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REPORTING PERIOD: 10/1/10 – 9/30/11

OCEAN ENVIRONMENT RESEARCH

OREGON STATE UNIVERSITY

COOPERATIVE INSTITUTE FOR MARINE RESOURCES STUDIES

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DIRECTOR'S STATEMENT

The OSU/NOAA Cooperative Institute for Marine Resources Studies (CIMRS) represents a strong, long-term, NOAA-university partnership dedicated to research in marine science, graduate and public education, and cooperation with regional industries and communities that are dependent on marine resources.

An integral part of the OSU's Hatfield Marine Science Center (HMSC), CIMRS is a model cooperative institute for many reasons. By its co-location with three regional NOAA laboratories representing two NOAA Line Offices, the Institute is able to bring together research partners from a variety of disciplines to address complex multidisciplinary issues relating to the living and non-living components of the marine environment. It is also the administrative home for approximately 37 research staff and 4 research faculty working on collaborative projects with NOAA investigators who serve as OSU courtesy faculty. No other OSU research institute provides both grant administration and personnel review in the manner of an academic department

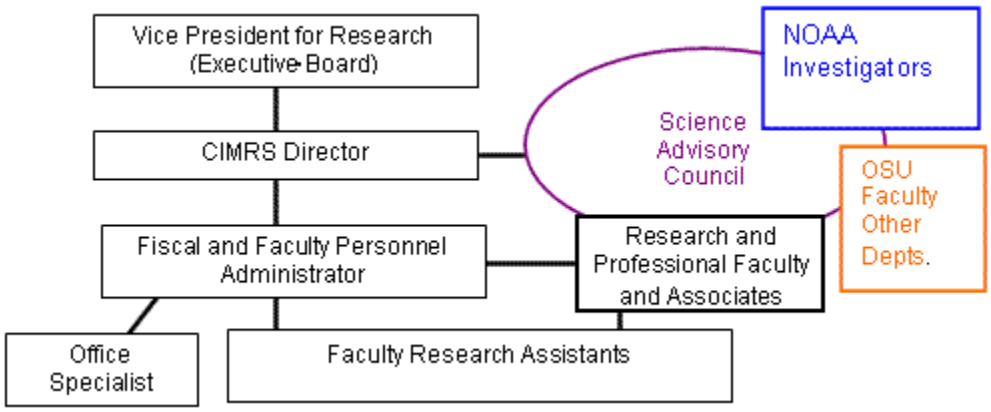
The research focus of CIMRS addresses living and non-living marine resources and is thus linked to programs that require environmental sampling or observing within the ocean and programs that characterize seafloor habitats. This focus encompasses the broad field of marine fisheries (including fisheries oceanography, habitat research, and ecosystem-based management), geological/chemical oceanography, marine mammal acoustics, and the effects of climate change on marine ecosystems. It thus addresses ecosystem and climate mission goals in NOAA's 5-year research plan and poises CIMRS research to contribute to NOAA's 20-year research vision.

The Institute thrives because of the commitment of leaders from within the laboratories of its NOAA associates and the OSU Research Office. As a result, during the past few years external research grant funding has grown, graduate student opportunities have diversified, and CIMRS has entrained many more OSU investigators from a broad range of disciplines to join together and address research problems of environmental, economic and social importance. Media recognition of CIMRS research this year included, but was not limited to Oregon Public Broadcasting, NPR, CNN, and Canadian Broadcasting Company. Thirty seven publications appeared in peer-reviewed scientific journals reporting results from CIMRS collaborative research. CIMRS is also grateful to announce that they were selected from among responses to an open competition for the West Coast NOAA/University Cooperative Institute in Marine Resource Studies. This solidifies a prosperous future for our research collaborations.

In summary, the scientific accomplishments of CIMRS demonstrate its value to both NOAA and the University. Its purpose is to serve as a bridge between traditional disciplines, a crossroad for fostering new ideas, and a dependable source of new research and analysis. It is anticipated that ongoing efforts will continue to raise the profile of the Institute and the partnerships it cultivates. For more information, please contact our website at http://oregonstate.edu/groups/cimrs. Additional information is available from the HMSC Annual Reports, http://hmsc.oregonstate.edu/overview.html.

