the available data and taking the information that feeds into the climate portal, http://www.pacificislandsclimate.org/. The disaster managers claimed that such a site that has easy to understand information on climate is what they need. As assumed, disaster managers have little time to search for new information. The nature of their work is that they are generally reactive than proactive. Although the initial assumptions of the project were fairly accurate, the mechanisms that the project pursued did not work in the current context of disaster management. There was no reason to pursue creating an advisory body on the data, because this would be redundant with the Pacific Climate Information System work. In addition, the disaster management community did not have the capacity to participate in the workshops and reviews required to develop the tools properly. After considerable time trying to arrange consultations, and realizing that the disaster management system was undergoing a series of challenges, it became apparent that another task or time requirement would not benefit the disaster management community. The project has since worked on a white paper explaining the capacities that are needed to increase climate knowledge in the disaster community, and that the tools that are available are sufficient for current needs. Another finding of the project is that there is no doubt among the disaster management community that climate is a real and pressing issue, and will exacerbate disasters, and therefore increase the need for more disaster awareness throughout government and the general public.

The second activity examined user needs for drought decision making and the potential of climate and drought information. Dr. Finucane, at the East-West Center, helped in the design of a survey instrument used by colleagues in another RISA program in Washington to understand their stakeholder needs related to drought.

The third activity was to continue building stakeholder involvement in the Pacific region, especially through maintenance and postings on the Pacific RISA website. This is an ongoing activity that was maintained during the past year, www.pacificrisa.org. Sustained stakeholder outreach has included individual and group dialogs in Hawaii, American Samoa, and Guam with government and non-government representatives from diverse sectors, updating and maintenance of the Pacific RISA website, presentation of a poster about the goals and upcoming activities of the Pacific RISA team at two conferences, and distribution of the Pacific RISA informational flyer at multiple events. Coping with Drought project activities have included reviewing and revising the interview protocol designed to explore the use and value of drought information, indicators, triggers, responses, and strategic planning. The project also facilitated identification of and access to potential interviewees in Hawaii. "Docu-Moment" videos of people experiencing drought were recorded and uploaded on the Pacific RISA website, www.pacificrisa.org.

Profiling CTD Float Array Implementation and Ocean Climate Research

P.I.: Mark A. Merrifield

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

NOAA Sponsor: Gregory C. Johnson

NOAA Goal(s)

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

Purpose of the Project

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

Progress during FY 2012

E. Steffen and the PMEL float lab took delivery of 78 Argo floats this year, of which 48 of those were a new model. She tested and installed lithium batteries in 30 of those floats. She diagnosed and coordinated repairs of many problems discovered with the floats. She worked on retooling of lab equipment and vessel storage racks to
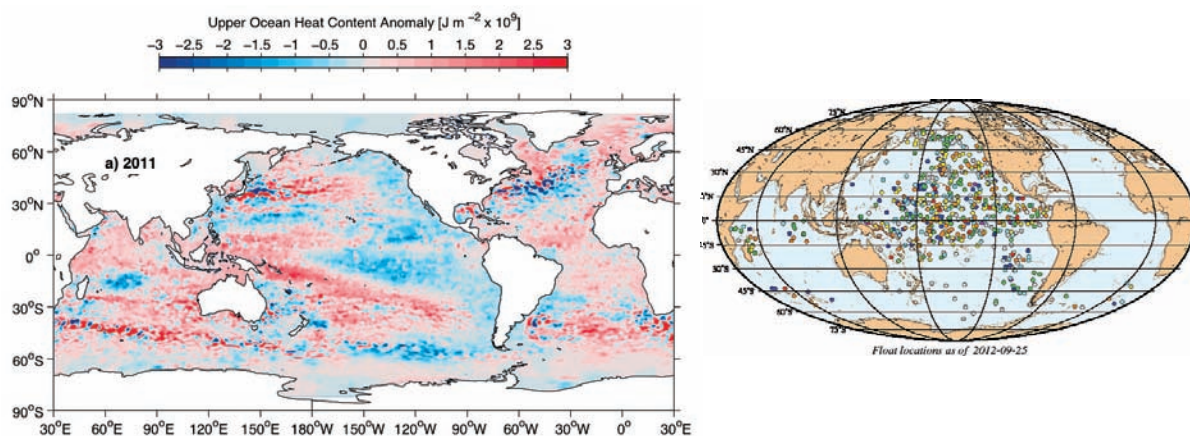
(left) Figure 1. Upper Ocean (0–750 dbar) Ocean Heat Content Anomaly [10⁹ J m⁻²] for 2011 relative to 1993-2011 estimated using in situ (mostly from Argo in recent years) temperature data and satellite altimeter sea surface height data (in colors, with red being warm and blue cold).

(right) Figure 2. Locations (filled circles) of Argo floats prepared by JIMAR float research analyst E. Steffen as of 25 September 2012. Grey indicates floats that have not reported for the last 20 days or more, colors more recently reporting floats.

accommodate the new floats, as well as working with data managers at the laboratory, national, and international levels to accommodate these new floats. She also arranged for float deployments and notified the national and international databases. She traveled to load floats on various ships and train deployers. Stated goals were met.

J. Lyman produced and analyzed (with JIMAR Senior Fellow Dr. Gregory Johnson) yearly maps of global upper ocean heat content from 1993 through 2011 (Fig. 1) combining in situ thermal data and satellite altimetry data, as well as yearly maps of sea surface salinity from 2005 through 2011. They continued working on estimating uncertainties in and improving estimates of global ocean heat content anomalies and their trends. This year Lyman was author or co-author of three journal articles. Stated goals were met.

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

P.I.: Shang-Ping Xie

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

NOAA Sponsor: Annarita Mariotti

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

Progress during FY 2012

To quantify the relationship between intraseasonal events in the Eastern Hemisphere and east Pacific, sensitivity tests in two separate models are used. When isolated from dry Kelvin wave fronts associated with the Madden-Julian Oscillation (MJO), the Community Atmospheric Model (CAM) produces similar east Pacific intraseasonal variability to observations. In the CAM, the communication of intraseasonal signals by Kelvin wave does not appear necessary to the initiation and maintenance of east Pacific intraseasonal variability suggesting that east Pacific intraseasonal events are independent of the MJO. However, communication by MJO-initiated Kelvin waves
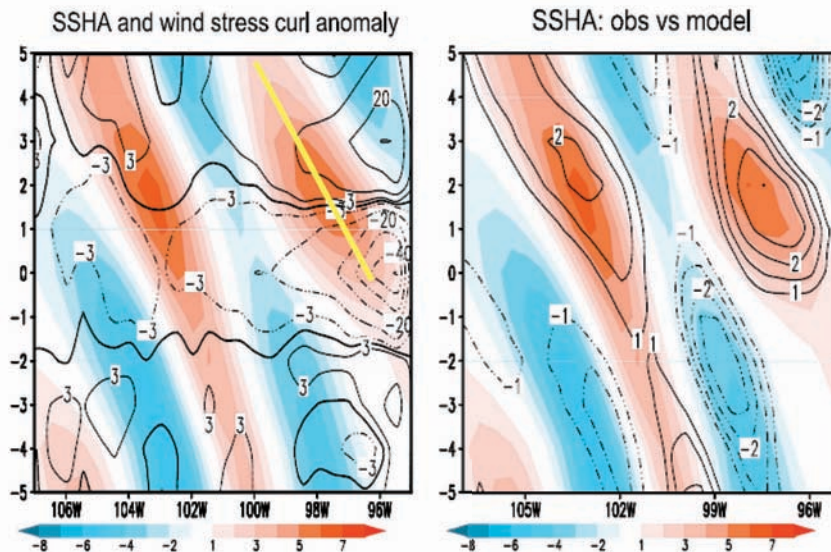
(Left) Distance-time diagram of observed SSH anomalies (cm; color) and wind stress curl anomaly along the Tehuantepec eddy-train axis. The y-axis indicates lags (in week). (Left) The offshore propagation speed, indicated by the yellow slope, is 13 cm/s. (Right) Comparison of SSH anomalies between observations (color) and an eddy-resolving model (black contours).

provides a possible phase locking mechanism between Eastern and Western Hemispheres. When the east Pacific is isolated from all remote intraseasonal signals in the IPRC Regional Atmospheric Model (IRAM), intraseasonal events there are weak and incoherent. In the IRAM, communication between the east and west Pacific appears necessary to the representation of east Pacific intraseasonal variability. However, the IRAM contains an important bias in the climatological low-level winds that affects the phase relationship between precipitation and surface flux anomalies and may suppress east Pacific intraseasonal variability.

Subseasonal variability in sea surface height (SSH) over the East Pacific warm pool off Central America is investigated using satellite observations and an eddy-resolving ocean general circulation model. SSH variability is organized into two southwest-tilted bands on the northwest flank of the Tehuantepec and Papagayo wind jets and collocated with the thermocline troughs. Eddy-like features of wavelength 600 km propagate southwestward along the high-variance bands at a speed of 9–13 cm/s. Wind fluctuations are important for eddy formation in the Gulf of Tehuantepec, with a recurring interval of 40–90 days. When forced by satellite wind observations, the model reproduces the two high-variance bands and the phase propagation of the Tehuantepec eddies. The observational analysis and model simulation suggest the following evolution of the Tehuantepec eddies. On the subseasonal timescale, in response to the gap wind intensification, a coastal anticyclonic eddy forms on the northwest flank of the wind jet and strengthens as it propagates offshore in the following two to three weeks. An energetics analysis based on the model simulation indicates that besides wind work, barotropic and baroclinic instabilities of the mean flow are important for the eddy growth. Both observational and model results suggest a re-intensification of the anticyclonic eddy in response to the subsequent wind jet event. Off Papagayo, ocean eddy formation is not well correlated with local wind jet variability. In both the Gulfs of Tehuantepec and Papagayo, subseasonal SSH variability is preferentially excited on the northwest flank of the wind jet. Factors for this asymmetry about the wind jet axis as well as the origins of wind jet variability are discussed.

Toward Reducing Climate Model Biases in the Equatorial Atlantic and Adjacent Continents

P.I.: Shang-Ping Xie

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

NOAA Sponsor: Jim Todd

NOAA Goal(s)

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

Purpose of the Project

This project aims to identify and probe the sources of tropical Atlantic biases in coupled climate general circulation models. Tropical Atlantic variability exerts crucial influence over the adjacent continents and to a significant extent on global climate. The tropical Atlantic annual mean, seasonal cycle and changes on longer time scales in coupled models typically manifest substantial deviations from observations for reasons that are not yet precisely known. The key goal is to further understand atmosphere-ocean-land interaction and reduce errors in simulations of the tropical Atlantic climate.

Progress during FY 2012

Climate change dynamics. Effects of sea surface temperature (SST) warming on the response of rainfall and atmospheric overturning circulation are investigated using Coupled Model Intercomparison Project simulations. The SST pattern effect is important in explaining both the multi-model ensemble mean distribution and inter-model variability of rainfall change over tropical oceans. Two SST patterns stand out both in the ensemble mean and inter-model variability: an equatorial peak anchoring a local precipitation increase, and a meridional dipole mode with increased rainfall and weakened trade winds over the warmer hemisphere. These two modes of inter-model variability in SST account for one third of inter-model spread in rainfall projection. The SST pattern also explains up to four fifth of the inter-model variability in intensity changes of overturning circulations.

Multi-model evaluation of tropical Atlantic simulations. Coupled general circulation model (GCM) simulations participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) are analyzed with respect to their performance in the equatorial Atlantic. In terms of the mean state, 29 out of 33 models examined continue to suffer from serious biases including an annual mean zonal equatorial SST gradient whose sign is opposite to observations. Despite serious mean state biases, several models are able to capture some aspects of observed interannual variability in the equatorial cold tongue, including amplitude, pattern, phase locking to boreal summer, and duration of events. The latitudinal position of the boreal spring ITCZ, through its influence on equatorial surface winds, appears to play an important role in initiating warm events.
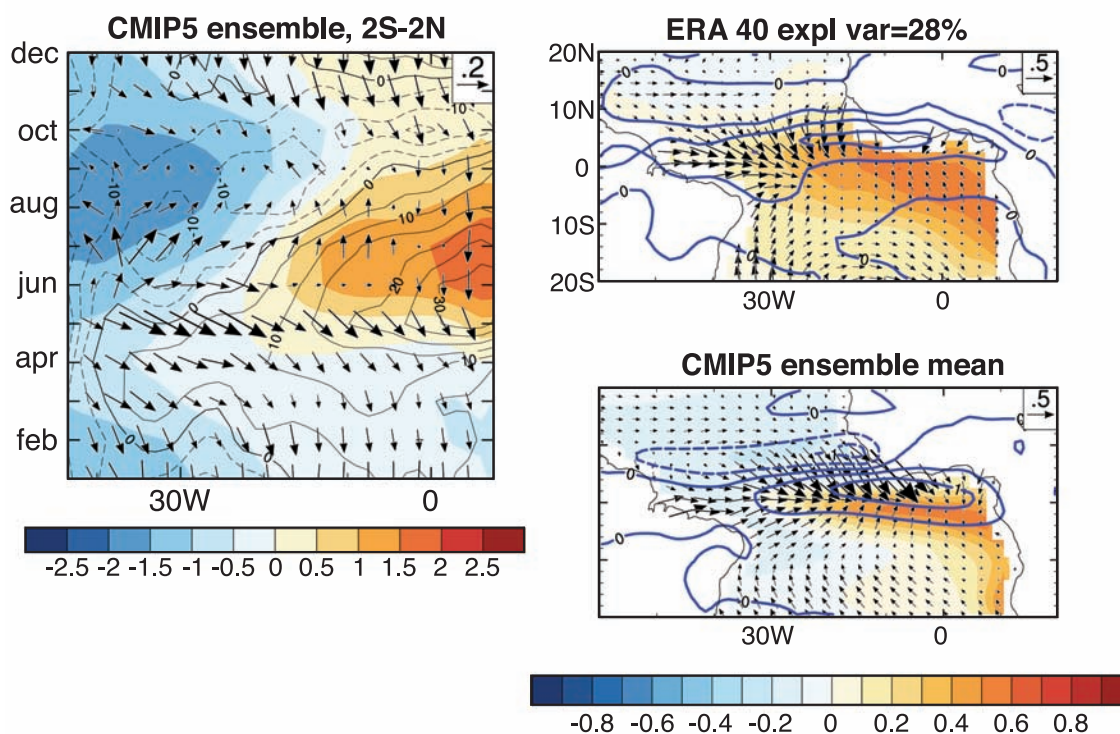
(Left) Model biases in SST (shading; K), 20C isotherm depth (contours), and surface wind stress on the equator. Atlantic Nino mode in (middle) observations and (b) CMIP5 models: SST (Shading, K); precipitation (contours); and surface wind. While CMIP5 models continue to suffer large biases in equatorial cold tongue simulations, they manage to capture the Atlantic Nino mode of interannual variability.

Tropical Meteorology

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

National Weather Service, Pacific Region Fellowship Program

P.I.: Mark A. Merrifield

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

NOAA Sponsor: Steve Goodman

NOAA Goal(s)

- 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

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

Progress during FY 2012

The NWS Fellows program provided important educational support through the provision of classroom computers, work experience stipends for undergraduates, and instructional materials used in the classroom as well as for outreach activities, in particular the SOEST Biennial Open House. The NWS Fellows project has supported numerous graduate research associates over the years, and during FY 2012 support was provided to Meteorology Department student Carl Barnes who is working with Professor Gary Barnes on a study of tropical cyclone eyewall reflectivity patterns.

The NOAA WP-3D aircraft have been flying into tropical cyclones (TCs) since 1977. The aircraft are equipped with a 5 cm lower fuselage radar that provides quantitative information on the reflectivity field out to about 75 km range. The radar provide excellent views of the eyewall whenever the aircraft is in the eye as there is little compromise due to beam attenuation and beam spreading. Carl Barnes is collecting these high quality radar scans from the NOAA/Atlantic Oceanographic and Atmospheric Laboratory/Hurricane Research Division archives for as many TCs as possible, ranging in intensity from tropical storm to category five on the Saffir-Simpson scale. To date, Carl has collected 175 scans in over 40 TCs. The scans are being used to characterize basic traits that include: eyewall width, eyewall area, inner and outer radial distance of the eyewall edges from the circulation center, eye area, mean and maximum reflectivity, eccentricity, and azimuthal completeness of the eyewall. These traits are then stratified by minimum sea-level pressure, TC motion, deep layer vertical shear of the horizontal wind, sea surface temperature, latitude, longitude, maximum potential intensity and deepening or filling rates. These data are from the Best Track and the Statistical Hurricane Intensity Prediction Scheme archives developed and maintained by NOAA scientists.

Preliminary examination of the reflectivity fields reveals some unexpected results. It is extremely difficult to define the number of convective cells in the eyewall. Here the high reflectivity blends together to mask individual cells. These findings support the interpretation that the eyewall may be frequently characterized as a mesoscale ring of ascent or a ring with one part ascending and the other descending. Eyewalls tend to have similar widths of 15-20 km when the edges of the eyewall are delineated by the 25 dBZ contours. Weaker TCs tend to have incomplete eyewalls with the highest reflectivity located down shear and to the left of the shear vector. Neither

maximum nor mean reflectivity increases with increasing TC intensity. This latter finding supports the conjecture that net latent heat release is poorly correlated with TC intensity. It may well be that the organization of the eyewall, perhaps its azimuthal completeness and its mean radial distance from the circulation center, that produces the strongest warm core that is most easily protected from environmental influences such as the entrainment of cool air into the core in the upper troposphere. There is the possibility that enough data are available to present the evolution of the eyewall for several TCs. Carl and Gary plan to develop a manuscript for *Monthly Weather Review* that has the potential to be a benchmark for those modeling eyewall reflectivity traits.

In March of 2012, four GOES-R products were successfully installed within the Honolulu Forecast Office (HFO) AWIPS workstations. These include the Convective Initiation (CI), Morphed Integrated Microwave Imagery -Total Precipitable Water (MIMIC TPW), Cooperative Institute for Mesoscale Meteorology (CIMSS) Regional Assimilation Model (CRAS), and Advanced Very High Resolution Radiometer (AVHRR) products. The products were installed the day prior to a major severe weather outbreak in March. Images of the CI product are included below which show the initial outbreak of severe weather over the Hawaiian Island chain.

In August, the project Postdoctoral Fellow, Roy Huff, successfully oversaw the Orbital Systems X/L band antenna installation and setup at Honolulu Community College (HCC) Building 7 rooftop. A dedicated server is currently being used to process Moderate Resolution Spectral Spectroradiometer (MODIS), Visible Infrared Imaging Radiometer Suite (VIIRS), and other satellite data. These products are available on the web in 1 km resolution. Additionally, five bands of VIIRS data including a Day/Night band are currently available within AWIPS workstations at the HFO. Also, an AWIPS II Data and Application Migration (ADAM) workstation and Local Data Manager (LDM) have been installed within the University that include GOES-R UW-Madison satellite products for use in development and training of GOES-R products and upcoming AWIPS I to AWIPS II transition.

National Weather Service Pacific International Desk

P.I.: Steven Businger

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

NOAA Sponsor: Jennifer Lewis

NOAA Goal(s)

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

Purpose of the Project

The project provides a comprehensive assessment of the Pacific International Training Desk (PITD). The assessment includes: 1) an evaluation of the efficacy of past Pacific Desk training; 2) a survey of the current infrastructure and practices at meteorological centers in the US affiliated and non-US affiliated Pacific Islands, with an eye to future developments and needs; 3) a review of resources available (data and applications) from partners in Japan, Australia, Indonesia, France, Finland, and New Zealand; 4) a review of the capacity to develop human resources at educational institutions in the region and globally such as the Fiji National University, World Meteorological Organization (WMO), Secretariat of the Pacific Regional Environment Programme (SPREP), and the Cooperative Meteorological Education and Training (COMET), with an eye to improving the theoretical and applied backgrounds of future Pacific Desk

Meteorological Center, Nandi, Fiji.

students; and 5) to review the administrative duties and requirements associated with the Pacific Desk with a goal of improving efficiency and coordination with partner organizations. World Meteorological Organization requirements for forecaster certification and future National Weather Service (NWS) directions are considered in the evaluation.

Progress during FY 2012

The assessment survey was conducted in both face-to-face meetings and emails with the principals and counterparts at a selection of the countries previously served by the Pacific Desk (Fig.1). The first trip undertaken by Dr. Businger in July 2012 included visits to Fiji (2 days), Samoa (3 days), and Vanuatu (3 days). The second trip undertaken by Mr. Gifford in August 2012 included visits to Nadi-Suva, Fiji (2 days), Tonga (3 days), Papua, New Guinea (3 days), and Solomon Islands (3 days). The field data have been analyzed and the PI Dr. Businger is currently authoring a report. The report will include, assessment of the efficacy of the PITD, recommendations regarding future PITD training with consideration of NWS and WMO criteria, and recommendations regarding the administration of the PITD.

Fisheries Oceanography

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

ADMB Open Source Project

P.I.: John Sibert

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

NOAA Sponsor: Samuel G. 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 purpose of the ADMB (Automatic Differentiation Model Builder) Open Source Project is to assist in the transition of the ADModel Builder software package from proprietary to free, open-source software. ADMB is currently used by all NOAA Fishery Science Centers to create stock assessment tools. The long-term goal is to enable the long-term support of this software through an active and committed group of user/developers located in laboratories and universities around the Nation and around the world.

Progress during FY 2012

The developer workshops identified parallel processing to improve ADMB application performance as a high-priority development goal. Parallel processing in ADMB is a challenging goal because of the extensive use of reverse mode automatic differentiation. Proofs of concept for three different approaches to parallel processing were established: OpenMPI, OpenCL and pthreads. All methods produce an approximate 5-fold decrease in computing time for test applications.

Cetacean Oceanography

P.I.: Mark A. Merrifield [JIMAR Project Lead: Melanie Abecassis]

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

NOAA Sponsor: Samuel G. Pooley, Jeffrey 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 purpose of this JIMAR project is to increase understanding of the spatial and temporal dynamics of cetaceans and their habitats in the central North Pacific. Project investigators work with researchers at the University of Hawaii to analyze several data sets collected by cetacean ecologists. Specifically, these include data on the movements of cetaceans collected from electronic tags, and physical oceanographic and acoustic data collected from sea gliders.

Progress during FY 2012

Project funds were utilized to cover the page charges for an article published in Marine Mammal Science. The article was published online in 2011 and the printed version published in 2012 [Woodworth, P., G. S. Schorr, R. W. Baird, et al. 2011. Eddies as offshore foraging grounds for melon-headed whales (*Peponocephala electra*). *Marine Mammal Science,* doi:10.1111/j.1748-7692.2011.00509.x]. As the project ended early in FY 2012, there was no subsequent activity.
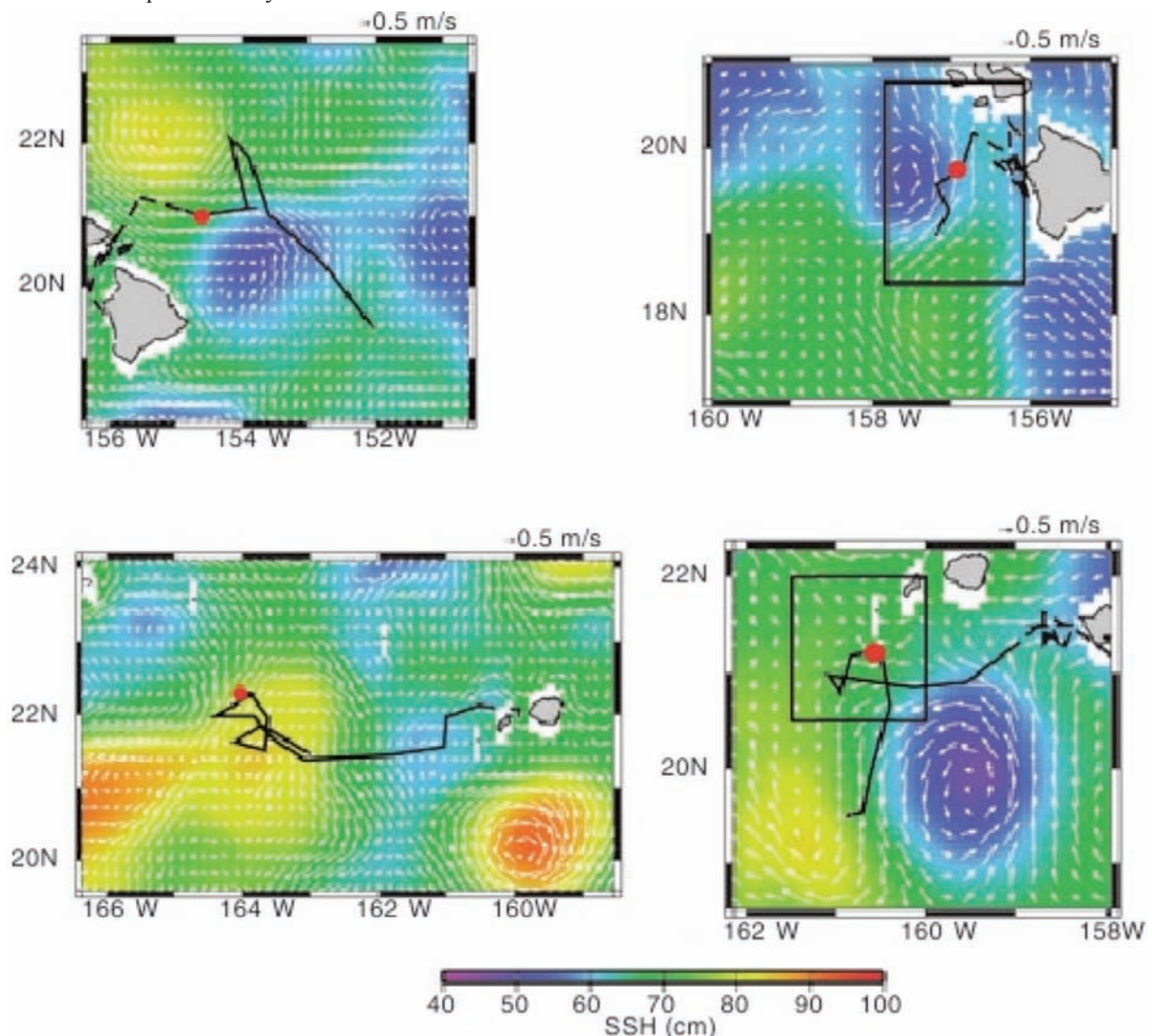

Figure 1. Clockwise from top left: Melon-headed whale tracks and HYCOM SSH (color) and surface currents (vectors) for 13 July 2008, 21 December 2008, 8 July 2008, and 9 May 2008, respectively. The nearshore segment of the track is represented by a dotted line, offshore by solid. The red circle designates the position of the melon-headed whale on the day coinciding with the HYCOM output.
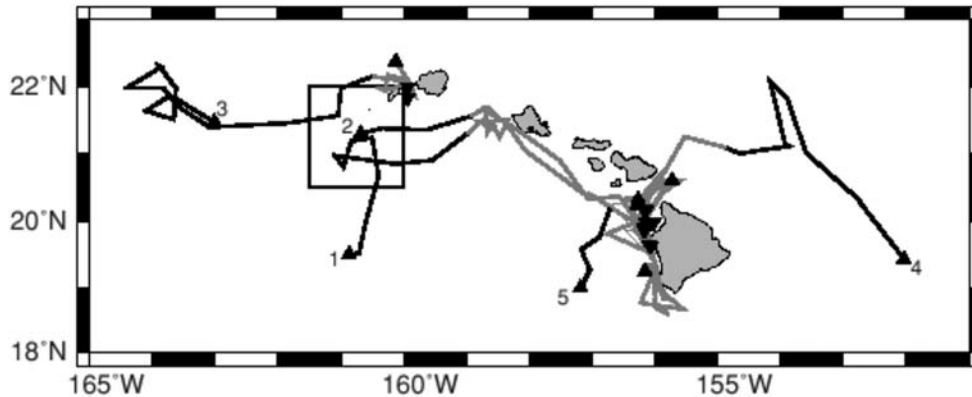
Figure 2. Tracks of all ten melon-headed whales from the main Hawaiian Islands population with nearshore portions in gray and offshore portions in black. Downward-pointing triangles represent tag-deployment positions while upward-pointing triangles represent final recorded track positions.

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

P.I.: Mark A. Merrifield

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

NOAA Sponsor: Franklin B. Schwing, Steven J. Bograd

NOAA Goal(s)

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

Purpose of the Project

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

Progress during FY 2012

NOAA-PFEL JIMAR scientists made progress on several fronts during FY 2012, resulting in 23 manuscripts published or in press and another 11 manuscripts submitted for publication. Highlights are presented below.

Modeling the temperature-nitrate relationship in the coastal upwelling domain of the California Current. Given the importance of nitrate in sustaining the high primary production and fishery yields characteristic of eastern boundary current ecosystems, it is desirable to know the amounts of this nutrient reaching the euphotic zone through the upwelling process. Palacios developed a predictive model of water-column nitrate based on temperature for a region of the California Current System within 50 km from the coast using generalized additive models (GAMs) and a compilation of ~42000 observations collected over the period 1959-2011. A temperature-only model had relatively high explanatory power but contained important depth, seasonal and latitudinal biases.

A model incorporating salinity in addition to temperature corrected for the latitudinal but not the depth or seasonal biases. The best model included oxygen, temperature and salinity (Figure 1) and adequately predicted nitrate temporal behavior at two widely separated with slight or no bias. For situations when only temperature is available a model including depth, month and latitude as proxy covariates corrects some of the biases and is superior to a temperature-only model. The results of this study have applications for the proxy derivation of nitrate availability
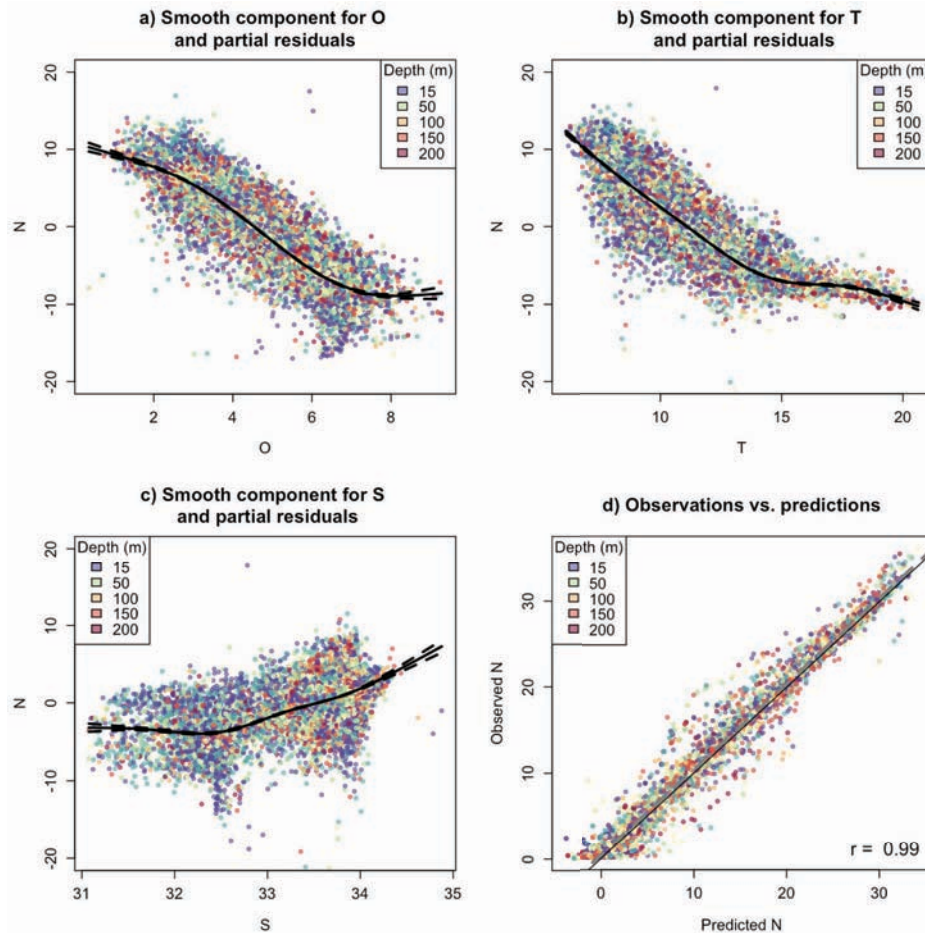
Figure 1. a-c) Estimated effects (solid black curves) at the scale of the linear predictor for each explanatory variable for a GAM based on oxygen, temperature and salinity for the training data set (1959-2004, n = 295473). The 95% confidence limits (strictly Bayesian credible intervals) are shown as dashed black lines. Dots are the partial residuals, colored by depth. d) Scatterplot of observed vs. predicted values by a GAM based on oxygen, temperature and salinity for the testing data set (2005-2011, n = 6423). Dashed gray line is the linear fit and black line is the 1:1 line. (From Palacios et al., submitted).

for primary producers in upwelling regions.

Reviews of fisheries ecology and biologging. Hazen published a book chapter on Fisheries Ecology in the *Sourcebook for Theoretical Ecology* that hopefully will serve as an important reference on the status of the field. The chapter examined the status of previously defined sub-disciplines such as physiological ecology and community ecology but also including new sub-disciplines such as coupled social-ecological systems since the field was defined in the early 1990s. Hazen also published a review paper on the status of ontogenetic-explicit research in top predator movement publications from tag data. Younger life stages are difficult to tag thus less studies are available based on top predator guild, but these are often critical stages in population viability models. Hazen also discussed the technological advantages underway that would make these studies more feasible.

Climate change impacts on top predator habitat in the North Pacific. As a follow-up to a study examining species-habitat relationships of top predators in the North Pacific (Block et al., 2011), Hazen et al. published a manuscript on the broad scale distribution and predicted habitat shifts using species-habitat relationships and

output from the GFDL Earth System Model. Hazen identified a large northward shift in top predator biodiversity predicted by the models, and showed that some species were at risk from losing habitat while others gained habitat in future projections (Figure 2). This paper received considerable national and international press coverage,
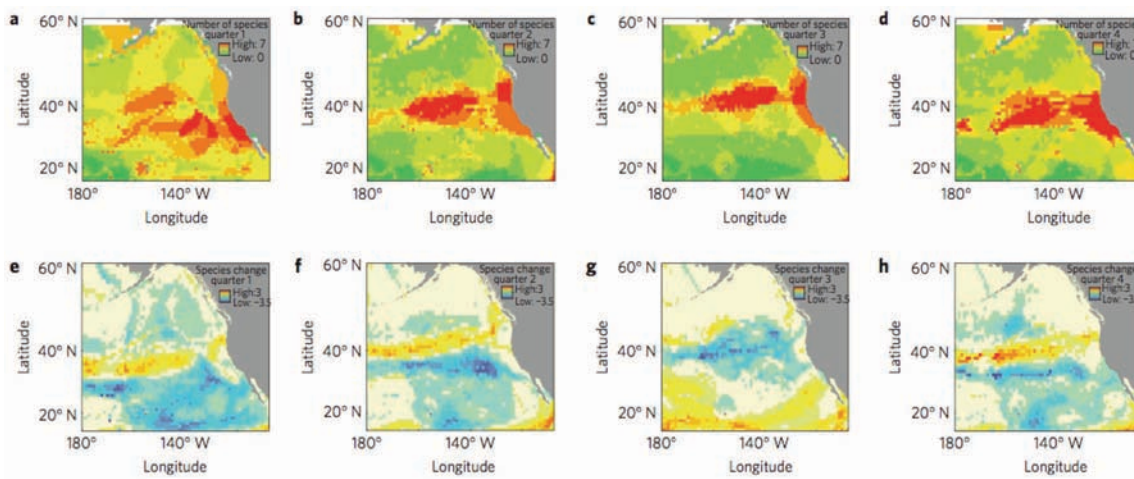
including a long story in the front section of the *Washington Post* and several radio interviews.

Figure 2. Modeled species richness values and predicted changes. a–h, Quarterly modelled species richness for 2001–2010 from 15 top predator species (a–d) and predicted changes in species richness over the next century (2001–2020 compared with 2081–2100) (e–h). (From Hazen et al., 2012b).

Remote sensing studies of marine ecosystems. In addition to continuing maintenance of CoastWatch infrastructure and data services in conjunction with ERD personnel, Foley added new data products, published in peer-reviewed journals, presented invited talks at meetings and participated in events intended to extend the scope of outreach and education efforts. Improvements to the based infrastructure included accommodations for changes in NESDIS data delivery mechanisms. Equipment upgrades included the acquisition and preparation of processing machines to handle the processing of the experimental data from the VIIRS sensor flown aboard the NPP-Suomi spacecraft. Data product improvements included continued work on an operational, satellite-based, Harmful Algal Bloom detection and monitoring product. High-resolution MODIS time series were developed for the CONUS coast lines in support of bottom fish modeling and Deepwater Horizon scientific evaluations.

Outreach and education. Additionally, Foley participated in several outreach and education activities. He presented GHRSST data products: 1) to IOOS Regional Associations; 2) via webinar; 3) as document for circulation; 4) via sample data streams installed on ERDDAP; and 5) as an instructor at the NOAA Satellite Applications Workshop held at the NOAA Coastal Services Center in Charleston, SC., March 2012.

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

P.I.: PingSun Leung

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

NOAA Sponsor: Samuel G. Pooley, 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 goal of this research project was to quantitatively assess the contribution, linkages and impacts of the fisheries sector to the State of Hawaii and other US-Affiliated Pacific Islands with a Social Accounting Matrix
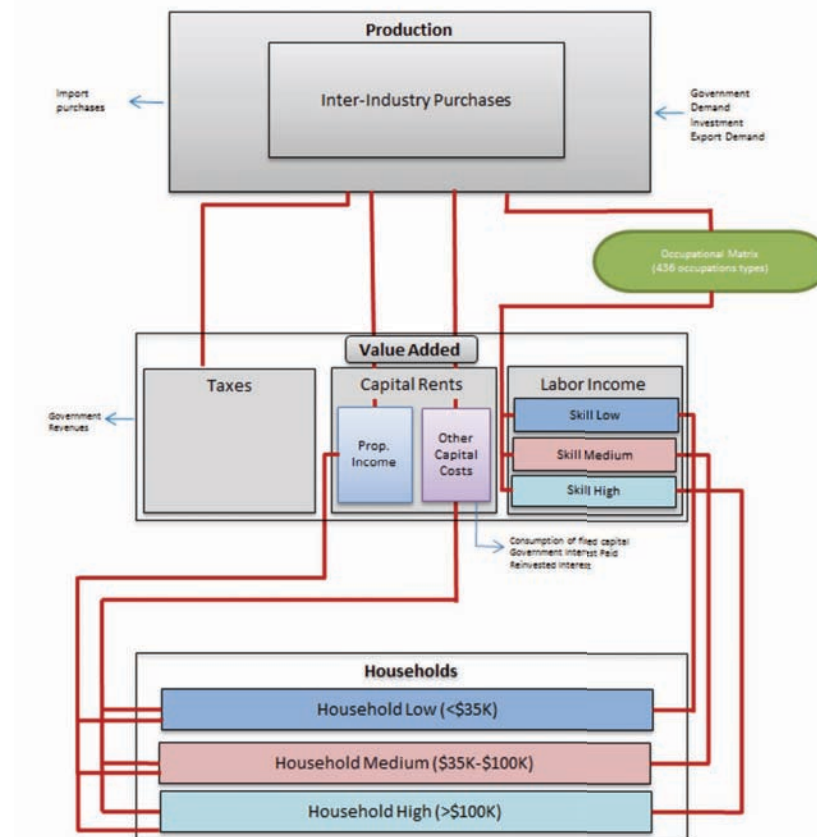
Figure 1. The construction of a SAM depends on the intended purpose of the model. In the assembly of the Hawaii Fishery SAM, special attention was given to decomposing the factor payments so that production activities could be reasonably linked towards households. The State's occupational matrix was used to disaggregate the industry-household linkage according to the composition of skill levels employed by each industry. The mechanism of income flows can be seen more clearly in Figure 2. Here the production sector's labor payments are identified by individual occupations. With the occupation matrix, the inputs are then mapped into appropriately defined skill levels based on the average salary of the occupation. The labor income is then mapped into the household sector, where the distribution of skill levels is appropriately mapped to follow the distribution of household socioeconomic groups. Total labor compensation is then combined with capital income to give total household income. Overall, this mapping gives a high level of precision in identifying skill intensive industries versus unskilled intensive industries. This approach provides explicit linkages between the distributions of income from the production sector to the household.

(SAM). Economic impact models on commercial fisheries are typically based on I-O (Input-Output) tables that focus exclusively on economic linkages among production sectors. However, managers of the fishery have to grapple with not only how much economic activity can be generated but also who are the primary beneficiaries of the fishery. A SAM makes it possible to identify the distributional characteristics of the economic impact from the fishery industry and is a useful tool to engage with fishery policy implications. The project also included two other separate components: a data collection program in Hawaii and Other U.S.-Affiliated Pacific Islands; and the organization of a PICES Workshop on Fisheries Economics.

Progress during FY 2012

Highlighted below are the accomplishments made by each of the three project components and the objectives, which were met.

• *Component 1. Contribution, linkages and impacts of the fisheries sector to the economies of Hawaii and other U.S.-Affiliated Pacific Islands: An extended input-output analysis.*

Update the I-O analysis on Hawaii's fisheries based on the 2002 I-O model and recent cost-earnings information. In the first fiscal year the economic Input-Output (I-O) analysis on Hawaii's fisheries was updated. The 2005
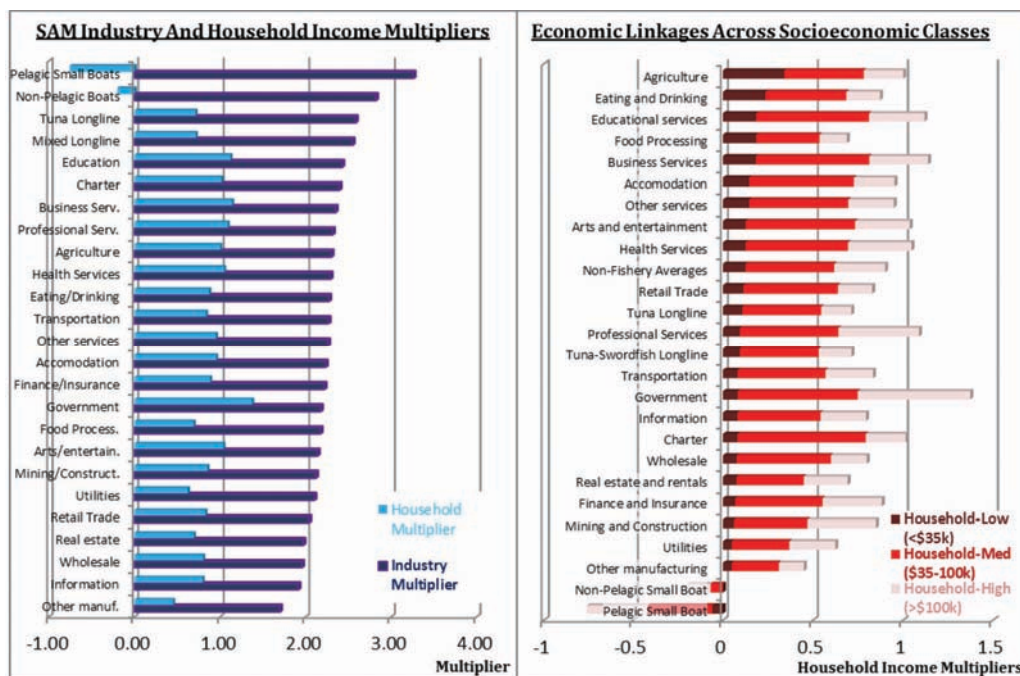
Figure 2. The SAM allows users to trace not only the industry impacts (left figure) but also the income flows across different socioeconomic groups. The figure on the right presents the distributional impacts on high (above $100,000), medium ($35,000-$100,000), and low (below $35,000) income households. Comparing the linkages across sectors, it can be assessed which sectors have higher linkages across different socio-economic groups. The multipliers indicate that the professional services and government sectors are linked to the high-income groups. This is reflected by the skill intensive nature of these sectors as well as, possibly, their low level of input usage. The agriculture and eating and drinking sectors have the strongest linkages to the low-income groups reflecting the relatively low skill nature of the occupations employed by the sectors.

fisheries I-O model was constructed based on updated cost earnings of the Hawaii longline and small boat fishery and the 2005 State of Hawaii Input Output Table, providing the project with 67 industry sectors and 5 fishery sectors.

Extend the I-O analysis to a social accounting matrix framework to assess not only fisheries' economic impacts but also their social impacts on fishing. The I-O analysis to the Social Accounting Matrix (SAM) framework was extended. IMPLAN data was employed to link the additional transfer payments across household and institutional accounts. Additionally, to complete the income distribution mapping from the industry sector to the household sector the project made use of the Hawaii State Industry Occupational Matrix.

The project applied the model to measure industry, value-added, and household multipliers for the 5 fishery sectors and 67 non-fishery sectors. Compared to previous studies on Hawaii's fishery, the SAM industry multipliers were slightly higher than the traditional I-O multipliers. This was explained by both structural changes in the industry and the greater preciseness of the SAM approach relative to the I-O approach. Using the industry-occupation linked setup, the SAM was able to deliver a rich analysis of household income and distributional linkages. The project found that the fishery sectors had relatively weak income linkages to the households, which were primarily concentrated on the lower and middle-income groups.

Dissemination and sharing of findings. The project presented their SAM findings at two academic venues in FY 2011. The preliminary findings were first presented at the PFRP PI meeting in Dec 2010. Updated findings were later presented at the North American Association of Fisheries Economists (NAAFE) meeting in May 2011. The Western Pacific Regional Fishery Management Council requested that the project estimate the economic and social impacts of the recent Bigeye closure that occurred at the end of 2010. Using the SAM model, the project ex-post ran estimates of the direct and indirect economic impacts of the closure and presented these findings at the June 2011 SSC meeting.

To help distribute the findings of their work two articles were generated. First, a technical report of the study, "Contribution, linkages and impacts of the fisheries sector to Hawaii's economy: A social accounting matrix analysis" was published as a JIMAR Contribution paper (11-373). Second, a short article entitled, "Socioeconomic

linkages of Hawaii's fishery sector" was generated for the PFRP newsletter (Vol. 15-1).

Elements of the project's work provided an important contribution to the literature of economic impact assessment and SAM models. This contribution was submitted as an article for peer review in the journal *Fisheries Research*. The journal recently asked for revisions and the revised article has been resubmitted for a second round of review.

• *Component 2. Data collection program in Hawaii and other U.S.-Affiliated Pacific Islands.*

Economic add-on program to the creel Survey in Guam and CNMI small boat fisheries. An economic data collection effort was established in the Commonwealth of the Northern Mariana Islands (CNMI) and Guam small boat-based fisheries through the collaboration with the local fisheries agencies of CNMI and Guam to collect fisheries dependent data. The participating agencies include CNMI government Department of Lands and Natural Resources' Division of Fish and Wildlife (DFW) and Guam Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR).

Annual cost survey for the American Samoa longline fleet. A cost earnings study of American Samoa's longline fleet was completed. American Samoa longline fishery cost earnings data was collected during the first fiscal year and was analyzed and assessed for economic performance in the second fiscal year. The findings of this analysis will be reported in a Pacific Islands Fisheries Science Center technical paper, "Cost earnings study of American Samoa longline fishery based on 2009 operation." A draft manuscript was completed and currently under review and revision for the publication of PIFSC administrative report.

• *Component 3. Organization of PICES workshop on fisheries economics*

A special session entitled "Economic relation between marine aquaculture and wild capture fisheries" was organized at the North Pacific Marine Science Organization (PICES) 2010 conference held October 22-31, 2010 in Portland, Oregon, U.S.A. As the first session on economics in PICES, it attracted broad participation of economists and experts from PICES member countries. Subsequently, a special issue of selected articles was published through the journal "Aquaculture Economics and Management."

Data Administration of Pelagic Fisheries Data

P.I.: Mark A. Merrifield [JIMAR Project Lead: William Walsh]

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

NOAA Sponsor: Samuel G. Pooley, 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

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

Progress during FY 2012

LODS was successfully upgraded twice in FY 2012. The project team worked closely with the LODS data manager and steering committee to identify new system requirements. Project team members utilized the NMFS JIRA issues management (trouble ticket) tool to track all system defects and enhancement requests and to ensure rigorous development, testing, and migration to production requirements. Database and application server upgrades and patching were supported to meet NOAA security and maintenance requirements.

In FY 2012, work on LLDS enabled enhancements in the integration of Logbook, Observer (LODS), and

catch landings, and vessel permit information and major reduction in time to create data submissions to regional fisheries monitoring organizations. The design and implementation of the Hawai`i Longline Limited Entry Permit History database enabled integration with the Hawai`i Longline Logbook data and dealer landings to produce data products for tracking catch history which is a key input in evaluating methodologies for instituting a catch shares system. Development of algorithms to calculate average mean fish weights for species enabled estimations of catch by weight in reports required by international treaties. The resulting LLDS resulted in significant reduction of processing time to produce annual reports and ensured reproducibility of data products.

Fisheries Oceanography: Ecosystem Observations and Research Program

P.I.: Mark A. Merrifield [JIMAR Project Leads: Meagan Sundberg, Haiying Wang]

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

NOAA Sponsor: Samuel G. Pooley, Michael P. Seki

NOAA Goal(s)

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

Purpose of the Project

This JIMAR project monitors and conducts research on ecosystems that involve marine species and resources of concern to the Pacific Islands Region. The project activities enable scientists to provide scientific advice to those charged with management of the resources as mandated by legislation (e.g., Reauthorized Magnuson Stevens Act, Marine Mammals Protection Act, Endangered Species Act, etc.). Current specific activities include support for data management of the various ocean observing system inputs, biological and ecological sampling of species for use in studies to advance population assessment efforts, and support for advancing public awareness of marine ecosystems observations

This work continuously supports fishery and ecosystem research and management within the Western and Central Pacific Ocean (WCPO) region. The objective of this project is to provide JIMAR support to scientist and resource managers at the Pacific Islands Fisheries Science Center (PIFSC) and the WCPO region in developing, maintaining and administration of geospatial databases, spatial data servers and services, and web-based applications, and in spatial data analysis, spatial data statistics, and ArcGIS technical support for

Figure 1. Fisheries associate extracting gonads from one of the deep-seven bottomfish species, Etelis coruscans *(onaga).*

fishery and ecosystem research and monitoring programs. This project will effectively improve communication and technology sharing procedures and contribute the effective stewardship and collaborations between JIMAR and PIFSC in marine fisheries and ecosystem resource management in the Pacific Islands.

Progress during FY 2012

Life History. This component of the project provides fundamental biological and ecological research on federally managed species to allow for an improved understanding of the mechanisms influencing resource distribution and abundance. This is accomplished by conducting field surveys using a variety of sampling gears, performing laboratory studies of biological specimens as well as organizing, analyzing and managing all collected and archived data in an efficient manner. The project continues to conduct biological studies aimed at improving knowledge of life history (LH) parameters (e.g., age and growth, reproduction, etc.) with specific intentions to complement and improve ongoing population assessments for fishery resources. To this end, a fisheries associate is supported to collect LH information of commercially important bottomfish species and biological samples for

age, growth, and reproduction studies. Routine sampling at the United Fishing Agency (UFA), a commercial fish auction, has been conducted to support the size- and age-based monitoring of the landed catches. LH data continues to be created in an Oracle-compatible format and full doc metadata for numerous LH program data sets were externally published in InPort. Preliminary maps of the MHI-caught bottomfish and juvenile swordfish were created using GIS software. Manuscripts describing the Lampris spp. and its distribution were delayed due to an inability to obtain specimens in pristine condition.

Additional project activities include: 1) extensive sampling of the deep-seven bottomfish reproductive organs (gonads) onsite at the UFA fish auction and off-island with the support of a cooperating Maui fisherman; 2) collaboration with the Pacific Islands Fisheries Group (PIFG) on an independent MHI bottomfish survey, creating LH sampling protocols, generating catch datasheets, and explaining established procedures to participating fishermen; and 3) analyzing and producing reports on data collected by JIMAR's Pacific Islands Monitoring and Sampling Program (PIMSP). This year's efforts also took the project to Guam and Saipan to observe bio-sampling activities and examine the archival methodologies in place for important life history specimen such as gonads and otoliths and American Samoa for an at-sea bottomfish research project.

Figure 2. Deep-seven bottomfish species available for sampling at the UFA fish market in Honolulu.

Data management. Project activities during FY 2012 include: 1) continue to maintain, update, and administer the ArcGIS map services, web-based applications, and back-end enterprise geo-database for the spatial information repository displaying, accessing and distribution; 2) continue to develop the Essential Fish Habitats (EFH) / Habitat Areas of Particular Concern (HAPC) geo-databases for Bottomfish, Crustaceans, Reef Fish, and Precious Corals in the WCPO region [Main Hawaiian Islands, Northwestern Hawaiian Islands, American Samoa, Commonwealth of the Northern Mariana Islands (CNMI), Guam, and Pacific Remote Islands Areas]; 3) providing support for the 2011 Fisheries Statistics and Annual Reports for Regional Fisheries Management Organizations in the Pacific, including the Western and Central Pacific Fisheries Commission (WCPFC), the International Scientific Committee on Tuna and Tuna-like Species (ISC), the Inter-American Tropical Tuna Commission (IATTC), and to submit statistics through the agreed U.S. government channels; and 4) support of the Pacific Islands Data Stewardship Community (DSC) with the development of the Data Documentation Implementation Plan (DDIP) and creation of metadata.

Fisheries Oceanography: Ecosystem Observations and Research Program: Analyses of Catch Data for Blue and Striped Marlins

P.I.: Mark A. Merrifield [JIMAR Project Lead: William A. Walsh]

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

NOAA Sponsor: Samuel G. Pooley, 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 objective of this project is to provide two types of input required for a stock assessment of blue marlin *Makaira nigricans* in the Hawaii-based pelagic longline fishery. These inputs are a corrected catch history

and catch-per-unit-effort (i.e., CPUE=catch per 1000 hooks) standardizations to be used as indices of relative abundance. The reason for pursuing this objective is that standardized CPUE generally yields a more accurate understanding of population status than nominal catch rates.

Progress during FY 2012

The blue marlin CPUE standardization and catch history correction work is in progress. A working paper summarizing the results should be available for the next ISC BILLWG meeting, which is scheduled for January
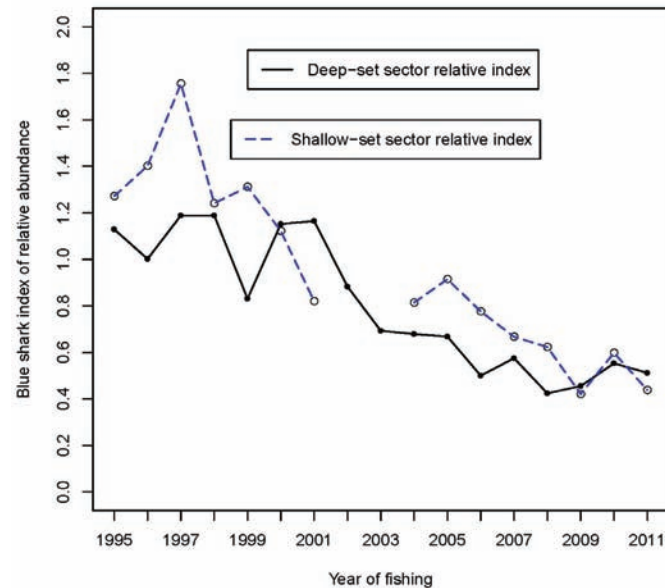

Figure 1. Blue shark indices of relative abundance in the deep- and shallow-set sectors of the Hawaii-based longline fishery as estimated from generalized linear model (GLM) analyses.
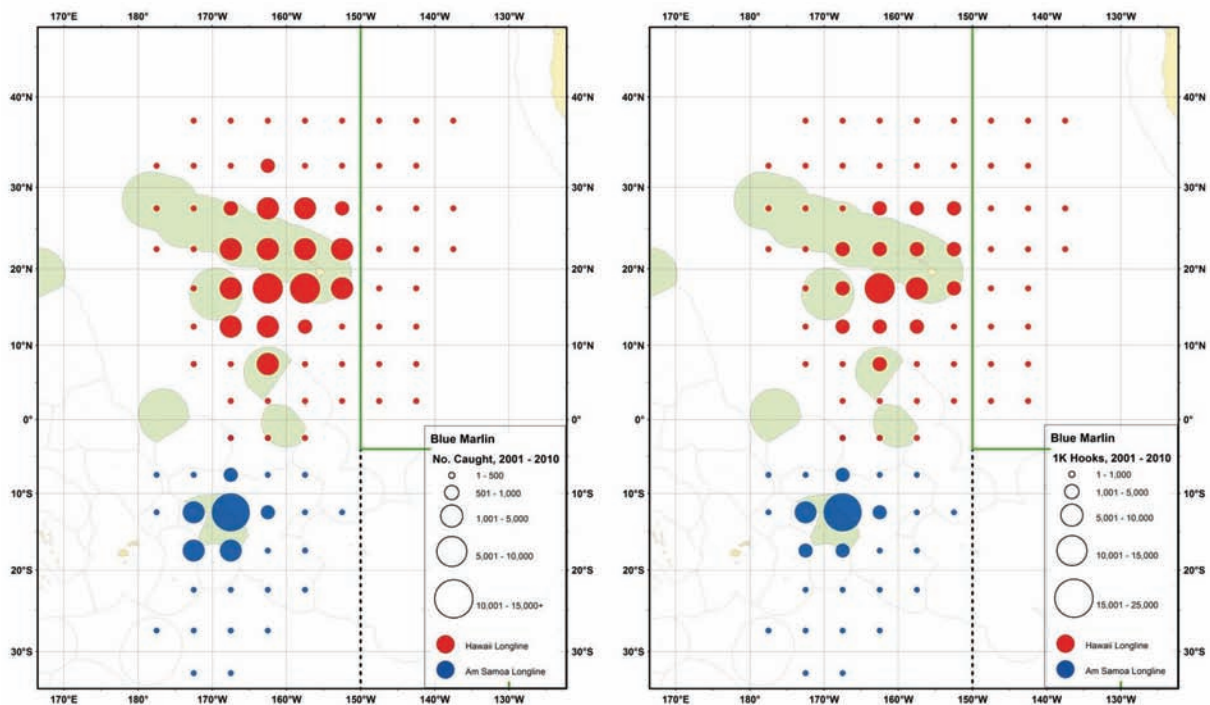

Figure 2. Blue marlin catches and CPUE in the Hawaii- (red) and American Samoa-based (blue) longline fisheries in 2001–2010.

2013 in Honolulu, with Dr. Jon K.T. Brodziak of NOAA PIFSC presiding as chairman.

Additional research progress included two sets of tasks. The first resulted from Researcher William Walsh being selected to serve as a member of the ISC SHARKWG (Sharks Working Group). This necessitated attendance at data preparation meetings held in advance of stock assessments and submission of working papers. The other set of tasks entailed preparation of draft web pages for blue marlin and several other species of interest to the ISC Billfish and Shark Working Groups (BILLWG: swordfish *Xiphias gladius*, blue marlin *Makaira nigricans*, and striped marlin *Kajikia audax*; SHARKWG: blue shark *Prionace glauca* and shortfin mako *Isurus oxyrinchus*). The webpages were prepared in the form of working papers; the billfish abstracts are available from the project upon request.

The principal departures from planned activities during FY 2012 consisted of the web page development work described above and a series of CPUE standardizations for oceanic whitetip shark *Carcharhinus longimanus* conducted in collaboration with Dr. Jon K.T. Brodziak, of NOAA PIFSC. These analyses represent continuations and enhancements of work begun in April 2011 in New Caledonia at the Secretariat of the Pacific Community, Oceanic Fisheries Programme.

Fisheries Oceanography: Ecosystem Observations and Research Program–Post-Release Survival, Vertical and Horizontal Movements, and Thermal Habitats of Istiophorid Billfishes in the Central Pacific Ocean

P.I.: Mark A. Merrifield [JIMAR Project Lead: Michael K. Musyl]

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

NOAA Sponsor: Samuel G. Pooley, 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

Pop-up satellite archival tags (PSATs) are used to determine post-release survival and vertical and horizontal movement patterns in commercially and ecologically important tuna, billfish, and shark species. This JIMAR research is intended for incorporation into population assessments, addressing fisheries interactions as well as improving the overall management and conservation of commercially and recreationally important species. Management strategies for mitigating effects on the bycatch of large-scale commercial fisheries require accurate estimates of post-release survival in captured pelagic species. High mortality from industrial fishing has the potential to reduce parental biomass and ultimately the ability of the stock to rebound. The uncertainty about post-release survival in many pelagic species is challenging for management, but this information is absolutely critical to improve stock assessments and to develop conservation measures. For catch-and-release to be a viable management bycatch mitigation strategy there must be a high likelihood of post-release survival. Marlin and other pelagic bycatch species are released from fishing gear, but it is largely unknown whether animals survive long term and what population-level effect might encompass. Effective strategies to mitigate bycatch also require knowledge of species-specific horizontal and, more importantly, vertical movement patterns. Knowledge of these vertical movement patterns may allow fishing crews to target the opportunity of mismatch between hook depth and species' vertical distributions and thus possibly minimize bycatch. The project objectives are as follows.
• Determine the post-release survival of large Pacific blue marlin (*Makaira nigricans*) and other istiophorid billfish (striped marlin, *Kajikia audax*, shortbill spearfish, *Tetrapturus angustirostris)* released from pelagic longline gear using PSATs.
• Develop biochemical techniques that are portable and applicable to the rapid analyses of post-release survivorship in many pelagic species. Blood and muscle samples will be collected from marlin and subjected to a comprehensive set of analyses to measure the levels of critical ions, metabolites and proteins to create a physiological profile for each fish. The long-term goals are to identify a model that can predict the likelihood of survival of bycatch and to develop analytical kits that could be distributed in the commercial fishery to allow rapid analysis of fish on site.
• To fill in gaps on migration within Pacific Islands, a pilot study was conducted to determine the vertical and horizontal movement patterns in commercially important wahoo *Acanthocybium solandri* around Niue.
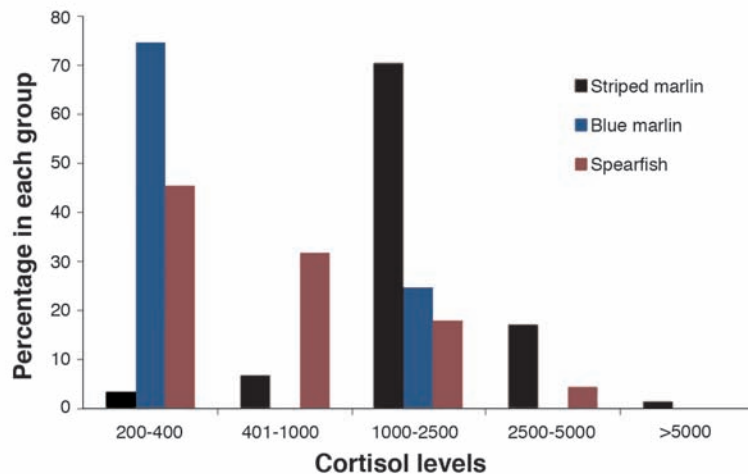
Figure 1. Cortisol levels for striped marlin, blue marlin, and spearfish. As with the indices of muscle damage, striped marlin stand out as the species that shows the greatest signs of stress arising from capture. The average cortisol level in striped marlin was more than twice that of the other two species.
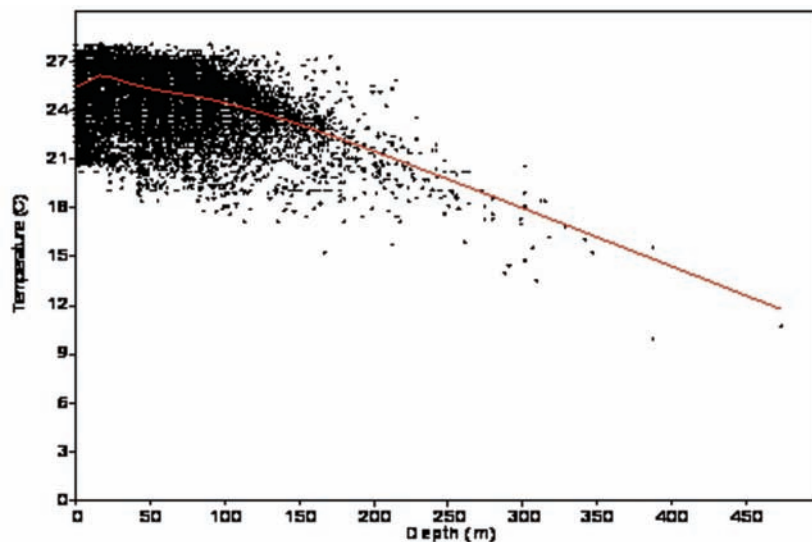
Figure 2. Temperature-depth profile of wahoo (Acanthocybium solandri) identified with PSATs using available data from all samples. LOESS smoother was used to estimate approximate location of Mixed-Layer Depth.

Progress during FY 2012

Project researchers analyzed samples from 149 billfish: 108 striped marlin, 10 Pacific blue marlin and 31 shortbill spearfish. Each sample has been analyzed for blood plasma parameters including ions (Na^+, Cl^-, Ca^{2+}, K^+, Mg^{2+}), metabolites (glucose, lactate), enzymes (alkaline phosphatase, alanine transaminase, aspartate aminotransferase, creatine phosphokinase, lactate dehydrogenase) and hormones (cortisol). The impression that emerges from the analyses to date suggests that the analyses will be successful in distinguishing between fish on the basis of physiological condition at capture. Many of the observations are reminiscent of previous work on blue sharks, but species-specific differences are also evident: 1) plasma inorganic ions (Na^+, Cl^-, Ca^{++}) do not show much variation between individuals of each species. Thus, it is expected that these will not be sensitive indicators of biological stress; 2) tissue enzymes (LDH, CPK) can vary up to 1000-fold mostly due to the condition of the fish during sampling. Thus, it is expected that these will be the most sensitive indicators of biological stress, though whether they reflect the propensity to survive upon release is yet to be determined; and 3) Stress hormones

(cortisol) also varied widely between fish. In contrast to lactate (which measures muscle metabolic activity), cortisol levels were much higher in striped marlin than blue marlin and spearfish, despite having comparable levels of lactate. Lastly, project staff prepared mRNA and made cDNA from the muscle samples that were generated and analyzed mRNA encoding a stress-sensitive gene product (heat shock protein 70, HSP70) and its constitutively expressed partner (HSC70) and an associated transcription factor (HSF); each of which serve as housekeeping genes. Expressing HSP70 over HSC70, shortbill spearfish varied up to 1900-fold, striped marlin 6000-fold and blue marlin 200-fold. Spearfish are displaying exceptionally high HSP70 expression, particularly in the fish that are landed in the poorest condition. Preliminary findings suggest that striped marlin are able to undertake much more strenuous activity, incur much greater activity muscle damage and metabolic stress, and yet tolerate these conditions with relatively less perturbation in homeostasis. Conversely, blue marlin and spearfish appear on the surface to be less affected than striped marlin, but they show greater perturbation in homeostasis. The analyses to date suggest that striped marlin may show evidence of incurring a greater perturbation in metabolism, but they may be less affected by the disturbance (i.e., they are less stressed, and possibly more likely to survive).

Wahoo is a migratory pelagic scombroid fish distributed worldwide throughout tropical and warm temperate seas. Despite its economic importance to many coastal nations, assessments of wahoo are hampered by a lack of basic life history information. The commercial catch rate of wahoo drops precipitously during onset of the wet season in Niue Island in the central Pacific. Whether fish migrated for spawning purposes, moved into deeper water or were being captured in offshore commercial fisheries gear was not clear. At the request of Niue Department of Agriculture, Fisheries and Forests, seven wahoo (size range ~ 17 to 25 kg) were tagged with x-tags from Microwave Telemetry in September 2010 to learn more about their overall movement patterns and vertical habitat for management purposes. Five of the x-tags reported (71%, bootstrap 95% CI, 0.43–1) after 19, 48, 49, 80, and 97 days-at-liberty. All of the tags were shed early and one individual apparently died (i.e., one of five reporting tags for a 20% mortality rate; 95% bootstrap CI, 0–0.6) after making a substantial transit to the east coast of Australia (linear displacement of ~2,054 nmi) and covered that distance in 80 days (~26 nmi day-1). The horizontal data indicated two general patterns: 1) fish that transited to the east coast of Australia after 80 and 97 days-at-liberty to presumably spawn; and 2) fish that remained near Niue (19, 48, 49 days-at-liberty). The vertical data indicated fish spent 86% of the time within 3°C of sea surface temperature during the daytime and 98% of the time during the night. Although wahoo are capable of diving beneath the mixed-layer depth (maximum depth, ~720 m; minimum temperature ~6°C) these excursions appear to be rare and the fish are more or less confined to the mixed-layer.

Fisheries Oceanography: Protected Species Investigation: Marine Turtle Research Program

P.I.: Mark A. Merrifield [JIMAR Project Lead: Wendy Marks]

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

NOAA Sponsor: Samuel G. Pooley, George Balazs

NOAA Goal(s)

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

Purpose of the Project

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

Progress during FY 2012

In the FY 2011 annual report, JIMAR's MTRP identified the following goals for FY 2012: 1) continue research of the pelagic ecology and movements of sea turtles to develop management strategies to reduce bycatch; 2) continue captive care and rehabilitation of captive-reared and stranded turtles; 3) conduct necropsies on stranded turtles and collect and manage biological samples; 4) conduct Longline Observer training; 5) participate in field captures of marine turtles in the main Hawaiian Islands, and 6) collect nesting data at French Frigate Shoals in the Northwestern Hawaiian Islands and 7) hire and train new JIMAR MTRP Stranding Associate. The project's progress toward these goals is discussed below.

• JIMAR Marine Turtle Specialist, Denise Parker, manages a Pacific-wide satellite-tracking database, prepares maps, analyses satellite-tracking data, and provides data for publication in peer-reviewed journals. Data has been managed and maps were produced for 46 turtles from eight projects throughout the Pacific during FY 2012.

• JIMAR employees Wendy Marks and Devon Francke, along with NMFS MTRP staff, were responsible for the care and rehabilitation of 15 stranded sea turtles at the NMFS Kewalo Research Facility. Daily care involved feeding, cleaning tanks, administering medications, assisting the veterinarian and conducting external visual exams.

• NOAA has constructed a new life support system for turtle rehabilitation and research at the Pacific Regional Center (PRC) at Ford Island. JIMAR Stranding Associate Wendy Marks is designated to undergo intensive training to learn how to operate this highly specialized and technical system. When NOAA moves to the PRC, marine turtle rehabilitation and captive care will be handled at this new facility.

Figure 1. *MTRP JIMAR Stranding Associate, Wendy Marks, providing care for a marine turtle at NOAA's Kewalo Research Facility who stranded on 8/21/11 at Ahihi-Kinau, Maui with fishing line strangulating the left front flipper. This turtle was later given a clean bill of health and released.*

• JIMAR employees Wendy Marks, Devon Francke, and Tyler Bogardus (July 2011 to January 2012) along with NMFS MTRP staff were responsible for conducting necropsies on stranded marine turtles. Salvaged carcasses are examined externally and a gross necropsy is performed to ascertain a cause of stranding. Biological samples such as skin for genetic analysis, food items for diet analysis and tumor tissue for disease studies are collected and managed by JIMAR MTRP stranding associates.

• JIMAR MTRP employees along with NMFS MTRP staff conducted two Longline Observer training sessions in FY 2012 (9/23/11 and 3/7/12). JIMAR project staff Wendy Marks and Devon Francke assisted during the hands-on training portion which demonstrated proper techniques for tagging and taking measurements, as well as taking a skin biopsy for genetic analysis. Tyler Bogardus led the 30-minute sea turtle biology Power Point presentation for the session on 9/23/11.
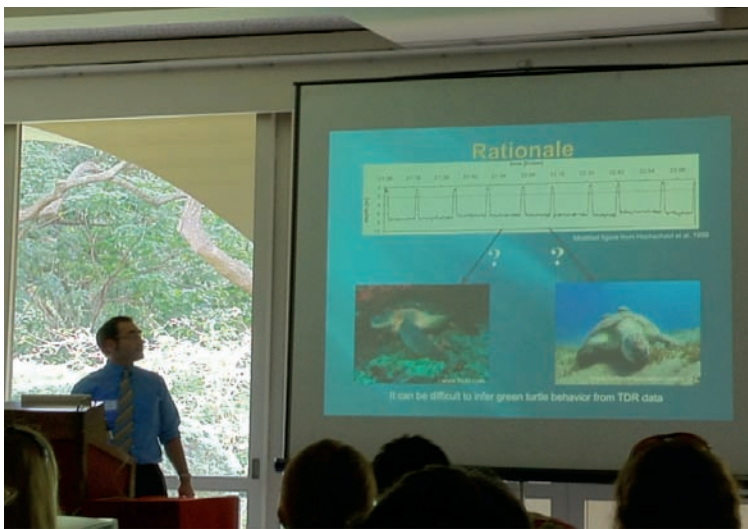

Figure 2. *MTRP JIMAR Stranding Associate, Devon Francke, presenting research data at the 1st Annual JIMAR Symposium on February 29, 2012.*

• JIMAR MTRP staff Wendy Marks and Devon Francke participated in field captures of marine turtles on July 10-12, 2012 at the Kailua Bay study sites. Juvenile green turtles were captured by hand/snorkel or by scoop net and then tagged, measured, weighed, examined and released.

• JIMAR MTRP Biological Research Associate (May 2012-August 2012), Irene Nurzia-Humburg completed a 28 day field camp at French Frigate Shoals in the Northwestern Hawaiian Islands, which is a major nesting site for green turtles. This is the 40th consecutive year of green turtle nesting data collection at this site.

• JIMAR MTRP Stranding Associate Devon Francke began employment in March 2012. He continues to be trained on new skills, but has a great understanding of his role in stranding response, assisting during necropsies and database entry and validation.

• JIMAR employee Wendy Marks is taking online classes at San Juan College toward obtaining an Associate Degree in Veterinary Technology and national certification. All three full time JIMAR MTRP employees presented at the 1st Annual JIMAR Symposium:

  • Wendy Marks, "Marine turtle strandings in the Hawaiian Islands" (oral)
  • Devon Francke, "Ground-truthing inferences made from the time-depth recorder data on juvenile green sea turtles" (oral)
  • Denise Parker, "What does the end of transmissions mean? A summary of dual transmitters deployed on loggerhead, green and olive ridley turtles in the Pacific Ocean" (poster)

Fisheries Oceanography: Protected Species Research Program

P.I.: Mark A. Merrifield [JIMAR Project Leads: Marie Hill, Liz Kashinsky]

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

NOAA Sponsor: Samuel G. Pooley, Erin Oleson, Charles Littnan, Frank Parrish

NOAA Goal(s)

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

Purpose of the Project

The JIMAR Protected Species Research Program is comprised of two components: the Cetacean Research Program (CRP) and the Hawaiian Monk Seal Research Program (HMSRP).

Cetacean Research Program. The JIMAR Cetacean Research Program (CRP) is charged with assessing the status of cetacean stocks within the U.S. Exclusive Economic Zone (EEZ) waters of the Pacific Islands region (PIR), which encompasses the EEZ around the entire Hawaiian archipelago, Johnston Atoll, Kingman Reef and Palmyra Atoll, Baker and Howland Islands, Jarvis Island, American Samoa, Wake Island, Guam, and the Commonwealth of the Northern Mariana Islands. At least 34 cetacean stocks occur in the Hawaiian EEZ alone, and many more exist in the other PIR EEZs, though most are largely unstudied. Assessment of cetacean stocks includes conducting inventories of species within each PIR EEZ, followed by evaluation of the structure of the stocks within each EEZ, the population status of each stock, and evaluation and mitigation of human impacts on cetacean stocks.

Hawaiian Monk Seal Research Program. The JIMAR Hawaiian Monk Seal Research Program (HMSRP) studies the relationship between environmental/oceanographic parameters and population biology of the Hawaiian monk seal (HMS) and develops mortality mitigation strategies to enhance the recovery of the species.

Progress during FY 2012

Cetacean Research Program. During FY 2012 the CRP conducted large vessel surveys within the Palmyra EEZ. The Palmyra Islands Cetacean Ecosystem Assessment Surveys (PICEAS) were accomplished during a fall (October 20-November 17) and a spring (April 23-May 17) cruise. The spring cruise departed from Pago Pago, American Samoa, completed the surveys lines within the Palmyra EEZ and ended in Honolulu, Hawaii. The data from these surveys will be used to update the abundance estimates for the National Marine Fisheries (NMFS) stock assessment reports.

The CRP Project Lead (Marie Hill) conducted small boat surveys during the FY 2012. This included: photo-identification and biopsy surveys for cetaceans off of the Kona coast of Hawaii Island in conjunction

with the Ecosystem and Oceanography Division's Kona Integrated Ecosystem Assessment survey (July 1-14); photo-identification and biopsy surveys for cetaceans off of Guam, Saipan, Tinian, and Rota; and photo-identification and behavioral surveys for spinner dolphins off of the Kona coast of Hawaii Island (March 2-14).

The CRP has been maintaining High-Frequency Acoustic Recording Packages (HARPs) for long-term continuous recording of cetacean occurrence off the Kona coast of the Island of Hawai'i, Kaua'i, Pearl and Hermes Reef in the Northwestern Hawaiian Islands, Wake Island, Tinian and Saipan. Results of these monitoring efforts will provide detailed accounts of the seasonal and diel behavior of cetaceans in these locations.

The CRP began testing deployment methods and configurations of acoustic recorders on longline gear to assess potential cues to false killer whales.

Hawaiian Monk Seal Research Program. Activities undertaken by the JIMAR HMSRP included population monitoring and assessment, survival enhancement activities, characterization of foraging ecology, evaluation of health and disease, and behavioral research. HMS research field camps were deployed to the Northwestern Hawaiian Islands (NWHI) in the reporting period from July 1-August 21, 2011 and June 15-August 5, 2012. JIMAR program staff trained field personnel in data and specimen collection techniques and provided logistical support for the camps. The JIMAR field personnel collected population information, removed marine debris from beaches, tagged seals for long-term identification, disentangled seals, reunited mother-pup pairs, and documented and mitigated mortality caused by males exhibiting aggressive behaviors towards other seals. In 2011, field staff participated in a trial of aversive conditioning techniques to dissuade these males from seeking out and harassing pups and other young seals at Kure Atoll. In January 2012 JIMAR staff assisted with the capture of one of these male seals at Midway Atoll. This seal is suspected to have caused the death of at least two pups in addition to having been observed exhibiting aggressive behaviors towards other seals. JIMAR staff assisted with transporting the seal to Oahu and participated in the captive care of the seal until he was relocated to the University of California Santa Cruz for monk seal physiology research.

Shark predation monitoring and mitigation to prevent monk seal pup mortality and fishing for predatory Galapagos sharks in nearshore areas of pupping sites occurred at French Frigate Shoals (FFS). Field staff translocated weaned pups from areas of higher to lower predation risk within the atoll in the 2011 and 2012 field seasons and in 2012 two pups were translocated from FFS to Laysan. Trials were conducted to determine the efficacy of a topical anthelminthic for treating young seals for parasite infection at Laysan Island in 2011 and 2012. The project expanded to include treating seals at Lisianski and Kure Atoll in 2012. JIMAR staff compiled data for manuscripts on large-scale HMS movements and impacts of nearshore fisheries on HMSs, created a data interface allowing for greater efficiency and improved ability to analyze data, and participated in directed studies of main Hawaiian Island (MHI) seal behavioral observations for anthropogenic interactions. A JIMAR staff member served as part of the HMS critical habitat review team for designation of critical habitat in the MHI and participated in outreach activities including serving as a HMS expert and liaison at Midway Atoll
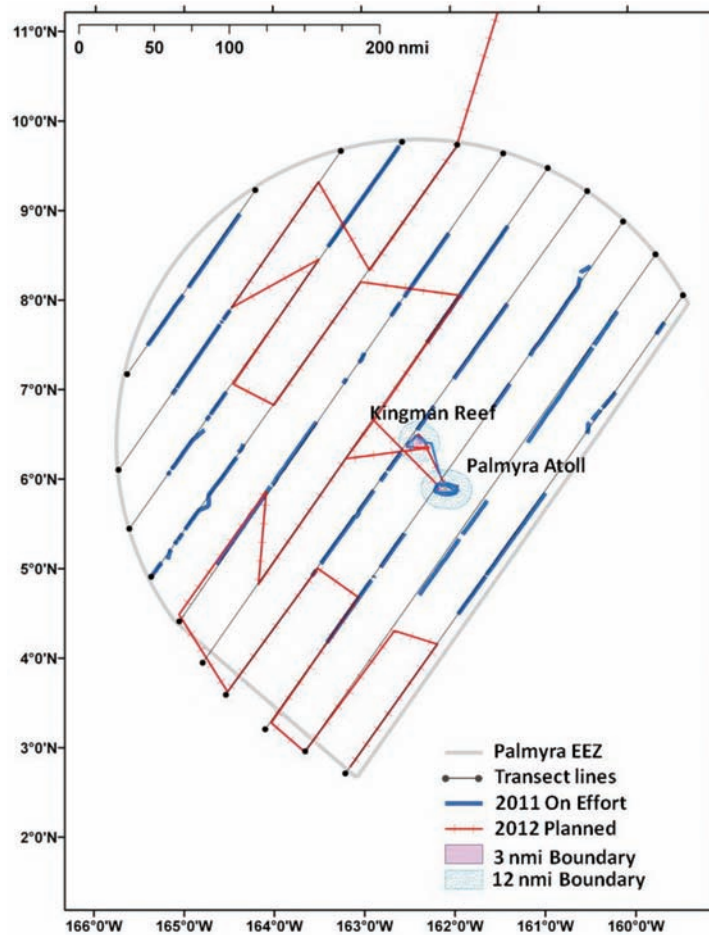

Figure 1. PICEAS Tracklines within the Palmyra EEZ during the Fall 2011 cruise.

providing information about monk seal biology, ecology, and research for a Duke University Marine Conservation Biology course and the Sylvia Earle and Wyland Expedition to Midway Atoll in January 2012.

The foraging ecology program continued with ongoing analysis of MHI seal scat for dietary studies. A manuscript detailing the diet of MHI seals was prepared and is in review. A manuscript detailing foraging behavior of MHI seals is also being prepared for submission. Telemetry equipment was deployed, including Crittercams to record high-definition video of HMS foraging behavior for the first time in the MHI. This project was supported in part by funding from the JIMAR visiting scientist program in collaboration with the National Geographic Society. This collaboration will increase understanding of HMS diet foraging success, fisheries interactions, and other aspects of HMS ecology in the MHI. Footage obtained is expected to be invaluable as outreach material and may result in national television coverage. The health and disease program collected biomedical samples for disease surveys in the MHI in conjunction with telemetry deployments and from stranded animals. Significant revisions

Figure 2. A spy-hopping melon-headed whale off Palmyra Atoll photo courtesy of NOAA Fisheries, Pacific Islands Fisheries Science Center, taken under Marine Mammal Permit # 14097.

to field collection protocols were made, including revisions to live animal biomedical sampling techniques in collaboration with researchers from the National Institute of Standards and Technology. The program managed the disposition of a large number of biomedical samples accumulated during population assessment activities, de-worming studies, and MHI epidemiological sampling, and continued a reorganization project to better manage the samples. JIMAR personnel provided support for, participated in, and coordinated stranding responses in the MHI. Persistent organic pollutants data were analyzed and a manuscript was published. JIMAR staff assisted with drafting a research plan for understanding and modifying HMS behavior, facilitated the relocation of staff, equipment, and specimens to the new Ford Island facility, and coordinated with a new live animal care life support system group at the facility to maintain and monitor the HMS component of the system.

Human Dimensions of Fishing and Marine Ecosystems in the Western Pacific

P.I.: Mark A. Merrifield [JIMAR Project Lead: Dawn Kotowicz]

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

NOAA Sponsor: Samuel G. Pooley, 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

The need for information on the human dimensions of marine ecosystems is becoming more important not only in assessing the effects of management on individuals, households, and communities, but in identifying possible management alternatives and accompanying social, cultural, and economic objectives. Establishment of new Marine National Monuments (MNMs) near Guam, the Commonwealth of the Northern Mariana Islands (CNMI), and American Samoa raises a number of sociocultural issues relevant to management of the MNMs. Required annual catch limits for managed marine species present another critical need for social research to study the social, economic, and cultural implications of allocation of catch for consideration of mangers. JIMAR researchers collect valuable sociocultural information by examining the impacts of the catch limits on Hawaii's fishing communities to consider what kinds of catch share plans might be appropriate. Researchers assist PIFSC in coordinating with local populations and collecting relevant information to describe the sociocultural considerations to managers as they develop management priorities and plans.

Progress during FY 2012

The Human Dimensions of Fishing and Marine Ecosystems in the Western Pacific project is comprised of several sub-projects described below.

• *Monitoring social impacts of the Hawaii longline bigeye tuna closure and implications for catch shares*. JIMAR researchers collected both primary and secondary information including catch reports and dealer information and reviewed recent relevant studies. Researchers conducted participant observation and unstructured interviews with a variety of fishing industry participants, especially seafood wholesalers and retailers who buy their fish at the Honolulu Fish Auction. As the closure date neared, researchers were positioned to monitor impacts. However, a budget amendment was passed which prevented the closure from taking effect. On November 19, 2011, through an act of Congress, the attribution of longline catch between the United States and U.S. territories was changed to allow U.S. vessels, who do not have American Samoa permits, to attribute their catch to American Samoa under certain conditions (Sec. 113, Consolidated and Further Continuing Appropriations Act, 2012). With the new standards for attributing catch, Hawaii and the U.S. longline bigeye fleets did not reach the U.S. quota in 2011. Therefore, JIMAR researchers refocused their efforts to related concerns of fish distribution channels in Honolulu for pelagic fish. This research focused on sociocultural influences on fish distribution apart from economic concerns to support understanding the sociocultural impacts of policy and management considerations related to distribution for the Western Pacific Regional Fishery Management Council. Results of this research were presented to the Pelagic Fisheries Research Program in December 2011. A brochure for public distribution has been drafted and a final report is currently being written.

• *An assessment of traditional fishing patterns in the Northern Islands Unit of the Marianas Trench Marine National Monument (MTMNM)*. JIMAR researchers reviewed the literature on traditional fishing in the CNMI and conducted 32 oral histories involving 40 persons with contemporary and past experiences in the waters or on the islands of the Islands Unit of the MTMNM. The findings from this research were presented at the Western Pacific Regional Fishery Management Council meetings in March 2012. A brochure aimed at presenting results to local residents and the general public has also been drafted and is in review. An internal report has been created based upon the preliminary results and a final report is currently being drafted.

Additionally, funds from the Rose Atoll project were directed to two Monument-related projects. The first is a documentary-style video for display in the MTMNM visitors' center and other educational outlets in the CNMI and Guam. Several stakeholders requested this project and several of the participants in the oral history project expressed interest in sharing their stories for the video. A multimedia specialist was subcontracted for filming and editing footage of peoples' stories of their experience in the islands and waters of the Islands Unit of the MTMNM. The second project was a survey of residents of CNMI and Guam of sociocultural aspects of the MTMNM, as described in the FY2010 project narrative. Due to the delay in approval of the survey assessing sociocultural aspects of the MTMNM, the survey was conducted in January and February 2012. A report describing the findings of this survey is currently being drafted.

• *An assessment of fishing patterns and cultural significance of Rose Atoll Marine National Monument*. JIMAR researchers held several scoping meetings with American Samoa territorial and federal partners regarding how to best proceed with this project in the fall of 2011. Through these meetings, project staff became aware of a similar project that was being conducted by researchers at the Samoan Studies Institute (SSI) of American Samoa Community College. Because of this similar in-progress effort, researchers decided to postpone this project until the SSI study was completed

JIMAR researcher Dawn Kotowicz interviews David Peter, former resident of Asuncion Island, Commonwealth of Northern Mariana Islands, the waters of which are now included in the Islands Unit of the Marianas Trench Marine National Monument.

and researchers could review results of the study. Based on this review, JIMAR staff from PIFSC and PIRO decided to redirect efforts to other social research questions. Researchers recently traveled to American Samoa to collect data that will be used to update the "American Samoa as a Fishing Community" profile report, originally written in 2009. This trip also afforded researchers the chance to speak with territorial and federal partners based in American Samoa, researchers at SSI, fishermen, and other community leaders about current research efforts as well as assess future research needs.

International Fisheries: Marine Turtle Conservation and Management Initiative

P.I.: Mark A. Merrifield [JIMAR Project Lead: Karen Frutchey]

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

NOAA Sponsor: Charles Karnella

NOAA Goal(s)

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

Purpose of the Project

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

Progress during FY 2012

Awareness activities for the general public and sea turtle encounter activities at Aquarium des Lagons (New Caledonia) included two summer workshops lead by the Program Officer for 24 children seven to twelve years old. In addition, 415 school children were hosted for participation in turtle themed activities during the school year. Continued during this reporting period were twice weekly public showings of an animated production on loggerhead sea turtles.