ORGANIZATION

CIMRS is administered through the OSU Research Office with oversight from an Executive Board made up of members from the participating NOAA laboratories and collaborating OSU colleges and programs under the terms of a Memorandum of Understanding between OSU and NOAA/NMFS. A Science Advisory Council (SAC) gives input on research directions, progress, and policy to the Director.



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EXECUTIVE BOARD

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Jerri Bartholomew – Associate Professor, OSU Microbiology

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Clare Reimers – Professor, OSU College of Oceanic and Atmospheric Sciences

Dawn Wright – Professor, OSU Geosciences

Ex-Officio – Michael Banks

RESEARCH PERSONNEL

Category	Number	B.S.	M.S.	Ph.D.
Research Scientist	5			5
Postdoctoral Fellow	9			8
Research Assistants	23	6	17	0

CIMRS researchers spent over 236 days at sea in FY 11 with an average of 18 days/researcher.

ADMINISTRATIVE SUPPORT STAFF

POSITION	FTE	Supported by Award
Director	.6 FTE	Partial
Administrator	1.0 FTE	No
Travel Specialist	.5 FTE	No
Purchasing Specialist	.5 FTE	No

RESEARCH SUPPORT

OAR Projects under Grant NA17RJ1362

Ocean Environment Research

This multidisciplinary project seeks to quantify the effects of submarine volcanic and hydrothermal activity on the ocean. Continuous acoustic monitoring of spreading centers in the world's oceans allows investigators to detect and study the chemical, physical, geological and biological effects of tectonic activity on the global ocean and to follow free-ranging populations of large cetaceans. Specific focus areas are *Ocean Observing Systems, Hydrothermal Venting, Marine Mammal Acoustics, Microbiology of Seafloor Vents and Eruptions, Fisheries Oceanography.* All projects within this award meet the following goals:

(1) Protect, restore, and manage the use of coastal and ocean resources through ecosystem based management.

(2) Understand climate variability and change to enhance society's ability to plan and respond.

Seafloor Mapping and Geographical Information Systems (OSU Research Staff: Andra Bobbitt, Sr. Faculty Research Assistant; Andy Lau, Applied Mathematician, Professional Faculty; NOAA Collaborator: Stephen R. Hammond, PMEL)
In conjunction with the Seafloor Imaging and Navigation project, the creation of metadata files was an important project in FY 10-11. Inclusion of the GIS and mapping data is a vital component to the creation of the metadata file and analysis of long time-series trends. The seafloor mapping and GIS component allows the survey of new areas of seafloor in unprecedented detail as well as resurvey of other areas to detect depth changes between visits due to volcanic activity.

Andy Lau located the Axial Eruption events on April 2011 and the Japanese 9.0 earthquake and tsunami signals from the SOSUS data. He also processed the time-stamping for the 2010-2011 Axial data from the Ocean Bottom Hydrophones (OBH) and removed the tidal signals from the for the Bottom Pressure Recorder (BPR) data from 2007 to 2011. He decoded and adopted the seismic data in SAC format for processing using the "seasick" program and continued to maintain computer programs for processing portable hydrophone data.

For the T-phase project, Mr. Lau monitored SOSUS data for seismic events, catalogued and processed data by locating the seismic events' origins. He visited the U.S. Naval Air Station at the Whidbey Island, Washington site to establish contacts with the new personnel and to

maintain the SOSUS data connections between Whidbey and Newport.

Sr. Faculty Research Assistant Andra Bobbitt attended the annual ESRI meeting in San Diego, California. These meetings are essential for learning new features of the GIS system used for all Vents Program data. The GIS is used to manage data collected from Vents research expeditions dating back to the 1980s, current expeditions and its integration with other data provided from other researchers to enable further understanding of the multidisciplinary sites studied by Vents Program research staff. Utilizing GIS software from ESRI, vector and raster data can be stored, analyzed and graphically displayed with an evolving toolkit of software innovations. Since 1993 and continuing through this past year, Ms. Bobbitt's attendance at the ESRI International User Conference has provided the program with a robust data management system through training sessions, personal access to ESRI developers, software development previews, and colleague networking. The GIS also keeps current with metadata standards, as well as information sharing technology within this discipline. OSU and NOAA researchers utilize the GIS for analyzing data, preparing figures for research publications and conferences, and in the preparation of cruise reports. They also rely upon the GIS at sea during research expeditions for coordinating/revising expedition plans and analyzing data at sea. Keeping their GIS skills in concert with current development allows them to respond quickly to developments in proposals, research and cruise planning with access to integrated data analysis and production capability.