An important part of this project is outreach and education efforts at community functions outside the aquarium. In this manner, the message of sea turtle biology and threats including feral dog predation of turtle eggs and problem of plastic pollution is more far reaching than being presented at the aquarium facility alone. JIMAR project staff attended county fairs in New Caledonia including the Yate Festival of the Sea, the Boulouparis Deer and Shrimp Festival and the Moindou Fruits Market. In addition, staff provided educational presentations to schools in Yate, Tontouta, Boulouparis and Mont Dore. Combined, these education and outreach efforts are estimated to have reached at least 768 people during July 2011-September 2012.

The Aquarium des Lagons donated turtle skin sampling equipment to field teams: a team from the Southern Province, association Bwara in Northern Province and a group participating in an annual mission to Turtle Reef d'Entrecasteaux. During this reporting period, 71 (37 green, 31 loggerhead, and 3 hawksbill) turtle samples were transferred to the National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center Marine Turtle Genetics Laboratory for analysis; these samples will contribute to NOAA's understanding of marine turtle stock structure in the South Pacific.

As this is the end of the project, and the Aquarium des Lagons wishes to continue the education and outreach work, the JIMAR Program Officer trained volunteers to take over these field activities prior to the end of her contract. The Aquarium will be able to provide some transportation cost reimbursement to volunteers that continue educating the New Caledonia public about loggerhead sea turtles, their biology and the need for community support to promote species recovery.

Kona Integrated Ecosystem Assessment

P.I.: Mark A. Merrifield [JIMAR Project Lead: Melanie Abecassis]

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

NOAA Sponsor: Samuel G. Pooley, Jeffrey 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 purpose of this JIMAR project is to develop an Integrated Ecosystem Assessment (IEA) of the Kona coast of the Island of Hawai'i and to provide scientific advice to local and regional managers. This activity involves the aggregation of ecosystem information in the Kona region, research and development on ecosystem indicators of key attributes, and the development of ecosystem, circulation and habitat models for this region.

Progress during FY 2012

During FY 2012, the development of a circulation model continued to improve the project's understanding of the role of oceanography in the pelagic early life history (egg and larval) stages of resident organisms around the Kona coastline of the island of Hawai'i. This circulation model is a subset of the high-resolution ocean circulation model HYCOM for the Kona region and drives a larval transport model under development for the IEA. Work on this model was conducted by Johanna Wren (UHM Oceanography graduate student). Work on reverse simulations was completed to identify likely spawning areas under various scenarios of pelagic larval duration. Results of this work were used in a paper (in prep.) aimed at understanding the effects of eddies on larval distribution in the Kona region.

In addition, a JIMAR social science researcher (Laurie Richmond) completed a report on potential socioeconomic indicators for the Kona region; available human dimension information in the Kona region was also consolidated in this report. The report and data will be used in FY 2013 to form human dimension "indicators" which can be used to track ecosystem societal "health" as a discrete time series. When complete, these will be made publicly available through the data portal on the Kona IEA website hosted at PIFSC.

During the reporting period, a Kona IEA science symposium was held in Kona to present historical and ongoing research to all stakeholders and to plan future work. More than 30 presentations were delivered and are available on the website. The symposium also
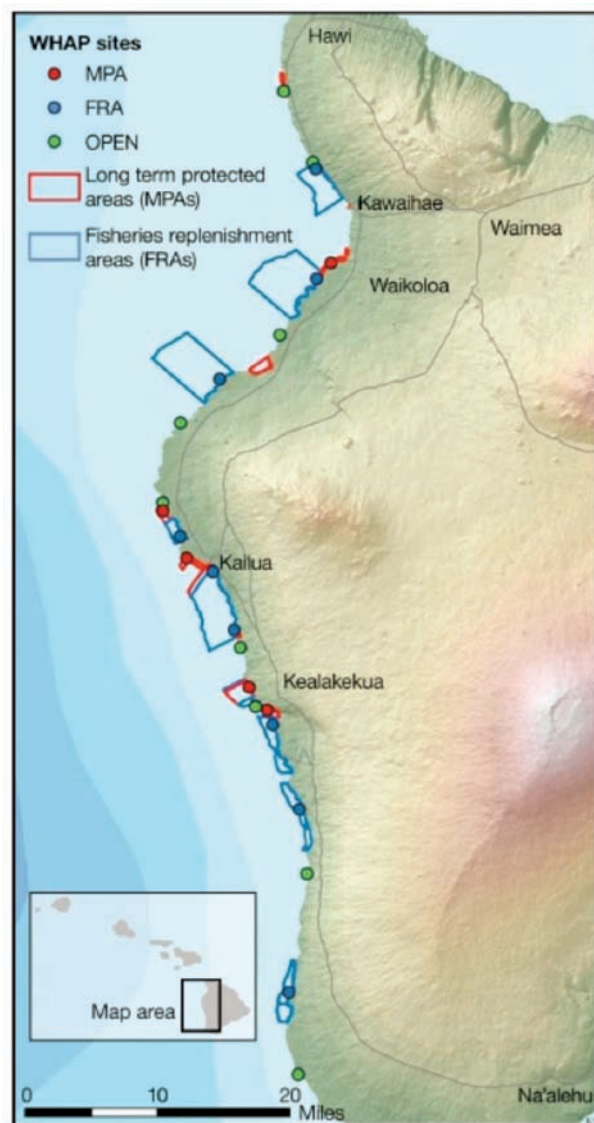
Figure 1. Map of the Kona coast region of Hawai'i Island covered by the IEA, with fishery management areas.
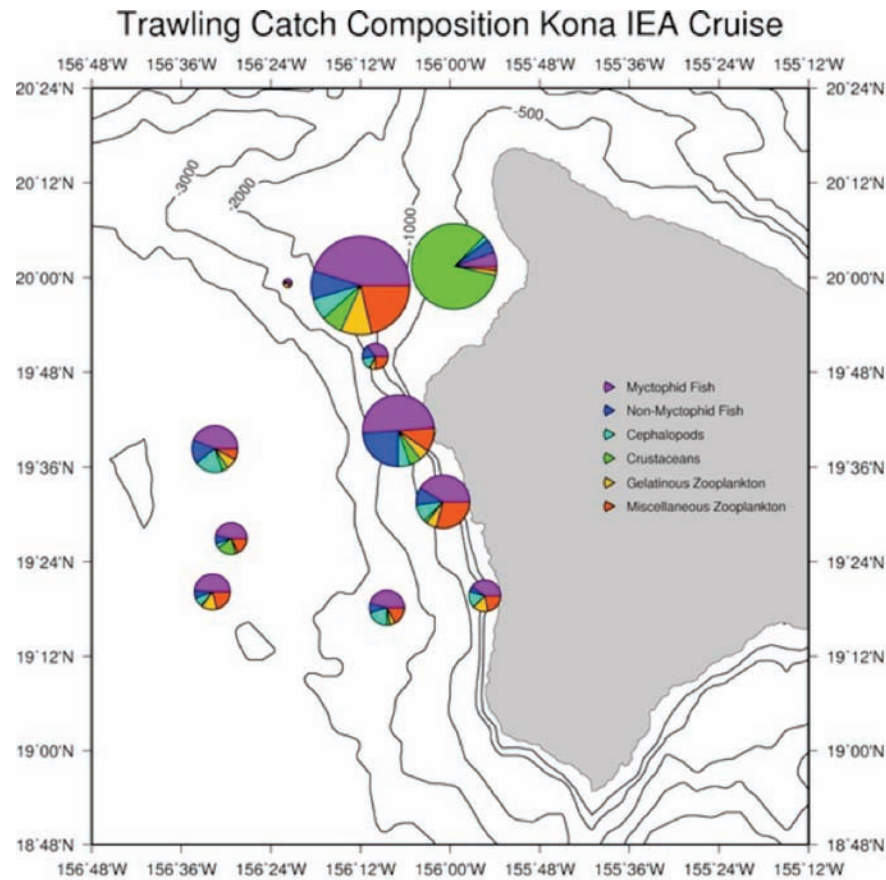
Figure 2. Map showing the catch composition of 16 trawls along the Kona coast of Hawai'i Island. The diameter of the pie charts is scaled after total volume of biomass caught at each site.

featured a panel discussion on management, featuring environmental managers from the Kona Coast region. Finally, the project assisted in the completion of a manuscript on an investigation of variations in fish recruitment in Hawai'i (Fox et al. 2012).

Main Hawaiian Islands Deep 7 Bottomfish Fast Track Project

P.I.: Mark A. Merrifield [JIMAR Project Lead: Jessica Miller]

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

NOAA Sponsor: Samuel G. Pooley, Kimberly Lowe

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 Hawaiian Islands (MHI) Deep 7 Bottomfish Fast Track Project is an ongoing JIMAR project that began September 2007. The Annual Catch Target (ACT) was implemented by NOAA Fisheries in the State of Hawaii to manage the "Deep 7" bottomfish species caught near the main Hawaiian Islands. The "Deep 7" complex is comprised of six eteline snappers and an endemic grouper, known locally as onaga (*Etelis coruscans*), ehu (*Etelis carbunculus*), opakapaka (*Pristipomoides filamentosus*), kalekale (*Pristipomoides sieboldii*), gindai (*Pristipomoides zonatus*), lehi (*Aphareus rutilans*) and hapu'upu'u (*Hyporthodus quernus*). Hawaii State law requires commercial fishers to submit their monthly fishing reports 10 days after the following month in which

Main Hawaiian Islands Monthly Catch of Deep 7 Bottomfish
(Includes ONLY data Recieved and Processed as of 09/18/2012)
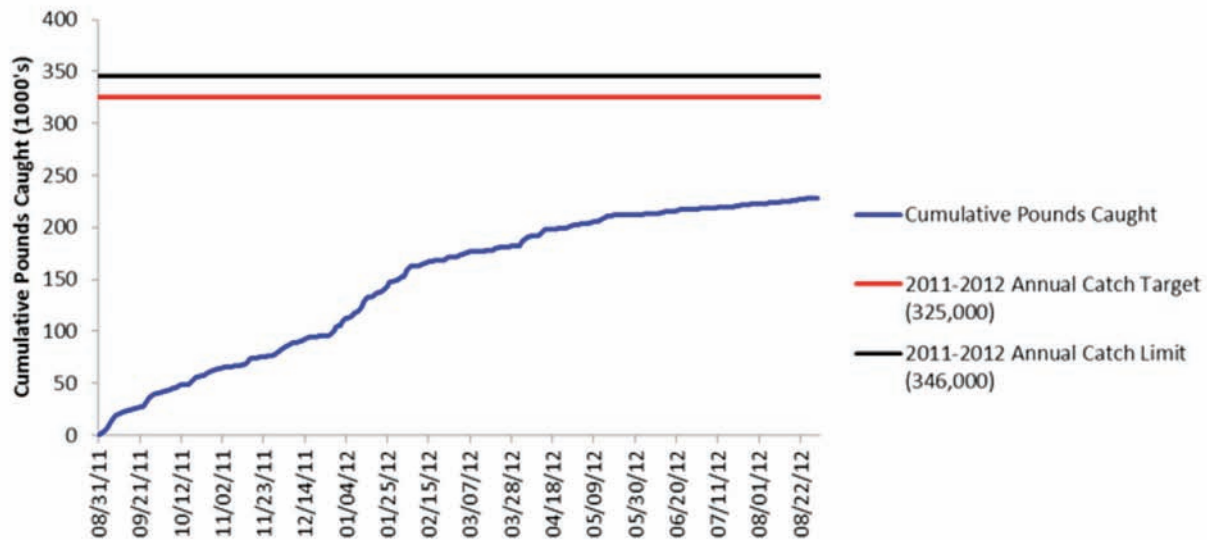
Figure 1. Graph showing the accumulation of the ACT and the Annual Catch Limit (ACL) for the 2011-2012 MHI Deep 7 Bottomfish Fishing year. The fishery remained open the full fishing year and closed on August 31, 2012 at 70.3% of the ACT.

marine life was taken. Department of Land and Natural Resources-Division of Aquatic Resources (DLNR-DAR) implemented a new law on September 1, 2011 requiring commercial fishermen who catch Deep 7 species to submit trip reports within 5 days of their trip end date. JIMAR staff work in collaboration with DLNR-DAR to fast-track Deep 7 bottomfish fishing and dealer data in order to successfully monitor the fishery. The fishing year for the Deep 7 bottomfish fishery opens on September 1, and closes when the total landings are predicted to reach the ACT or on August 31, whichever occurs first. Near real-time monitoring is needed to close the fishery when the ACT is near attainment, so data collection and processing must be fast-tracked to provide timely and accurate landing information to assist in the monitoring and management of this fishery.

Progress during FY 2012

The project continued to successfully manage the MHI Deep 7 bottomfish fishery. JIMAR staff met this objective through accurate and timely data entry. In order to facilitate timely submittal, monthly reminder letters were mailed to Deep 7 dealers. Fishers who submitted late trip reports were mailed reminder letters in an effort to encourage fishers to abide by the new state law requiring Deep 7 bottomfish trip reports to be submitted within 5 days of the trip end date. Of the 3,075 Deep 7 trip reports submitted, 75% were received on time. JIMAR staff entered commercial fishing and dealer data within two days of receiving the report and a second staff member proofed the entered data. JIMAR staff generally followed up with fishers and dealers within three days to correct any questionable or incorrect data that was submitted online or through mail. Using a computer program, fisheries data was error checked on a daily basis and weekly updates were sent to fishery managers beginning in September 2011. Reports containing discrepancies between fish and dealer reports were created monthly and rectified by contacting fishers and dealers for corrections. JIMAR staff was unable to create monthly reports comparing the date fished to the dates the catch was reported because the web developers were unable to provide a fixed date for the received date. The web developers are still working on the issue, so it may be an option in the future. Bottomfish newsletters were mailed to active Deep 7 bottomfishers in October 2011, February 2012, and June 2012 to update them on the progress of the fishery. The Deep 7 bottomfish fishery opened on September 1, 2011 with an ACT of 325,000 pounds and an Annual Catch Limit (ACL) of 346,000 pounds. The fishery was set to close when the ACT was reached

but based on the weekly updates JIMAR staff sends fishery managers, it was predicted that the ACT would not be met before the fishery closed on August 31, 2012. JIMAR staff mailed notices to the active Deep 7 fishers in August 2012 informing them that the fishery would close on August 31, 2012 and reopen the next day with an ACT, of 325,000 pounds and an ACL of 346,000 pounds for the 2012-2013 Deep 7 bottomfish fishing year. At the close of the fishery, 468 commercial fishers reported landing 228,389 pounds of Deep 7 (70.3% of the ACT) and 66 fish dealers reported purchasing 196,915 pounds of Deep 7 (data as of September 18, 2012). This is the first time since the bottomfish fishery has been managed using a catch limit that the limit was not reached before the closing date. Fishermen have stated that the weather has not been conducive to bottomfish fishing, which

Figure 2. Eric Yokomori presents the Deep 7 Fastrack project to local fishermen at the 2012 Hawaii Fishing and SeaFood Festival.

may be a reason that the fishery did not reach the ACT. The 2011-2012 catch limit was the highest it has been since catch limits were implemented in 2007, it is 22% larger than the catch limits set in the 2009-2010 and 2010-2011 fishing years, another possible reason why the fishery did not reach the ACT.

Month	Deep 7	Fishing Report				Dealer Report				
		no. fishers	no. trips	pieces	lbs	no. fishers	no. dealers	pieces	lbs. sold	value
TOTAL	Opakapaka	350	1,918	33,242	110,338	278	50	27,892	97,309	$592,783.05
	Onaga	259	1,186	12,026	55,866	196	48	10,423	50,307	$404,435.80
	Ehu	322	1,484	12,455	27,381	222	52	9,008	20,342	$118,587.99
	Lehi	115	349	912	8,063	104	29	768	7,360	$33,240.51
	Hapuupuu	157	421	1,146	10,483	129	27	984	9,357	$47,378.59
	Kalekale	220	900	6,652	12,338	157	41	4,851	9,500	$39,371.58
	Gindai	175	498	1,777	3,920	111	26	1,011	2,740	$12,039.34
	SUM	468	3,075	68,210	228,389	358	66	54,937	196,915	$1,247,836.86

Data as of 09/24/12

ACT: 325,000 70.3%
ACL: 346,000 66.0%

Total Landings Reported by Fishers from September 2011 to Present:
228,389   70.3% of ACT

Figure 3. Table showing the number of Deep 7 reported landed and the number of Deep 7 reported sold between September 1, 2011 and August 31, 2012 as of September 18, 2012.

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

P.I.: Mark A. Merrifield [JIMAR Project Lead: HingLing Chan]

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

NOAA Sponsor: Samuel G. Pooley, 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 purpose of this JIMAR project is to conduct economic assessments of commercial and recreational fisheries and the seafood market in the Pacific Islands Region.

Progress during FY 2012

The project has been successful in continuing data collection and monitoring activities in the Hawaii longline and American Samoa longline fisheries. The database continues to be updated with additional observations. Summaries of key economic indicators are prepared and periodically updated to the PIFSC website. The project to collect economic data for small-boat fisheries in Guam and CNMI received Office of Management and Budget (OMB) Paperwork Reduction Act (PRA) clearance. A JIMAR project employee traveled to Guam and CNMI for training and data quality control in September 2011. A protocol has been developed for data entry and data quality control. Collected data was entered, analyzed, and summarized for website publication. Seafood market research extended last year's project to two other states including Colorado and Florida and a total of 600 survey responses were collected

Interviewer of the creel survey in Guam is measuring the size of a wild capture fish.

in-person and online in summer 2012. Analysis of the new collected data is currently underway.

The project hosted the Pacific Islands Region Catch Shares Workshop in Honolulu in 2010, which aimed to investigate the potential applications for catch share management systems to the Pacific Islands areas. An administrative report summarizing the outcomes of the workshop was published in 2012. Another potential publication includes a special issue of *Marine Policy* containing the papers presented at the workshop.

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

P.I.: Mark A. Merrifield [JIMAR Project Lead: Nathan Chan]

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

NOAA Sponsor: Samuel G. Pooley, Jerry Wetherall, Susan K. 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 JIMAR project is to provide scientific information services to JIMAR and federal research staff at the Pacific Islands Fisheries Science Center (PIFSC).

Progress during FY 2012

The JIMAR Scientific Information Specialist completed co-development of a new SIS (Scientific Information Services) Fisheries Data Catalog—a Web-based listing of PIFSC fisheries and research data holdings that includes summaries of essential metadata and related literature such as code lists, forms and log sheets, and field specifications. JIMAR also completed co-development of a Discovery Metadata catalog, which is a more current and comprehensive Web-based listing of discovery level metadata on all datasets inventoried and maintained by the PIFSC. Both catalogs will be made available to users when PIFSC's new Intranet is released in October 2012. The data collections support fisheries and ecosystem research by PIFSC staff and JIMAR scientists affiliated with PIFSC.

The project continued providing technical support to the PIFSC SIS group on various aspects of data services, including support of PIFSC and JIMAR staff. The project performed quality control on and managed the timely data entry of fisheries and research data for input into an Oracle database. Finally, the project recruited, trained, and guided University of Hawaii (UH) student staff that review, enter, and verify these fishery statistics.

Marine Resource Dynamics & Assessment Program (MARDAP): Research Support–Fisheries Data Monitoring

P.I.: Mark A. Merrifield [JIMAR Project Lead: Walter Machado]

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

NOAA Sponsor: Samuel G. Pooley, Kurt Kawamoto, 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

This JIMAR project works to provide PIFSC with timely and accurate Fishery Management Plan (FMP) logbook data and other fishery information for use in research and management. The main focus of the work is the daily monitoring of Hawaii's pelagic longline fleet, which is presently, and increasingly subject to international management at the species level. The project provides PIFSC and the fishing industry a contact point for feedback and information exchange with fishery scientists and managers.

Progress during FY 2012

The JIMAR Fisheries Specialist continues to provide timely high-level support to fishery monitoring activities by providing high quality fisheries data to JIMAR and NMFS. The daily burden of quality control and processing logbook data have increased due to fast tracking procedures which were implemented to track Hawaii's big eye tuna (BET) landings for use in forecasting landings prior to implementing a Hawaii longline BET fishery closure if/when the WCPFC and IATTC annual US longline caught BET quota is predicted to be reached. These additional monitoring requirements increase the daily workload and are compiled weekly or as necessary as the quota gets taken. Additional quality control procedures and cross checks of relevant databases have been implemented as needed to continually improve the results and timeliness of the product. As an example, a matching program comparing the longline logbook tuna counts to sales records at the United Fishing Agency auction was developed and is now used to improve the quality of the data. The general Hawaii longline fleet wide quarterly reports are completed 45 days after the end of the quarter.

A photo database of Hawaii's pelagic longline fishing fleet was created to document and monitor permitted vessels in the fleet, and this album is continually updated throughout the year. The logbook scanning project

Figure 1. Local fishermen unload swordfish from a mid-size longline vessel.

Figure 2. JIMAR Fisheries Specialist Walter Machado receives a longline log book from a local fisherman (Capt. Steve Gates).

has successfully archived 20 years of the Hawaii longline logbooks with 2 more years of logbooks yet to be scanned.

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

P.I: Mark A. Merrifield [JIMAR Project Lead: Hui-Hua Lee]

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

NOAA Sponsor: Samuel G. Pooley, 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 JIMAR program are to: 1) assess the status of pelagic species in the Pacific Ocean; 2) assess the status of insular resources in the Pacific Islands Region (PIR) including Hawaiian Archipelago and U.S. Territories, and 3) assess the impact of fishing on these stocks. During a technical review of stock assessment procedures for insular resources in the PIR, it was recommended that collaborative research programs with industry, the Pacific Islands Fisheries Science Center (PIFSC), and universities (University of Hawaii and Hawaii Pacific University) be developed to 1) provide independent estimates of population size; 2) generate updated estimates of population dynamics; and 3) advance insular stock assessment methodologies in the PIR. In addition, Pacific Ocean Regional Fisheries Management Organizations (RFMOs including Western and Central Pacific Fisheries Commission; WCPFC and Inter-American Tropical Tuna Commission; IATTC) and Pacific Ocean Regional Fisheries Organizations (RFOs including International Scientific Committee for Tuna and Tuna-like species in the North Pacific Ocean; ISC) have emphasized the need for pelagic stock assessments in the Western and Central Pacific Ocean (WCPO), and recommended that arrangements to facilitate assessments move forward. PIFSC and JIMAR staff primarily conducts assessments of pelagic fish stocks in the Pacific Ocean collaboratively with scientists from Japan, Taiwan, Korea, China, Mexico, IATTC and the Secretariat of the Pacific Community (SPC) under the auspices of the ISC. Priority is given to marlins, swordfish and oceanic sharks species (blue, oceanic whitetip, silky, and thresher sharks) in the Pacific Ocean, and to bottomfish and crustaceans in the PIR.

Progress during FY 2012

The JIMAR FY 2011 annual report outlined three goals for FY 2012, including: 1) planning and participation in four ISC meetings, including the ISC11 plenary meeting, one ISC shark working group workshop and two ISC billfish working group workshops; 2) conducting modeling work for North Pacific striped marlin and North Pacific albacore stock assessments and completion of stock assessment reports; and 3) advancing stock assessment methodologies for pelagic species in the North Pacific Ocean and for insular species in the Pacific Islands Region.

Additionally, insular research and assessments were accomplished in FY 2012. In particular, the completion of three stock assessments for U.S. Territory bottomfish in the PIR, as well as the continuation of a main Hawaiian Islands (MHI) bottomfish research program to: 1) access the feasibility of a developing and implementing a fishery independent survey; 2) expand the scope of the MHI tagging program to include additional species and areas; and 3) expand the collection of fishery dependent biological data. To advance capacity building and establish scientific collaborations with staff at Shanghai Ocean University, China, the 2nd Joint International Scientific Symposium was convened in Shanghai, China during April 2012. This symposium builds on the success of the 1st Joint International Scientific Symposium convened in 2009. Of all the goals articulated, accomplishments are summarized as follows.

• *Planning and participation in four ISC meetings, including the ISC11 plenary meeting, one ISC shark working group workshop and two ISC billfish working group workshops*. The project coordinated and participated in two ISC Plenary meetings (ISC11 and ISC12), two ISC Billfish Working Group workshops, two ISC shark Working Group workshops, Joint International Scientific Symposium with Shanghai Ocean University, JIMAR/PIFSC Symposium and Vulnerable Marine Ecosystem Workshop. Two ISC Plenary meetings were convened with

significant support from JIMAR staff as Secretariat and scientists for the ISC. The goals of the ISC11 (July 2011) and ISC12 (July 2012) were to review results and conclusions of albacore and striped marlin based on new data and stock assessment. Two workshops of the ISC Billfish Working Group were convened on December 2011 and April 2012. The goals were to: 1) complete the stock assessment for Western and Central North Pacific Ocean (WCNPO) striped marlin; 2) complete stock future projection for WCNPO striped marlin; and 3) review available Pacific blue marlin fishery-dependent

Figure 1. Participants at the July 2011 ISC Plenary meeting.

and fishery-independent data for possible inclusion in the stock assessment, including region specific Category I, II, & III data (catch and effort data, CPUE time series and length compositions sampled from the catches) and life history parameters. Both workshop reports were finalized and submitted to the ISC12 Plenary for review and adoption. Two workshops of the ISC Shark Working Group were convened, 28 November-6 December 2011 and 28 May-4 June 2012, to facilitate the data preparation works for coming blue shark stock assessment in 2013. A Joint International Scientific Symposium (April 2012), JIMAR/PIFSC Symposium (February 2012) and Vulnerable Marine Ecosystem Workshop (November 2011) were convened to communicate research developments to students, scientists, and managers on stock assessment methods, fishery management approaches, bycatch mitigation, marine mammal ecology, and coral reef habitat and ecosystem monitoring. JIMAR staff provided coordination of the workshops and presentations at both symposiums and workshop.

• *Conducting modeling for North Pacific striped marlin and North Pacific albacore stock assessments and completion of stock assessment reports*. Completion of modeling work for North Pacific albacore, Pacific sharks (including blue shark, shortfin mako, oceanic whitetip and silky shark), WCNPO striped marlin, MHI Kona crab, and four PIR bottomfish stock assessments (MHI, American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), and Guam), along with the stock assessment reports. Ten publications related to stock assessments for MHI Kona crab, PIR bottomfish, Pacific sharks and WCNPO striped marlin were completed, as well as three comprehensive stock assessment reports and one master thesis. Additional modeling work integrated oceanographic data into the stock assessment model for North Pacific albacore, which was presented, at the IATTC Stock Assessment Workshop in October 2011.

• *Advancing stock assessment methodologies for pelagic species in the North Pacific Ocean and insular species in the PIR*. Numerous stock assessments were completed in consultation with JIMAR staff, and significant progress on population model development also occurred in FY 2012. Seven publications are articles in refereed scientific journals and NOAA Technical Memorandum covering Hawaiian lobster life history and stock assessment modeling topics.

• *Implementation of a fishery independent pilot survey for bottomfish stocks in the MHI*. The development of a PIR fishery independent survey

Figure 2. Tagging Opakapaka

for bottomfish is recognized as a high priority among regional fishery managers and scientists. This is a multiyear project developed in collaboration with JIMAR, and data from the survey will be used to determine optimal gear(s), sample sizes, and number of vessels needed to implement fishery independent surveys in the PIR. Results to date include the completion of 12 fishing trips aboard local fishing vessels to collect requisite data for assessing the feasibility of a fishery independent bottomfish survey, collection of 360 biological samples to advance bottomfish age and growth research, and completion of 3 outreach sessions with local constituents. In addition, 17 fishermen were contracted to conduct tagging operations in the MHI and 1,375 bottomfish (snappers) were tagged and released; a total of 45 fish were recaptured. A final report describing the results of year 2 will be completed by Oct 2012. A MHI bottomfish fishery-independent calibration survey continued in waters surrounding Maui and Oahu. The goal of this research is to conduct provisional gear calibration studies between existing commercial fishing gear and non-extractive sampling gear including the Simrad EK60 echosounder system, baited underwater video cameras (BotCam), and Autonomous Underwater Vehicle (AUV). The *R/V Oscar Elton Sette* conducted a total of 9 continuous acoustic survey transects including five days of daytime acoustic surveys in conjunction with targeted fishing operations. The University of Hawaii contracted vessel, *Hukipono*, completed 98 standardized BotCam drops. Additionally, partner fishing vessels completed 108 daytime fishing stations in conjunction with BotCam drops and the acoustic transects.

• *JIMAR collaboration with the Fishery Interaction and Conservation Program and Socioeconomics Program within PIFSC*. Research work on trade-offs among catch, bycatch, and revenue for pelagic species including tunas, swordfish, marlins, sharks for American Samoa longline fishery is in progress with a draft manuscript in review.

Mesophotic Reef Ecosystems of Hawaii's Au'au Channel

P.I.: Mark A. Merrifield [JIMAR Project Lead: John Rooney]

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

NOAA Sponsor: Samuel G. Pooley, Frank Parrish, 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 original multi-agency project under which the JIMAR project was spawned was entitled, "CRES 2007: Investigating the Deep (50-100 m) Coral Reefs of Hawai'i", and the intention of the effort was to study a complex of what are now referred to as "mesophotic" coral reefs in the Au'au Channel between the Hawaiian Islands of Maui and Lanai. Benthic communities of scleractinian corals, other invertebrates, macroalgae and fishes are being studied, along with the physical oceanography of the area, to develop a better understanding of the structure, composition, ecological dynamics, and management needs of mesophotic coral ecosystems.

Progress during FY 2012

Planned accomplishments for the reporting year included modeling the distribution of mesophotic corals in the greater Au'au Channel area, presenting results of the project to increase the awareness of mesophotic coral ecosystems within the resource management community, improving capabilities for conducting research under NOAA Diving Program auspices, and determining growth rates for the dominant species of mesophotic coral in the Au'au Channel, *Leptoseris hawaiiensis*.

All the planned accomplishments have been completed. Of particular note, working in collaboration with the NOAA Biogeography Program and Hawaiian Islands Humpback Whale National Marine Sanctuary, data on benthic communities collected by the project was used to model the distribution of scleractinian corals at mesophotic depths, including *Porites sp., Montipora sp., and Leptoseris sp.* Results were published in a NOAA Technical memorandum. Although it turned out to be much more involved than was ever expected, the growth rate for a colony of *Leptoseris hawaiiensis* collected from a depth of 79 m was finally resolved, with results from staining with alizarin red, ^{14}C dating, a transect of isotopic ratios across the colony and U-series ages and all concurring that the rate is a surprisingly fast ~1 cm year[1].

Figure 1. Divers at 76 m off Oahu examine colonies of Leptoseris hawaiiensis and Montipora capitata. Cover of mesophotic corals outside of the Au'au Channel is typically far less than cover inside the channel. Photo: John Hansen

Figure 2. A typical well developed reef of Leptoseris hawaiiensis in the Au'au Channel. Recent evidence suggests that this species is actually a mix of somewhere between two and six species. Photo: Hawaii Undersea Research Laboratory

Oceanography Initiative

P.I.: Mark A. Merrifield [JIMAR Project Lead: Melanie Abecassis]

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

NOAA Sponsor: Samuel G. Pooley, Jeffrey Polovina

NOAA Goal(s)

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

Purpose of the Project

This JIMAR project aims at utilizing existing satellite tagging data, environmental datasets, and habitat models to get a better understanding of the migration pathways and foraging ecology of a number of large pelagics, such as swordfish, loggerhead turtles.

Progress during FY 2012

Results from the first part of the project, which focused on the foraging behavior of swordfish and predicting their daytime mean depth in the North Pacific, were published in Marine Ecology Progress Series. A Generalized Additive Model (GAM) was developed and, where tagging data was available, produced prediction maps of swordfish daytime mean depth in the area between Hawaii and the coast of California. The GAM is based on three environmental indices: temperature at depth, chlorophyll-a concentration and dissolved oxygen concentration at depth. It is anticipated that these results will help longline fishermen who target swordfish to set at deeper depths during daytime rather than shallower depths at night close to the surface where interactions with loggerhead turtles happen.

A draft manuscript describing the analysis of juvenile loggerhead turtles tracks and modeling of their movements with a Eulerian habitat-based model, using an advection-diffusion scheme (a simplified version of the SEAPODYM model) is in preparation for publication. This study details the characterization of juvenile loggerheads' thermal preferences, swimming capabilities, and behavior in the North Pacific. Implementing those findings into the model, an index of their habitat preference is produced, and movements driven by that habitat index are simulated and compared to observed tracks.

Finally, adaptation of the SEAPODYM model to swordfish in the Pacific, using fishing data from NMFS and the Secretariat of the Pacific Community, is well underway. This work is on going.

The research cruise that was planned in June 2012 was canceled for lack of available sea-days, so the work focused on the Kona coast of the island of Hawaii will be conducted in FY2013.

During the reporting period, JIMAR scientist Amy Comer analyzed acoustics data collected on a 2010
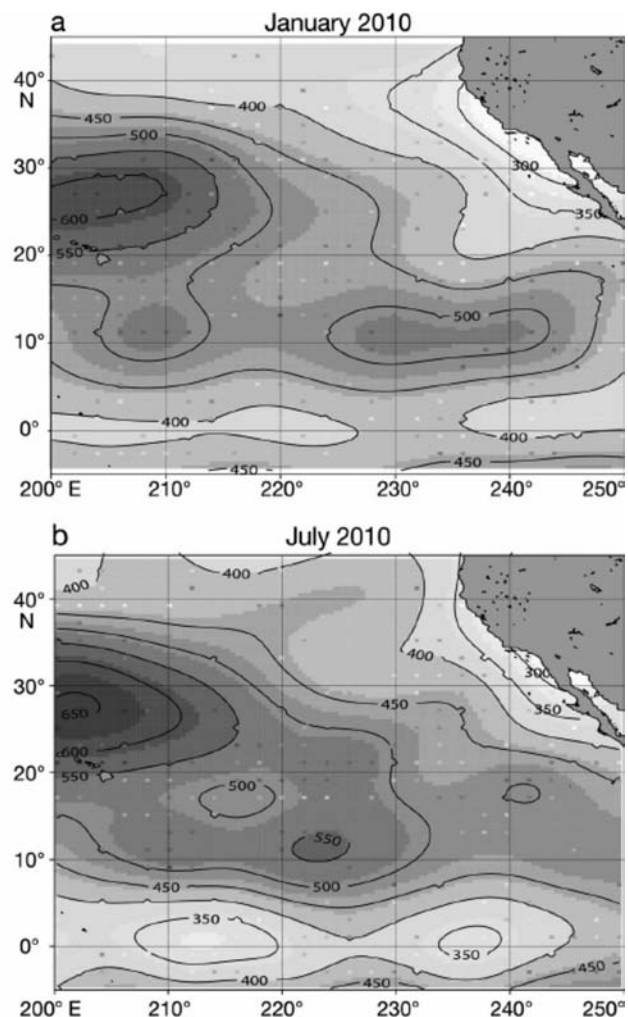
Prediction maps for North Pacific swordfish daytime mean depth for (a) January 2010 and (b) July 2010. Numbered lines: depth contours (m).

cruise to CNMI, which led to a paper accepted for publication. Amy Comer also assisted with active acoustics operations and analysis for a NOAA cruise focused on bottomfish abundance assessment in the main Hawaiian Islands in September 2011. Oceanographic and acoustics data from the cruise are currently under analysis.

Pacific Islands Monitoring and Sampling Program

P.I.: Mark A. Merrifield [JIMAR Project Lead: Dios Gonzales]

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

NOAA Sponsor: Samuel G. Pooley, Kimberly Lowe

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 ensure that local fisheries resource managers have the most accurate and complete dataset available from fisheries in the Pacific Islands, for the long-term sustainability of the non-pelagic fishery resource. This is obtained through: 1) detailed census sample of all commercial, local, non-pelagic fish on a per-trip basis; 2) collecting, processing, and analyzing biological samples from a subsample of the commercial catch for aging, reproductive and other studies; and 3) data input, management, and quality assurance and quality control measures.

Progress during FY 2012

Throughout FY 2012, this project has achieved near 100% coverage of market sampling of spearfish fisheries in American Samoa and the Commonwealth of the Northern Mariana Islands (CNMI). Whole catches by spearfishers have been sampled for length and weight by species and 8-10 species from each region have been examined in depth in the laboratory, including removal of gonads, otoliths and finclip samples for DNA. Work at the Guam Fishermen's Cooperative has included more bottomfish catches, in addition to spearfishing. The work in American Samoa and the CNMI has recently expanded to include more bottomfish, and Guam Biosampling has sought to include more spearfishing. The goal is to conduct representative sampling of all commercial fisheries, with an emphasis on coastal fisheries. Additionally, the project has supported dockside monitoring at a per-trip level for Hawaii. The JIMAR staff intercepts fishermen at the docks and on the phone to ensure PIFSC can collect the most complete and accurate monitoring data possible. The data collected are establishing reliable length-weight relationships for hundreds of commercial species across the region, as well as conducting data quality control to ensure complete reporting by species of the catch in support of NOAA's sustainable fisheries mission.

Figure 1. Meagan Sundberg (JIMAR Fisheries Technician) and Carl DelaCruz (Guam Division of Aquatic & Wildlife Resources) conduct length and weight sampling of bottomfish catch at the Guam Fishermen's Cooperative Association.

Figure 2. Part of a catch of deep slope eteline snappers sampled on Saipan, Northern Mariana Islands, including ehu (Etelis carbunculus) and gindai (Pristipomoides zonatus).

Pacific Islands Region Outreach and Education Program

P.I.: Mark A. Merrifield [JIMAR Project Lead: Gary Karr]

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

NOAA Sponsor: Wende Goo

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 is to plan, develop, and implement effective outreach and education programs as a partnership between JIMAR and the NOAA Fisheries Service Pacific Islands Region (PIR)–including both the Pacific Islands Regional Office (PIRO) and the Pacific Islands Fisheries Science Center (PIFSC). The project staff serves as a resource, advisors and points of contact for outreach and education activities for JIMAR and NOAA Fisheries Service staff, in the divisions and programs of both offices. This project directly supports the JIMAR theme of achieving a sustainable balance between the forces of coastal development, conservation and preservation goals by performing outreach and education.

Progress during FY 2012

During the fiscal year two new staff members joined the JIMAR Outreach and Education team: a Multimedia Specialist and a Communications Specialist. The PIR Multimedia Specialist provided support and services in the area of video editing and back up support to the JIMAR Graphic Artist and Webmaster. The Communications Specialist provided supervision for the Communications Team including the Outreach and Education Coordinator and Multimedia Specialist as well as writing, editing and assistance to the PIR Communications Officer.

During FY 2012, the program produced outreach and education materials that JIMAR staff and other NOAA Fisheries PIR divisions and programs displayed or distributed at public events or other forums. The ORE program supports all the divisions and program within both PIRO and PIFSC creating a consistent outward facing message and image. Participation in outreach and education events informed and engaged the public and stakeholders

Figure 1. Fisheries in Your Neighborhood at the Kahala and Windward Malls attracted hundreds of visitors who learned about NOAA Fisheries and gained practical knowledge about fishing.

concerning PIRO and PIFSC efforts to manage and conserve the marine resources under its jurisdiction. The events in which the ORE program participated in ranged from an elementary class size to over 20,000 at the Hawaii Fishing and Seafood Festival. ORE program staff coordinated and implemented participation as well as designed and produced displays and informational materials for outreach events and activities throughout the year. Events staffed or supported during FY 2012 include the following.

- 6th Annual Hawai'i Fishing & Seafood Festival at Honolulu's Pier 38
- Hawaii Seafood Symposium
- School of Ocean and Earth Science and Technology (SOEST) Open House, UH Manoa
- Kailua Intermediate Ocean and Earth Science Career Night
- Career Days at Washington, Niu Valley and Stevenson Middle Schools
- Kamehameha Schools Sustainability Fair
- Hawaii State Science Fair
- Hawaii Ocean Expo 2012
- Marine Corp Base Hawai'i (MCBH) Earth Day Fair
- Boy Scout Makahiki
- St. Ann's School Class Presentation
- Sea Life Park Keiki Summer Camp
- North Shore Ocean Fest at Turtle Bay
- NOAA Education Showcase at Bishop Museum (One NOAA event)
- Ka 'ike o ka Moana Exhibition at Honolulu Hale (One NOAA event)
- World Ocean Day
- NOAA Fisheries Honolulu Service Center blessing ceremony
- Hawaii Conservation Conference
- Fisheries in Your Neighborhood at Kahala Mall
- Fisheries in Your Neighborhood at Windward Mall

Materials and displays produced include the following.
- Hawaiian Monk Seal Good Neighbors exhibit at Honolulu Hale
- NOAA Fisheries Honolulu Service Center blessing ceremony
- Aku Boat Photo Display activity
- Marine Science 101 interactive educational activity
- New Pacific Islands Regional Office brochure
- Graphics, text revision, design and layout for Hawaiian Monk Seal brochure
- Graphics, text, design and layout for Marine Wildlife Viewing Guidelines brochure
- PIFSC Quarterly Report Bulletin design and layout
- PIFSC twitter account development and maintenance
- PIFSC blog account development and maintenance
- PIRO website revisions, e.g., Federal Register Notices
- Various video presentations for PIRO visitors lobby monitor
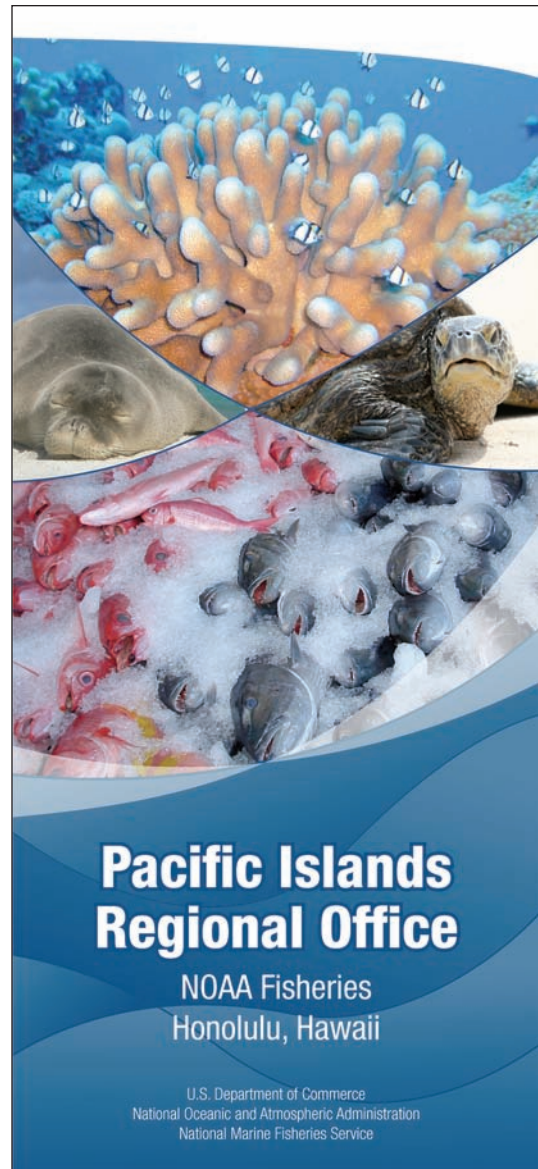- Graphics and design support for Pacific Regional Center (PRC) exhibits

Figure 2. The new Pacific Islands Regional Office brochure provides updated information about PIRO's mission, key actions, mandates, organization and activities and services.

Pacific Islands Regional Observer Program

P.I.: Mark A. Merrifield [JIMAR Project Lead: Dan Luers]

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

NOAA Sponsor: John Kelly

NOAA Goal(s)

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

Purpose of the Project

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

Figure 1. Dan Luers with graduating observer training class in Espiritu Santo, Vanuatu.

Progress during FY 2012

Over the reporting period, 457 observer trips were debriefed. This number greatly exceeds the 400 trips estimated in the plan for the previous fiscal year, but is roughly consistent with an extrapolation of these numbers over a 15-month period. Program staff led instruction sessions and developed training modules for two observer training classes in Honolulu. A high retention of observers in the Hawaii and American Samoa longline fisheries obviated the need for a third observer training class. The program provided support to developing fisheries in the Pacific Islands by training new observers and observer trainers in the Republic of the Marshall Islands, Fiji, Republic of Vanuatu and the Federated States of Micronesia. The program worked with the Forum Fisheries Agency (FFA) and the Secretariat of the Pacific Communities (SPC) in cooperation to develop and enhance at-sea fisheries monitoring programs and aid in the development of observer databases. The program developed a comprehensive seabird identification guide to aid observers in at-sea identification of any seabirds that may be sighted on a fishing trip. Program staff also presented research papers at the American Fisheries Society and the Pacific Seabird Group annual conferences regarding causes of fluctuation in seabird bycatch rates in the Hawaii deep-set longline fishery.

Figure 2. Cheree Smith teaches marine mammal identification during observer training in Fiji.

Pelagic Fisheries Research Program (PFRP): Program Management

P.I: Kevin Weng

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

NOAA Sponsor: Samuel G. Pooley

NOAA Goal(s)

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

Purpose of the Project

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

Progress during FY 2012

- *Request for proposals*. No RFP was issued during FY 2012 because the funding was reduced such that the PFRP had no funds available.
- *Multi-year projects*. The PFRP was unable to fulfill its commitments to multi-year projects funded in prior cycles, due to inadequate funding.
- *International collaboration in research on pelagic fisheries*. The PFRP continues to work with SPC's Pacific Tuna Tagging Program (PTTP) to unify the analysis of data between PTTP and the Hawaii Tuna Tagging Project 2 (HTTP2).

The PFRP continues to support the ADMB Project, an international effort to ensure that the AD Model Builder software will be maintained in the future. (This software is used in over 200 fisheries management agencies for statistical modeling and assessment of fish population around the world; see http://admb-project.org/.) In 2012 the PFRP recruited a new postdoctoral scholar to conduct research in collaboration with the ADMB community on subjects relating to the geolocation of marine animals.

- *PFRP program manager*. The PFRP program manager made a presentation to the Scientific and Statistical Committee (SSC) of the Western Pacific Regional Fishery Management Council, titled "Deep 7 Bottomfish Tracking, Ni'ihau Pinnacles" (October 2012). The PFRP program manager also participated in the following: 1) Regional Ecosystem Advisory Panel, Western Pacific Regional Fishery Management Council, May 2012; and 2) Pelagics Plan Team, Western Pacific Regional Fishery Management Council, April 2012.

The PFRP program manager serves on the steering committee of CLIOTOP–Climate Impacts on Top Predators, and in 2012 volunteered to be the co-chair of the committee. Program manager is assisting with the organization of the CLIOTOP symposium to be held in Noumea, New Caledonia, February 2013.

The PFRP conducted an analysis for the Western Pacific Regional Fishery Management Council titled "Habitat usage, dependence, and movement patterns of five ubiquitous mesopredators in Palmyra Atoll", lead by PFRP PhD student Gen Del Raye.

The PFRP, in collaboration with the Large Pelagics Research Center at the University of Massachusetts, initiated a website to serve and support the use of geolocation tools for the scientific community. http://code.google.com/p/geolocation/

PFRP: Age and Growth of Striped Marlin, *Kajikia audax* Caught in the Hawaii-based Longline Fishery

P.I.: Kevin Weng [Richard Keller Kopf, Robert Humphreys]

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

NOAA Sponsor: Samuel G. Pooley

NOAA Goal(s)

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

Purpose of the Project

   Striped marlin are an important component of commercial longline fisheries in the Indian and Pacific Oceans and are a vital ecological resource as a top predator in the open ocean ecosystem. Approximately 4000 mt are harvested each year from the US Western and Central Pacific Ocean but the sustainability of these catches are uncertain due to a lack of biological information pertaining to this species. The project proposes a study of the key age and growth characteristics of the population of striped marlin caught in the Hawaiian-based longline fishery in order to support stock assessment in this region. This research aims to develop a sex-specific age and growth model for striped marlin in the north-central Pacific Ocean based on previously developed and validated aging methods. The study will take advantage of previous collections of biological hardparts (dorsal fin spines and sagittal otoliths) provided by a collaboration with the Pacific Islands Fishery Science Center as well as current and on-going collections of these hardparts through Pacific Island Regional Observer programs. The expected outcomes of this research are intended to provide length-at-age and growth rate information, which are required to develop a stock assessment model for striped marlin in the North Pacific Ocean.

Progress during FY 2012

   Progress of project objectives is as follows.
• December 2011- Finished observer sampling regime (3 continuous years; 2009 -2011).
• March 2012-*Determine the periodicity of annulus formation in fin spine sections using a Marginal Increment Analysis*. The project finished first age readings and measurements of marginal increments of fin spine samples collected through December 2011.
• March 2012-*Evaluate presumed daily periodicity of micro-increments formed in sagittal otoliths by comparing back-calculated hatch dates with the spawning season*. Finished first age readings and measurements of otolith samples collected through December 2011.
• October 2012-*Corroborate the location of the first yearly annulus formed in fin spine sections using otolith micro-increment counts*. Completed second and third reading of all samples and assigned final age estimates and measurements.
• Est. November 2012-*Model daily and annual growth and length-at-age of male and female striped marlin*. Work completed. Project to complete draft final report and make presentation at next PFRP PI meeting.

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

P.I.: Kevin Weng [Patrick Lehodey]

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

NOAA Sponsor: Samuel G. Pooley, Reka Domokos

NOAA Goal(s):

• To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management
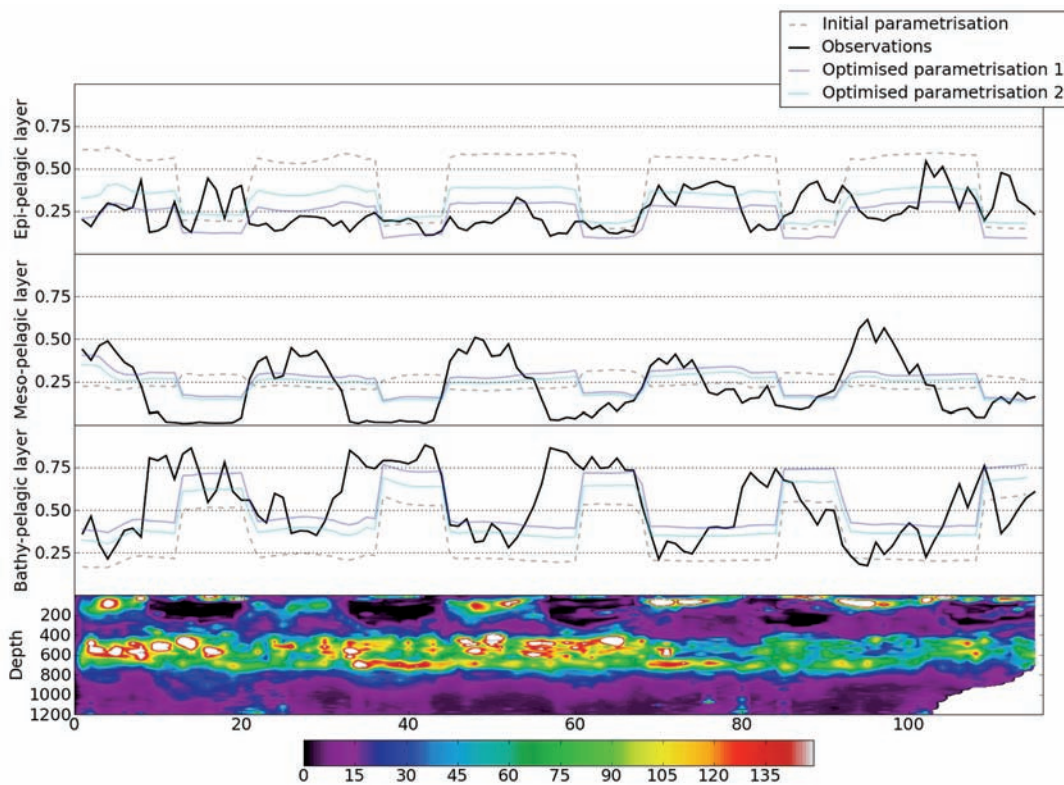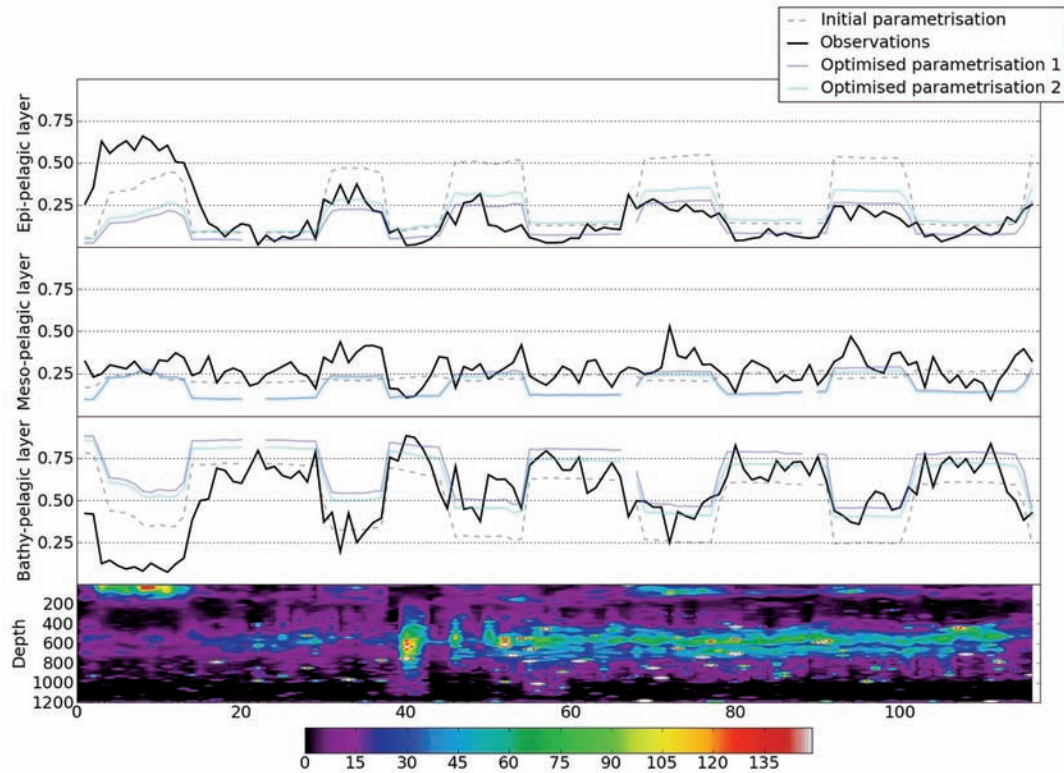
Observed (signal) and predicted (biomass) relative values over the three vertical biological layers of the micronecton model for (top) the north Pacific transect used for optimization experiments and (bottom) the Tasman Sea transect used for validation

Purpose of the Project

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

Progress during FY 2012

After the development and validation phase of the data assimilation approach in the micronekton model conducted in 2011, the first optimization experiments with actual *in situ* acoustic data were conducted using North Central Pacific transects. However, the biomass in the surface layer was largely underestimated due to the position of the transducer below the hull. Thus, the project decided to add 10% of biomass in the surface (e.g., Grandperrin 1975). The transects were also revealed to have a high noise to signal ratio that was filtered. Then, three optimizations experiments were conducted. The first one used original Hawaii transects without any modification of the data before the processing, the second used the same data but the ratio of the epipelagic layer is increased by 10 percent of the biomass in the water column, and the last one used the same transects but after filtering to reduce the noise to signal ratio. There is a clear improvement in the fit to data between initial parameterization and those resulting from optimization. Still more encouraging, the new parameterization also improves the fit to independent acoustic transects recorded between Tasmania and New Zealand in August 2009 and June and August 2010. Since the parameterization strongly depends on the definition of vertical layers used to integrate the signal, the project is analyzing in more details the biophysical characteristics that can be used to define these layers. Then final optimization experiments will be conducted before the publication of results in a scientific article.

PFRP: Biological, Economic, and Management Drivers of Fishery Performance: A Global Meta-analysis of Tuna and Billfish Stocks

P.I.: Kevin Weng [Trevor A. Branch]

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

NOAA Sponsor: Samuel G. 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 purpose of this project is to collate all stock assessments of tuna and billfish species (marlin, swordfish, etc.), in order to understand the global status and trends of tuna and billfish species: trends in catches, biomass, stock status relative to fisheries reference points, and lost yield from overfishing and underfishing.

Progress during FY 2012

The project obtained data underlying stock assessments for all 35 assessed tuna and billfish stocks in the world. The project analyzed total biomass trends, total catch trends, estimated lost yield due to overfishing

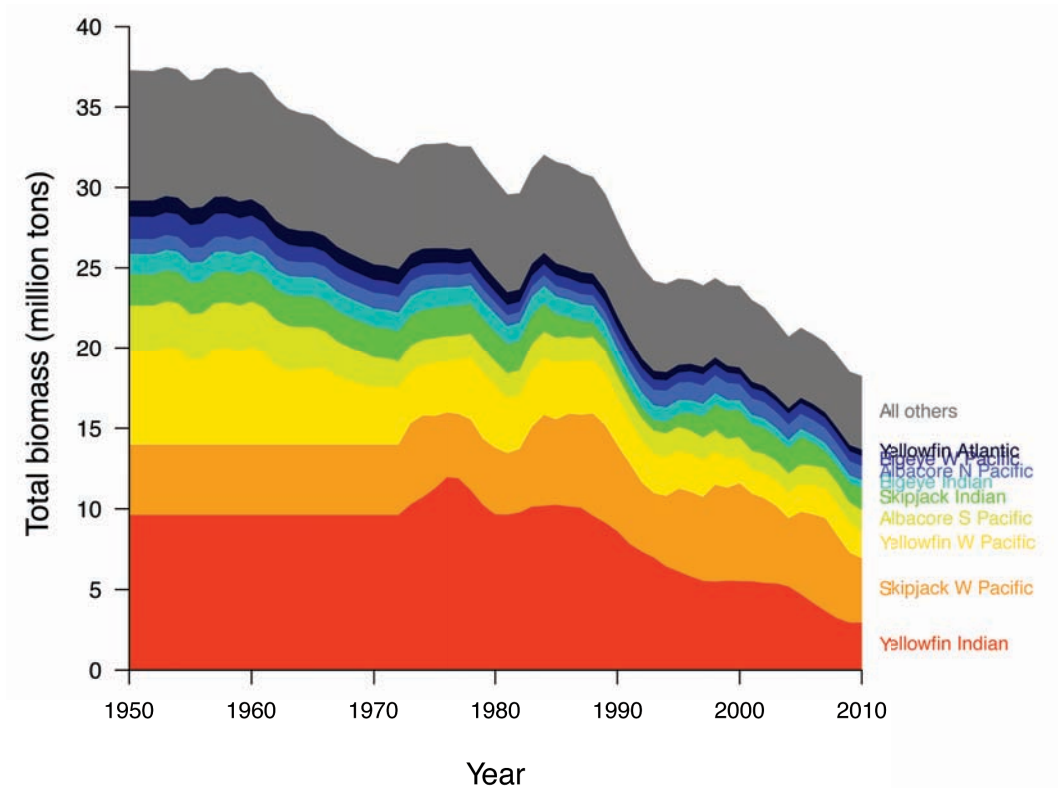*Figure 1. Total biomass (t) of tuna and billfish stocks according to stock assessments (draft).*
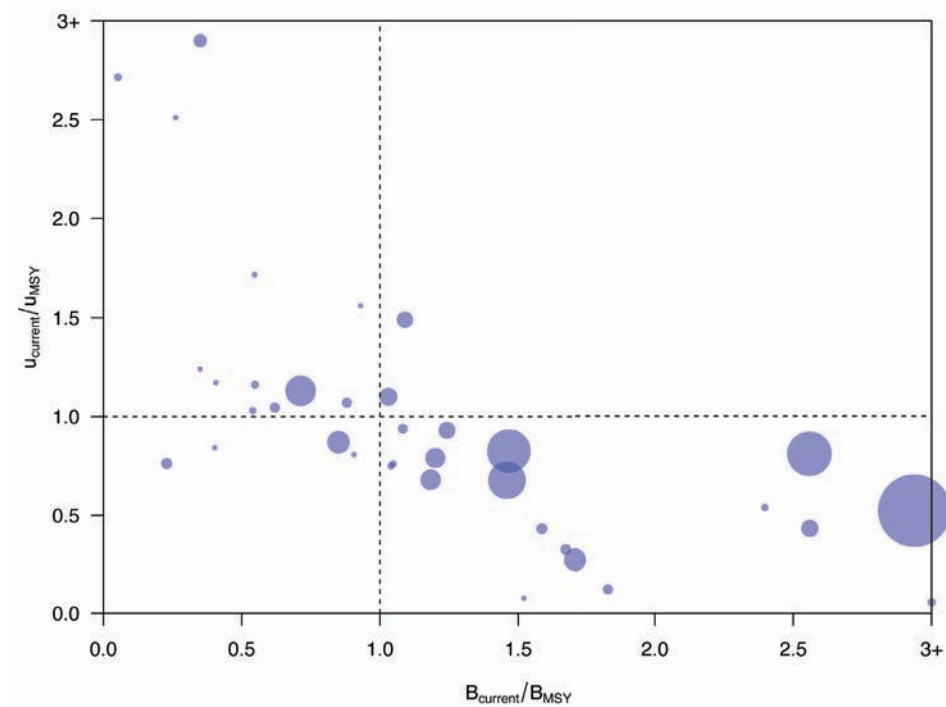
Figure 2. Stock status of tuna and billfish stocks. The horizontal axis is biomass relative to the biomass that would produce maximum sustainable yield (MSY). The vertical axis is exploitation rate relative to the exploitation rate that would produce MSY. The size of the circles is proportional to MSY.

and underfishing, calculated current stock status relative to fisheries reference points. A draft manuscript is in preparation for publication.

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

P.I: Kevin Weng

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

NOAA Sponsor: Samuel G. Pooley

NOAA Goal(s)

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

Purpose of the Project

Monchong is a generic local name given to two deep water pomfret species—the sickle pomfret, *Taractichthys steindachneri*, and the lustrous pomfret, *Eumegistis illustris*. The sickle pomfret is a common incidental catch in pelagic longline fisheries throughout the North Pacific. The lustrous pomfret exhibits fidelity towards deep slope or seamount habitats and are generally caught by short-line or handline. Hawaii seafood wholesale and processing firms who have successfully promoted it in the fresh market and restaurant trade value both monchong species. These species have become an increasingly important component of local Hawaii fisheries in terms of commercial fishery landings and sales in recent years. In the case of the lustrous pomfret, most of the catch occurs at Cross Seamount, a smallish seamount 8 km in diameter at the summit located 290 km south of Honolulu. Concerns over the sustainability of current pomfret removal rates with respect to recruitment from this limiting habitat have prompted the Western Pacific Regional Fishery Management Council, in coordination with PIFSC, to launch an investigation into expanding knowledge of pomfret life history and ecology. This monchong study will occur in conjunction with the Hawaii Tuna Tagging Project 2 (HTTP2), a PFRP-funded project that is an integrated component of a Pacific wide tuna tagging and assessment program being implemented by the Secretariat of the Pacific Community, Pacific Tuna Tagging Project (PTTP). Tagging programs are widely recognized as important tools for understanding the population dynamics, dispersal patterns and fisheries interactions of fish populations and produce additional data inputs necessary to improve stock assessments and predictive models.
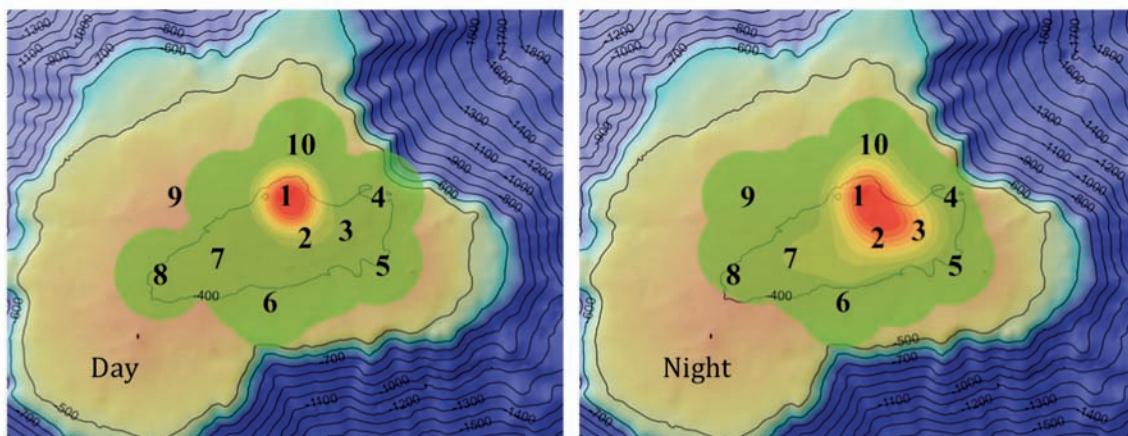
Figure 1. Day and night average location kernal density plot for 14 monchong. Numbers indicate station locations.

Progress during FY 2012

The commercial fishing vessel utilized by the project during prior years was unable to conduct Cross Seamount trips in 2012. The project therefore conducted a search to find a new vessel. Two cruises to Cross Seamount were conducted in 2012 on this new vessel. On the first trip eight monchong were tagged, and on the second 35

monchong were tagged. All of these fish were tagged with an upgraded transmitter than has an extended depth range, which will help to solve a previous issue of having depth records that bottomed out.

A detailed analysis of movement behavior and residency of monchong at Cross Seamount has been conducted. The next round of data will be incorporated into this analysis after the next data download.

Sampling of monchong at the Honolulu fish auction has been conducted throughout nearly a full annual cycle to obtain gonad samples. These samples are being analyzed histologically to determine the reproductive cycle of *Eumegistis illustris*. These research efforts are being conducted as part of the MSc research for a student in the UH Manoa Oceanography Department.

In addition to the primary project focusing on monchong, the project opportunistically conducted a study on the reproduction of walu. A university of Hawaii undergraduate student will use this project for a senior honors thesis.

Figure 2. Top: Vitellogenic oocyte of E. illustrus stained with Richardsons stain. Bottom: Perinuleolar and cortical vesicle stage oocytes of E. illustrus stained with H&E
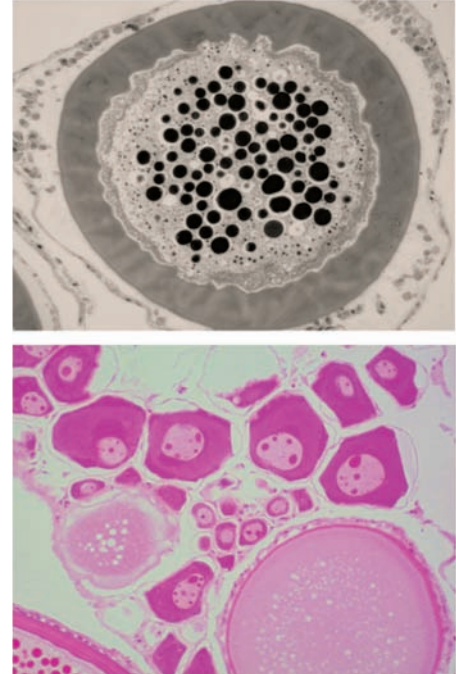
PFRP: Biotelemetry Tag Retention in Pelagic Tunas

P.I: Kevin Weng [Todd Jones, Michael Musyl, John Wang]

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

NOAA Sponsor: Samuel G. Pooley

NOAA Goal(s)

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

Purpose of the Project

To study the drag, lift, and torsion of pop-off satellite tags (PSATs) in order to increase retention times of the tags in large pelagic fish. The median retention time for PSATs in Bigeye tuna is 9 days, (range: 1-36). PSATs cost upward of several thousand dollars with battery life intended for year deployments. Using force transducers and a tow tank capable of speeds > 20 m s^{-1} and accelerations up to 15 m s^{-2} the project will determine the forces involved in unseating the anchor head which is typically inserted into the base of the dorsal fin between the pterygiophores. The unseating of the anchor head leads to premature ejection of the tag and possibly to misinterpretation of the data.

Progress during FY 2012

In the past year the project completed procurements (motor, variable frequency drive, force sensors) and designed a tow tank capable of testing tags at sustained speeds of 20 m s^{-1} and accelerations of 15 m s^{-2} doubling the capability from year one. This research will continue through April 2013. This PFRP funded research supports four 4th-year capstone project students from the Department of Mechanical Engineering, University of British Columbia. Continuing from this summer the project will test all commercially available PSAT tags at 1-20 m s^{-1} and accelerations of 1-15 m s^{-2}.

PFRP: Early Life Stage Dispersal of Yellowfin Tuna (*Thunnus albacares*) in the Central North Pacific

P.I.: Kelvin Richards [Claire Paris]

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

NOAA Sponsor: Samuel G. 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 purpose of this project is to understand larval dispersal patterns of yellowfin tuna (*Thunnus albacares*) in the Hawaiian Region. The project investigated the early life stage movement of yellowfin tuna, quantifying the degree of larval self-retention in the Hawaiian region, thus providing supplemental information on the origin of yellowfin tuna available to Hawaii fisheries that is vital for local-scale management. This was accomplished by incorporating the output from a three-dimensional model that simulates ocean circulation (HYCOM) into an Individual-based model (CMS, Connectivity Modeling System) that depicts adult spawning strategies, larval development, behavior, and dispersal (Paris et al. 2007). This allows the characterization of larval dispersal pathways in the Hawaiian archipelago and the project is investigating how these patterns vary across years and over ecological time scales relevant to the management of pelagic resources. In summary, this project fills a gap in the understanding of marine population dynamics in the study area, while having the potential to improve stock assessment and fisheries management.
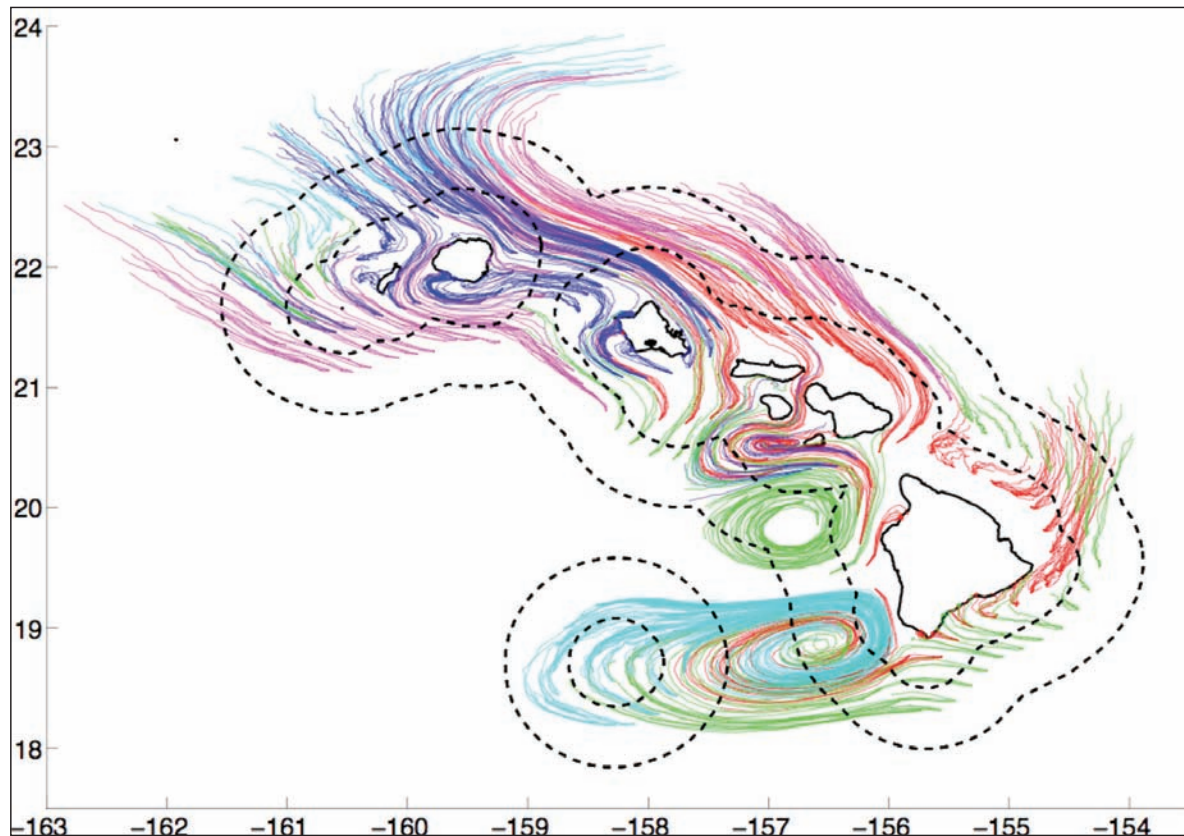

Figure 1. Trajectories of larvae dispersed for 30 days by the regional HYCOM flow fields averaged from 2009 to 2011. Colors are used to highlight dispersal from different areas.

Progress during FY 2012

During FY 2012 the project set up and ran the Individual-based model CMS using velocities from a regional implementation of HYCOM to generate larval distributions of yellowfin tuna around the Main Hawaiian Islands and Cross Seamount. This methodology revealed potential characteristics of yellowfin tuna larval dispersal pathways in the Hawaiian archipelago. Specifically, the project evaluated if larvae spawned around the MHI and Cross Seamount were locally retained, and if biological traits affect yellowfin tuna larvae retention and seasonal variability. Finally, estimates of inshore-offshore larval distribution patterns, and its implications for larval survival, were explored.

The proportion of larval retention from different mortality schemes (absence of mortality, constant mortality, and spatially-temporally varying mortality) was not significantly different. In the same way, using different ontogenic vertical migration (OVM) schemes did not substantially affect the proportion of retained larvae. Further, different mortality or migration schemes did not significantly affect inshore-offshore larval distributions. All results were tested with a t-test, at 95%. Considering these results, no mortality coefficient was applied to the larvae. Their behavior was parameterized by the first OVM scheme, with larvae concentrated between 10 to 20 meters depth. The number of eggs released per spawning site was based on Itano (2000). A minimum of 40 eggs (per release site) were released in November, while a maximum of 800 eggs were spawned in July.

According to the results, the physical environment during yellowfin tuna spawning season was favorable for larval retention. Simulations results showed that after 20 days of dispersal, the number of retained larvae was nearly constant, at both inshore (less than 37 km from the islands) and offshore (less than 92 km) regions around the MHI and Cross Seamount. This was a strong indication that yellowfin tuna larvae released in Hawai'i were locally retained. Despite the high amount of larval retention (40%), no persistent pathways or concentration zones were

Figure 2. Mean (black) and standard deviations (red) of the monthly onshore-offshore dispersal probabilities of (a) hatching eggs (1 day of dispersal), (b) feeding larvae (6 days of dispersal), (c) post-flexion larvae transitioning to piscivory (16 days of dispersal), (d) transitional juvenile (26 days of dispersal). Mean and standard deviations are based on 100 simulations, during the spawning season of yellowfin tuna from 2009 to 2011. The dispersal kernels are based on the number of larvae within 90 km of the Hawaiian Islands, not considered dispersion to the open ocean. Larval stages were based on Margulies et al. (2007), Wexler et al. (2011) and Jeanne Wexler (personal communication).

present for the period of simulation. Indeed, larvae dispersed by the averaged flow field showed even larger retention values (Figure 1), implying that the time evolving eddying flow contributed to disperse larvae at the spatio-temporal scales considered in this study. Although the physical environment was conducive to larval retention, no seasonal cycle was apparent in the retention patterns, indicating that other factors are optimizing the spawning cycle observed for yellowfin tuna in the Hawaiian Islands. The inshore-offshore dispersal probabilities obtained with the model showed that the proportion of larvae retained nearshore (less than 10 km from the coast) increased with time and independently of the release location (Figure 2).
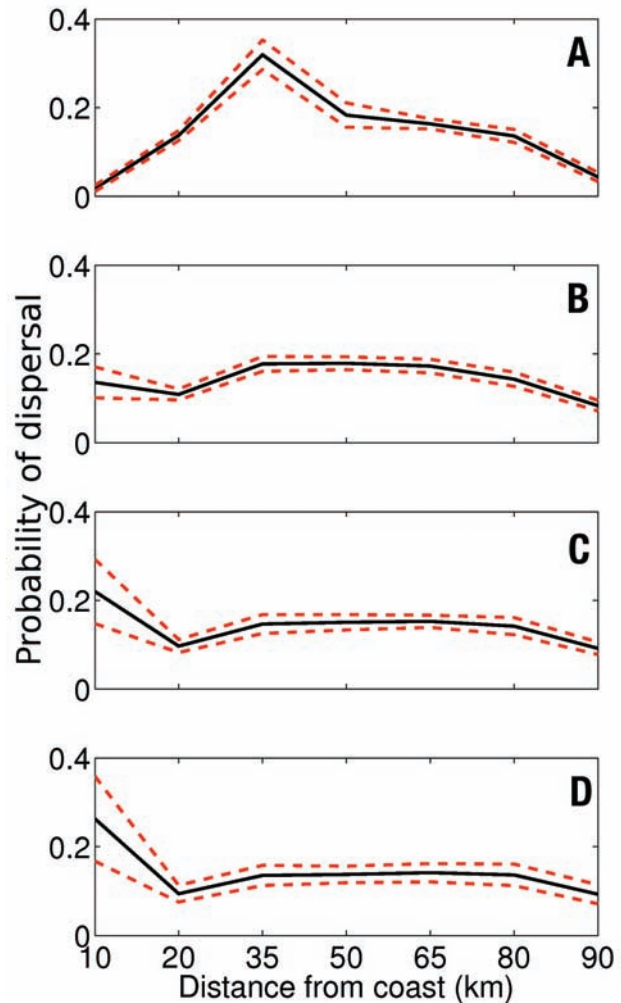
PFRP: Examining Pelagic Food Webs using Multiple Chemical Tracers

P.I.: Jeffrey C. Drazen, Brian Popp [Peter Nichols, Charles Phleger]

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

NOAA Sponsor: Samuel G. Pooley

NOAA Goal(s)

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

Purpose of the Project

Middle trophic level organisms (namely macroplankton and micronekton) are the decisive link between primary producers and top predators as well as food items of many commercially important pelagic predators. However, the trophic dynamics of many macroplankton and micronekton are poorly known. Consequently, fishery models and ecosystem-based management decisions would benefit greatly from detailed information on the trophic dynamics of these organisms in the pelagic environment. The project utilizes multiple chemical analyses (bulk stable isotopes, compound specific isotopes, lipid biomarkers, and mercury concentrations) in conjunction with supplementary stomach content analyses to characterize the pelagic food web, incorporating organisms from primary producers to top predators in waters surrounding the Hawaiian Islands. The specific objectives are: 1) to evaluate variation in diet amongst commercially important top predators and amongst major taxonomic and ecological groups of middle trophic level pelagic animals; and 2) to determine major trophic connections between epipelagic, mesopelagic, and bathypelagic habitats and communities.

Results from this project will increase the understanding of trophic connectivity between the forage base and top predators and further elucidate the structure and variability of pelagic food webs, which is necessary information for ecosystem-based managers and ecosystem modelers.

Progress during FY 2012

The project has met most of the target goals for this third year of the project, which principally included laboratory analysis of collected samples and data analysis. In the beginning of the project year (August 2011) additional zooplankton and micronekton sampling was conducted aboard the RV *Kilo Moana* using both the 1m² and 10m² MOCNESS systems. In this sampling the project obtained depth discrete samples to over 1000 meters for biochemical analysis. In addition the project filtered particles in water at discrete depths to 2000 meters. During this cruise 50 water samples, 180 zooplankton samples, and 1090 micronekton samples were collected. Nearly all of the laboratory analysis (mercury, fatty acid analysis, and AA-CSIA) of samples was completed. Project researchers Brian Popp, Jeffrey Drazen and Anela Choy all visited project colleagues at CSIRO in Tasmania last winter. During this time the final samples were examined for fatty acid biomarkers, including additional predators and numerous representatives of their micronekton prey. Data analysis continued and the project's three main findings are outlined below.

Large mesopelagic fishes such as lancetfish, escolar, snake mackerel and opah are poorly studied yet their populations are apparently increasing in the central North Pacific (Polovina et al 2009). The diets of all but lancetfish have not been described which prevents mechanistic hypotheses about the population changes. The project has described the diet of bigeye and smalleye opah, lancetfish and snake mackerel. Escolar were also studied but the high proportion of empty stomachs prevented an adequate description of diet. The opah species consume more cephalopods than the lancetfish, which eat predominantly hatchetfishes, salps, and hyperiid amphipods (which live inside the salps). These lancetfish results align largely with previous studies from this and other regions although the findings continue to surprise scientists because these fish have an enormous gape and large dagger-like teeth. Based on detailed examination of squid beaks the squids eaten by opah are overwhelmingly more active Onychoteuthids and Ommastrephids whereas the lancetfish consumed many more sluggish cranchiid and histioteuthid squids. The snake mackerel have a diet similar to opah including the composition of the squid but with greater proportions of fish overall. Lancetfish and opah (both bigeye and smalleye) consume a large amount of plastic; across all fishes that were examined, 23% ingested plastic and for lancetfish it was 58% of individuals. These fishes do not likely occur at the surface thus the plastic (which is positively buoyant based on lab tests) was probably consumed in the water column where it had become neutrally or negatively buoyant due

to biofouling. Although plastic ingestion has been noted in a few fishes they were all surface caught animals. Project results imply that plastics are also common in deeper strata of the water column.

Information on the vertical connectivity of pelagic food webs is sparse yet these connections are important for understanding the production of commercially exploited fish stocks and the biological carbon pump. The project hypothesized that the vertical gradients in biochemical signatures would be evident due to the microbial reworking of detritus and its entry into deeper waters. Preliminary results suggest that there are increases in $\delta^{15}N$ values with depth evident across several trophic levels. Particles increase ~6-7‰ from the surface to about 200 m and then remain fairly constant with depth. Zooplankton $\delta^{15}N$ values of all size fractions (0.5 mm to >5 mm) increase by about the same magnitude but over a greater depth range. Micronekton increase from $\delta^{15}N$ values of 6-7 ‰ in epipelagic species to over 9‰ in mesopelagics. The reasons for these depth related increases are not entirely clear. Conventional interpretation of these isotopic data would suggest that there is an increase of two trophic levels in zooplankton with depth and about one trophic level for the micronekton. However, amino acid specific isotope analysis suggests that there is both an increase in average trophic position of zooplankton with depth and based on the $\delta^{15}N$ values of phenylalanine baseline nitrogen isotopic values are also higher. This gradient may relate to microbial processes and if they are consistent over time may provide an isotopic fingerprint for depth of forage of vertical migratory species or those for which basic life histories and vertical habitat is currently not known. Analysis of micronekton amino acid isotopes is underway and should further illuminate this topic.

In conjunction with Joel Blum (U. of Michigan) the project has been exploring the use of the isotopic compositions of mercury (Hg) to understand biogeochemical cycling of Hg and the source(s) of Hg in pelagic fishes. Mercury enters at the base of food webs and is transferred and bioaccumulated to higher trophic level organisms via diet. Therefore, examining Hg in fishes can aid substantially in reconstructing marine food webs.

Mercury has seven stable isotopes, and the isotopic compositions of Hg display mass-dependent fractionation (MDF) during most biotic and abiotic chemical reactions. Additionally, Hg displays unusual large mass-independent fractionation (MIF) during photochemical radical pair reactions, where isotope fractionation is greater for the odd (^{199}Hg, ^{201}Hg) than the even (^{198}Hg, ^{202}Hg) isotopes. The project measured Hg stable isotope ratios in a group of Hawaiian pelagic fish for which Hg concentration and median depth of occurrence are known. The project hypothesized that the amount of MIF ($\Delta^{199}Hg$) in Hg from fish tissue would decline with depth of occurrence because methylmercury (MeHg) at shallower depths would undergo more photochemical demethylation prior to introduction into the marine food web. Changes in $\Delta^{199}Hg$ values with depth clearly support this hypothesis and indicate that Hg at shallower depths undergoes a greater extent of photochemical reduction prior to introduction into the marine food web and may provide a way to measure the depth of forage where Hg was acquired. Depth trends in $\Delta^{199}Hg$ and $\delta^{202}Hg$ values are inconsistent with production of MeHg in the photic zone, deposition of MeHg from the atmosphere or lateral advection of MeHg from coastal regions, because in these cases it is not expected to see decreases with depth in $\Delta^{199}Hg$ values in fish. The project suggests that MeHg must be produced at depth (below the mixed layer) and is then advected upward into the photic zone where it becomes highly degraded (~80%) by exposure to sunlight and in the process acquires a very high and distinct $\Delta^{199}Hg$ value of 5-6‰.

PFRP: Hawaii Tuna Tagging Project 2

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

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

NOAA Sponsor: Samuel G. Pooley

NOAA Goal(s)

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

Purpose of the Project

To update understanding of the movement patterns and growth rates of three species of tuna (skipjack, yellowfin and bigeye) found in coastal Hawaiian waters. Particular emphasis is placed on FAD (Fish Aggregating Device)-associated animals and the impact of FADs on their movements and condition. This project is an official "Sub-Regional Project" of the ongoing tagging project of the WCPFC and data will be shared with this agency.

Progress during FY 2012

The original design of this study placed heavy emphasis on access to the state's one remaining pole-and-line commercial tuna vessel. However, despite the continued support of the vessel's owner, the captain has not allowed scientists access to the vessel. Consequently, emphasis changed from attempting large numbers of releases of fish marked with "spaghetti tags" to the use of smaller numbers of electronic tags deployed from the UH *R/V Opah*. Emphasis was also shifted to evaluation of the body condition of animals captured near FADs by using Bioelectrical Impedance Assessments (BIA).

Electronic tagging was successfully conducted on FAD-associated yellowfin and bigeye tuna and over tuna have been tested using the BIA methodology. The BIA method was also calibrated using captive tuna held at HIMB. Tagged fish continue to be recaptured and reported by fishers.

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

P.I.: Kevin Weng

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

NOAA Sponsor: Samuel G. Pooley

NOAA Goal(s)

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

Purpose of the Project

Seamounts have extraordinary levels of endemism and exert a powerful aggregating effect on species, attracting fishes, cetaceans, seabirds and turtles. Only a few of the world's 100,000 seamounts have been explored, resulting in a minimal understanding of the biology of seamount organisms. Despite this, seamounts experience intensive fisheries, and interviews of commercial fishermen in Hawaii reveal frequent catches of bentho-pelagic sharks. As a result, the Western Pacific Regional Fishery Management Council and NOAA are responsible for the management of species that are potentially endemic, highly vulnerable to fishing, and so poorly understood that they cannot be assessed and for which no definitions of essential fish habitat (EFH) exist. While seamounts have been hypothesized as stepping-stones, it is not known if seamount sharks are isolated populations or if they move between seamounts and landmasses. Deep set longline fishing will be conducted at Cross Seamount

Figure 1. Depth habitat of Shark 1, a mature male Hexanchus griseus *that left Hawaii during its time at liberty. Black bars show night, white bars day. Thermocline and oxycline data are shown in blue and green lines respectively.*

to characterize the elasmobranch community. Detailed studies will be conducted for the three highest trophic level bentho-pelagic elasmobranchs, the Cooke shark (*Echinorhinus cookei*) the sixgill shark (*Hexanchus griseus*) and the sleeper shark (*Somniosus pacificus*). A combination of acoustic, satellite and accelerometry technologies will be used to characterize their behavior, habitat use and connectivity with other seamounts and islands. The resulting data will allow definitions of EFH and determination of appropriate management units. The proposal includes a low risk−high reward component, using established methods on new species; as well as a high risk−high reward component, that aims to develop a novel method to study these deep water animals.

Progress during FY 2012

• *Characterization of bentho-pelagic elasmobranchs.* Demersal longline sets have been conducted in depths ranging from 200 m to 1000 m and three species of demersal elasmobranch recorded.

• *Determination of fine-scale habitat use.* The project made extra efforts to recover satellite tags that popped up at sea, using a radio direction finder from the boat (or in the case of tags that hit land, conducting searches on foot along the shoreline). Five out of six tags that reported were recovered. The sixth reported from a distant location, precluding a search. These tag recoveries allowed staff to download extremely detailed records of depth, temperature and light, characterizing the fine-scale behavior of the animals.

• *Determination of connectivity and long-range movements.* The project placed VR2 acoustic receivers in deep water around Oahu and Penguin Banks. Acoustic devices deployed and maintained by other researchers are located in other regions of the Main and Northwest Hawaiian Islands. The project has tagged 11 sharks with acoustic transmitters that can be detected by these receivers and has deployed seven satellite tags on two deep water demersal elasmobranchs to characterize movement patterns.

• *Studying foraging behavior to reduce by-catch.* The Daily Diary accelerometer was to have been housed for use in deep water by the developers at Swansea University, UK. They have been unable to develop a deep water version of the daily diary tag. Project researchers therefore undertook a search for alternate devices, and found one company that produces an accelerometer that can release itself from the animal for recovery. These devices have been acquired and will be tested and deployed them in the near future.

The project also conducted a foraging study of deep water elasmobranchs using bulk and compound specific stable isotope techniques to gain an understanding of the trophic level and food web interactions.