Seafloor Imaging, Navigation and Volcanology (OSU Research Staff: William Chadwick, Professor, Sr. Res.; Susan Merle, Sr. Faculty Research Assistant; NOAA Collaborator: Robert W. Embley, PMEL/OERD)

The goal of the Geophysical Monitoring program is to better understand how submarine volcanoes function and contribute to ecosystem dynamics. Efforts continue to be divided between projects focused on volcano monitoring in the NE Pacific and seafloor mapping and exploration in the Western Pacific.

Axial Seamount has been the site of a long-term seafloor observatory in the NE Pacific for over a decade. This year, these monitoring efforts paid off when Axial Seamount erupted in April 2011. The timing of this eruption had been anticipated in papers published in 2006 and 2009, and represents the first successful forecast of a submarine volcanic eruption. Researchers discovered the new lava flows that were produced by this eruption during an expedition in July 2011. Monitoring instruments that were in place during the eruption recorded data that will illuminate the dynamics of such events.

In the W Pacific, this team is publishing some of the results of their 2009 and 2010 expeditions to NW Rota-1 volcano, in the Mariana arc. A large landslide had occurred that removed up to 100 m of the summit and deposited material up to 8 km downslope in August 2009. The biological community at the volcano was greatly impacted by the slide with some species almost wiped out while others experienced huge new recruitments. The event was recorded by an in-situ hydrophone, which documented the sequence of events.

Dr. Chadwick attended the IEEE Symposium and Workshop on Scientific Use of Submarine Cables and Related Technologies in September 2011. A multi-authored paper was presented: Paros, J., E. N. Bernard, J. R. Delaney, C. Meinig, M. Spillane, P. Migliacio, L. Tang, W. Chadwick, T. Schaad, and S. Stalin, "Breakthrough underwater technology holds promise for improved local tsunami warnings."

Also in the W Pacific (NE Lau Basin) Susan Merle participated in a rock dredging, seafloor mapping expedition. The expedition in December 2010 was the fourth in a series of cruises to the NE Lau Basin, possibly the most volcanically active site in the world's oceans, since November 2008. Several publications are in press relating to these expeditions.

In March 2011, Susan Merle with Joe Haxel attended a 3-day NOAA Ocean Satellite Data Course at OSU. The course focused on ocean remote sensing and satellite applications for NOAA research.

T-Phase Event Detection (OSU Research Staff: Robert Dziak, Professor., Sr. Res.; Haru Matsumoto, Assistant Professor, Sr. Research; Matthew Fowler, Faculty Research Assistant; Joe Haxel, Sr. Faculty Research Assistant; NOAA Collaborator: Stephen R. Hammond, PMEL).

The Acoustic Monitoring Project provides wide-area, continuous seismic monitoring of global ridge systems using low-frequency acoustics. The primary focus of the effort is in using the U.S. Navy SOSUS hydrophone arrays to provide real-time monitoring of the Juan de Fuca /Gorda Ridge systems to queue event response efforts. Additionally, CIMRS investigators maintain and deploy both autonomous and near real-time (via satellite) hydrophone technologies for acoustic characterization of remote regions of the global oceans.

In order to acoustically monitor areas of the world ocean not covered by existing fixed hydrophone arrays, CIMRS scientists have developed autonomous moored hydrophone instruments that record acoustic energy from both underwater seismic activity as well as that from whale calls. These instruments are capable of recording frequencies from 1 - 1000 Hz, and can record data for over a year before servicing is required. The hydrophones are designed to be deployed as an array of independent instruments whose geometry can be determined by the needs of the experimenter in order to localize acoustic sources of interest.