Note that due to difficulties in conducting shark fishing operations from commercial fishing vessels that will allow researchers to join their trips, the project has yet to tag at Cross Seamount. However, large amounts of data have been gathered from the Main Hawaiian Islands and the project is working to develop the capacity to capture deep water sharks at Cross Seamount.
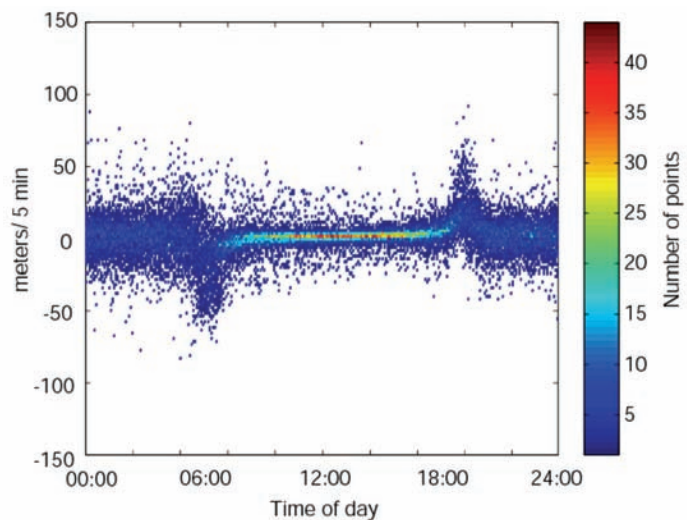
Figure 2. Vertical rate of movement versus time of day for Shark 3. This shark displayed a clear ascent and descent, and a greater rate of movement at night than during the day, indicative of nocturnal foraging activity.

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

P.I.: Kevin Weng, Simon Hoyle, Fabrice Bouye, Shelton Harley

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

NOAA Sponsor: Samuel G. 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 objectives of this project are: to create a standalone application ('the application'), downloadable from a website, that allows a user to evaluate various management options using forward projections with the most recent WCPFC stock assessment models; and to change MULTIFAN-CL so that it provides outputs that are more relevant to the needs of fisheries decision-makers.

Progress during FY 2012

As of December 2011 the project had TUMAS 1.x working in both Windows and Linux with all three tropical tuna species. TUMAS provided options to have catch or effort management restrictions for all fisheries, and then for the equatorial purse seine fisheries there was the additional option of having either total spatial closures (for various high seas areas or EEZs) or closures that only apply to FAD related fishing. At this stage there were two primary weaknesses that the project was looking to address: 1) problems with the Java Web Start online content delivery system that was being using for the downloading at automatic updates–it just did not work consistently; and 2) TUMAS was using large amounts of computer memory that made it cumbersome on lower end machines. With all the major developments within the PFRP funding project complete, the project's aim was to address these minor issues and then include other MULTIFAN-CL assessments into TUMAS (both from WCPFC and other RFMOs). Unfortunately, not all of this has eventuated.

Early in 2012 project researchers became aware that one of the key tools used in TUMAS, JavaFX runtimes (that could not be legally packaged) was essentially no longer supported by Oracle (who had purchased Java). This left the project and many other software developers in the cold. The new versions under development did not support important features, e.g., image export. The project immediately contacted colleagues at PFRP to make them aware of this issue, which had essentially rendered TUMAS inoperable. For the remainder of 2012 the project has headed down three parallel lines: 1) trying to get Java to fix the problems currently being encountered; 2) developing a new version of TUMAS using the new version of Java-FX; and 3) investigating the potential to develop a GUI interface that works within the R software domain.

The project's attempts at getting Oracle to 'lift their game' were not immediately successful, but the project has now developed TUMAS 2.0 using the latest JavaFX runtimes. These can be packaged within TUMAS so users longer have to deal with Java Web Start. This new version has 90% of the functionality of version 1.0 with a few minor exporting options to be addressed. The project intends to release TUMAS 2.0 in December 2012 and is hopeful that this version will also include the South pacific albacore and southwest pacific striped marlin assessments conducted in 2012. Investigations into using R have indicated that the GUI would be very inferior to the current JavaFX version, and the approach taken by the "R-project" for making available the necessary dll's would mean that TUMAS could not be used on Linux or Mac OS. There are no plans to head down this path at this time, but the project will continue monitoring.

PFRP: Integrating Conventional and Electronic Tagging Data into the Spatial Ecosystem and Population Model SEAPODYM

P.I.: Kevin Weng [Inna Senina, Francois Royer, Patrick Lehodey]

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

NOAA Sponsor: Samuel G. Pooley

NOAA Goal(s)

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

Purpose of the Project

The purpose of the project is to integrate conventional and electronic tagging data within SEAPODYM habitat-based population dynamics model. It is proposed to develop a fully-operational model allowing assimilation of both fishing and tagging data, and to validate it performing two case studies, with a focus on Pacific skipjack (*Katsuwonus pelamis*) and yellowfin (*Thunnus albacares*) tuna populations.

Progress during FY 2012

Due to the reduction of the FY 2011 PFRP budget, funding for year 2 work was not provided. The tasks and activities for year 2 were re-prioritized in order to achieve the principal goal of the project, i.e., the integration of the conventional tagging data and the technical validation of the application with minimization of nonlinear cost function, composed of catch, length and tagging data. The work was accomplished in the following phases:

- *Technical code developments*. Combining tagging data with SEAPODYM age-structured population model leads to augmentation of the model state vector by large amount of variables describing the density of the cohorts of tags. To make the method for the integration of tagging data into full population model feasible, a substantial code development was required. Thus, part of the adjoint code was rewritten in order to reduce the size of the memory required for saving the intermediate variables for computation of the cost function gradient. This resulted in the decrease of the gradient stack size by 15%. Also, the input-output operations were eliminated completely from the runs with optimization in order to optimize the computational time. In addition to that, the code was adapted and recompiled with more recent version of gcc 4.4 and consequently with latest AUTODIF library, which allowed allocation of more than 4Gb necessary for computation of the cost function gradient. All together these developments reduced the time for one function evaluation (computing the cost function and its gradient) by 50%.

- *Method implementation*. A new dimension, *population*, was added to the existing single population structure. Thus in addition to the age-structured population of a given species, the project now considered the populations of tagged tuna. Each population of tags is initialized according to the following definition: "Population of tags is the ensemble of individuals, tagged with conventional method, which were recaptured at the same time period (month-quarter)". Each population of tags follows the same age structure as the population of modeled species; and the predicted spatial and temporal dynamics is the solution of the analogous advection-diffusion equations with the reaction term set to zero (i.e., no mortality term). All model parameters, except those of fisheries are shared between populations. Fisheries do not take part in the dynamics of the populations of tags. Finally, the likelihood function is augmented with the third component being the error of the predicted spatial distribution of tags with respect to the observed.

- *Validation and sensitivity analysis*. The validation of the approach included: 1) the derivative check, which is necessary to assure that the derivative (adjoint) code is correct; and 2) the so called twin experiments, which consist in creating pseudo-data sets for conventional data and running the model in optimization mode to test if the original solution used to create the artificial tagging data can be retrieved. A set of such experiments was done for the tasks of minimizing the recapture likelihood only and minimizing the full likelihood with catch, length and recapture components. Also, the sensitivity analyses were done in order to reveal the parameters, which can be estimated due to integration of the tagging data. As expected, the parameters driving the movement, i.e., maximal sustainable speed, diffusion, and movement habitat parameters have the high sensitivity (relative sensitivity > 10%). This result is also corroborated by the twin experiment study, showing that optimal for tagging data movement and habitat parameters can be retrieved even while minimizing the three-component likelihood function.

- *Application to Pacific skipjack*. Using compiled tagging datasets provided by NRIFSF and SPC collaborators the populations of tags were defined. The first preliminary experiment is planned for Pacific skipjack by the end of this year. This run will be done with monthly time step and with the spatial resolution 1 degree based on physical (SODA) and biogeochemical (VGPM) forcing variables. The method and results will be described in a scientific article and presented to the scientific committee of the Western Central Pacific Fisheries Commission in 2013.

PFRP: Integrating Electronic and Conventional Tagging Data into Modern Stock Assessment Models

P.I.: Kevin Weng [Simon Nicol, Pierre Kleiber, Mark Maunder]

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

NOAA Sponsor: Samuel G. Pooley

NOAA Goal(s)

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

Purpose of the Project

Extensive electronic and conventional tagging data sets exist for tuna species however the information available is not fully utilized in the tuna stock assessment models. The project aims to maximize the utilization of movement information contained in tagging data. It is based on the four key elements of the tagging data that could directly

or indirectly inform stock assessment and management advice: 1) analysis of horizontal movements for estimation of movement parameters (both conventional and electronic tags); 2) direct estimation of movement parameters from other models; 3) conversion of movement parameters estimates into block-transfer rates that are used in Multifan-CL and stock synthesis; and 4) incorporation into stock assessment models through one or more priors. Stock assessments undertaken in 2012 are expected to benefit from this development thereby assisting Regional Fisheries Management Organizations with the sustainable management of tuna resources.

Progress during FY 2012

A workshop for researchers involved in the analyses of tagging data and stock assessments was held in October 2011 to collaborate on approaches for incorporating tagging data into stock assessments. A paper resulting from the discussion generated at this workshop has been drafted and will be presented at the Indian Ocean Tuna Commission (IOTC) Symposium in October 2012 with a subsequent publication in *Fisheries Research* expected as part of the meeting proceedings (to be submitted in January 2013). The analyses of horizontal movement and tagger effects have been completed and the results will also be presented and published as part of the IOTC Symposium. Movement analyses from electronic tags have been completed for all yellowfin tagged in the Western and Central Pacific Ocean. These results will be incorporated into the 2013 stock assessment of yellowfin for the Western and Central Pacific Fisheries Commission. The estimation of block transfer rates for Multifan-CL using the spatially explicit SEAPODYM model has been delayed as the movement parameters generated by this model for skipjack are currently estimated on the fixed boundaries indicating unsatisfactory results. This component of the project will be completed when tagging data is fully incorporated into SEAPODYM (see PFRP project Integrating Conventional and Electronic Tagging Data into SEAPODYM).

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

P.I.: Kevin Weng

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

NOAA Sponsor: Samuel G. 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 objective of this research is to integrate the results of different components of the Pelagic Fisheries Research Program into a consistent framework that integrates knowledge of fish movement and population dynamics, the fishing process, economics and oceanography. The primary focus is the development of spatial models of pelagic fish population dynamics that explicitly include movement, mortality, and fisheries. The work emphasizes collaboration with other PFRP projects. The specific objectives are to continue improving and maintaining the movemod diffusion and advection modeling software and to run the movemod model with new and existing data sets. The PFRP modeling project also collaborates with, and supports the development of the ADMB Project. Recent work includes development of code for the analysis of acoustic array tracking data, which are inherently biased by the nature of fixed receiver arrays.

Progress during FY 2012

A postdoctoral scholar, Martin Pedersen, was brought to the PFRP in 2012. Dr. Pedersen will conduct research into the development of rigorous statistical framework for analysis of acoustic array tracking data. Such datasets typically include data obtained only from locations where receivers are placed, introducing spatial bias; include many gaps, introducing temporal bias; and are strongly affected by the original design of the study. Dr. Pedersen will also work on geolocation of fishes that do not yield good light curves, via alternate sources of environmental information such as tidal, bathymetric, temperature, thermocline.

PFRP graduate student Eun Jung Kim (University of Hawaii, Oceanography Department) continued with development of a model to quantitatively capture the effects of fish aggregating devices (FADs) on the movement of skipjack tuna population. This model had been successfully tested in simulation. Additional work by Kim is underway to compute estimates of drifting FAD density in the WCPO using particle tracking software.

PFRP: Ocean Acidification Impacts on Tropical Tuna Populations

P.I.: Kevin Weng [Simon Nicol, Dan Margulies, Vernon Scholey]

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

NOAA Sponsor: Samuel G. 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 unaccounted impacts of ocean acidification (and warming) upon tuna stocks in the Pacific (and globally) represent a serious risk to the achievement of sustainability based management objectives for both Regional Fisheries Management Organizations and for the policies of sovereign states responsible for tuna fisheries management in the Pacific region. Research has demonstrated that the early life history stages of some fish species (and numerous other marine organisms) are sensitive to ocean acidification levels that are projected to occur by the end of this century. Those findings have significant implications for future recruitment success and population levels for those species. This project aims to elucidate the impacts of projected ocean acidification levels upon

Figure 1. Multiple experimental tanks with nested egg incubators. Photo Donald Bromhead.

processes and life history stages of yellowfin tuna (*Thunnus albacores*) that are considered critical to recruitment success: sperm motility, embryonic development, hatching rates, condition, development, growth and survival in pre- and post-feeding larvae. The outputs from this project will reduce uncertainty regarding future stock trends as provided to tuna Regional Fisheries Management Organizations in the Pacific, increasing the likelihood that these organizations can make decisions that ultimately achieve sustainability based management objectives

Progress during FY 2012

Trials were grouped into sperm and fertilization trials and egg and larval trials. The project originally proposed two years of experimental trials with the first year undertaking pilot studies in preparation for experimentation in the second year. The second year of the project was cancelled due to cessation of PFRP funding.

Experimental trials in year one were conducted at the IATTC's Achotines Laboratory, Panama, in October and November of 2011. Results are as follows:

• *Sperm activity and fertilization trials*. The genetic component of this research assessed two areas: 1) which parents within the Achotines Laboratory broodstock population contributed to offspring in the next generation

for each ocean acidification experiment; and 2) whether offspring survival is associated with their genetic composition or level of genetic variation when exposed to different pCO_2 levels. Parentage analyses have been undertaken using molecular marker-based pedigrees. Standard methods were used for DNA extraction and amplification of highly polymorphic microsatellite loci from yellowfin tuna. Fifteen replicate individuals per pCO_2 scenario per experiment were extracted. Parentage were analyzed using the genetics software package COLONY and F-statistics, allelic diversity, and the numbers of effective and private alleles are currently being used to estimate the overall genetic diversity and inbreeding

Figure 2. Vertebral deformation observed at pH 7.3 and 7.7. Photo Jeanne Wexler.

coefficients of the sample population using the software FSTAT. There appears to be substantial variation in allelic richness and frequency amongst individuals regardless of pH treatment. The relative contribution of some individuals decreased with increasing acidity whereas others had no clear pattern or increased in contribution. The 15 replicates were insufficient to detect all fluctuations in allelic richness / allele frequency. A power analysis has been completed and the number of individuals is currently being increased from 15 to 50 to guarantee with 95% confidence that contribution from all parents is included.

The sperm motility component of this work was undertaken to examine fertilization success under different pCO_2 levels. Despite many attempts, obtaining fresh sperm from male yellowfin tuna proved impossible and sperm from black skipjack tuna was used as a surrogate. Preliminary results showed that black skipjack sperm were relatively robust to ocean acidification: pH decreases from 8.1 (control) to 7.3 or 6.8 units had no significant effect on sperm swimming speeds. However the percentage of motile sperm at pH 6.8 was only 20.7% of that in control (pH 8.1) treatments. There was no significant effect of pH 7.3 on sperm motility. These results suggest that near-future ocean acidification (to $\approx$ 7.7 pH units) is unlikely to influence the fertilization success of black skipjack tuna. Whether these results are representative of yellowfin tuna remains to be determined, however the extreme pH changes needed here to effect a response lead us to be cautiously optimistic that ocean acidification is unlikely to affect yellowfin tuna fertilization success in the coming century.

• *Egg and larval trials*. Analyses are ongoing to describe the condition of selected target tissues of larvae based on histological analysis. Based on prior research results with cod and herring larvae exposed to lowered pH, it is anticipated that the most important larval tissues for histological examination of possible reduced-pH effects will include the liver, kidney, and pancreas.

The morphological development component of this work has examined deformity in relation to each pCO_2 scenario. Techniques were developed to extract small otoliths from first-feeding larvae that were sampled during both experiments. Morphometric analyses (size, shape) of the otoliths by high magnification light microscopy will be conducted in early 2013 to assess the potential impact of pCO_2 on otolith formation. Analyzes are ongoing to summarize morphometric parameters of eggs, yolk-sac larvae and feeding larvae exposed to variable pH in the experiments. Key morphometric measurements that are being summarized and compared among pCO_2 treatments include: egg diameter, oil globule volume, hatching length, yolk-sac volume, body depth of yolk-sac larvae, length at first-feeding, length at final sampling, and selected body depth parameters of feeding larvae. This work is expected to be completed in early 2013.

Estimates of larval growth (length, dry weight, body dimensions) and survival were derived from the experiments conducted. The data have been formatted and preliminary GLM based statistical analyses of survival data completed and reviewed by the project group. A revision of those analyses is currently in progress to take

into account issues identified during the group review. Growth and survival analyzes are expected to have been finalized by mid November 2012.

PFRP: The Role of Social Networks on Fishermen Economic Performance in Hawaii's Longline Fishery

P.I.: PingSun Leung, Shawn Arita, Stewart Allen

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

NOAA Sponsor: Samuel G. Pooley

NOAA Goal(s)

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

Purpose of the Project

This project seeks to examine the role of Social Network Capital on vessel economic performance in the Hawaii Longline Fishery (HLF). With an ethnically fragmented participation structure, the HLF offers an interesting case to examine the economic effects of social networks on natural resource users. The research framework combines two methodological tools: Social Network Analysis (SNA) and stochastic production frontier/
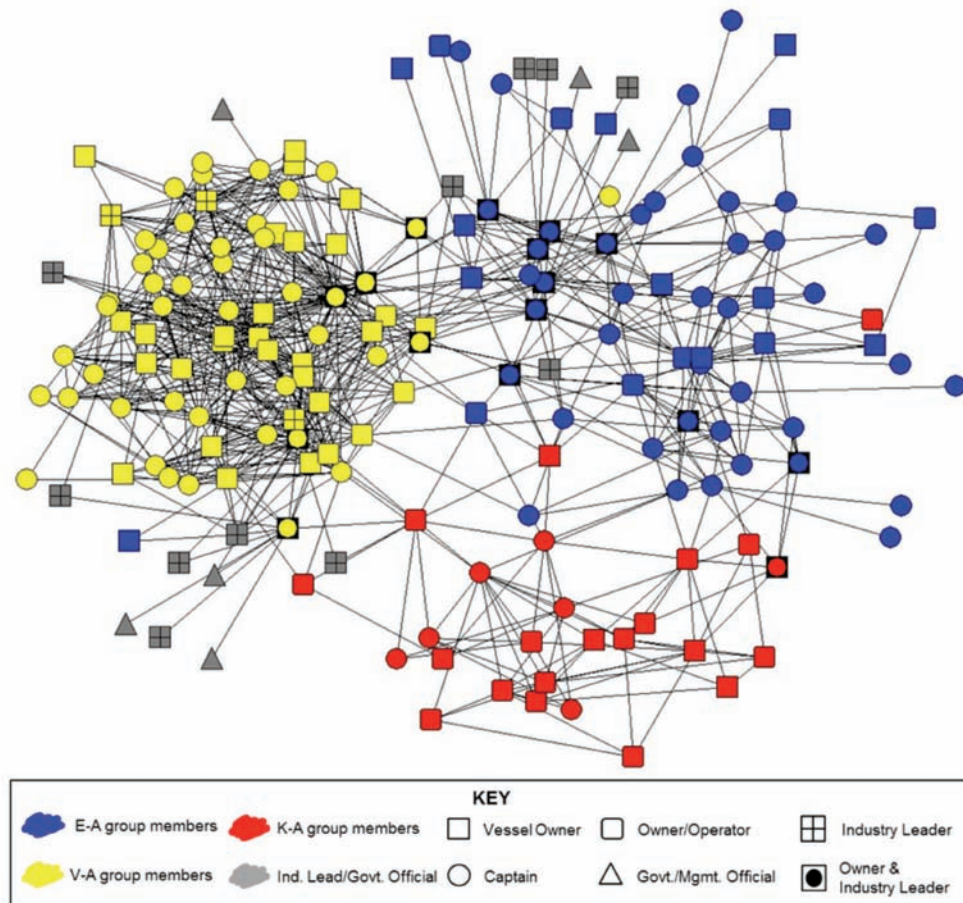
Figure 1. HLF network configuration, adapted from Barnes-Mauthe et al. (in press). The network includes all relations identified by the population of vessel owners and operators in the HLF. Nodes (representing actors) with the smallest path lengths to each other are placed closest together by an algorithm that uses iterative fitting. Node color and shape represent the actors' title and ethnicity affiliation as described in the key.

econometric analysis. Unfortunately, due to restricted program funding for PFRP, the second year plan of work in linking an economic analysis to the SNA was not funded. This report covers only the accomplishment from the first year of support.

Progress during FY 2012

The goal of the first fiscal year of this project was to complete the first objective as listed in the proposal, to perform a Social Network Analysis of the HLF. How this objective was completed is discussed below.

Map out the entire social network structure of the HLF. Three separate surveys were designed to measure the social linkages for members of HLF and their individual social capital for vessel owners, vessel captains, and owner-operators that were carefully tailored. The project field team was successful in administering the social network questionnaires obtaining almost the complete population of fishermen (response rate of 91.2%). With the sociometric network information collected, social network analysis tools were applied to map out the network structure of all fishers in the HLF and assess the patterns of social linkages. Using the UCINET suite of social network programs the project was able to visually show the social network structure of the fishery and map out the social network structure by ethnic groups (See figure 1 below).

Describe the mechanisms and processes that led to the development of social networks within the longline fleet. To investigate the mechanism and processes which lead to the development of social networks within the longline fleet, project

Figure 2. Network configurations generated in NetDraw (Borgatti 2002) by ethnic groups. Network depictions include all ties identified (top), and of ties between members of the same ethnic group only (bottom). Nodes (representing actors) with the smallest path lengths to each other are placed closest together. Node color and shape represent the actor's title and ethnicity affiliation as described in the key.

researchers examined socio-demographic and information sharing characteristics of the HLF fishers. A thorough social network analysis of the fishery was conducted. The principle sociometrics examined in this study were: 1) component analysis; 2) relational contingency table analysis (RCT); 3) K-core analysis; and 4) cut-point analysis.

Ethnicity was identified as the primary factor influencing the social network structure of the HLF. The component and RCT analysis confirmed that there was a strong homophily effect by ethnic groups. The K-Core and Cut-point analysis identified the characteristics of these different social networks group.

Calculate measures for Social Network Capital based upon individual levels of social connectedness and Ethnic-Social-Capital (aggregate measures of social capital) across groups. Various sociometrics were calculated to explore the level bonding, bridging, and linking social network capital for each community of fishers, and for the HLF as a whole. The project found that while the Vietnamese-American and Korean-American ethnic groups were characterized by a bonding social network structure, the Euro-American was characterized by a coalition. The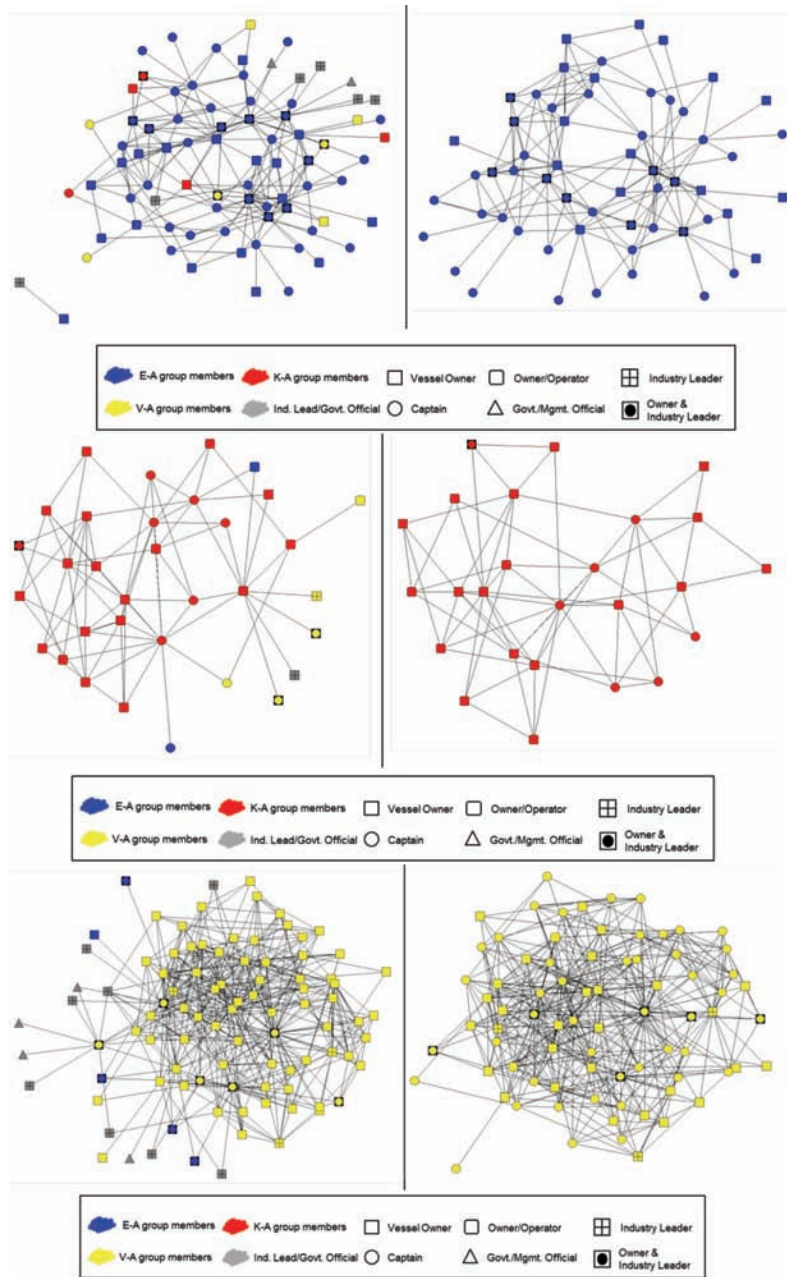 project also examined linking social capital through the amount of group connections to industry leaders, management and government officials.

Explore linkages to policy implications. The mapping of the social network structure has introduced important policy implications. Critically, from a management perspective, the structure of a fisher's social networks and the existence or absence of social capital was found to affect the diffusion of information and innovation and impact attitudes toward fishery policy among individual fishers. All of these factors can play a role in the effectiveness of management initiatives. For example the Korean-American group was found to have lower levels of social network capital and very weak linkages to industry leaders, management, and government officials. Considering these fishers reported the lowest percentage of total ties for both bycatch (27%) and regulations (45%) as a discussion topic, the findings suggest that the fragmented nature of the fishery may be leading to barriers to communication flows that are conducive to maintaining a sustainable fishery.

Distribution and publication of findings. Two research outputs are in progress. First, a draft of a technical report of this work has been completed, "A Network Analysis of Fisher's Social Capital and the Effects of Ethnic Diversity in Hawaii's Longline Fishery." The paper has been published under JIMAR's technical report series. Secondly, the results of this original study provide an important contribution to the literature of SNA in natural resources. An article of the project's findings has been submitted for review to *Ecology and Society.* The journal recently asked for revisions to the article and it has been resubmitted for a second round of review.

Protected Resources Environmental Compliance Initiative

P.I.: Mark A. Merrifield [JIMAR Project Lead: Karen Frutchey]

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

NOAA Sponsor: Alecia Van Atta

NOAA Goal(s)

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

Purpose of the Project

This JIMAR project works to develop and implement strategies to further recover marine species protected under the Endangered Species Act (ESA) and /or the Marine Mammal Protection Act (MMPA), including conduct of Section 7 consultations under the ESA. The project assists in the analysis and procedural requirements to manage federal fisheries in compliance with the ESA and the MMPA, and develops and delivers outreach and education campaigns for the public concerning protected resources issues.

Progress During FY 2012

The objectives established for this period included: 1) sea turtle conservation, management and fisheries related mitigation activities within the PRECI; 2) assisting in outreach and education missions by managing and developing outreach programs, materials and activities, and 3) creating partnerships with other federal and state agencies and non-profit organizations.

JIMAR Protected Resources Division (PRD) International Turtle Conservation and Management Liaison, Karen Frutchey, conducted technical monitoring site visits in the fall of 2011 in the Commonwealth of the Northern Marianas (CNMI) and Guam and discussed progression of turtle conservation and management objectives with PIRO-funded project Principal Investigators and other stakeholders in regional marine turtle conservation. During these site visits, she also introduced Pacific Islands Science Center (PIFSC) staff to government and contractor partners in the Marianas to promote a collaborative effort of marine turtle recovery from both science and management perspectives. Project staff participated in Endangered Species Listing and Candidate Assessment training and applied those skills in a supporting role to the Loggerhead Sea Turtle Critical Habitat Team as they

considered designating critical habitat for the endangered North Pacific distinct population segment of loggerhead sea turtles. To maintain disaster response preparedness, Karen completed a Hazardous Waste Operations and Emergency Response refresher course and participated in the NOAA Disaster Response Workshop in Seattle and in post-workshop meetings to discuss coordination of regional response to marine turtles and other protected species during oil spills. Continuing as liaison between international marine turtle conservation project principal investigators and PIRO, project staff served as technical monitors for international marine turtle projects in Vietnam, New Caledonia, Federated States of Micronesia, the Republic of the Marshall Islands and French Polynesia in addition to territorial projects in Guam, CNMI and American Samoa. Technical support for a marine turtle genetic sampling project was provided in collaboration with the NOAA Southwest Fisheries Science Center (SWFSC) scientists to characterize western Pacific green turtle nesting stocks. To progress in this research, staff assisted countries and territories with sample organization, Convention on International Trade of Endangered Species (CITES) compliance and served in a supporting role in analysis of green turtle skin samples. As part of this genetics project, JIMAR assisted the governments of French Polynesia, Guam, American Samoa, the Commonwealth of the Northern Marianas and New Caledonia with sample transfer to SWFSC. Karen also reviewed sample datasets from several regional partners before samples were shipped to and incorporated in the SWFSC archive. Furthermore, reviews were conducted on internal NOAA documents including marine turtle grant applications, grant progress reports, and U.S. position statements regarding the Secretariat of the Pacific Regional Environment Programme (SPREP) marine species action plans.

JIMAR PRD Sea Turtle Biologist, Kim Maison served as technical monitor for three grant funded projects including Hawaii Island hawksbill monitoring, Maui hawksbill monitoring, and conservation and research on sea turtles at Palmyra Atoll. In addition, she led the completion of a 12-month finding and response to a petition to list bumphead parrotfish under the ESA. She updated research and analysis on the effectiveness of global efforts to reduce greenhouse gas emissions as a contribution to the ongoing evaluation of an ESA listing petition for 82 species of corals. JIMAR completed numerous mapping projects using GIS software creating products including sperm whale stranding locations, false killer whale critical habitat, proposed spinner dolphin areas closures, monk seal pupping and haul out sites, north Pacific loggerhead critical habitat, and various maps depicting action areas and extent of various impacts (mainly acoustic) on protected species and habitats

Figure 1. A rare daytime main emergence of hawksbill turtle hatchlings on the Kau coast of the Big Island.

Figure 2. JIMAR Sea Turtle Biologist Kim Maison observes hawksbill hatchlings transiting to the sea right after hatching.

for ESA Section 7 consultations. Staff reviewed six project progress reports, two scientific research permits applications, and completed 12 informal Section 7 consultations. Kim serves as the lead on analysis of permitted research activities within the Papahanaumokuakea Marine National Monument and their potential impacts on sea turtles, monk seals, and cetaceans via ESA Section 7 consultations. Kim continued to maintain a Sea Turtle Reference database for PRD and served as a supporting team member on Section 7 consultations, providing technical assistance to the regulatory team on numerous projects and consultations. In particular, language in agency documents is periodically updated to incorporate the impacts of climate change into analyses. Staff attended three professional conferences (in Hawaii, New Zealand, and Mexico) and gave an oral presentation at the Society for Conservation Biology conference in Auckland in December 2011. Kim co-planned and convened an annual Hawaii Hawksbill Recovery Group Meeting with PIFSC and FWS colleagues. As the Climate Change Point of Contact for all of PIRO, PRECI JIMAR staff continues to provide information and guidance on incorporating the effects of climate change into management analyses and identifying gaps in climate science where information would be useful for marine resource management. Project staff also represents PIRO by serving on two steering committees and one working group for regional climate change organizations.

JIMAR PRD Outreach and Education Specialist, Jen Metz, continued to provide assistance and guidance with the various outreach and education efforts for PRD. Jen worked closely with the PRD Assistant Hawaiian Monk Seal Coordinator on outreach efforts aimed at promoting awareness and conservation of the Hawaiian monk seal. These programs included the completion and distribution of an educational animated video about responsible wildlife viewing of the Hawaiian monk seal; and the development of a story board and script for a future Hawaiian monk seal Public Service Announcement. The video, "Good Neighbors: How to Share Hawaiʻi's Beaches with Endangered Monk Seals," can be viewed on the PIRO website: http://www.fpir.noaa.gov/PRD/prd_good_neighbors.html. JIMAR Outreach staff presented Hawaiian monk seal focused outreach and education programs throughout the year including hosting outreach booths at Malama I Ke Kai; FOCUS (Forests Oceans and Us); Endangered Species Day at the Honolulu Zoo; the Ocean Expo; and the Ocean Fest at Turtle Bay Hilton. Outreach staff also conducted Hawaiian monk seal focused activities with local youth at the Na Kama Kai Ocean Clinic at Ewa Beach, the Washington Middle School Explorers Club, and the North Shore Junior Lifeguard Program. Staff worked closely with the PIRO PRD Sea Turtle Team Lead on evaluating the "Fishing Around Sea Turtle" outreach program by conducting a NOAA Office and Management and Budget approved survey and stakeholder meetings. Products were revised and a new poster was developed in response to resulting feedback from the evaluation. Jen also collaborated with Hawaiʻi Pacific University (HPU) professor, Kristi West; HIHWNMS Education Coordinator, Patty Miller; and the PIRO Marine Mammal Response Coordinator to write a project proposal for NOAA Education internal funding. The project is developing a web-based marine mammal stranding and response themed 7th-9th grade curriculum entitled, "Marine Mammals, Ocean Health and You." The first teacher workshop on Oʻahu to roll out the curriculum is scheduled for November 2012 with plans to take the workshop to the neighbor islands in 2013 if funding is available. Finally, outreach staff continues to manage web content manager for PRD; serve as the PIRO representative for the Hawaiʻi Watchable Wildlife Committee; as an Advisory Board Member for the National Association for Interpretation, Pacific Islands Chapter; and as the lead for the PIRO Green Team.

Reducing Shark Bycatch with Electropositive Metals

P.I.: Mark A. Merrifield [JIMAR Project Lead: John Wang]

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

NOAA Sponsor: Samuel G. Pooley, Keith Bigelow

NOAA Goal(s)

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

Purpose of the Project

The incidental capture of sharks is thought to be a major contributor to the declines of several shark species. Sharks often comprise a large proportion of the total catch in many fisheries. NOAA Fisheries has recognized shark bycatch as a management priority and has indicated, "Management entities should invest in elasmobranch research,

fishery monitoring, reduction of bycatch and bycatch mortality, minimization of waste, and enforcement". This JIMAR project examines potential deterrents that may be useful in reducing shark interactions with fishing gear. Specifically, the project conducted at-sea field trials to compare catch rates of sharks caught on hooks with and without an electropositive metal, specifically Nd-Pr (neodymium/praseodymium). This lanthanide metal alloy has been identified to repel sharks from approaching baited gear, and this research aims to identify the alloy's potential use as an effective bycatch mitigation method to reduce the unwanted capture of sharks in fishing gear.

Progress during FY 2012

Analysis of longline trials conducted in Hawaii, California, and Ecuador that tested the use of these alloys were completed, and a manuscript describing this work has been accepted for publication. In addition, the project completed a collaboration with the Worm lab based in Dalhousie University to test the efficacy of these metals to deter shark interactions in longline fisheries based in the North Atlantic. In collaboration with the Canadian longline industry, a total of 6,300 hooks with three hook treatments: standard hooks, hooks with rare-earth alloys (Neodymium/Praseodymium), and hooks with lead weights were deployed in 2011 near Sambro, Nova Scotia. Results suggest that rare-earth metals do not have any significant deterrent effect on the most common shark bycatch species and as such do not appear to be a practical bycatch mitigation option in the Canadian fishery. Results for this experiment have been analyzed, written up and a manuscript is under review with Fisheries Research.

The Ecuadorian longline vessel, F/V Siempre Olayita, was contracted to help conduct gear trials in ETP to examine tools potentially useful to reduce shark bycatch in longline fisheries. In Ecuador, a mother ship such as the Siempre Olayita will tow smaller fishing boats (a.k.a. pangas) hundreds of kilometers off shore. These smaller pangas then leave the mother ship to fish each night, returning only to off load the catch and get more bait.

Review and Possible Refinements of the EFH and HAPC Designations All Federal Management Unit Species in the Western Pacific Region, Excluding Hawaiian Bottomfish Management Unit Species

P.I.: Mark A. Merrifield [JIMAR Project Lead: Haiyang Wang]

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

NOAA Sponsor: Samuel G. Pooley, 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

This JIMAR project conducted a comprehensive review of the following: 1) essential fish habitats (EFH) and habitat areas of particular concern (HAPC) definition requirements; 2) current EFH/HAPC definitions for the federal management unit species (MUS) in the Western Pacific Region (WPR), except for the MHI Bottomfish Management Unit Species (BMUS); and 3) new information relevant to federal MUS in the WPR. Most of the efforts are focused on identifying and summarizing new scientific literature, unpublished reports, unpublished data, and any other sources of information regarding critical life history stages, reproductive cycles, preferred habitats and movement patterns. The information will be provided to PIRO and the Western Pacific Regional

Fishery Management Council (WPRFMC) in detail for potential inclusion as addendums in the fishery ecosystem management plans.

Progress during FY 2012

The project has compiled a variety of studies pertaining to habitat use by pelagic and seamount species in the WPR, updated and refined the existing spatial references and potential boundaries of EFH and HAPC in WPR, and provided a final research report of the findings to the WPRFMC.

Sea Turtle Bycatch and Mitigation: Research and Development

P.I.: Mark A. Merrifield [JIMAR Project Lead: John Wang]

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

NOAA Sponsor: Samuel G. Pooley, Keith Bigelow

NOAA Goal(s)

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

Purpose of the Project

Fisheries bycatch has been implicated in the population declines of numerous marine megafauna species, including several species of sea turtles. Reducing the incidental and unwanted capture of sea turtles is a priority for the fishing industry, fisheries managers, and conservationists. As such, JIMAR research efforts are aimed to improve the selectivity of fishing gear worldwide, to decrease the overall interactions of sea turtle species, and to better understand the feeding ecology of these species. This project consisted of several objectives that include developing strategies to reduce sea turtle bycatch and improve target selectivity of various fisheries and to understand the energetics and habitat use of sea turtles.

Progress during FY 2012

During this past year, a variety of field trials were conducted with the aim of developing and testing technologies useful to reduce the bycatch and mortality rates of sea turtles interacting with a variety of fisheries. Experiments aimed at reducing the impact coastal gillnet fisheries have on sea turtles tested the use of UV illumination for nets. These studies found that UV illuminated nets had a 40% decrease in green sea turtle capture rates. When tested in commercial gillnet fisheries based in Bahia de los Angeles, Baja California Norte, the UV illuminated nets did not have an effect on the overall target catch rates or overall catch value. Analysis of the catch composition found that the experimental nets showed a 45% increase in California halibut, the primary target species, and a 30% decrease in overall elasmobranch bycatch, with a 55% decrease in scalloped hammerhead bycatch. This suggests that UV illuminated nets may also be a method of reducing scalloped hammerhead bycatch. The project also tested net illumination in two commercial gillnet fisheries. Experiments in a small scale gillnet fisheries based in Peru showed that green LED illuminated nets caught 43% less green sea turtles. Experiments conducted on the Mexican INAPESCA's research vessel, R/V UNICAP XVI, found that illuminated gillnets could reduce pacific loggerhead sea turtle bycatch by 57% during night time sets. When daytime control nets were compared to nighttime illuminated nets, the catch rates of loggerhead sea turtles decrease by 74%. In addition, experiments were conducted to develop technologies to reduce sea turtle mortality rates in the Japanese pound net fisheries. This resulted in four different pound net escape devices (PEDs)

Figure 1. Dr. John Wang working with Mexican fishermen to conduct trials examining the use of LED lightsticks to illuminate nets as a way to reduce sea turtle bycatch. Early results show that illuminating nets can reduce Pacific loggerhead sea turtle interactions with gillnets by 55%.

that were tested for turtle escape and fish retention. The designs showed a turtle escape of 80-100% and all PED designs showed 100% fish retention.

Research work to understand the energetic and habitat use of pelagic sea turtles included the collection and analysis of over 200 samples of sea nettles (*C. fuscescens*), purple stripe (*C. colorata*), egg-yolk (*Phacellophora camtshatica*), and moon jellies (Aurelia sp.) from the leatherback conservation area (central California) to determine their energy density (via bomb calorimetry analysis) and trophic status (compound specific nitrogen stable isotope analysis of amino acids (CSIA-AA)). Samples were collected and analyzed to determine variation in energy density and trophic status between and within seasons, with size (mass and bell diameter), and between species and body parts (e.g., bell, oral arms, and manubrium/stomach/gonads). Variation in energy densities was estimated using a hierarchical model. The energy density was highest for *C. fuscescens* (0.16 ± 0.02 kJ g-1 WM) and lowest for Aurelia sp. (0.08 ± 0.02 kJ g-1 WM). There was also variation in the body parts of the jellies with the stomach, manubrium, and gonads having the highest energy density and the bell the lowest.

Figure 2. Dr. John Wang releasing a Pacific loggerhead sea turtle after it had been caught in a coastal gillnet. Research with net illumination has shown that this method of fishing may reduce turtle bycatch without significantly affect target catch.

Interestingly, *C. fuscescens*, while having the highest energy density, was feeding at the lowest trophic position (TP_{AA}) based on CSIA-AA (TP_{AA} = 2.2 -2.7) compared with *P. camtshatica* (TP_{AA} = 2.9) and Aurelia sp. (TP_{AA} = 2.8-3.0). Adult leatherbacks, with maintenance costs of 2.2 x 104 kJ day-1, would need to consume 100 to 275 kg of sea jellies per day depending on prey items or 25% to 68% of their body mass in sea jellies daily to meet maintenance costs. These results provide a better understanding of leatherback biology, energetics, and trophic status, and further strengthen knowledge of the ecosystem roles of leatherbacks in the Pacific Ocean.

Social and Economic Analysis of Western Pacific Fisheries

P.I.: Mark A. Merrifield [JIMAR Project Lead: HingLing Chan]

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

NOAA Sponsor: Samuel G. Pooley, Justin Hospital

NOAA Goal(s)

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

Purpose of the Project

This JIMAR project intends to collect and analyze economic information relevant to current and upcoming fisheries management and marine ecosystem issues in the Western Pacific region. This project encompasses several types of activities and the specific research areas reflect recent developments in fisheries and marine ecosystem policy and management in the Western Pacific region including recent bigeye tuna closures in Hawaii. The project seeks a better understanding of the economic

Courtney Beavers and Kolter Kalberg presented posters at the first annual JIMAR Symposium entitled "The Main Hawaiian Islands bottomfish fishery: An overview of economic and social characteristics" and "The impacts of geographic and demographic on willingness to pay for seafood products- interaction analysis approach in conjoint study," respectively.

and social characteristics of the Hawaii bottomfish and for-hire (charter) fisheries. In addition, the project also examines the retailer pricing dynamics for Hawaii seafood markets and the social lifecycle of Hawaii fisheries.

Progress during FY 2012

Project research conducted and published on the Hawaii bigeye tuna, bottomfish and for-hire (charter) fisheries provides important economic and social baseline information on the implications of potential catch share management for these fisheries. Research results were presented in multiple formats; including peer-reviewed manuscripts, and symposium presentations. Brochures describing preliminary results provide important feedback to the fishing community, fishery managers, and stakeholder groups.

Ongoing efforts with draft manuscripts in progress include the retail pricing behavior, social lifecycle assessment, and impacts of the Hawaii bigeye tuna closure studies. The retail pricing manuscript is currently undergoing edits based on reviewer comments to improve the methodology. The social lifecycle project examined the life cycles of open ocean aquaculture in Hawaii versus wild-caught fishery production in terms of their "carbon footprint". Secondary data were collected and fed into a software program specifically for Social Lifecycle Assessment analyses. The results will be presented at the American Center for Life Cycle Assessment Conference in September 2012.

One project outlined in the proposal, *A Social Accounting Matrix Analysis of Catch Limits in the Hawaii Bottomfish Fishery*, was not completed. The reason for this setback was primarily logistical as a suitable candidate to conduct the research could not be identified. However, efforts completed during this year will allow this project to proceed at some time in the future if a suitable candidate can be identified.

Sustainable Fisheries Initiative

P.I.: Mark A. Merrifield [JIMAR Project Lead: Christopher Hawkins]

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

NOAA Sponsor: Michael Tosatto, Alvin Z. Katekaru

NOAA Goal(s)

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

Purpose of the Project

The project has two components: 1) to collect, compile and analyze social science data supporting regional federal fisheries policy-making per the Fishery Conservation and Management Act, the National Environmental Policy Act, and other federal statutes (social science); and 2) to further communication with stakeholders in the Region–including fishermen, the general public, non-government organizations and government agencies (outreach). In addition, within the Sustainable Fisheries Division (SFD), JIMAR staff addresses several individual NOAA fisheries initiatives in the Region. One of these in particular is the new NOAA Saltwater Recreational Fishery Management Agenda. Non-commercial fishing in the Pacific Islands is motivated by diverse social drivers and is conducted in a complex social context. SFD staff brings fisheries social science and outreach expertise to bear on these issues.

Progress during FY 2012

Science Component. The JIMAR/SFD Social Scientist accomplished the following.
• Incorporated potential social impacts to fishery participants and communities into nine fishery management plan amendments and associated documents (e.g., community development program proposals) per requirements of the FCMA and NEPA. As a result, the Western Pacific Regional Fishery Management Council and NOAA Fisheries were able to make better-informed policy choices and the documents more fully met required national standards for fishery policy-making.
• Served as official mentor to three NOAA Hollings Scholar undergraduate interns during the reporting period. These internships resulted in an internally-published document of contemporary social and economic portraits of all regional federal fisheries. A separate portrait of non-commercial fisheries in the Region and a report regarding social science research needs are being finalized.

• Addressed Goals 2 and 3 of the Regional Saltwater Recreational Action Agenda (Improve Recreational Catch, Effort, and Status Data; Improve Social and Economic Data on Recreational Fisheries.

• Traveled to Maui and the Big Island (Kona) and met with recreational fishermen regarding island-specific concerns.

• Assisted the SFD Assistant Regional Administrator, Alvin Katekaru, with all aspects of the first regional Recreational Fishing Summit (July 21-23, 2012) in Honolulu.

• Developed a mail survey of boat-based Hawaii recreational fishermen.

• Developed information regarding the flow of non-commercially caught fish through selected communities on the Big Island managed via a contract with a UH Hilo professor.

• Developed a portrait of historical and current information regarding the Hawaii charter fishing fleet via a contract with Impact Assessment, Inc.

• Presented social aspects of PIR's non-commercial fisheries to the 2011 American Fisheries Society conference in Seattle, WA.

• Developed a draft risk-based approach to fishery social assessments and delivered a presentation at the NOAA Social Coast Forum (Charleston, S.C., February 2012) regarding this effort.

• Co-established the new all-region

Figure 1. *The poster session at the Pacific Islands Recreational Fishing Mini-summit (July21-23, 2012). Posters were developed or supported by Melanie Jordan.*

Figure 2. *Christopher Hawkins co-facilitates a round table discussion at the Pacific Islands Recreational Fishing Mini-summit (July 21-23, 2012).*

NMFS/Fisheries Management Council (informal) Social Science Policy Group, whose members seek to learn from each other regarding efforts to integrate social science into federal fishery policy making.

• Provided social science guidance or draft comment response verbiage to other divisions as appropriate (e.g., Protected Resources Division's False Killer Whale listing document, PIR Observer Program's Fishery Observer survey).

• Incorporated social science-based policy information needs into the PIFSC Human Dimensions Research Program's (HDRP) ongoing activities. For example, brought together SFD policy analysts and an HDRP scientist to discuss an upcoming Science Center data collection in American Samoa.

• Developed, in collaboration with other SFD staff, the Hawaii Seafood Dealers and Processors report documenting the universe of seafood dealers and process in Hawaii for use in policy formulation and communication;

• Co-developed an analysis of the impacts of the 2009 tsunami in American Samoa, which was used by the Regional Administrator and the Secretary of Commerce in decision-making regarding determining a commercial fishery failure per the FCMA. This effort was publicly recognized at a PIRO All Hands meeting in February 2012.

Outreach Component. The JIMAR/SFD Outreach and Education Specialist accomplished the following.

• Design and production of: 1) *Sharks of the Marianas Archipelago*, a 25-page booklet developed to help fishermen identify the different species of sharks that are found in waters near CNMI and Guam, and background information about the sharks such as age at maturity, size, life history, stock info, characteristics, and their importance to fisheries; 2) *Island Fishing: What's the Catch*, an informative brochure about the most common offshore pelagic

species that are landed by charter fishermen; 3) *Input from Hawaii's Registered Boaters*, a mail survey of boat-based Hawaii recreational fishermen; 4) cover and page set-up of *Fisheries of the Pacific Islands Region: A contemporary social perspective and annotated bibliography of relevant literature*, an internal report prepared by NOAA Hollings Scholar undergraduate interns; 5) cover and page layout of *Seafood Dealer Inventory: A Project to Identify Seafood Buyers, Sellers, and Processors in the State of Hawaii*; 6) cover of *2012 Annual Report: Seabird Interactions and Mitigation Efforts in the Hawaii Longline Fisheries*; and 7) cover of *Socio-Economic Review of the Hawaii Charter Fishing Industry*.

• Developed and edited text and graphics regarding federal fishing permits, recreational fishing, regional fishery policies and management activities, and annual catch limits web pages and managed web content for the Sustainable Fisheries website.

• Designed several ads that were published in *Hawaii Fishing News* between November 2011-September 2012.

• Researched and acquired new stock images for the Sustainable Fisheries photo library.

• Developed an internal report as a result of a trip with other PIRO outreach staff to visit several science and marine-related museums in the San Francisco area. This report addresses how science can be more effectively communicated and how outreach activities can utilize new technologies.

• Developed presentations and displays for various outreach events for and in collaboration with Sustainable Fisheries Division.

• Developed visuals for event displays and game activities used at the Honolulu Seafood and Fishing Festival, October 2012.

• Developed visuals for event displays and game activities used at the 2012 Ocean Expo.

• Developed approximately 25 posters for display at the Recreational Fishing Summit (July 21-23, 2012) in Honolulu, as well as event signage and Summit program.

Third International Conference on Acoustic Communication by Animals

P.I.: Whitlow Au

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

NOAA Sponsor: Jason Gedamke

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 purpose of this conference is to bring together biologists, engineers, and other scientists from various fields to discuss the field of acoustic communication by animals. Secondary goals of this conference are to: 1) encourage discussion among experts in acoustic communication of different species; 2) promote networking between attendees with background in the physical and biological aspects of acoustical communication; 3) introduce new techniques and equipment in this rapidly emerging field from developers of software products, equipment and other emergent tools; and 4) to facilitate communications among scientists and engineers from various organizations and countries which work on various aspects of acoustic communication of animals and improving the understanding of basic acoustics, especially as it relates to animal communication.

Progress during FY 2012

The Third International Conference on Acoustic Communication by Animals was held August 1-5, 2011, at Cornell University in Ithaca, New York. One hundred and thirty one people attended of which 40% consisted of student participation. Conference participants came from 27 U.S. states, Canada, Mexico and 12 other countries, including those in Europe, South America, Australia and the Middle East. There were twenty participants representing the host institution, Cornell University.

A total of 96 oral and poster presentations were given. The keynote speaker was Dr. Peter Narins (UCLA Department of Integrative Biology & Physiology), whose address entitled "Building on Darwin's Legacy: Environmental Influences on the Evolution of Communication Systems" was enthusiastically received. Topics covered during the conference included: cognition/language, song and call classification, rule learning, acoustic

ecology, communication in noisy environments, environmental noise impacts, development and evolution of animal communication, and methodology for measuring and analyzing complex animal sounds, including new equipment and software. All sessions were plenary and were loosely organized by ideas and concepts rather than by animal groups.

Most conference events were held at the Statler Hotel and Conference Center on the Cornell University campus. One event consisted of a tour of the Cornell Lab of Ornithology. The tour focused particularly on the Bioacoustics Research Program and the Macaulay Library, the world's leading scientific collection of biodiversity media. The main conference was preceded on the opening day by a four-hour optional workshop in Acoustic Ecology, hosted by the Cornell Bioacoustics Research Program, and held at the Cornell Lab of Ornithology.

Western Pacific Fishery Information Network Project (WPacFIN)

P.I.: Mark A. Merrifield [JIMAR Project Lead: Dios Gonzales]

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

NOAA Sponsor: Samuel G. Pooley, Kimberly Lowe

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 JIMAR project is to ensure that local fisheries resource managers in the Pacific Region have the most accurate and complete dataset to address data needs to protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management for the long term sustainability of marine resource. This is obtained by WPacFIN continuing and expanding technical and operational support to participating fisheries agencies enabling them to produce timely reports and summaries of the best available fisheries data from each of their island areas. Participating agencies from each island area include the American Samoa Department of Marine and Wildlife Resources (DMWR); the Hawaii Division of Aquatic Resources (DAR); the Guam Division of Aquatic and Wildlife Resources (DAWR); and the Commonwealth of the Northern Mariana Islands (CNMI) Division of Fish and Wildlife (DFW). Two popular projects for which JIMAR WPacFIN staff currently provide technical support are the Main Hawaiian Islands (MHI) Deep 7 Bottomfish Fast Track Project and the Western Pacific Region's Commercial Fisheries Bio-Sampling (CFBS) program.

Progress during FY 2012

WPacFIN staff has made continual improvements to the CFBS program over the past year, which have made this data system even more statistically robust and added many convenient features and report generators which allow the user to quickly display summaries of length-frequency data, length-weight regressions and catches sampled by area and fishery. Throughout the region, this effort is increasingly integrated with the existing boat-based and shore-based creel survey data systems that have been supported by the WPacFIN Program for decades. This year, WPacFIN's JIMAR staff has successfully integrated American Samoa CFBS data with boat-based creel survey data, making it possible to improve the accuracy of the species-level breakdown in expanded catch estimates. Integrating the American Samoa CFBS data with the shore-based creel survey data was not successful because the current level of specification of fishing area between the two datasets does not share sufficient commonality to be reliably linked. Additional joint planning of CFBS and shore-based creel survey design will be needed to make it feasible to integrate these datasets.

Michael Quach and Ray Roberto with CNMI staff entering creel survey data.

WPacFIN staff made significant progress migrating existing databases from all island areas to MySQL and Oracle databases and successfully migrated two Visual-FoxPro-generated Fishery Statistics of the Western Pacific (FSWP) and Fisheries of the United States (FUS) reports to Visual C#. The program successfully implemented the use of an online data collection form for the new Aquarium Report for DAR. In addition, staff revised and implemented data support for new interview forms for American Samoa, Guam and CNMI, which now include economic data collection.

WPacFIN staff participated effectively in a Pacific Fisheries Science Center and Southwest Fisheries Science Center "Value Stream Mapping" effort. The group conducted joint planning on how to more efficiently provide highly migratory species data on pelagic species, such as tunas and billfishes to the Western Pacific Fisheries Commission. WPacFIN plays a vital role in this effort to monitor US fisheries harvest of species such as bigeye and yellowfin tuna, for which international quotas exist.

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.

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

P.I.: Mark A. Merrifield [JIMAR Project Lead: Lucas Moxey]

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

NOAA Sponsor: Samuel G. Pooley, 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 NOAA OceanWatch-Central Pacific node supplies near-real time, remotely sensed oceanographic and environmental data for the entire Pacific-based communities, including resource managers, researchers, educators and the general public; JIMAR staff play a key role in this work. The satellite-derived products include ocean surface temperature, ocean color, ocean surface topography, ocean surface wind fields, environmental indicators (Empirical Orthogonal Functions–EOFs), and high-resolution (1.1 km) thermal infrared High Resolution Picture Transmission (HRPT) imagery from the NOAA AVHRR satellites. The HRPT data is collected daily by the AVHRR receiving station located in Ewa Beach, Oahu (Hawaii).

Progress during FY 2012

During FY 2012, the Ocean Remote Sensing (ORS) project completed all the objectives it had established during FY2011, and also completed additional relevant projects. ORS supported users from Hawaii, the Pacific-rim and from around the globe by providing satellite remotely-sensed data and products. In an effort to accommodate for the addition of new products, the OceanWatch website has been updated, including the updating of the entire dataset holdings descriptions. Other updates and improvements were also conducted on the Live Access Server (LAS) and THREDDS data servers in order to enable greater connectivity and data access customizations for PacIOOS/HiOOS. During FY 2012, JIMAR staff in ORS also implemented the reprocessing of the AVISO sea-level height dataset to incorporate the most updated data available and improve the near-shore sea-surface height measurements. Additionally, ORS also incorporated the Cross-Calibrated Multi-Platform Ocean Surface Wind dataset into the development LAS that includes global monthly data for the period 1987–2010 (Figure 1). As
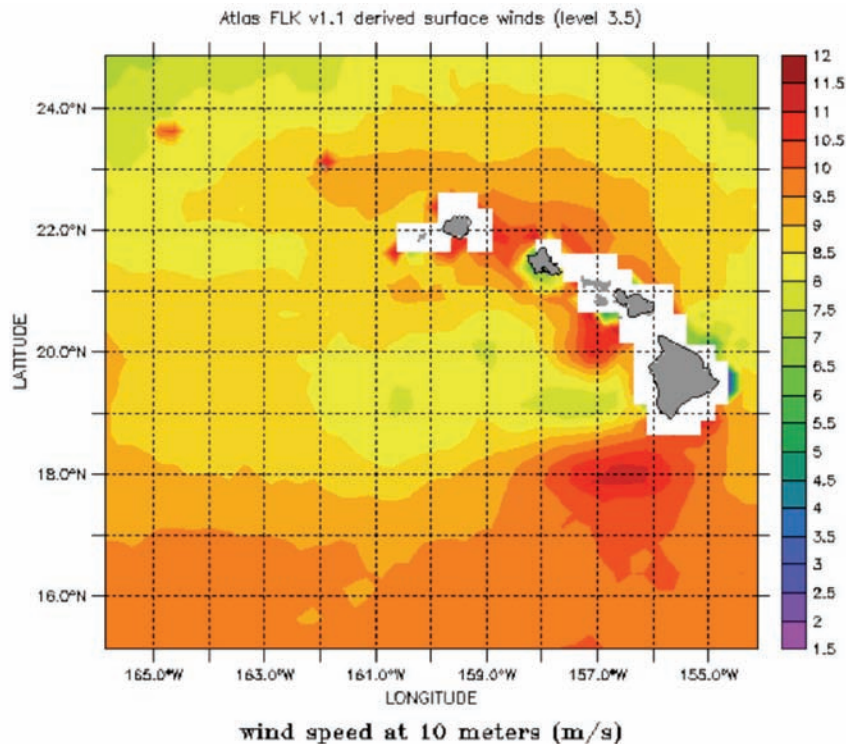
Figure 1. Example of Cross-Calibrated Multi-Platform (CCMP) Ocean Surface Wind of data for March 2011.
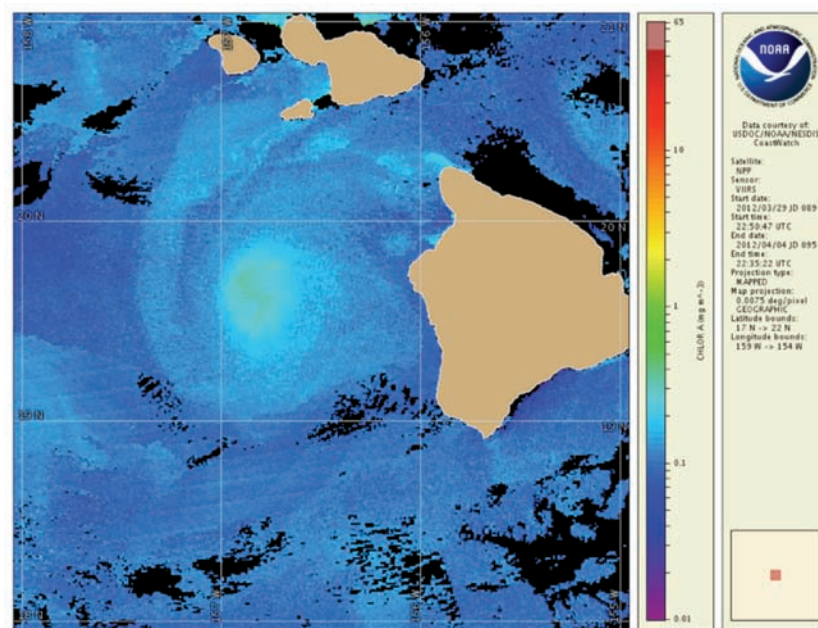
Figure 2. Preliminary ocean color data from the newly launched NPP VIIRS satellite sensor showing evidence of localized upwelling off the Kona coast (Hawai`i).

part of a collaborative effort with PIFSC Coral Reef Ecosystem Division (CRED), ORS provided customized satellite remote sensing products (e.g.: Photosynthetically Available Radiation, ocean surface winds, and sea-surface height) in support of the multinational Coral Triangle Initiative Consortium in SE Asia.

During the reporting period, ORS worked with the NOAA PIFSC ITS team to design and coordinate a server cloud configuration and implementation with the objective of furthering the efficiency and maximizing

the capacity of the currently existing hardware resources for large-scale data remote sensing management and processing. Additional efforts conducted by ORS included the co-organization (along with Jeffrey Polovina and Kyle Higa) and hosting of the 2012 NOAA CoastWatch Node Managers Meeting in Kailua-Kona. Additionally, various outreach and education projects were conducted, including the collaboration with the University of Hawaii GEAR UP program for engaging local high school students in the field of Science, Technology, Education, and Math (STEM) through technical hands-on activities and projects. Lastly, ORS also partnered with the Western Pacific Regional Fishery Management Council for developing and leading a series of teacher workshops and presentations in concert with the WPRFMC 156th meetings in Saipan and Guam.

Coral Reef Management Initiative

P.I.: Mark A. Merrifield [JIMAR Project Lead: Kimberly Maison]

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

NOAA Sponsor: Robert Schroeder

NOAA Goal(s)

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

Purpose of the Project

The purpose of this project is to enhance the management of coral reef and protected resources throughout the US Pacific Islands. One of the objectives, via support of the Coral Reef Ecologist position in the PIRO Habitat Conservation Division is to contribute to coral reef protection through regulation of impacts to coral reefs across the U.S. Pacific Islands via implementation of various federal mandates.

Progress during FY 2012

The first objective, to protect coral reefs, was met by conducting several hundred Essential Fish Habitat and Fish and Wildlife Coordination Act consultations, which involved providing technical advice and conservation recommendations on a range of monitoring protocols and mitigation plans for proposed Army Corp actions. Additional activities related to this and other objectives include those of the Outreach and Education Specialist and Climate Change Point of Contact. The project also supported attendance of technical representations to U.S. Coral Reef Task Force Meetings, with goals to promote conservation or coral reef habitat.

The Outreach and Education Specialist (OES) conducted a variety of activities related to coral reef conservation and on the petition received by PIRO to list 83 species of coral under the Endangered Species Act. The OES worked with PIRO staff in developing and disseminating outreach messages and materials regarding coral and coral conservation at the Hawaii Conservation Conference in Honolulu in July 2012. She also participated in a week-long teacher training regarding coral reef science education at the Hawaii Institute of Marine Biology in 2012. The JIMAR OES developed draft content for NOAA websites related to the coral petition, and was otherwise available to provide advice and input to PIRO staff on coral-related outreach and education.

The JIMAR Climate Change point of contact (CC POC) at PIRO collects and disseminates the latest climate change science to PIRO employees and fulfills requests for related information at higher levels. The CC POC drafted summaries of climate change impacts on corals and of global efforts to reduce greenhouse gas emissions for multiple documents related to the status review for 82 species of coral being conducted by the PIRO Protected Resources Division. She has attended numerous webinars on climate change and related impacts on marine biodiversity including corals. In response to a petition to list 83 species of coral she also co-presented a webinar on how climate change is influencing the decision making process. The CC POC attends steering committee meetings for the Pacific Islands Climate Change Cooperative and the Pacific Climate Science Center to exchange knowledge and information between these entities and PIRO that relates to coral reef health and management in the face of climate change.

National Environmental Policy Act (NEPA) Initiative

P.I.: Mark A. Merrifield [JIMAR Project Lead: Karen Frutchey]

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

NOAA Sponsor: Michael Tosatto, Charles Karnella

NOAA Goal(s)

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

Purpose of the Project

Under the Federal National Environmental Policy Act (NEPA), federal agencies must insure that environmental information is made available to public officials and citizens before decisions are made and actions are taken. The purpose is to promote management and policy decisions that will prevent or eliminate damage to the environment, stimulate health and welfare of humans, and enrich understanding of ecological systems and natural resources important to the nation. The major focus of this initiative is to obtain technical assistance on an activity- and project-specific basis to ensure timely and legally sufficient agency compliance with applicable NEPA requirements. The initiative addresses NOAA Fisheries' NEPA compliance with international treaties as well as fostered international marine resource conservation measures. While NOAA Fisheries has addressed NEPA compliance associated with federal activities (i.e., development of fishery management plans) in the past, this NEPA initiative represents a holistic effort to foster compliance with NEPA in international projects. Information and lessons learned from this NEPA initiative will be evaluated and applied to future NEPA actions. NEPA-focused hires under this initiative will closely coordinate and collaborate with several existing organizations with marine resource protection mandates. These include, but are not limited to: NOAA Pacific Islands Region Fisheries Science Center, NOAA National Ocean Service, NOAA and NOAA Fisheries headquarters components, and the Western Pacific Regional Fishery Management Council.

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

Progress during FY 2012

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

In the last fiscal year, project staff continued work on two Environmental Assessments (EAs), for the implementation of the decisions of the Sixth Regular Annual Session of the WCPFC and for the Seventh Regular Annual Session of the WCPFC. One of these EAs was published for public review and comment in February 2012. A new EA, which supplemented an EA prepared under this initiative in 2009, was developed. This new EA analyzed the implementation of a decision–a 2012 bigeye tuna catch limit–of the Eighth Regular Annual Session of the WCPFC. It is anticipated that all of these EAs will be completed in the next fiscal year. Preliminary research regarding appropriate NEPA analysis was also conducted to prepare for the implementation of the anticipated decisions of the Ninth Regular Annual Session of the WCPFC, which will be held in December 2012.

Sustaining Healthy Coastal Ecosystems

P.I.: Mark A. Merrifield [JIMAR Project Leads: Annette DesRochers, Jamie Gove, Kyle Koyanagi, John Rooney, Bernardo Vargas-Angel, Jill Zamzow]

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

NOAA Sponsor: Samuel G. Pooley, Russell Brainard

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 JIMAR Sustaining Healthy Coastal Ecosystems project mission is to provide sound science to enable informed and effective implementation of ecosystem-based management and conservation strategies for coral reef ecosystems of the U.S.-affiliated Pacific Islands Region. To accomplish this mission, project scientists lead and participate in a multi-partner, integrated, interdisciplinary program of ecosystem assessment and long-term monitoring, benthic habitat mapping, and applied research on the coral reef ecosystems of 40 primary islands and atolls in the Hawaiian Archipelago, the Mariana Archipelago (Guam and the Commonwealth of the Northern Mariana Islands), American Samoa, and the Pacific Remote Island Areas (PRIA). This work supports NOAA and other agencies in meeting mandates of the Coral Reef Conservation Act of 2000 and various executive orders issued to ensure conservation and protection of the nation's coral reef ecosystems.

Progress during FY 2012

The tasks and accomplishments of the Benthic Habitat Research Team are as follows.

- *Pacific RAMP*. In a continuation of decade-long monitoring of coral reef ecosystem health in the U.S. Pacific Islands, interdisciplinary Pacific Reef Assessment and Monitoring Program (RAMP) cruises were conducted aboard the NOAA Ship *Hi'ialakai* around the islands and banks of the Pacific Remote Island Areas (PRIA; Johnston Atoll, Howland Is, Baker Is, Jarvis Is, Palmyra Atoll, Kingman Reef) and the American Samoa Archipelago. Scientists from NOAA Coral Reef Ecosystem Division (CRED), JIMAR, and partner agencies conducted integrated assessments and monitoring of fish, corals, algae, and invertebrates and collected a variety of oceanographic and water-quality observations. The *Hi'ialakai* left Honolulu en route to Johnston Atoll and the Phoenix Islands on February 27, 2012, and JIMAR scientists closely examined the reefs around Howland and Baker Islands for signs of recovery/change after the mass bleaching event documented during the prior RAMP expedition in 2010. A reduction in the levels of turf algae concomitant with an increase in the cover of the anthozoan *Rhodactis* was particularly evident at Howland. Around the American Samoa and the Line Islands the majority of benthic surveys revealed reef conditions similar to those reported during surveys in previous years. Notwithstanding, a remarkable reduction in levels of cyano-bacteria and an observable increase in encrusting coralline algal cover were noted at a shipwreck site (ROS-07), compared to surveys conducted between 2006 and 2010. JIMAR scientist also collected quantitative biological data along Kingman Reef's NE backreef, aimed at monitoring the effects of a shipwreck occurred in 2008.
- In support of CRED's ocean acidification research, JIMAR scientists collected coral cores and tissue from *Porites sp.* at select sites in the Phoenix and Line Islands to develop historical, skeletal extension (annual growth) rate and calcification rate chronologies, and gain insight into the energetic status of sampled corals. JIMAR scientists also recovered 370 Calcification Acidification Units (CAUs) previously deployed during the 2010 RAMP expedition, at 78 sites around 11 islands and atolls, to generate a comprehensive baseline assessment of net reef calcification and accretion rates Pacific-wide. Personnel from partner agencies including, NOAA Southeast Fisheries Science Center, Fagatele Bay National Marine Sanctuary, Papahanaumokuakea Marine National Monument, U.S. Fish and Wildlife Service, University of Hawaii, and San Diego State University, participated in the RAMP operations on all three legs of the cruise. Additionally, over 130 students, guests, and jurisdictional partners visited and toured the *Hi'ialakai* during the education and outreach activities held as part of ASRAMP 2012 in Tutuila.
- Results from the 2012 cruises to American Samoa and the PRIA were summarized in three cruise reports. Previous American Samoa RAMP surveys were summarized in a booklet (Coral Reef Ecosystems of the American
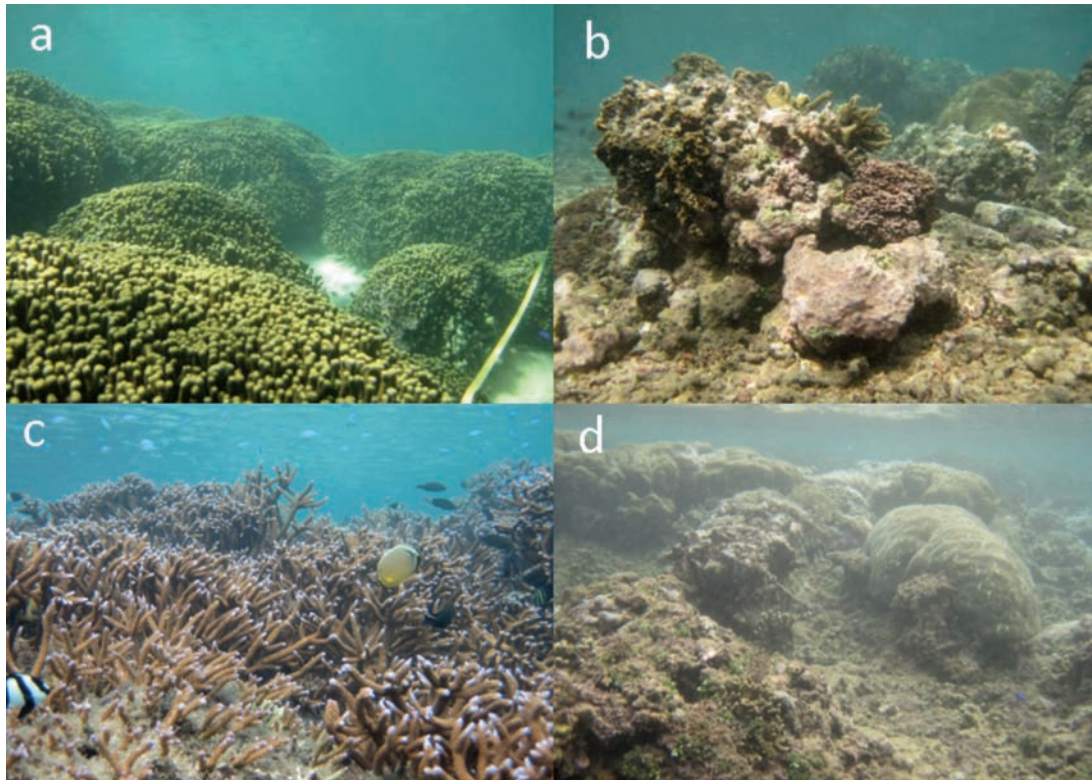
Figure 1. Coral communities at Faga'alu Bay, American Samoa. High coral cover carpets dominated by thickets of branching Porites and Acropora (a, c), contrasted to the sediment impacted and coral-poor north reef dominated by rubble and turf algae. (b, d).

Samoa: 2002-2010 Overview), which was released and distributed to Jurisdictional partners at the American Samoa Coral Reef Advisory Group meeting in Pago Pago on March 26, 2012. Additionally some important publications resulting from the RAMP data include: "Assessing Coral Reefs on a Pacific-Wide Scale Using the Microbialization Score" published in a 2012; and another major paper describing disease prevalence worldwide published on Diseases of aquatic Organisms.

• The *Coral Reef Ecosystem Monitoring Report for the Mariana Archipelago: 2003-2007* was released in March of 2012. This 1000+ page report provides a comprehensive integrated ecosystem assessment of the coral reefs of the Mariana Archipelago from Pacific RAMP surveys conducted in 2003, 2005, and 2007.

• JIMAR scientists conducted focused benthic surveys in areas of special interest around Tutuila. Surveys for percent benthic cover, diversity, colony densities, and coral condition were conducted in March and August 2012 at 40 sites in Faga'alu Bay. These surveys are part of a larger project lead by JIMAR scientists aimed at understanding water flow dynamics and sedimentation effects to coral colonies in the Bay. The coral reef in this area is severely affected by siltation stress, due to excessive terrigenous runoff resulting from prolonged, deficient land use practices within the boundaries of the adjacent watershed. By conducting these surveys JIMAR coral scientists are providing critical, baseline information to local and Federal managers to evaluate the effectiveness of reef-to-ridge management practices aimed at reducing land-based sources of pollution in Faga'alu Bay.

The tasks and accomplishments of the Reef Fish Team are as follows.

• The Coral Reef Fish Research Team met all established objectives for FY 2012, including but not limited to: successful completion of ASRAMP 2012 and SE-12-07 cruises, an interactive product for American Samoa stemming from ASRAMP 2012 data, a two-page data product for the Puako region of the island of Hawaii generated from long-term datasets, metadata records for the Kahekili herbivore fisheries management area on Maui, fulfillment of hundreds of data analysis requests from the Hawaii Division of Aquatic Resources and tens of data requests from other interested parties, a two page, R-script-generated data product stemming from the SE-12-07 annual catch limit cruise, size-estimation and species identification training of ten partner divers for use as fish surveyors on cruises.

The tasks and accomplishments of the Benthic Mapping Team are as follows.

• The project continues in the collection, processing, and dissemination of acoustic and optical benthic habitat mapping data products in the region to fill needs for spatial data. This includes coastal and marine spatial planning, and any resource management activity that includes a spatial component and requires data on where the resources are located in order to be both effective and efficient at achieving desired outcomes. Primary focuses of the project in FY 2012 included filling gaps in existing maps to make seamless benthic habitat map layers that extend from the shoreline to the outer edge of coral reef ecosystems, and improving understanding of the range, extent and location of coral reef resources.

• A wide variety of benthic habitats mapping tasks were proposed by the project in FY 2012. These include: 1) a suite of tasks related to the publication and distribution of Kaneohe Bay multibeam data; 2) multibeam surveying off Oahu in attempt to acoustically identify high densities of the invasively behaving alga *Avrainvillea amadelpha*; 3) completion of two cruises using an Autonomous Underwater Vehicle (AUV) as a fisheries-independent method for stock assessment; 4) conducting multibeam surveying around the island of Hawaii; 5) conducting a size class analysis of mesophotic corals found off Maui; 6) conducting a mapping project off Saipan; 7) deriving seafloor depths off the island of Rota

Figure 2. Oceanographer Chip Young conducts a coral coring operation at Kingman Reef. Coral cores provide important information related to historical coral health and coral growth rates.

using WorldView-2 satellite imagery; 8) preparing a presentation for the International Coral Reef Symposium; and 9) re-working multibeam data from the Northwestern Hawaiian Islands to highlight ledges between 30-85 m depths.

• All proposed mapping tasks were completed except for the Saipan project, for which funding was not received. Also, funding was only received to extract near shore bathymetry from half of the island of Rota. Of particular note were projects to conduct multibeam surveying in the main Hawaiian Islands. Nearshore gaps in coverage exist around most of the islands and not having complete data layers makes use of the data that do exist problematic for some purposes. The project's survey launch R/V AHI was shipped to Kawaihae on the island of Hawaii. Three weeks of surveying were conducted along the northwestern coast of the island, to fill in gaps in existing bathymetry coverage using a multibeam echosounder, and to characterize the benthic substrates and communities found there using a camera sled. Another objective was to complete two cruises using an AUV to survey fish communities. The AUV was used off Maui to survey bottomfish on one cruise, and to survey deeper reef fish in another off the island of Tutuila in American Samoa.

The tasks and accomplishments of the Marine Debris Team are as follows.

• Continuing annual efforts, begun in 1996, to identify and remove marine debris from the Papahanaumokuakea Marine National Monument in the Northwestern Hawaiian Islands (NWHI), JIMAR staff from the Coral Reef Ecosystem Division (CRED) completed two marine debris survey and removal operations in Summer 2012 (late May through mid-July): a 27 day shore-based operation at Midway Atoll; and a 30 day ship-based joint operation aboard the NOAA Ship *Oscar Elton Sette* which combined JIMAR's Protected Species camp deployments with the marine debris removal operations. As part of the 2012 mission, the CRED Marine Debris Team conducted

Figure 3. Survey launch R/V AHI *at its berth in Kawaihae Harbor, prior to a day of multibeam surveying along the northwestern coastline of the island of Hawaii.*

extensive surveys on Midway Atoll looking for debris related to the 2011 Japan tsunami event. Though no debris was found with an obvious connection to the tsunami, the Marine Debris Team successfully completed surveys and debris removals in all high density areas along the shorelines and fringing reefs of Midway Atoll. A total of nearly 53 metric tons of marine debris, primarily derelict fishing gear and plastics, was removed during this year's efforts at Midway, Kure, and Pearl and Hermes Atolls, Lisianski and Laysan Islands, and French Frigate Shoals. The Marine Debris Project continues to receive both national and international recognition with the removal of over 754 metric tons of marine debris from the NWHI since 1996. In addition, JIMAR staff also participated in the Japan Tsunami Marine Debris Assessment and Response Framework Workshop, participated on the NWHI and Main Hawaiian Islands Subject Matter Expert Groups, and conducted seven marine debris education/outreach events and presentations.

The tasks and accomplishments of the Oceanographic Research Team are as follows.

• At the request of the U.S. Fish and Wildlife Service (USFWS), the benthic team quantitatively surveyed the shipwreck at Kingman Reef during cruise HA1201 Leg IV. Since running aground in 2009, metal parts and debris from the teak fishing vessel have spread from Kingman's forereef to the internal lagoon, negatively impacting the marine community. The reef in this area was originally surveyed in December 2009 by USFWS, and again in 2010 by CRED Pacific RAMP. In both instances, the surveys were qualitative. In 2010, CRED reported that cyanobacteria, an invasive and toxic bacteria, and *Rhodactis* sp., an invasive corallimorph (*Rhodactis* sp.) known to cause coral mortality, were generally absent along the reef crest but that a cyanobacteria bloom was observed in the lagoon, extending from 5-25 m water depth. Preliminary results from the 2012 survey reveal cyanobacteria representing the highest percent cover (54.4%) of the benthic community, while hard coral was only 7.6%. Visual observations indicated high percent cover of *Rhodactis sp.* in the shallower reef crest of this site and cyanobacteria exhibiting increased dominance at ~10 m. In addition, towed-divers noted several portions of the shipwreck (metal decking, timbers, fiberglass, pipe work, etc.) were present in the area with the highest cyanobacteria cover (~75%). The USFWS has received funding to remove the shipwreck in 2013.

• To further scientific understanding of ocean acidification, JIMAR's Oceanography Research Team implemented a new coral coring technique that will provide pertinent information related to coral health extending 50–100

Figure 4. The FY2012 JIMAR Marine Debris Team aboard the NOAA Ship Oscar Elton Sette*.*

years back in time. In collaboration with Woods Hole Oceanographic Institution (WHOI), coral core analysis is conducted by employing a non-destructive, high resolution CT scan technique that provides an accurate assessment of historical coral growth and calcification rates. With this information, JIMAR researchers can assess corals' response to past environmental conditions and longer-term climatic forcing mechanisms such as the El Nino Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO), providing context for the future of corals in a highly variable and changing climate.

The tasks and accomplishments of the Information Services Team are as follows.

• In FY 2012, the JIMAR Information Services Team, including Data Management, GIS, and Information Products, provided technical expertise to support several of the CRED and/or PIFSC's projects and initiatives. The team's contributions to those projects are summarized here.

• *Pacific RAMP*. A data manager was provided to staff the 3-month Pacific RAMP cruise to the PRIA and American Samoa (cruise number HA1201) and data management support was provided at the start and end of the cruise. The data collected from the 2011 Pacific RAMP missions to Wake Island and the Marianas Archipelago (HA1101) and Papahanaumokuākea Marine National Monument's cruise to the Northwestern Hawaiian Islands (HA1103) were processed and migrated into the Division's master database, and metadata records for HA1101 were also generated and submitted to the NOAA Coral Reef Information System (CoRIS).

Significant contributions were also made to the management and development of the reports produced for the Territory of American Samoa and the Marianas Archipelago that were released in FY 2012. In particular, data management played a key role in the development and implementation of a new process to manage the data resulting from the Division-wide effort to analyze benthic images, the findings of which were included in the publication for American Samoa. Following the release of the overview report for American Samoa, development began on an outreach and education flyer to foster support for management of large-bodied fish.

• *Marine Debris*. In cooperation with the JIMAR Marine Debris Team, a pamphlet, *Removing Marine Debris,* was developed and a data manager was also provided to prepare for and staff the Marine Debris Removal Operation in

the Northwestern Hawaiian Islands during the summer 2012.

• *Petition to list coral species under the Endangered Species Act (ESA).* In cooperation with the Biological Review Team (BRT), the approximately 600 page *Status Review Report of 82 Candidate Coral Species Petitioned Under the U.S. Endangered Species Act* was developed and completed (NOAA Technical Memorandum, NMFS-PIFSC-27) in September 2011 and released to the public in April 2012. A manuscript for publication to the journal *Conservation Biology* was also submitted in April 2012. In addition, logistical support was provided for the NOAA Pacific Islands Coral Listing Science Workshop that took place in June 2012, and a summary report was written following the workshop that was finalized in July 2012.

• *Habitat Blueprint.* To support the Pacific Islands Habitat Blueprint Regional Initiative, an Ecopath model was developed to characterize trophic structures and energy flows in coral reef systems, the results of which are intended to feed into the planned Atlantis Ecosystem Model for the coral reef ecosystems around Guam. In addition, the data management support was provided for the benthic image analysis effort for Guam.

• *Fishery Bulletin.* In April, the team's technical editor transitioned to the position of associate editor of the quarterly *Fishery Bulletin*, the oldest and one of the finest fisheries journals in the world. During FY 2012, 4 of 7 papers were edited for the July 2012 issue, *Fish Bull.* Vol. 110, No. 3, and one additional paper was edited in June.

• *CRED Website Revamp.* Working with

Figure 5. The JIMAR Marine Debris Team works to haul derelict fishing debris onto a small boat.

team representatives, the content for the CRED website was reviewed and updated materials were compiled and are planned to be provided to the PIFSC web master for incorporation into the evolving PIFSC web page templates in FY 2013.

• *Editorial review.* Several editorial reviews for the Division were conducted including three PIFSC quarterly reports, two PIFSC Internal Reports, two cruise/mission reports, 24+ abstracts, one manuscript, and one NOAA Tech Memo paper.

• *Coral Triangle Initiative (CTI).* In cooperation with the oceanography team and CTI partners, satellite-derived climatologies of key ocean surface properties were developed for the Coral Triangle region, including sea surface temperature, chlorophyll-*a*, irradiance, ocean surface currents, night lights, and winds, and assistance was provided to incorporate these environmental data into the Coral Triangle Atlas. Data management support was also provided for the March 2012 mission that took place in the Verde Island Passage, Philippines, in the Coral Triangle region, and for the development of figures, supplemental materials, and presentations for various purposes.

• *Worldview-2 (WV-2).* In cooperation with the Mapping team, a method originally developed for deriving nearshore depths from Ikonos satellite imagery for use with WV-2 imagery was adapted, and development of a report describing this process was initiated with the intent for it to be published as a NOAA Technical Memorandum

Figure 6. A JIMAR diver works to cut a marine turtle free of derelict fishing gear during the FY2012 marine debris removal operation.

in FY 2013. This method is intended to be widely used in the Pacific Islands Region to provide high-resolution bathymetry data.

• *Expanded Benthic Surveys.* The team provided support in preparation for the two rounds of surveys at Tutuila, and also processed/migrated the data collected into CRED's master database.

• *Pacific Islands Data Documentation Project.* The team participated in the Pacific Islands Data Documentation Workshop in October 2011, and contributed to the development of the Pacific Islands Data Documentation Implementation Plan (first draft December 2011) and coordinated preliminary implementation of the Plan within CRED. The Plan describes how the Pacific Islands region will meet the requirements of the NMFS Data Documentation Procedural Directive.

• *Guam Coastal Management Program (GCMP) Data Management Initiative.* To support Guam's long-term Coral Reef Monitoring Program, a relational data model for the existing benthic data that has been collected by the GCMP has been designed, and development of a web-based data entry interface has been initiated. The final deliverables to Guam for this project are due in FY 2013.

• *PIFSC System Upgrades.* JIMAR provided support for the upgrade of the Oracle database to Oracle 11g, and the GIS team supported the ongoing upgrade of ArcGIS Server to version 10.1, which as of Oct 2012 was still in progress.

• *Integrated Ocean Observing System (IOOS) Biological Observations Data Project.* In cooperation with the JIMAR Fish Research Team, IOOS, OBIS-USA, PacIOOS, and other external partners, a pilot project aimed at addressing the Data Management and Communications (DMAC) requirements that pertain to standards and interoperability of marine biological observations collected by various ocean observing systems was completed in September 2011. As a result of this project, an informatics framework was developed for the representation and integration of diver-based observations of coral reef fishes collected by the Division, the National Park Service, and Papahanaumokuakea Marine National Monument.

• *Reef Box*. While CRED's new online data dissemination tool was not officially released in FY 2012 as originally planned, significant enhancements to the underlying data products, the user interface, and to the 'behind the scenes' functionality were made to the now named "Reef Box" web-based application. In addition, the Data Documentation Module, a new tool designed to document all elements in the Division's Oracle database and to enable the accessibility of that information via a web service, was developed and preliminary implemented in the Reef Box application.

• *National Data Buoy Center*. A connection to the National Data Buoy Center to serve CRED's telemetered sea surface temperature data in near real-time through a web service was successfully established. It should be noted that in September 2012 CRED decided that it would no longer provide the near-real-time data from their SST buoys due to funding constraints.

In FY 2012, Information Services participated in or contributed to several workshops and meetings in addition to those already mentioned. The GIS team prepared activities for and volunteered at HIGICC's GIS Day 2011 at the Bishop Museum in December. In January, data management participated in the PIFSC Data Management Strategic Planning 3-day Workshop, sponsored by NOAA Fisheries Information System and coordinated by the PIFSC Data Management Steering Committee, and contributed to several activities initiated as a result of the workshop including finalizing the Committee's Terms of Reference. In May, data management gave a presentation entitled *Disseminating Data from an Integrated Ecosystem Monitoring Program* in the *Improving and integrating biological and chemical information across NOAA in ways for useful decision making* session at the 3rd Annual NOAA Environmental Data Management Conference in Silver Spring, MD.

JIMAR Publications

Author(s) Names	Publication Date	Title	Published In (Journal Name, volume and page number)	Type of Publication	Citation No. or Hyperlink	Project Title
Abecassis, M., H. Dewar, D. Hawn, and J. Polovina	4/25/12	Modeling swordfish daytime vertical habitat in the North Pacific Ocean from pop-up archival tags	Mar. Ecol. Prog. Ser., 452, 219-236	Journal Article	doi: 10.3354/meps09583	Oceanography Initiative
Alexander, M.A., H. Seo, S.-P. Xie, and J.D. Scott	May 2012	ENSO's impact on the gap wind regions of the eastern tropical Pacific Ocean	J. Climate, 25, 3549-3565	Journal Article	doi:10.1175/ JCLI-D-11-00320.1	Remote Versus Local Forcing of Intraseasonal Variability in the IAS Region: Consequences for Prediction
Annamalai, H., K.P. Sooraj, A. Kumar and H. Wang	2012	Feasibility of dynamical seasonal precipitation prediction for the Pacific Islands	Science and Technology Infusion Climate Bulletin, NOAA, National Weather Service	Technical Report	http://www.nws. noaa.gov/ost/climate/ STIP/36CDPW/36cdpw-hanna.pdf	Development of an Extended and Long-range Precipitation Prediction System over the Pacific Islands
Arita, S., M. Pan, J. Hospital, and P.S. Leung	2011	"Socioeconomic linkages of Hawaii's fishery sector". PFRP newsletter, Vol. 15-1, 13-16.		Newsletter	http://www.soest.hawaii. edu/PFRP/newsletters/2011_ annual_issue.pdf	PFRP: The Role of Social Networks on Fishermen Economic Performance in Hawaii's Longline Fishery
Asher, J., and J. Rooney	3/1/12	Photographic and cideographic imagery collection and analysis activities at the Coral Reef Ecosystem Division of the NOAA Pacific Islands Fisheries Science Center	Report of the National Marine Fisheries Service Automated Image Processing Workshop: Seattle, WA. Sept. 4-7, 2010	Workshop Proceedings	http://www.pifsc.noaa.gov/ library/pubs/tech/NOAA_ TM_NMFS_F-SPO_121.pdf	Sustaining Healthy Coastal Ecosystems
Aucan, J., R. Hoeke, and M. A. Merrifield	7/27/12	Wave-driven sea level anomalies at the Midway tide gauge as an index of North Pacific storminess over the past 60 years	Geophys. Res. Lett., 39, 17	Journal Article		University of Hawaii Sea Level Center
Ayotte P., K. McCoy, I. Williams, and J. Zamzow	12/1/11	Coral Reef Ecosystem Division standard operating procedures: data collection for Rapid Ecological Assessment fish surveys	Pacific Islands Fisheries Science Center Administrative Report H-11-08. 24 p.	Report	http://www.pifsc.noaa.gov/ library/pubs/admin/PIFSC_ Admin_Rep_11-08.pdf	Sustaining Healthy Coastal Ecosystems

Bailey H., S.R. Benson, G.L. Shillinger, S.J. Bograd, P.H. Dutton, S.A. Eckert, S.J. Morreale, F.V. Paladino, T. Eguchi, D.G. Foley, B.A. Block, R. Piedra, C. Hitipeuw, R.F. Tapilatu, and J.R. Spotila	2012	Identification of distinct movement patterns in Pacific leatherback turtle populations influenced by ocean conditions	Ecol. Appl., 22, 735-747	Journal Article		Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Bailey, H., S. Fossette, S.J. Bograd, G.L. Shillinger, A.M. Swithenbank, J.-Y. Georges, P. Gaspar, K.H.P. Stromberg, F.V. Paladino, J.R. Spotila, B.A. Block, and G.C. Hays	2012	Movement patterns for a critically endangered species, the leatherback turtle (Dermochelys coriacea), linked to foraging success and population status	PLoS ONE, 7(5), e36401	Journal Article	doi:10.1371/journal. pone.0036401.	Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Barceló, C, A. Domingo, P. Miller, L. Ortega, B. Giffoni, G. Sales, L. McNaughton, M. Marcovaldi, S. Heppell, and Y. Swimmer	In press	General movement patterns of tracked loggerhead sea turtles (*Caretta caretta*) in the southwestern Atlantic Ocean	Mar. Ecol. Prog. Ser.	Journal Article		Sea Turtle Bycatch & Mitigation: Research and Development
Barnes, M.	12/15/2011	The social networks of Hawaii's longline fishery - A preliminary assessment	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/ PFRP/dec11mtg/dec11mtg. htm	PFRP: The Role of Social Networks on Fishermen Economic Performance in Hawaii's Longline Fishery
Barnes-Mauthe, M., S. Arita, S. Allen, and P.S. Leung	2012	A network analysis of fisher's social capital and the effects of ethnic diversity in Hawaii's longline fishery	JIMAR Contribution Report 12-381	Technical Report		Contribution, Linkages and Impacts of the Fisheries Sector to the Economies of Hawaii and other U.S.-Affiliated Pacific Islands: An Extended Input-output Analysis
Becker E.A., D.G. Foley, K.A. Forney, J. Barlow, J.V. Redfern, and C.L. Gentemann	2012	Forecasting cetacean abundance patterns to enhance management decisions	Endanger. Species Res., 16, 97-112	Journal Article	doi:10.3354/esr00390.	Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Belmadani, A., V. Echevin, B. Dewitte, and F. Colas	4/14/12	Equatorially-forced intraseasonal propagations along the Peru-Chile coast and their relation with the nearshore eddy activity in 1992-2000: A modelling study	J. Geophys. Res.-Oceans, 117, C04025	Journal Article	doi:10.1029/2011JC007848	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center
Blyth-Skyrme, V.	2/29/12	Mesophotic coral reef ecosystems and essential fish habitat for the coral reef ecosystem fishery	JIMAR/PIFSC Symposium: Honolulu, HI. February 29, 2012	Presentation		Sustaining Healthy Coastal Ecosystems
Blyth-Skyrme, V.	2012	Benthic habitat mapping of coral reef ecosystems	Coastal and Marine Spatial Planning Workshop, organized by Pacific Islands Regional Office	Presentation		Sustaining Healthy Coastal Ecosystems

Booth, J.A.T., E. McPhee-Shaw, P. Chua, E. Kingsley, M. Denny, R. Phillips, S.J. Bograd, L.D. Zeidberg, and W.F. Gilly	2012	Natural intrusions of hypoxic, low pH water into nearshore marine environments on the California coast	Cont. Shelf Res., 45, 108-115	Journal Article		Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Brainard, R.E., J. Asher, V. Blyth-Skyrme, E.F. Coccagna, K. Dennis, M.K. Donovan, J.M. Gove, J. Kenyon, E.E. Looney, J.E. Miller, M.A. Timmers, B. Vargas-Ángel, P.S. Vroom, O. Vetter, B. Zgliczynski, T. Acoba, A. DesRochers, M.J. Dunlap, E.C. Franklin, P.I. Fisher-Pool, C.L. Braun, B.L. Richards, S.A. Schopmeyer, R.E. Schroeder, A. Toperoff, M. Weijerman, I. Williams, and R.D. Withall	2012	Coral reef ecosystem monitoring report of the Mariana Archipelago: 2003–2007	Pacific Islands Fisheries Science Center, PIFSC Special Publication, SP-12-01, 1019 p. + 4 Appendices	Special Publication		Sustaining Healthy Coastal Ecosystems
Brodziak, J., and L. Katahira	12/16/11	Patterns in catches, standardized CPUEs, and fishery length compositions of the Western and Central North Pacific striped marlin stock	ISC Billfish Working Group Workshop: Honolulu, HI. Dec 6-16, 2011	Workshop Proceedings	http://isc.ac.affrc.go.jp/pdf/BILL/ISC11_BILL_3/ISC11BILLWG-3_WP04.pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Brodziak, J., and L. Katahira	12/16/11	Report of the ISC Meeting of the Pacific Billfish Working Group	ISC Billfish Working Group Workshop: Honolulu, HI. Dec 6-16, 2011	Workshop Proceedings	http://isc.ac.affrc.go.jp/pdf/ISC12pdf/Annex%205%20-%20Report%20of%20the%20BILLWG%20Workshop%20(Dec%202011).pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Brodziak, J., D. Courtney, L. Wagatsuma, J. O'Malley, H-H. Lee, W. Walsh, A. Andrews, R. Humphreys, and G. DiNardo	10/1/11	Stock assessment of the main Hawaiian Islands Deep 7 bottomfish complex through 2010	U.S. Dept. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-29, 176 p. + Appendix	Technical Report	http://www.pifsc.noaa.gov/library/pubs/tech/NOAA_Tech_Memo_PIFSC_29.pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Brodziak, J., J.M. O'Malley, B. Richard, and G. DiNardo	2012	Stock Assessment update of the status of the bottomfish resources of American Samoa, the Commonwealth of the Northern Mariana Islands, and Guam, 2012	Pacific Islands Fisheries Science Center, Administrative Report H-12-04	Technical Report	http://www.pifsc.noaa.gov/library/pubs/admin/PIFSC_Admin_Rep_12-04.pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Brodziak, J., T. Gedamke, C. Porch, J. Walter, D. Courtney, J. O'Malley, and B. Richards	6/1/12	A workshop on methods to estimate total and natural mortality rates using mean length observations and life history parameters	U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-32, 26 p. + Appendix	Technical Report	http://www.pifsc.noaa.gov/library/pubs/tech/NOAA_Tech_Memo_PIFSC_32.pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program

Brodziak, J., X.J. Dai, and L. Katahira	4/9/12	Report of the ISC Meeting of the Pacific Billfish Working Group	ISC Billfish Working Group Workshop: Shanghai, China. April 2-9, 2012	Workshop Proceedings	http://isc.ac.affrc.go.jp/pdf/ISC12pdf/Annex%207%20-%20Report%20of%20the%20BILLWG%20Workshop%20(Apr%202012)%20FINAL.pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Cahoon, M., C. Littnan, and K. Longenecker	2/29/12	Diet and foraging behavior of monk seals in the main Hawaiian Islands.	JIMAR/PIFSC Symposium: Honolulu, HI. February 29, 2012	Presentation		Fisheries Oceanography: Protected Species Research Program
Cahoon, M., C. Littnan, and K. Longenecker	5/3/12	Investigating diet and foraging behavior to explain divergent population trends in monk seals.	5th Annual Hawaiian Islands Symposium: Honolulu, HI. May 2-3, 2012	Presentation		Fisheries Oceanography: Protected Species Research Program
Cahoon, M., C. Littnan, and K. Longenecker	8/1/12	Investigating diet and foraging behavior to explain divergent population trends in monk seals.	20th Annual Hawaii Conservation Conference: Honolulu, HI. July 31-August 2, 2012	Presentation		Fisheries Oceanography: Protected Species Research Program
Chambers, D. P., M. A. Merrifield, and R. S. Nerem	6/25/12	Is there a 60-year oscillation in global mean sea level?	Geophys. Res. Lett., 39(18), L18607	Journal Article		University of Hawaii Sea Level Center
Chan, H., and M. Pan	January 2012	Spillover effects of environmental regulation for sea turtle protection: The case of the Hawaii shallow-set longline fishery	NOAA Technical Memorandum NMFS-PIFSC-30	Technical Report	www.pifsc.noaa.gov/library/pubs/tech/NOAA_Tech_Memo_PIFSC_30.pdf	Marine Resource Dynamics & Assessment Program (MARDAP): Economics of Fisheries Initiative
Chang, C.-H., S.-P. Xie, N. Schneider, B. Qiu, J. Small, W. Zhuang, B. Taguchi, H. Sasaki, and X. Lin	2012	East Pacific ocean eddies and their relationship to subseasonal variability in Central American wind jets	J. Geophys. Res., 117, C10001, doi:10.1029/2011JC007315	Journal Article	10.1029/2011JC007315	Remote Versus Local Forcing of Intraseasonal Variability in the IAS Region: Consequences for Prediction
Chiang, W.-C., C.-L. Sun, G. DiNardo, W.-C. Su, M.K. Musyl, H.-M. Hung, S.-C. Chen, S.-Z. Yeh, W.-Y. Chen, and D.-C. Liu	2011	Multinational Pacific billfish tagging program – Status of electronic tagging in eastern Taiwan	ISC Billfish Working Group Workshop: Honolulu, HI. Dec 6-16, 2011	Workshop Proceedings	ISC/11/BILLWG-2/12	Fisheries Oceanography: Ecosystem Observations & Research Program: Post-release Survival, Vertical and Horizontal Movements, and Thermal Habitats of Istiophorid Billfishes in the Central Pacific Ocean
Chowdhury M. R.	Accepted	The variability of ENSO and predictability of seasonal flooding: Pacific Islands and Bangladesh	IAHS Red Book, No. 357, International Association of Hydrological Sciences, IAHS Press, Oxford, UK	Journal Article		Pacific ENSO Applications Center

Chowdhury, M. R.	2012	CGE Training Materials for Vulnerability and Adaptation Assessment (Coastal Resources)	Vulnerability and Adaptation Assessments Hands-on Training Workshop for the Latin American and Caribbean Region, July 9-13, 2012, United Nations Framework Convention on Climate Change	Presentation		Pacific ENSO Applications Center
Choy, C. A, J. C. Drazen, B. Popp, P. Nichols, R. Phleger, and J. Blum	12/1/11	Examining pelagic food webs using multiple chemical tracers: the diets of large mesopelagic predators	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Examining Pelagic Food Webs using Multiple Chemical Tracers
Choy, C. A., J.C. Drazen, B.N. Popp, P.C. Davison, A. Flynn, J.C. Hoffman, J.P. McClain-Counts, T.W. Miller, S.W. Ross, and T.T. Sutton	2/1/12	Global comparison of trophic positions of mesopelagic myctophids and stomiids using amino acid nitrogen isotopic analyses	Ocean Sciences Meeting: Salt Lake City, UT. February 20-24, 2012	Presentation		PFRP: Examining Pelagic Food Webs using Multiple Chemical Tracers
Combes, V., F. Chenillat, P. Riviere, E. Di Lorenzo, M.D. Ohman, and S.J. Bograd	2012	Cross-shore transport variability in the California Current System: Ekman upwelling vs. eddy regime	Prog. Oceanogr.	Journal Article	http://dx.doi.org/10.1016/j.pocean.2012.10.001	Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Comer, A., and R. Domokos	12/15/2011	Characterizing micronekton of the Kona region using active acoustics	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Assimilating in situ Bioacoustic Data in a Mid-trophic Level Model and its Impact on Predicted Albacore Feeding Habitat in the American Samoa Waters
Comfort, C.	12/15/2011	OTEC impacts on pelagic fisheries	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Management Project
Costa B.M., M.S. Kendall, J. Rooney, M. Chow, J. Lecky, F.A. Parrish, A. Montgomery, R.C.Boland, and H. Spalding	6/1/12	Prediction of esophotic coral distributions in the Auʻau Channel, Hawaii	NOAA Technical Memorandum NOS NCCOS 149	Technical Report		Meso-photic Reef Ecosystems of Hawaii's Auʻau Channel
DiNardo, G., K. Dahl, L. Katahira, and S. Shoffler	8/1/12	Report of the ISC12 Plenary	International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean: Sapporo, Japan. July 18-23, 2012	Workshop Proceedings	http://isc.ac.affrc.go.jp/pdf/ISC12pdf/ISC12_Plenary_Report-FINAL.pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program

DiNardo, G., K. Dahl, S. Shoffler, and L. Katahira	8/10/11	Report of the ISC11 Plenary	International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean: San Francisco, CA. July 20-25, 2011	Workshop Proceedings	http://isc.ac.affrc.go.jp/pdf/ ISC11pdf/ISC11_Plenary_ FINAL_September.pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Domingo, A., M. Pons, S. Jiménez, P. Miller, C. Barceló, and Y. Swimmer	1/1/12	Effects of the use of circle hooks in the Uruguayan pelagic longline fishery	Bull. Mar. Sci., 88, 499-511	Journal Article		Sea Turtle Bycatch & Mitigation: Research and Development
Domokos, R.	12/15/2011	Acoustic investigation of bottomfish spatiotemporal distribution and biomass in the Hawaii Archipelago	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/ PFRP/dec11mtg/dec11mtg. htm	PFRP: Assimilating in situ Bioacoustic Data in a Mid-trophic Level Model and its Impact on Predicted Albacore Feeding Habitat in the American Samoa Waters
Donovan, M., P. Fisher-Pool, M. Lammers, and K. Wong	5/4/2012	Northwestern Hawaiian Islands, passive acoustic monitoring site FFS1, French Frigate Shoals ecological acoustic recorder (EAR), 25 September 2007 to 15 September 2008, Level 1 of analysis of passive acoustics observations	NOAA PIFSC Internal Report IR-12-016	Report		Sustaining Healthy Coastal Ecosystems
Drazen, J. C., C. A. Choy, and B. N. Popp	2/1/12	Multiple approaches to characterizing the pelagic food web in the central North Pacific	JIMAR/PIFSC Symposium: Honolulu, HI. February 29, 2012	Presentation		PFRP: Examining Pelagic Food Webs using Multiple Chemical Tracers
Drazen, J.C.	7/25/12	Vertical connectivity in deep-sea food webs	Monterey Bay Aquarium Research Institute (MBARI) Summer 2012 Seminar: Monterey, CA. July 25, 2012	Presentation		PFRP: Examining Pelagic Food Webs using Multiple Chemical Tracers
Espinasse, B., M. Zhou, Y. Zhu, E.L. Hazen, A.S. Friedlaender, D.P. Nowacek, D. Chu, and F. Carlotti	2012	Austral fall transition of mesozooplankton assemblages and krill aggregations in an embayment west of the Antarctic Peninsula	Mar. Ecol. Prog. Ser., 452, 63-80	Publication List		Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Félix, F., D.M. Palacios, S.K. Salazar, S. Caballero, B. Haase, and J. Falconí	2011	The 2005 Galápagos Humpback Whale Expedition: A first attempt to assess and characterize the population in the archipelago	J. Cetacean Res. Manage. (Special Issue 3), 291-299	Journal Article		Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations

Fiedler, P.C., R. Mendelssohn, D.M. Palacios, and S.J. Bograd	In press	Pycnocline variations in the eastern tropical and North Pacific, 1958-2008	J. Climate	Journal Article	doi:10.1175/ JCLI-D-11-00728.1	Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Fox, H.E., K.M. Haisfield, M.S. Brown, T.C. Stevenson, B.N. Tissot, W.J. Walsh, and I.D. Williams	8/30/12	Influences of oceanographic and meteorological features on reef fish recruitment in Hawai'i	Mar. Ecol. Prog. Ser., 463, 259-272	Journal Article	doi: 10.3354/meps09838	Kona Integrated Ecosystem Assessment
Fu, X., and P.-C. Hsu	8/3/11	Extended-range ensemble forecasting of tropical cyclogenesis in the northern Indian Ocean: Modulation of Madden-Julian Oscillation	Geophys. Res. Lett., 38, L15803	Journal Article	doi:10.1029/2011GL048249	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center
Fu, X.H., B. Wang, J.-Y. Lee, W.Q. Wang, and L. Gao	8/1/11	Sensitivity of dynamical intra-seasonal prediction skills to different initial conditions	Mon. Wea. Rev., 139,2572–2592	Journal Article	doi:10.1175/2011MWR3584.1	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center
Glazier, E., and L. Madge	12/15/2011	Small-scale fisheries of the Pacific	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/ PFRP/dec11mtg/dec11mtg. htm	PFRP: Descriptive Assessment of Small-Scale and Traditional Fisheries in the Western Pacific
Gobush, K.S., and S.C. Farry	9/14/2012 (online)	Non-lethal efforts to deter shark predation of Hawaiian monk seal pups	Aquat. Conserv. (online)	Journal Article	http://onlinelibrary.wiley.com/ doi/10.1002/aqc.2272/abstract	Fisheries Oceanography: Protected Species Research Program
Gove, J., G. Williams, M. McManus, S. Heron, O. Vetter, D. Foley, and S. Sandin	7/9/12	Quantifying environmental forcing on exceedance thresholds on coral reefs	12th International Coral Reef Symposium: Cairns, QLD, Australia. July 9-13, 2012	Presentation		Sustaining Healthy Coastal Ecosystems
Hall, M., Y. Swimmer, and M. Parga	1/1/12	No "silver bullets" but plenty of options: working with artisanal fishers in the Eastern Pacific to reduce incidental sea turtle mortality in longline fisheries	In Seminoff, J.A., and B.P. Wallace (eds.). Sea Turtles of the Eastern Pacific Ocean: Advances in Research and Conservation	Journal Article	ISBN: 978-0-8165-1158-7	Sea Turtle Bycatch & Mitigation: Research and Development
Hall, M., Y. Swimmer, and M. Parga	In press	No "silver bullets" but plenty of options: working with the Eastern Pacfic Artisinal Fishers to reduce sea turtle mortality in fisheries	Marine Turtles of the Eastern Pacific: Conservation Challenges and Signs of Success	Book Chapter		Sea Turtle Bycatch & Mitigation: Research and Development
Hazen, E.L., S. Jorgensen, R. Rykaczewski, S.J. Bograd, D.G. Foley, I. Jonsen, S.A. Shaffer, J. Dunne, D.P. Costa, and B.A. Block	2012	Predicted habitat shifts in Pacific top predators in a changing climate	Nature Climate Change, doi: 10.1038/ nclimate168	Journal Article	doi: 10.1038/nclimate1686.	Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations

Hazen, E.L., and L.B. Crowder	2012	Fisheries Ecology	In Hastings, A., and L. Gross (eds.). Encyclopedia of Theoretical Ecology, University of California Press, pp. 280-287	Book Chapter		Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Hazen, E.L., H. Bailey, S.J. Bograd, P. Gaspar, B. Godley, M. Hamann, G.L. Shillinger, and J.R. Spotila	2012	Ontogeny in biologging science: tag technologies and data gaps	Mar. Ecol. Prog. Ser., 457, 221-240	Journal Article		Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Hoen, D. K., B.N. Popp, J.C. Drazen, N.E. Hussey, S.L. Kim, and N.J. Wallsgrove	2/1/12	Compound specific isotopes analysis in food web studies: the need for accurate estimates of trophic enrichment factors	Ocean Sciences Meeting: Salt Lake City, UT. February 20-24, 2012	Presentation		PFRP: Examining Pelagic Food Webs using Multiple Chemical Tracers
Hong, C.-C., Y.-H. Li, T. Li, and M.-Y. Lee	8/30/11	Impacts of central Pacific and eastern Pacific El Niños on tropical cyclone tracks over the western North Pacific	Geophys. Res. Lett., 38, L16712	Journal Article	doi:10.1029/2011GL048821	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center
Howell, E.A., S.J. Bograd, C. Morishige, M.P. Seki, and J.J. Polovina	2012	On the North Pacific circulation and associated marine debris concentration	Mar. Pollut. Bull., 65, 16-22	Journal Article	doi:10.1016/j.marpolbul.2011.04.034.	Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Hoyle, S.	12/15/2011	TUMAS: Improved effectiveness of WCPFC through better informed fishery decision makers	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Improved Effectiveness of WCPFC through Better Informed Fishery Decision Makers
Humphreys, R., and K. Kopf	12/15/2011	Age and growth of striped marlin, Kajikia audax, in the Hawaii-based longline fishery	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Age and Growth of Striped Marlin, Kajikia audax Caught in the Hawaii-based Longline Fishery
Ishihara, T., Y. Matsuzawa, H. Peckham, and J. Wang	12/1/11	Meeting report: 2nd International workshop to mitigate bycatch of sea turtles in Japanese pound nets	Marine Turtle Newsletter, 130, 27-28	Newsletter	http://www.seaturtle.org/mtn/archives/mtn130/mtn130p27.shtml	Sea Turtle Bycatch & Mitigation: Research and Development
Ishihara, T., Y. Matsuzawa, J. Wang, and H. Peckham	1/1/12	Building a better pound net	SWOT Report, 7, 16-17	Technical Report	http://seaturtlestatus.org/sites/swot/files/report/030612_SWOT7_FinalA.pdf	Sea Turtle Bycatch & Mitigation: Research and Development
Itano, D.	12/15/2011	Spatial characteristics of yellowfin tuna in relation to their environment	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Hawaii Tuna Tagging Project 2

Johnson, G.C., S. Schmidtko, and J. M. Lyman	4/10/12	Relative contributions of temperature and salinity to seasonal mixed layer density changes and horizontal density gradients	J. Geophys. Res., 117, C04015	Journal Article		Profiling CTD Float Array Implementation and Ocean Climate Research
Jones, T.T.	12/15/2011	Biotelemetry tag retention in pelagic tunas	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Biotelemetry Tag Retention in Pelagic Tunas
Kahng, S., D. Wagner, C. Lantz, O. Vetter, J. Gove, and M. Merrifield	7/9/12	Temperature related depth limits of warm-water corals	12th International Coral Reef Symposium: Cairns, QLD, Australia. July 9-13, 2012	Presentation		Sustaining Healthy Coastal Ecosystems
Kim, E.J.	12/15/2011	Effects of FADs on tuna	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Modeling Project
Kim, E.J., and J. Sibert	5/21/12	The influence of FADs on skipjack tuna in the equatorial Pacfic Ocean	Proceedings of the 63rd Tuna Conference: Lake Arrowhead, CA. May 21-24, 2012	Conference Proceedings	http://www.tunaconference.org/PDFfiles/63rdMeeting/63rd-Annual-TC-Proceedings.pdf	PRFP: Modeling Project
Kotowicz, D., and L. Richmond	12/15/2011	Fish distribution channels and markets for longline-caught fish in Hawaii	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Distribution and Use of Seafood in the Context of the Community: A Case Study of the Main Hawaiian Islands
Kruk, M.C., J.J. Marra, P. Ruggiero, D. Atkinson, M. Merrifield, D. Levinson, and M. Lander	2012	Pacific Storms Climatology Products (PSCP): Understanding extreme events	Bull.Am. Met. Soc., doi:10.1175/BAMS-D-11-00075.1	Journal Article	doi:10.1175/BAMS-D-11-00075.1	University of Hawaii Sea Level Center - Tsunami Research
Lee, H.H.	10/12/11	Integrating oceanographic data into Stock Synthesis: application to north Pacific albacore	Including Oceanography in Fisheries Stock Assessment and Management Workshop: I-ATTC, LA Jolla, CA. October 11-14, 2011	Presentation	http://www.fisheriesstockassessment.com/TikiWiki/tiki-index.php?page=Agenda+2011	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Lee, H.H.	2/29/12	A simulation-based method to evaluate the ability of estimating natural mortality within a fisheries stock assessment and determine model misspecification	JIMAR/PIFSC Symposium: Honolulu, HI. February 29, 2012	Presentation		Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Lee, H.H., K. Piner, G. DiNardo, and I. Taylor	4/9/12	Future projections of Western and Central Pacific striped marlin	ISC Billfish Working Group Workshop: Shanghai, China. April 2-9, 2012	Workshop Proceedings	http://isc.ac.affrc.go.jp/reports/bill/bill_2012_1.html	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program

Lee, H.H., M. Maunder, K. Piner and R. Methot	5/1/12	Reply to 'The reliability of estimates of natural mortality from stock assessment models'	Fish. Res., 119-120, 154-155	Journal Article	http://dx.doi.org/10.1016/j.fishres.2012.02.015	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Lee, H.H., M. Maunder, K. Piner and R. Methot	8/1/12	Can steepness of the stock-recruitment relationship be estimated in fishery stock assessment models?	Fish. Res., 125-126, 254-261	Journal Article	http://dx.doi.org/10.1016/j.fishres.2012.03.001	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Lemos, R.T., and B. Sansó	January - March 2012	Conditionally linear models for non-homogeneous spatial random fields	Stat. Methodol., 9, 1-2, 275-284	Journal Article	http://dx.doi.org/10.1016/j.stamet.2011.02.001	Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Littnan, C., and T. Wurth	7/31/12	A legacy of enhancement: the benefits accrued from 15 years of monk seal recovery efforts	20th Annual Hawaii Conservation Conference: Honolulu, HI. July 31 -August 2, 2012	Presentation		Fisheries Oceanography: Protected Species Research Program
Liu, F., and B. Wang	2/1/12	A model for the interaction between the 2-day waves and moist Kelvin waves	J. Atmos. Sci., 69, 611-625	Journal Article	doi:10.1175/JAS-D-11-0116.1	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center
Liu, L., W. Yu, and T. Li,	9/1/11	Dynamic and thermodynamic air–sea coupling associated with the Indian Ocean Dipole diagnosed from 23 WCRP CMIP3 models	J. Climate, 24, 4941-4958	Journal Article	doi: 10.1175/2011JCLI4041.1	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center
Loeb, N. G., J.M. Lyman, G.C. Johnson, R.P. Allan, D.R. Doelling, T. Wong, B J. Soden, and G.L. Stephens	1/22/12	Observed changes in top-of-the-atmosphere radiation and upper-ocean heating consistent within uncertainty	Nature Geosci., 5, 110-113	Journal Article		Profiling CTD Float Array Implementation and Ocean Climate Research
Lopez, J.	2/29/12	Persistent organic pollutants in the Hawaiian monk seal (Monachus schauinslandi) from the main Hawaiian Islands.	JIMAR/PIFSC Symposium: Honolulu, HI. February 29, 2012	Presentation		Fisheries Oceanography: Protected Species Research Program
Lopez, J., C. Littnan, G.M. Ylitalo, and D. Boyd	5/2/12	Persistent organic pollutants in the Hawaiian monk seal (Monachus schauinslandi) from the main Hawaiian Islands.	5th Annual Hawaiian Islands Symposium: Honolulu, HI. May 2-3, 2012	Presentation		Fisheries Oceanography: Protected Species Research Program
Lopez, J., D. Boyd, G.M. Ylitalo, and C. Littnan	11/28/11-12/2/11	Persistent organic pollutants in the Hawaiian monk seal (Monachus schauinslandi) from the main Hawaiian Islands. (poster)	19th Biennial Conference on the Biology of Marine Mammals: Tampa, FL. November 27-December 2, 2011	Presentation		Fisheries Oceanography: Protected Species Research Program

Lopez, J., D. Boyd, G.M. Ylitalo, C. Littnan, R. Pearce	8/9/2012 (online)	Persistent organic pollutants in the endangered Hawaiian monk seal *(Monachus schauinslandi)* from the main Hawaiian Islands.	Mar. Pollut. Bull. (online), 65, 11, 2588-2598	Journal Article	http://dx.doi.org/10.1016/j.marpolbul.2012.07.012	Fisheries Oceanography: Protected Species Research Program
Lyman, J. M.	12/16/11	Estimating global energy flow from the global upper ocean	Surv. Geophys., 33, 387-393	Journal Article		Profiling CTD Float Array Implementation and Ocean Climate Research
Ma, J., and S.-P. Xie	In press	Regional patterns of sea surface temperature change: A source of uncertainty in future projections of precipitation and atmospheric circulation	J. Climate, 2012	Journal Article	doi: http://dx.doi.org/10.1175/JCLI-D-12-00283.1	Roles of Ocean-Atmosphere-Land Interaction in Shaping Tropical Atlantic Variability and Toward Reducing Climate Model Biases in the Equatorial Atlantic and Adjacent Continents
Maxwell, S.M., E.L. Hazen, L.E. Morgan, H. Bailey, and R.L. Lewison	2012	Finding Balance in Fisheries Management. (Response to "Reconsidering the consequences of selective fisheries")	Science, 336, 413			Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
McDole T, J. Nulton, K.L. Barott, B. Felts, C. Hand, M. Hatay, H. Lee, M.O. Nadon, B. Nosrat, P. Salamon, B. Bailey, S.A. Sandin, B. Vargas-Angel, M. Youle, B.J. Zgliczynski, R.E. Brainard, and F. Rohwer	9/7/2012	Assessing coral reefs on a Pacific-wide scale using the microbialization score	PLoS ONE 7(9), e43233	Journal Article	doi:10.1371/journal.pone.0043233	Sustaining Healthy Coastal Ecosystems
Merrifield, M. A., and M. E. Maltrud	11/5/11	Regional sea-level trends due to a Pacific trade wind intensification	Geophys. Res. Lett., 38, L21605	Journal Article		University of Hawaii Sea Level Center
Merrifield, M. A., P. R. Thompson, and M. Lander	4/17/12	Multidecadal sea level anomalies and trends in the western tropical Pacific	Geophys. Res. Lett., 39, 13	Journal Article		University of Hawaii Sea Level Center
Merrifield, M. A., P. Thompson, D. P. Chambers, G. T. Mitchum, M. Menéndez, R. S. Nerem, E. Leuliette, L. Miller, S. Holgate, J. J. Marra, and W. Sweet	7/1/12	[Global oceans] Sea level variability and change [in "State of the Climate in 2011"]	Bull. Amer. Meteor. Soc., 93 (7), S68-S69	Journal Article		University of Hawaii Sea Level Center
Moon, J.-Y., B. Wang, and K.-J. Ha	2/15/12	MJO modulation on 2009/10 winter snowstorms in the United States	J. Climate, 25, 978-991	Journal Article	doi:10.1175/JCLI-D-11-00033.1	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center
Moon, J-Y, B. Wang, and K.-J. Ha	Sept. 2011	ENSO regulation of MJO teleconnection	Climate Dynamics, 37, 5-6, 1133-1149	Journal Article	doi:10.1007/s00382-010-0902-3	Multi-Model Ensemble Forecast of MJO

Muir, J.	12/15/2011	The behavior and residence of bigeye tuna at an oceanic seamount	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Management Project
Musyl, M.K.	2012	Meta-analysis of post-release mortality in striped (*Kajikia audax*) and blue marlin (*Makaira nigricans*) using pop-up satellite archival tags	ISC Billfish Working Group Workshop: Shanghai, China. April 2-9, 2012	Workshop Proceedings	ISC/12/BILLWG-1/07	Fisheries Oceanography: Ecosystem Observations & Research Program: Post-release Survival, Vertical and Horizontal Movements, and Thermal Habitats of Istiophorid Billfishes in the Central Pacific Ocean
Musyl, M.K.	2012	Electronic tagging studies in pelagic fisheries research	JIMAR/PIFSC Symposium: Honolulu, HI. February 29, 2012	Presentation	Univ. Hawaii, Honolulu, Feb. 29. (oral presentation and poster)	Fisheries Oceanography: Ecosystem Observations & Research Program: Post-release Survival, Vertical and Horizontal Movements, and Thermal Habitats of Istiophorid Billfishes in the Central Pacific Ocean
Musyl, M.K.	2012	Post-release mortality in Istiophorid billfish	110th SSC Meeting, Western Pacific Regional Fishery Management Council: Honolulu, HI. June 19-21, 2012	Presentation		Fisheries Oceanography: Ecosystem Observations & Research Program: Post-release Survival, Vertical and Horizontal Movements, and Thermal Habitats of Istiophorid Billfishes in the Central Pacific Ocean
Nadon, M.O., J.K. Baum, I.D. Williams, J.M. McPherson, B.J. Zgliczynski, B.L. Richards, R.E. Schroeder, and R.E. Brainard	4/26/12	Re-creating missing population baselines for Pacific reef sharks	Conserv. Biol., 26, 3, 493-503, June 2012	Journal Article	http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.2012.01835.x/abstract	Sustaining Healthy Coastal Ecosystems
Nichols, P.D, K. Phillips, K. Abrantes, J. Drazen, J. Young, and R. Phleger	11/1/11	Signature lipids – where are we at and what is next?	Australasian Section of the American Oil Chemists' Society (AAOCS) Biennial Conference, Adelaide, Australia	Presentation		PFRP: Examining Pelagic Food Webs using Multiple Chemical Tracers
Nonaka, M., S.-P. Xie, and H. Sasaki,	2/1/12	Interannual variations in low potential vorticity water and the subtropical countercurrent in an eddy-resolving OGCM	J. Oceanogr., 68, 139-150	Journal Article	doi:10.1007/s10872-011-0042-3	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center

O'Malley, J.M., J.C. Drazen, B.N. Popp, E. Gier, and R.J. Toonen	3/8/12	Spatial variability in growth and prey availability of lobsters in the Northwestern Hawaiian Islands	Mar, Ecol. Prog. Ser., 449: 211-220. doi: 10.3354/meps09533	Journal Article	http://www.int-res.com/articles/meps2012/449/m449p211.pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
O'Malley, J.M.	2/29/12	Growth dynamics of NWHI lobsters and the use of commerical bottomfish catch and tagging data	JIMAR/PIFSC Symposium: Honolulu, HI. February 29, 2012	Presentation		Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
O'Malley, J.M.	August 2011	Spatiotemporal variation in the population ecology of scaly slipper lobsters *Scyllarides squammosus* in the Northwestern Hawaiian Islands	Mar. Biol., 158, 8, 1887-1901	Journal Article	http://www.springerlink.com/content/k4hw0100440w8314/	Marine Resource Dynamics & Assessment Program (MARDAP): Stock Assessment Research Program
Páez-Rosas, D., D. Aurioles-Gamboa, J.J. Alava, and D.M. Palacios	2012	Stable isotopes indicate differing foraging strategies in two sympatric otariids of the Galapagos Islands	J. Exper. Mar. Biol. Ecol., 424-425: 44-52		doi:10.1016/j.jembe.2012.05.001	Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Palacios, D.M., J.C. Herrera, T. Gerrodette, C. García, G.A. Soler, I.C. Avila, S. Bessudo, E. Hernández, F. Trujillo, L. Flórez-González, and I. Kerr	2012	Cetacean distribution and relative abundance in Colombia's Pacific EEZ from survey cruises and platforms of opportunity	J. Cetacean Res. Manage., 12(1): 45-50			Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Pan, M., and P.S. Leung (eds.)	2012	Special issue on economic relations between marine aquaculture and wild capture fisheries	Aqua. Econ. Manage., 16:97-181	Conference Proceedings		Contribution, Linkages and Impacts of the Fisheries Sector to the Economies of Hawaii and other U.S.-Affiliated Pacific Islands: An Extended Input-output Analysis
Parke, M., C. Kelley, A. Ramirez, M. Donovan, H. Wang, and J. Rooney	3/2/12	Review of scientific Information for the EFH and HAPC designations for Federal Fishery Management Unit Species (MUS) in the Pacific Islands Region (excluding Hawaii Bottomfish MUS and Crustacean MUS)	Review of Scientific Information for the EFH and HAPC designations for Federal Fishery Management Unit Species (MUS) in the Pacific Islands Region (excluding Hawaii Bottomfish MUS and Crustacean MUS)	Report		Sustaining Healthy Coastal Ecosystems
Pichel, W.G., T.S. Veenstra, J.H. Churnside, E. Arabini, K.S. Friedman, D.G. Foley, R.E. Brainard, D. Kiefer, S. Ogle, P. Clemente-Colon, and X. Li	2012	GhostNet marine debris survey in the Gulf of Alaska: Satellite guidance and aircraft observations	Mar. Pollut. Bull., 65:28-41			Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations

Pillai, P.A., and H. Annamalai	1/1/12	Moist dynamics of severe monsoons over South Asia: Role of the tropical SST	J. Atmos. Sci., 69, 97-115	Journal Article	doi:10.1175/JAS-D-11-056.1	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center
Piner, K., H.H. Lee, I. Taylor, L. Katahira, D. Tagami and G. DiNardo	12/16/11	Preliminary striped marlin stock assessment	ISC Billfish Working Group Workshop: Honolulu, HI. Dec 6-16, 2011	Workshop Proceedings	http://isc.ac.affrc.go.jp/pdf/BILL/ISC11_BILL_3/ISC11BILLWG-3_WP01.pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Piner, K.P., H.H. Lee, M. Maunder, and R. Methot	9/20/11	A simulation-based method to determine model misspecification: examples using natural mortality and population dynamics models	Mar. Coastal Fish., 3, 336-343	Journal Article	http://www.tandfonline.com/doi/pdf/10.1080/19425120.2011.611005	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Piovano, S., G. Basciano, Y. Swimmer, and C. Giacoma	1/1/12	Evaluation of a bycatch reduction technology by fishermen: A case study from Sicily	Mar. Policy, 36(1)	Journal Article		Sea Turtle Bycatch & Mitigation: Research and Development
Popp, B.N., C.A. Choy, J.C. Drazen, and J.D. Blum	5/1/12	Stable isotopic compositions of mercury indicate depth of forage in North Pacific predatory fishes and their prey from Hawaii	Proceedings of the 63rd Tuna Conference, Lake Arrowhead, CA. May 21-24, 2012	Conference Proceedings		PFRP: Examining Pelagic Food Webs using Multiple Chemical Tracers
Potemra, J.T.	1/1/12	Numerical modeling with application to tracking marine debris	Mar. Pollut. Bull., 65, 42-50	Journal Article	doi:10.1016/j.marpolbul.2011.06.026	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center
Rauzon, M.J., D.J. Forsell, E.N. Flint, and J.M. Gove	2011	Islands 25 years after cat eradication: The recovery of seabirds in a biogeographical context	In Veitch, C.R., M.N. Clout, and D.R. Towns (eds). Island invasives: Eradication and Management, Proceedings of the International Conference of Island Invasives. Gland, Switzerland, IUCN, and Auckland, New Zealand, CBB.	Book Chapter	http://www.issg.org/pdf/publications/Island_Invasives/pdfHQprint/3Rauzon.pdf	Sustaining Healthy Coastal Ecosystems
Richards, B.L., I.D. Williams, O.J. Vetter OJ, and G.J. Williams	3/19/12	Environmental factors affecting large-bodied coral reef fish assemblages in the Mariana Archipelago	PLoS ONE, 7(2), e31374.	Journal Article	http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0031374	Sustaining Healthy Coastal Ecosystems
Richter, I., S.-P. Xie, A.T. Wittenberg, and Y. Masumoto	0/0/2012	Tropical Atlantic biases and their relation to surface wind stress and terrestrial precipitation	Clim. Dyn., 38, 985-1001	Journal Article		Roles of Ocean-Atmosphere-Land Interaction in Shaping Tropical Atlantic Variability and Toward Reducing Climate Model Biases in the Equatorial Atlantic and Adjacent Continents

Rooney, J., S. Lindfield, and V. Blyth-Skyrme	7/10/12	Mesophotic coral ecosystems of the Mariana Archipelago	12th International Coral Reef Symposium: Cairns, QLD, Australia. July 9-13, 2012	Presentation		Sustaining Healthy Coastal Ecosystems
Rooney, J., V. Blyth-Skyrme, and S. Lindfield	2/29/12	Mesophotic coral ecosystems in the Mariana Archipelago	JIMAR/PIFSC Symposium: Honolulu, HI. February 29, 2012	Presentation		Sustaining Healthy Coastal Ecosystems
Rydbeck, A., E. Maloney, S.-P. Xie, J. Hafner, and J. Shaman	In press	Remote forcing versus local feedback of East Pacific intraseasonal variability	J. Climate	Journal Article	doi: 10.1175/ JCLI-D-12-00499.1	Remote Versus Local Forcing of Intraseasonal Variability in the IAS Region: Consequences for Prediction
Sala, E., E. Ballesteros, P. Dendrinos, A. Di Franco, F. Ferretti, D. Foley, S. Fraschetti, A. Friedlander, J. Garrabou, H. Guclusoy, P. Guidetti, B. S. Halpern, B. Hereu, A. A. Karamanlidis, Z. Kizilkaya, E. Macpherson, L. Mangialajo, S. Mariani, F. Micheli, A. Pais, K. Riser, A. A. Rosenberg, M. Sales, K. A. Selkoe1, R. Starr, F. Tomas, and M. Zabala	2012	The structure of Mediterranean rocky reef ecosystems across environmental and human gradients, and conservation implications	PLoS ONE, 7(2), e32742		doi: 10.1371/journal. pone.0032742.	Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Scholey, V., D. Bromhead, D. Margulies, S. Nicol, J. Wexler, M. Santiago, J.E. Williamson, S. Hoyle, P. Schlegel, J. Havenhand, T. Ilyina, and P. Lehodey	2012	Novel research Into the impacts of ocean acidification upon tropical tuna	PFRP Newsletter 16(1)	Newsletter		PFRP: Ocean Acidification Impacts upon Tropical Tuna Populations
Schroeder, T.A., M.R. Chowdhury, M.A. Lander, C. Guard, C. Felkley, and D. Gifford	6/1/12	The role of the Pacific ENSO Applications Center in reducing vulnerability to climate hazards	Bull. Am. Met. Soc., 93(6), 1003-1015	Journal Article		Pacific ENSO Applications Center
Senina, I., F. Royer, P. Lehodey, J. Hampton, S. Nicol, M. Ogura, H. Kiyofuji, and J. Sibert	5/15/12	Integrating conventional and electronic tagging data into SEAPODYM	PFRP Newsletter, 16(1), 9-14	Newsletter article		PFRP: Integrating Conventional and Electronic Tagging Data into the Spatial Ecosystem and Population Model SEAPODYM
Serafy, J., S. Cooke, G.A. Diaz, J. Graves, M. Hall , M. Shivji, and Y. Swimmer	1/1/12	Evaluating circle hooks in commercial, recreational and artisanal fisheries: research status and needs for improved conservation and management	Bull. Mar. Sci., 88(3), 371-391	Journal Article		Sea Turtle Bycatch & Mitigation: Research and Development

Shillinger, G.L., E. Di Lorenzo, H. Luo, S.J. Bograd, E.L. Hazen, H. Bailey, and J.R. Spotila	2012	On the dispersal of leatherback turtle hatchlings from meso-American nesting beaches	Proceedings of the Royal Society-B, doi:10.1098/rspb.2011.2348		doi: 10.1098/rspb.2011.2348.	Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Shillinger, G.L., H. Bailey, S.J. Bograd, E.L. Hazen, P. Gaspar, B. Godley, M. Hamann, and J.R. Spotila	2012	Tagging through the stages: Technical and ecological challenges in observing life histories through biologging	Mar. Ecol. Prog. Ser., 457, 165-170			Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Sibert, J.	12/15/2011	Changes in skipjack movement and mortality in the WCPO from 1977 to 2005	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Modeling Project
Sibert, J.	12/15/2011	Use of an ecosystem model to explore conservation measures for bigeye tuna in the WCPO	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Modeling Project
Sibert, J., I. Senina, P. Lehodey, and J. Hampton	2012	Shifting from marine reserves to maritime zoning for conservation of Pacific bigeye tuna (*Thunnus obesus*)	PNAS, 109(44), 18221-18225	Journal Article	www.pnas.org/cgi/doi/10.1073/pnas.1209468109	ADMB Open Source Project
Sooraj, K.P., H. Annamalai, A. Kumar, and H. Wang	2012	A comprehensive assessment of CFS hindcast and forecast skills over the tropics	Weather Forecast., 27(1), 3-27	Journal Article	doi: http://dx.doi.org/10.1175/WAF-D-11-00014.1	Development of an Extended and Long-range Precipitation Prediction System over the Pacific Islands
Stewart J.S., E.L. Hazen, D.G. Foley, S.J. Bograd, and W.F. Gilly	In press	Modeling marine predator migration during range expansion: Humboldt squid (Dosidicus gigas) in the California Current System	Mar. Ecol. Prog. Ser.	Journal Article	doi: 10.3354/meps10022	Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Suntsov, A., and R. Domokos	in press	Vertically migrating micronekton and macrozooplankton communities around Guam and the Northern Mariana Islands	Deep-Sea Res., 71, 113-129	Journal Article	http://www.sciencedirect.com/science/article/pii/S0967063712002063	Oceanography Initiative
Thompson, S.A., W.J. Sydeman, J.A. Santora, B.A. Black, R.M. Suryan, J. Calambokidis, W.T. Peterson, and S.J. Bograd	2012	Linking predators to seasonality of upwelling: Using food web indicators and path analysis to infer trophic connections	Prog. Oceanogr., 101, 106-120			Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Thorne, L., D. Johnston, D. Urban, J. Tyne, L. Bejder, R. Baird, S. Yin, S. Rickards, M. Deakos, J. Mobley, Jr., A. Pack, and M. Hill	8/24/12	Predictive modeling of Spinner Dolphin (Stenella longirostris) resting habitat in the Main Hawaiian Islands	PLoS ONE, 7(8), e43167	Journal Article	http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0043167	Fisheries Oceanography: Protected Species Research Program

Vaz, A.	12/15/2011	Early life stage dispersal of yellowfin tuna (Thunnus albacares) in the Central North Pacific	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/PFRP/dec11mtg/dec11mtg.htm	PFRP: Early Life Stage Dispersal of Yellowfin tuna (Thunnus albacares) in the Central North Pacific
Vaz, A.C., K. Richards, C. Paris, and Y. Jia	9/9/11	Here today, gone tomorrow: flow variability, larval dispersal and fisheries management in Hawai'i	University of Miami	Presentation		PFRP: Early Life Stage Dispersal of Yellowfin Tuna (*Thunnus albacares*) in the Central North Pacific
Vaz, A.C., K. Richards, C. Paris, and Y. Jia	9/15/11	Flow variability and its impact on connectivity for the Kona coast of the Hawai'i Island	Symposium on Kona's Marine Ecosystem: Past, Present and Future: Kona, HI. September 15-16, 2011	Workshop Proceedings		PFRP: Early Life Stage Dispersal of Yellowfin Tuna (*Thunnus albacares*) in the Central North Pacific
Vaz, A.C., K. Richards, C. Paris, and Y. Jia	2/20/12	Flow variability and its impact on connectivity for the Island Hawai'i	Ocean Sciences Meeting: Salt Lake City, UT. February 20-24, 2012	Conference Proceedings		PFRP: Early Life Stage Dispersal of Yellowfin Tuna (*Thunnus albacares*) in the Central North Pacific
Vaz, A.C., K. Richards, C. Paris, and Y. Jia	in press	Mesoscale flow variability and its impact on connectivity for the Island Hawai'i	Geophys. Res. Lett.	Journal Article	doi: 10.1029/2012GL054519	PFRP: Early Life Stage Dispersal of Yellowfin Tuna (*Thunnus albacares*) in the Central North Pacific
Vetter, O.J., and J.M. Gove	7/9/12	Quantifying wave stress on coral reefs	12th International Coral Reef Symposium: Cairns, QLD, Australia. July 9-13, 2012	Presentation		Sustaining Healthy Coastal Ecosystems
Walsh, W.A.	12/6/11	Preliminary analyses of catch and catch rate data for blue shark and shortfin mako in the Hawaii-based longline fishery in 1995–2010	ISC Shark Working Group Workshop: La Jolla, CA. November 28-December 6, 2011.	Workshop Proceedings	http://isc.ac.affrc.go.jp/pdf/SHARK/ISC11_SHARK_2/02-Walsh-ISC-WP-Final.pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Walsh, W.A.	2/29/12	CPUE standardization for oceanic whitetip and silky sharks in the Hawaii-Based pelagic longline fishery	JIMAR/PIFSC Symposium: Honolulu, HI. February 29, 2012	Presentation		Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Walsh, W.A., and S.C. Clarke	9/1/11	Analyses of catch data for oceanic whitetip and silky sharks reported by fishery observers in the Hawaii-based longline fishery in 1995–2010	NOAA PIFSC Administrative Report 11-010	Report	http://www.pifsc.noaa.gov/library/pubs/admin/PIFSC_Admin_Rep_11-10.pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program
Walsh, W.A., and S.L.H. Teo	6/4/12	Catch statistics, length data, and standardized CPUE for blue shark Prionace glauca taken by longline fisheries in Hawaii and California	ISC Shark Working Group Workshop: Shimizu, Japan. May 28-June 4, 2012.	Workshop Proceedings	http://isc.ac.affrc.go.jp/pdf/SHARK/ISC12_SHARK_1/02-Walsh&Teo-US%20longline-final.pdf	Marine Resources Dynamics Assessment Program (MARDAP): Stock Assessment Research Program

Walsh, W.A., D.T. Tagami, and H. Wang	March 2012	A long-term nominal catch history for blue marlin Markaira nigricans in Hawaiian waters	ISC Billfish Working Group Workshop: Shanghai, China. April 2-9, 2012. ISC/12/ BILLWG-1	Technical Report	http://isc.ac.affrc.go.jp/ pdf/BILL/ISC12_BILL_1/ ISC12BILLWG-1_WP03.pdf	Fisheries Oceanography: Ecosystem Observations & Research Program
Wang, H., M. Parke, and D. Tagami	2/29/2012	GIS applications in the marine fisheries and ecosystem management in the Pacific islands	JIMAR/PIFSC Symposium: Honolulu, HI. February 29, 2012	Presentation		Fisheries Oceanography: Ecosystem Observations & Research Program
Weng, K.	12/15/2011	Preliminary data for movements of monchong at Cross Seamount	PFRP Principal Investigators Meeting: Honolulu, HI. December 15-16, 2011	Presentation	http://www.soest.hawaii.edu/ PFRP/dec11mtg/dec11mtg. htm	PFRP: Biology and Habitat Use of Monchong (Eumegistis illustris) at Cross Seamount, Hawaii
Weng, K., A. Gray, J. Muir, D. Itano, K. Holland, and M. Seki	5/21/12	Movements of monchong at a heavily fished seamount	Proceedings of the 63rd Tuna Conference: Lake Arrowhead, CA. May 21-24, 2012	Conference Proceedings	http://www. tunaconference.org/ PDFfiles/63rdMeeting/63rd-Annual-TC-Proceedings.pdf	PFRP: Biology and Habitat Use of Monchong (Eumegistis illustris) at Cross Seamount, Hawaii
Weng, K., and J. Sibert	5/21/12	The Pelagic Fisheries Research Program - 15 Years of fisheries science	Proceedings of the 63rd Tuna Conference: Lake Arrowhead, CA. May 21-24, 2012	Conference Proceedings	http://www. tunaconference.org/ PDFfiles/63rdMeeting/63rd-Annual-TC-Proceedings.pdf	PFRP: Management Project
Williams, G., J. Asher, R. Brainard, J. Ehses, J. Gove, T. Jones, I. Wiliams, and S. Sandin	7/9/12	Coral reef resilience across US-affiliated islands in the Pacific Ocean	12th International Coral Reef Symposium: Cairns, QLD, Australia. July 9-13, 2012	Presentation		Sustaining Healthy Coastal Ecosystems
Williams, I., J. Zamzow, K. Lino, M. Ferguson, and E. Donham.	10/9/12	Status of coral reef fish assemblages and benthic condition around Guam: a report based on underwater visual surveys in Guam and the Mariana Archipelago, April-June 2011	U.S. Dept. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-33, 22 p. + Appendices.	Technical Report	http://www.pifsc.noaa.gov/ library/pubs/tech/NOAA_ Tech_Memo_PIFSC_33.pdf	Sustaining Healthy Coastal Ecosystems
Wingfield, D.K., S.H. Peckham, D.G. Foley, D.M. Palacios, B.E. Lavaniegos, R. Durazo, W.J. Nichols, D.A. Croll, and S.J. Bograd	2011	The making of a productivity hotspot in the coastal ocean	PLoS ONE 6(11), e27874	Journal Article	doi: 10.1371/journal. pone.0027874.t001.	Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
Woodworth, P., G.S. Schorr, R.W. Baird, D. Webster, D. McSweeney, M.B. Hanson, R. Andrews, and J. Polovina	2011	Eddies as offshore foraging grounds for melon-headed whales (Peponocephala electra)	Mar. Mammal Sci.	Journal Article	doi: 10.1111/j.1748-7692.2011.00509.x	Cetacean Oceanography
Wurth, T.	11/8/11	The status of monk seals in the main Hawaiian Islands: a positive, but fragile trend	18th Annual Wildlife Society Conference: Kona, HI. November 5-10, 2011	Presentation		Fisheries Oceanography: Protected Species Research Program

Wurth, T.	2/29/12	The status of monk seals in the main Hawaiian Islands: a positive, but fragile trend	JIMAR/PIFSC Symposium: Honolulu, HI. February 29, 2012	Presentation		Fisheries Oceanography: Protected Species Research Program
Wurth, T.	5/3/12	The status of monk seals in the main Hawaiian Islands: a positive, but fragile trend	5th Annual Hawaiian Islands Symposium: Honolulu, HI. May 2-3, 2012	Presentation		Fisheries Oceanography: Protected Species Research Program
Yoshida, S., B. Qiu, and P. Hacker	12/8/11	Low-frequency eddy modulations in the Hawaiian Lee Countercurrent: Observations and connection to the Pacific Decadal Oscillation	J. Geophys. Res.-Oceans, 116, C12009	Journal Article	doi: 10.1029/2011JC007286	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center
Young, C., J. Gove, and R. Brainard	7/9/12	Quantiyfing inter-island variability in aragonite saturation state	12th International Coral Reef Symposium: Cairns, QLD, Australia. July 9-13, 2012	Presentation		Sustaining Healthy Coastal Ecosystems
Zhang, C.X., Y. Wang, A. Lauer, K. Hamilton, and F. Xie	8/11/12	Cloud base and top heights in the Hawaiian region determined with satellite and ground-based measurements	Geophys. Res. Lett., 39, L15706	Journal Article	doi: 10.1029/2012GL052355	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center
Zhang, C.X., Y. Wang, and K. Hamilton	11/1/11	Improved representation of boundary layer clouds over the Southeast Pacific in WRF-ARW using a modified Tiedtke cumulus parameterization scheme	Mon. Wea. Rev., 139, 3489-3513	Journal Article	doi: 10.1175/ MWR-D-10-05091.1	Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center

JIMAR Publications—Deep Water Horizon

Project #	PI Name/Author Names	Publication Date	Publication Title	Published In (Journal Name, volume and page number)	Type of Publication	Citation No. or hyperlink
661261	Jones, T.T.	2011	Gulf Diaries 2: On the Events, People, and Turtles of the Mississippi Shoreline	State of the World's Sea Turtles (SWOT), 6, 20-21	Magazine Article	www.seaturtlestatus. org/sites/swot/files/ report/033111_ SWOT6_p16-21_ Disaster Strikes.pdf
658543	MacPherson, S., R. Trindell, B. Schroeder, L. Patrick, D. Ingram, K. Frutchey, J. Provancha, A. Lauritsen, B. Porter, A. Foley, A. Meylan, B. Witherington, M. Pico	4/12/2011 (submitted)	Sea Turtle Nest Translocation Effort in the Florida Panhandle and Alabama, USA, in Response to the Deepwater Horizon (Mc-252) Oil Spill in the Gulf of Mexico	Proceedings of the 31st Annual Symposium on Sea Turtle Biology and Conservation, San Diego, California, USA, 12 - 15 April 2011	Conference Proceedings	

Appendix I List of Acronyms

AA-CSIA	Amino Acid Compound Specific Isotope Analysis
ACC	Anomaly Correlation Coefficient
ACL	Annual Catch Limit
ACT	Annual Catch Target
ADAM	AWIPS II Data and Application Migration
ADCP	Acoustic Doppler Current Profiler
ADMB	Automatic Differentiation Model Builder
ALOHA	A Long Term Oligotrophic Habitat Assessment
APDRC	Asia-Pacific Data Research Center
ARL	Air Resources Laboratories
ARSHSL	Archive of Rapidly-Sampled Hawaiian Sea Level
ASCAT	Advanced Scatterometer
ASRAMP	American Samoa Reef Assessment and Monitoring Program
AUTODIF	Library used in AD Model Builder; admb-project.org
AUV	Autonomous Underwater Vehicle
AVHRR	Advanced Very High Resolution Radiometer
AVISO	Archiving Validation and Interpretation of Satellite Oceanographic Data
AWIPS	Advanced Weather Interactive Processing System
BAMS	Bulletin of the American Meteorological Society
BET	Big Eye Tuna
BIA	Bioelectrical Impedance Assessments
BILLWG	ISC Billfish Working Group
BMUS	Bottomfish Management Unit Species
BREP	Bycatch Reduction Engineering Program
BRT	Biological Review Team
BSISO	Boreal Summer Intraseasonal Oscillation
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
CAM	Community Atmospheric Model
CAU	Calcification Acidification Units
CC POC	Climate Change Point of Contact
CCA	Canonical Correlation Analysis
CCMP	Cross-Calibrated Multi-Platform
cDNA	Complimentary DNA
CE	Common Era
CFBS	Commercial Fisheries Biosampling
CFS	Climate Forecast System
CI	Convective Initiation
CIMSS CRAS	Cooperative Institute for Mesoscale Meteorology Regional Assimilation Model [System]
CITES	Convention on International Trade of Endangered Species
CLIDDSS	Climate Information Delivery and Decision Support System
CLIOTOP	Climate Impacts on Top Predators
CLIVAR	Climate Variability and Predictability Research Program
CLS	Collecte et Localisation par Satellites
CMIP5	Coupled Model Intercomparison Project Phase 5
CML	Commercial Marine License
CMS	Connectivity Modeling System
CNES	Centre National d'Etudes Spatiales
CNMI	Commonwealth of the Northern Mariana Islands
COMET	Cooperative Meteorological Education and Training
CONUS	Continental United States
CoRIS	Coral Reef Information System

COSMIC	Constellation Observing System for Meteorology, Ionosphere and Climate
CPC	Climate Prediction Center
CPK	Creatine phosphokinase
CPUE	Catch Per Unit Effort
CRED	Coral Reef Ecosystem Division
CRES	Coral Reef Ecosystem Studies
CRP	Cetacean Research Program
CSIA-AA	Compound Specific Nitrogen Stable Isotope Analysis of Amino Acids
CSIRO	Commonwealth Scientific and Industrial Research Organization
CTD	Conductivity-Temperature-Depth
CTI	Coral Triangle Initiative
DAFF	Department of Agriculture, Fisheries and Forests (Niue)
DAR	Division of Aquatic Resources (Hawaii)
DAWR	Division of Aquatic and Wildlife Resources (Guam)
DDIP	Data Documentation Implementation Plan
DEM	Digital Elevation Model
DFW	Division of Fish and Wildlife (CNMI)
DLL	Dynamic Link Libraries
DLNR	Department of Land and Natural Resources
DM	Data Management
DMAC	Data Management and Communications
DMWR	Department of Marine and Wildlife Resources (American Samoa)
DNA	Deoxyribonucleic acid
DO	Dissolved Oxygen
DODS	Distributed Ocean Data System
DSC	Data Stewardship Committee
DSS	Data Server Systems
EA	Environmental Assessments
E-A	Euro-American
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ENSO	El Niño Southern Oscillation
EOF	Empirical Orthogonal Function
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESRL	Earth Systems Research Laboratory
ETP	Eastern Tropical Pacific Ocean
EWC	East-West Center
FA	Fatty Acid
FAD	Fish Aggregating Device
FCMA	Fishery Conservation and Management Act
FEMA	Federal Emergency Management Agency
FFA	Forum Fisheries Agency
FFS	French Frigate Shoals
FMP	Fishery Management Plan
FOCUS	Forests Oceans and Us
FSWP	Fishery Statistics of the Western Pacific
FUS	Fisheries of the United States
FWS	Fish and Wildlife Service
FY	Fiscal Year
GAM	Generalized Additive Model
GCM	General Circulation Model
GCMP	Guam Coastal Management Program
GCOS	Global Climate Observing System

GEAR UP	Gaining Early Awareness and Readiness for Undergraduate Program
GEOSS	Global Earth Observation System of Systems
GFDL	Geophysical Fluid Dynamics Laboratory
GIS	Geographic Information System
GLM	Generalized Linear Model
GLOSS	Global Sea Level Observing System
GODAE	Global Ocean Data Assimilation Experiment
GOES-R	Geostationary Operational Environmental Satellite R-Series
GPS	Global Positioning System
GrADS	Grid Analysis and Display System
GTS	Global Telecommunications System
GUI	Graphical User Interface
HAPC	Habitat Areas of Particular Concern
HARP	High-frequency Acoustic Recording Package
HCC	Honolulu Community College
HDRP	Human Dimensions Research Program
HFO	Honolulu Forecast Office
Hg	Mercury
Hg^0	Elemental Mercury
Hg^P	Particulate Mercury
HIGICC	Hawaii Geographic Information Coordinating Council
HIHWNMS	Hawaiian Islands Humpback Whale National Marine Sanctuary
HIMB	Hawaii Institute of Marine Biology
HiOOS	Hawaii Ocean Observing System
HLF	Hawaii Longline Fishery
HMS	Hawaiian Monk Seal
HMSRP	Hawaiian Monk Seal Research Program
HOT	Hawaii Ocean Time Series
HPF	High-Pass Filtered
HPU	Hawaii Pacific University
HRPT	High Resolution Picture Transmission
HSC70	Heat Shock Chaperone 70
HSF	Heat Shock Transcription Factor
HSP70	Heat Shock Protein 70
HTML	HyperText Markup Language
HTTP2	Hawaii Tuna Tagging Project 2
HYCOM	Hybrid Coordinate Ocean Model
IAS	Inter-American Seas
IATTC	Inter-American Tropical Tuna Commission
IDEA	Integrated Data and Environmental Applications
IEA	Integrated Ecosystem Assessment
IFOMC	International Fisheries Observer and Monitoring Conference
IG	Infragravity
IMPLAN	Impact Analysis for Planning - economic analysis software
I-O	Input-Output
IOOS	Integrated Ocean Observing System
IOTC	Indian Ocean Tuna Commission
IPRC	International Pacific Research Center
IRAM	IPRC Regional Atmospheric Model
ISC	International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean
ISO	Intraseasonal Oscillation
ISVHE	IntraSeasonal Variability Hindcast Experiment
ITS	Information Technology Services
JAMSTEC	Japan Agency for Marine-Earth Science and Technology

JASL	Joint Archive for Sea Level
JIMAR	Joint Institute for Marine and Atmospheric Sciences
K-A	Korean-American
KAP	Knowledge, Attitudes and Perceptions
LAS	Live Access Server
LDH	Lactate Dehydrogenase
LDM	Local Data Manager
LED	Light-Emitting Diode
LH	Life History
LiDAR	Light Detection and Ranging
LLDS	Longline Logbook Data System
LODS	Longline Observer Data System
LOESS	Locally Weighted Scatterplot Smoothing ("Local regression")
MARDAP	Marine Resource Dynamics and Assessment Program
MCBH	Marine Corps Base Hawaii
MDF	Mass-Dependent Fractionation
MeHg	Methylmercury
MEPS	Marine Ecology Progress Series
MHI	Main Hawaiian Islands
MIF	Mass-Independent Fractionation
MIMIC - TPW	Morphed Integrated Microwave Imagery -Total Precipitable Water
miniPAT	Mini Pop-up Archival Transmitting tag
MJO	Madden-Julian Oscillation
MLO	Mauna Loa Observatory
MLRM	Multiple Linear Regression Model
MME	Multi-Model Ensemble
MME1	Multi-Model Ensemble Mean 1
MMEB2	Multi-model Ensemble Best 2
MMEB3	Multi-model Ensemble Best 3
MMPA	Marine Mammal Protection Act
MNM	Marine National Monuments
MOCNESS	Multiple Opening/Closing Net and Environmental Sensing System
MODIS	Moderate Resolution Spectral Spectroradiometer
mRNA	Messenger RNA
MSY	Maximum Sustainable Yield
mt	Metric Tons
MTL	Mid-Trophic Level
MTMNM	Marianas Trench Marine National Monument
MTRP	Marine Turtle Research Program
MUS	Management Unit Species
NAAFE	North American Association of Fisheries Economists
NASC	Nautical Area Scattering Coefficient
NCCOS	National Centers for Coastal Ocean Science
NCEP	National Center for Environmental Prediction
NEDIS	National Environmental Data and Information Service
NEPA	National Environmental Policy Act
NGO	Non Governmental Organization
NLOM	Navy Layered Ocean Model
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NODC	National Oceanographic Data Center
NORPAX	North Pacific Experiment
NOS	National Ocean Service
NPOESS	National Polar Orbiting Environmental Satellite System

NPP	NPOESS Preparatory Project
NRIFSF	National Research Institute of Far Seas Fisheries
NSF	National Science Foundation
NWFSC	Northwest Fisheries Science Center
NWHI	Northwestern Hawaiian Islands
NWS	National Weather Service
OBIS-USA	Ocean Biogeographic Information System – United States America
OCO	Office of Climate Observation
OES	Outreach and Education Specialist
OFES	Ocean model For Earth Simulator
OLR	Outgoing Long Radiation
OMB	Office of Management and Budget
OPeNDAP	Open-source Project for a Network Data Access Protocol
ORE	Outreach and Education Program
ORS	Ocean Remote Sensing
OVM	Ontogenic vertical migration
PacIOOS	Pacific Islands Ocean Observing System
PCF	Parallel Computing Facility
PDO	Pacific Decadal Oscillation
PEAC	Pacific ENSO Applications Center
PED	Pound net Escape Device
PFEL	Pacific Fisheries Environmental Laboratory
PFRP	Pelagic Fisheries Research Program
PICEAS	Palmyra Islands Cetacean and Ecosystem Assessment Survey
PICES	Pacific International Council for the Exploration of the Sea, now referred to as the North Pacific Marine Science Organization
PIFG	Pacific Islands Fisheries Group
PIFSC	Pacific Islands Fisheries Science Center
PIMSP	Pacific Islands Monitoring and Sampling Program
PIR	Pacific Islands Region
PIRO	Pacific Islands Regional Office
PIROP	Pacific Islands Regional Observer Program
PITD	Pacific International Training Desk
PMEL	Pacific Marine Environmental Laboratory
PRA	Paperwork Reduction Act
PRC	Pacific Regional Center
PRD	Protected Resources Division
PRECI	Protected Resources Environmental Compliance Initiative
PRIA	Pacific Remote Island Areas
PRSN	Puerto Rico Seismic Network
PSATs	Pop-up Satellite Archival Tags
PSD	Power Spectral Density
PSMSL	Permanent Service for Mean Sea Level
PTTP	Pacific Tuna Tagging Project
PTWC	Pacific Tsunami Warning Center
PTWS	Pacific Tsunami Warning System
R/V	Research Vessel
RA	Regional Associations
RAMP	Reef Assessment and Monitoring Program
RFMO	Regional Fisheries Management Organization
RFO	Regional Fisheries Organization
RFP	Request for Proposal
RGM	Reactive Gaseous Mercury
RISA	Regional Integrated Climate and Assessment

RMM1	Realtime Monitoring Mode 1
RMM2	Realtime Monitoring Mode 2
SAM	Social Accounting Matrix
SC	Stomach Content
SEAPODYM	Spatial Ecosystem and Population Dynamics Model
SFD	Sustainable Fisheries Division
SHARKWG	ISC Shark Working Group
SIS	Scientific Information Services
SL	Sea Level
SNA	Social Network Analysis
SODA	Simple Ocean Data Assimilation
SOEST	School of Ocean and Earth Science and Technology
SOI	Southern Oscillation Index
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
SPTA	South Pacific Tuna Act
SPTT	South Pacific Tuna Treaty
SSC	Scientific and Statistical Committee
SSH	Sea Surface Height
SSI	Samoan Studies Institute
SST	Sea Surface Temperature
STEM	Science, Technology, Education and Math
SWFSC	Southwest Fisheries Science Center
TAC	Total Allowable Catch
TB	Terrabyte
TC	Tropical Cyclone
THREDDS	Thematic Real-time Environmental Distributed Data Services
TOGA	Tropical Ocean Circulation Experiment
TP	Trophic Position
TPAA	Trophic Position as determined through Amino Acid analysis
TUMAS	Tuna Management Simulator
UFA	United Fishing Agency
UH	University of Hawaii
UHM	University of Hawaii at Manoa
UHSLC	University of Hawaii Sea Level Center
UMiami	University of Miami
USAPI	U.S. Affiliated Pacific Islands
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service
UV	Ultraviolet
UW-Madison	University of Wisconsin-Madison
V-A	Vietnamese-American
VGPM	Vertically Generalized Production Model
VIIRS	Visible Infrared Imaging Radiometer Suite
WCATWC	West Coast and Alaska Tsunami Warning Center
WCNPO	Western and Central North Pacific Ocean
WCPFC	Western and Central Pacific Fisheries Commission
WCPFCIA	Western and Central Pacific Fisheries Convention Implementation Act
WCPO	Western and Central Pacific Ocean
WesPac	Western Pacific Regional Fishery Management Council
WHAP	West Hawaii Aquarium Project
WHOI	Woods Hole Oceanographic Institution
WHOTS	WHOI Hawaii Ocean Time-series Station
WMO	World Meteorological Organizationa

WOCE	World Ocean Circulation Experiment
WPacFIN	Western Pacific Fisheries Information Network
WPFMC	Western Pacific Fisheries Management Council
WPR	Western Pacific Region
WPRFMC	Western Pacific Regional Fishery Management Council
WWF	World Wildlife Fund

Appendix II Visiting Scientists

Date	Name/Affiliation	Purpose of Visit
07/10/11 - 07/16/11	Cara Field Associate Veterinarian Audubon Nature Institute New Orleans, LA	To meet with NMFS monk seal health and diseases staff and participate in field research activities.
08/17/11 - 08/27/11	Mary Wicksten Professor Texas A&M University College Station, TX	To participate in a cruise on board the *R/V Kilo Moana*.
09/12/11 - 09/19/11	Colette Wabnitz Researcher University of British Columbia Vancouver, BC, Canada	To further develop the software used for ecosystem modeling and present results at the PIFSC 2011 Symposium on Kona's Marine Ecosystem.
09/23/11 - 10/03/11	Nathalie Zilberman Postdoctoral Scholar UC San Diego La Jolla, CA	To work on a joint manuscript, "Analytical estimates of M2 internal tide generation at the Hawaiian Ridge".
10/20/11 - 10/22/11	Richard Carbone Science Advisor Earth Observing Laboratory, NCAR Boulder, CO	To assist Dr. Yangping Li in the preparation of their presentation at the WCRP Open Science Conference and to initiate planning of the next phase of WPWP rainfall/SST research.
11/01/11 - 11/03/11	Richard Carbone Science Advisor Earth Observing Laboratory, NCAR Boulder, CO	To assist Dr. Yangping Li in the preparation of their presentation at the WCRP Open Science Conference and to attend planning meeting of the next phase of WPWP rainfall/SST research.
11/15/11 - 11/17/11	Richard Carbone Science Advisor Earth Observing Laboratory, NCAR Boulder, CO	To discuss and clarify manuscript review and responses with Gary Barnes, revise Joint Atmospheric Science article with Dr. Yangping Li, work on computation scheme for next oceanic convection paper.

11/30/11 - 12/02/11	Richard Carbone Science Advisor Earth Observing Laboratory, NCAR Boulder, CO	To complete the revised manuscript for publication in JAS ("Excitation of rainfall in the tropical Western Pacific"); continued work on another journal paper concerning propagation of deep convection from coastlines of continents into oceans; and outlining the content of a third paper to qualify the relative strengths of SST gradient forcing and free tropospheric tropical wave in the Western Pacific warm pool region.
12/14/11 - 12/17/11	Yi Chao Scientist Jet Propulsion Lab California Institute of Technology Pasadena, CA	Invited keynote speaker at the 2011 Annual Pelagic Fisheries Research Program Principal Investigators Meeting.
02/07/12 - 03/06/12	Rui-Xin Huang Senior Scientist Woods Hole Oceanographic Institution Woods Hole, MA	To collaborate on the study of ocean circulation dynamics and coastal sea level variability in the Pacific Ocean.
02/10/12 - 02/10/12	Hailey L. Ramey Marine Scientist Lahaina, Maui, HI	To attend a workshop at the Kewalo Research Facility to discuss marine/fish ecology and statistical data analysis methods.
02/15/12 - 02/16/12	Richard Carbone Science Advisor Earth Observing Laboratory, NCAR Boulder, CO	To meet with faculty at the SOEST Department to discuss various collaborative activities.
02/24/12 - 02/28/12	Noel E. Davidson Principal Research Scientist Australia Bureau of Meteorology Melbourne, Australia	To give a seminar and to join group discussions on the topic of tropical cyclone research at CAWCR (Center of Australian Weather and Climate Research).
03/09/12 - 03/13/12	Robert Guza Professor University of California at San Diego San Diego, CA	To discuss ongoing research topics with the students and staff and present a seminar discussing nearshore research.
03/12/12 - 03/17/12	Mark N. Mauder Head Scientist Stock Assessment Program Inter-American Tropical Tuna Commission La Jolla, CA	To participate in the ADMB (AD Model Builder) Developers Workshop.

03/12/12 - 03/18/12	Weihai Liu Research Scientist Michigan State University Lansing, MI	To participate in the ADMB (AD Model Builder) Developers Workshop.
03/12/12 - 03/17/12	David Fournier President Otter Research Ltd. Sidney, BC, Canada	To participate in the ADMB (AD Model Builder) Developers Workshop.
03/12/12 - 03/16/12	Hans Skaug Professor Universitetet i Bergen, Matematisk Institutt Bergen, Norway	To participate in the ADMB (AD Model Builder) Developers Workshop.
03/12/12 - 03/17/12	Christopher Grandin Stock Assessment Scientist Ladysmith, BC, Canada	To participate in the ADMB (AD Model Builder) Developers Workshop.
03/12/12 - 03/17/12	Anders Nielsen Senior Scientist National Institute of Aquatic Resources Technical University of Denmark Charlottenlund, Denmark	To participate in the ADMB (AD Model Builder) Developers Workshop.
03/12/12 - 03/17/12	Steven J.D. Martell Professor University British Columbia Vancouver, BC	To participate in the ADMB (AD Model Builder) Developers Workshop.
03/12/12 - 03/17/12	Arni Magnusson Senior Scientist Marine Research Institute Reykjavik, Iceland	To participate in the ADMB (AD Model Builder) Developers Workshop.
03/12/12 - 03/18/12	Yukio Takeuchi Fisheries Scientist National Research Institute for Sea Fisheries Shizuoka, Japan	To participate in the ADMB (AD Model Builder) Developers Workshop.
03/29/12 - 04/18/12	Benjamin J. Sunders Research Associate University of Western Australia Crawley, Western Australia	To collaborate and share techniques in the preparation and deployment of baited remote underwater video stations (BRUVs) in Pago Pago, American Samoa and aboard the NOAA vessel *Oscar Elton Sette*. Also to analyze of data while the vessel is in port after the cruise.
06/11/12 - 06/13/12	Euan Harvey Associate Professor Oceans Institute University of Western Australia Crawley, Australia	To participate in the PFISC Workshop to discuss needs, specifications, and designs for the development of a modular stereo-video system.

06/11/12 - 06/13/12	Clay Kunz Research Engineer Woods Hole Oceanographic Institute Woods Hole, MA	To participate in the PFISC Workshop to discuss needs, specifications, and designs for the development of a modular stereo-video system.
06/18/12 - 06/19/12	Anne Cohen Tenured Associate Scientist Woods Hole Oceanographic Institute Woods Hole, MA	To participate in the 82nd Corals Scientific Workshop and visit JIMAR and NOAA PIFSC.
06/19/12 - 06/21/12	Christopher D. Moyes Professor Queen's University at Kingston Kingston, ON, Canada	To participate in the Scientific and Statistical Committee (SSC) meetings.
06/26/12 - 07/04/12	Jason M. Blank Assistant Professor California Polytechnic University San Luis Obispo, CA	To help set up experiments with PFRP staff regarding the impacts of climate change on tuna physiology.
07/09/12 - 07/21/12	Simon J. Holgate Sea Level Scientist National Oceanography Centre Liverpool, United Kingdom	To discuss ongoing research topics with student and staff, and to formalize the data exchange protocols between UHSLC and the Permanent Service for Mean Sea Level.
07/19/12 - 08/24/12	Jerom Aucan Research Scientist Institut de Recherche pour le Developpement Noumea, New Caledonia	To discuss ongoing research topics with students and staff, to conduct CNES funded field study on infragravity waves around the Hawaiian Islands.
07/23/12 - 08/03/12	Jerald Ault Professor of Marine Biology Rosenstiel School of Marine & Atmospheric Science University of Miami RSMAS Miami, FL	To give presentations at the Coral Reef Fisheries Stock Assessment workshops in Jakarta and Mataram, Indonesia.
08/19/12 - 09/01/12	Kyler Abernathy Director of Research National Geographic Society Washington, DC	To participate in the Monk Seal Field work in Honolulu and Molokai.
08/19/12 - 09/01/12	Gregory Marshall Vice President Remote Imaging National Geographic Society Washington, DC	To participate in the Monk Seal Field work in Honolulu and Molokai.

08/28/12 - 09/24/12	Takashi Ishihara Researcher University of Tokyo Tokyo, Japan	To work with Dr. John Wang on the research of coastal Japanese pound nets and the development of pound net escape devices.
09/23/12 - 09/29/12	James A. Sulikowski Associate Professor University of New England Portland, ME	To assist in developing experiments relating to the survivorship of fishes released from commercial fishing gear, conducting laboratory studies, and collection and analyses of fish blood samples using techniques that quantify blood chemistry.

Appendix III Workshops and Meetings Hosted by JIMAR

PFRP Principal Investigators Meeting
December 15-16, 2011
Pacific Room, Imin Conference Center, UH-Manoa

Melanie Abecassis
Michelle Barnes
Keith Bigelow
Pat Caldwell
Yi Chao (guest speaker)
Anela Choy
Amy Comer
Christina Comfort
Gerard Dinardo
Reka Domokos
Jeff Drazen
Andrew Gray
Don Hawn
Kim Holland

Evan Howell
Simon Hoyle
Robert Humphreys
Melanie Hutchinson
David Itano
Yan Li Jia
Todd Jones
Chris Kelley
Eun Jung Kim
Pierre Kleiber
Leila Madge
Roy Morioka
Jeff Muir
Mike Musyl

Robert Olson
Minling Pan
Jeffrey Polovina
Sam Pooley
Laurie Richmond
Michael Seki
John Sibert
Chi-Lu Sun
Ana Vaz
John Wang
Kevin Weng
Johnoel Ancheta
Dodie Lau

JIMAR/PIFSC Symposium
February 29, 2012
Koi Room, Imin Conference Center, UH-Manoa

Melanie Abecassis
Tomoko Acoba
Christina Aiu
Brian Akizuki
Shawn Arita
George Balazs
Michelle Barbieri
Mallory Barnes
Michelle Barnes
Courtney Beavers
Brenda Becker
Paul Bienfang
Viv Blythe-Skyrme
Chris Boggs
Amanda Bradford
Rusty Brainard
Jon Brodziak
Samantha Brooke
Karen Brousseau
Shannon Brunson
Colleen Bryan
Caitlin Burgess
Marie Cahoon
Nathan Chan
Anela Choy
Jeanette Clark
Edmund Coccagna
Christina Comfort
William Conner
Chris Demarke
Ed DeMartini
Annette DesRochers
Gerard Dinardo

Robert Dollar
Reka Domokos
Mary Donovan
Jeff Drazen
Megan Duncan
Matt Dunlap
Julia Ehses
Eric Firing
Pollyanna Fisher Pool
Devon Francke
Erik Franklin
Alan Friedlander
Jason Friedman
Jamie Gove
Marisa Guarinello
Sean Guerin
Jan Hafner
Michelle Han
Kimberlee Harding
Jeff Hare
Chris Hawkins
Adel Heenan
John Henderson
Kevin Higaki
Marie Hill
Evan Howell
Robert Humphreys
Cynthia Hunter
Yanli Jia
Thea Johanos
T. Todd Jones
Blanche Kaiura
Kolter Kalberg

Susan Kamei
Troy Kanemura
Liz Kashinsky
Angie Kaufman
Kurt Kawamoto
Christoper Kelley
Vikram Khurana
Don Kobayashi
Marc Lammers
Dodie Lau
Michel Laudier
Hui-Hua Lee
Jo Ann Leong
Frances Lichowski
Charles Littnan
Jessica Lopez
Dan Luers
Wendy Marks
Mark Merrifield
Jessica Miller
William Misa
Camlo Mora
Virginia Moriwake
Lucas Moxey
Bruce Mundy
Shawn Murakawa
Mike Musyl
Paul Nachtigall
Katie Nichols
Pat O'Bryen
Joseph O'Malley
Marcia Oshiro
Minling Pan

Michael Parke
Frank Parrish
Jeff Polovina
Sam Pooley
Brian Popp
Jim Potemra
Carly Quisenberry
Adrian Ramirez
Benjamin Richards
Alison Rieser
Audrey Rollo
John Rooney
Kelley Sage
Eva Schemmel
Michael Seki
Noriko Shoji
Cheree Smith
Katie Smith
Mark Sullivan
Dennis Sunada
Megan Sundberg
Daryl Tagami
Jeremy C. Taylor
Lennon Thomas
Frank Timmers
Mary Timmers
Molly Timmers
Ashley Tomita
Eric Tong
Rob Toonen
Matthew Vandersande
Oliver Vetter
Bernardo Vorger

Nicole Wakazuru-Yoza
William A. Walsh
Haiying Wang
John Wang
Matt Waterhouse
Bin Wei
Mariska Weijerman
Jonathan Weiss
Kevin Weng
Ivor Williams
Connie Winterstein
Kevin Wong
Johanna Wren
Tracy Wurth

ADMB Developers Workshop
March 13-16, 2012
Kamehameha Room, Imin Conference Center, UH-Manoa

Teresa Amar
Johnoel Ancheta
Casper Berg
Jon Brodziak
Mollie Brooks
Ray Conser
David Fournier
Chris Grandin
Jim Ianelli
Eun Jung Kim
Pierre Kleiber
Chris Legault

Weihei Liu
Arni Magnusson
Steven Martell
Mark Maunder
Anders Nielsen
Derek Seiple
John Sibert
Hans Skaug
Matthew Supernaw
Yukio Takeuchi
Ian Taylor

Appendix IV JIMAR Personnel

Information as of September 30, 2012

Category	Number	Unknown	High School	Associates	Bachelors	Masters	Ph.D.
Research Scientist	19	0	0	0	0	0	19
Visiting Scientist	0	0	0	0	0	0	0
Postdoctoral Fellow	9	0	0	0	0	0	9
Research Support Staff	108	0	2	5	61	36	4
Administrative	10	0	0	0	7	2	1
Undergraduate Students	34	0	34	0	0	0	0
Graduate Students	36	0	0	0	18	18	0
Received less than 50% NOAA support	3	0	0	0	0	0	3
Total	**219**	**0**	**36**	**5**	**86**	**56**	**36**
Located at Lab (include name of lab)	PMEL: 2 PFEL: 4 PIRO: 10 PIFSC: 103 ESRL: 3						
Obtained NOAA employment within the last year	2						
Postdoctoral Fellows and Students from Subgrantees	Postdocs: 4 Students: 1						

Appendix V Awards

Kathryn Dennis
- NOAA PIFSC Team Member of the Year

Vikram Khurana
- Nominated for 2011 RCUH Outstanding Employee of the Year

Hui-Hua Lee
- NOAA PIFSC Team Member of the Month for July 2011

Daniel Luers
- 2011 NOAA PIRO Team Member of the Year

Meagan Sundberg
- NOAA PIFSC Team Member of the Year, May 2012

John Wang
- 2011 World Wildlife Fund International Smartgear Runner-up Award, Net illumination as a strategy to reduce sea turtle bycatch in gillnets. Awarded to Ocean Foundation and John Wang (Co-PI)

John Wang
- 2010 Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring. Awarded to Ocean Discovery Institute. (Science Advisory Board). Received in 2011.

Group Awards

Group Nomination for 2011 RCUH Outstanding Employee of the Year
- JIMAR/Coral Reef Operations & Marine Debris Team: Kyle H. Koyanagi, Marie H. Ferguson, Mark E. Manuel, Kevin D. O'Brien, Russell T. Reardon, and Max D. Sudnovsky

Appendix VI Graduates

Melanie Abecassis, PhD
"Modeling the interactions between swordfish, loggerhead sea turtles, and longline fisheries in the North Pacific"

Michelle Barnes-Mauthe, MS
"Bonding, bridging, and linking social capital in an ethnically diverse fishery: The case of Hawaii's longline fishery"

Alexandra Bayless, MS
"Acoustic monitoring of interactions between false killer whales (*Pseudorca crassidens*) and the Hawaii-based pelagic longline fishery"

Christina Comfort, MS
"Spatial and trophic ecology of the bluntnose sixgill shark: Environmental drivers of behavior and comparative trophic position in two distinct habitats"

Mary Donovan, MS
"Demographic patterns in the Peacock grouper (*Cephalopholis argus*), an introduced Hawaiian reef fish"

Devon Francke, MS (Hawaii Pacific U)
"To dive or not to dive: Juvenile green sea turtle (*Chelonia mydas*) behavior and habitat use in Kawaiʻnui, Oʻahu, Hawaiʻi"

Cynthia Grace-McCaskey, PhD
"Fishermen, politics, and participation: An ethnographic examination of commercial fisheries management in St. Croix, U.S. Virgin Islands"

Jessica Lopez, MS (Hawaii Pacific U)
"Patterns and trends of persistent organic pollutants in the Hawaiian monk seal (*Monachus schauinslandi*) from the main Hawaiian Islands: Looming threat or benign concern?"

Jeffrey Muir, MS
"Bigeye tuna behavior on an oceanic seamount"

Lennon R. Thomas, MS (Hawaii Pacific U)
"Characterizing the Kona crab (*Ranina Ranina*) fishery in the main Hawaiian Islands"

Ana Carolina Vaz, PhD
"Flow variability. Larval dispersal and fisheries management in Hawaiʻi"

Appendix VII Publication Summary

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

		FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
Peer-Reviewed	JIMAR Lead Author	18	36	50	36	32	31	47	40	46	26
	NOAA Lead Author	33	22	26	20	26	25	22	17	15	14
	Other Lead Author	20	30	26	28	43	51	42	68	41	38
Non-Peer-Reviewed	JIMAR Lead Author	16	39	31	24	11	18	18	24	67	46
	NOAA Lead Author	10	17	14	16	18	8	18	9	19	17
	Other Lead Author	14	21	17	17	20	17	9	9	15	25