In FY11, the analysis of hydrophone recorded earthquakes throughout the NE Pacific Ocean continued in an effort to monitor for major volcanic events off the Washington, California, and Oregon coasts. Our previous year's expectation of a significant volcanic event was correct as Axial Volcano erupted on 6 April 2011, producing thousands of micro-earthquakes recorded on our Ocean-Bottom Hydrophones (OBHs) and expelling a huge volume of lava onto the seafloor. Our analysis of the earthquakes recorded on the OBHs will be combined with water-column and geologic mapping ground-truth work done at the volcano, leading to several collaborative projects with oceanographers and geologists both within NOAA and at other US academic institutions. Interestingly, one of the OBHs deployed at Axial Volcano was buried under 30 cm of lava during the eruption; however, its transponder remained functional and continued to transmit to the ship. This instrument thus provides an unexpected source of first-order

information on lava flow temperatures and viscosity never previously available on the deep seafloor. New research funding was acquired and allowed for deployment of autonomous hydrophones at the equatorial Mid-Atlantic Ridge, a slow-rate spreading center. The focus of the Mid-Atlantic Ridge project is to quantify seismic activity along this poorly studied portion of the ridge, as well as to test models of earthquake predictability (retrospectively) at the large transform faults within this region. The Atlantic work is primarily an NSF project, however ship time costs are shared between NOAA Vents Program and NSF. Our NOAA Ocean Exploration funded project within the Bransfield Strait of Antarctica ended in 2010; however, both Arctic and Antarctic ocean acoustic datasets are still being analyzed and are providing fascinating insights into the dynamics of sea ice in these regions and allowing us to evaluate the acoustic energy released into the global ocean due to ice breakup caused by short and long-term climate changes.

Dr. Dziak and Sr. FRA Joe Haxel attended the American Geophysical Union meeting in San Francisco presenting results of their Axial Volcano research.

Matt Fowler once again performed the at sea recovery of the ocean bottom hydrophones (OBH) from the Axial Volcano study site during the NEMO 2011 cruise. Sr. FRA Joe Haxel continued his processing of the earthquake acoustic data from the Axial instruments. Thousands of small magnitude earthquakes have been observed at Axial prior to the eruption on 6 April. Most importantly, a distinct increase in earthquake activity at Axial volcano correlates an inflation, or rise, of the caldera floor, marking the accent of magma within the volcano prior to erupting. Combining this seismic catalog with bottom pressure measurements for Axial Volcano will be the basis for his upcoming AGU presentation in fall 2011.

RA Fowler participated in two cruises this year under this award: the NeMO cruise in July/August preparing equipment and mobilizing the turnaround for the OBH and BPR instruments, and the Antarctica cruise to the Bransfield Strait in December 2010. Upon return from the cruises Mr. Fowler resumed data analysis duties and began preparations for a research paper on the acoustics of the Iceberg A53-A breakup. Additionally, he assisted in the training of two part-time data analysts for the project.

Hydrothermal Emissions **(**OSU Research Staff: Leigh Evans and Ron Greene, Faculty Research Assistants; NOAA Collaborator: John E. Lupton, PMEL)

CIMRS researchers involved in the Hydrothermal Emissions project collect, measure, and analyze trace elemental gases in hydrothermal fluids, particularly helium-3, using ultra-high vacuum mass spectrometry. The objective of this research is to assess the locations, mechanisms, chemical flux rates and ages of active hydrothermal systems along sea floor spreading centers with the eventual end result of quantifying and predicting large-scale spatial and temporal effects of venting on ocean chemical and thermal budgets.

During this reporting period, Research Assistant Ron Greene participated in a seagoing expedition to the Northern Lau Basin (Vents 2010c). Research Assistant Leigh Evans participated in an expedition involving the Jason remotely-operated vehicle to the NeMO site on

the Juan de Fuca Ridge.

Research Assistants Leigh Evans and Ron Greene processed and completed mass spectrometer measurements for helium isotopes on a large number of samples during the year. These included samples collected from NW Rota in 2009 and 2010 and samples from the Northern Lau Basin collected in 2008 and 2010.

Another group effort was undertaken to expand the lab's capability to include three stable isotopes of neon. The usual sources of hydrothermal emissions, arc volcanoes, magmatic hot spots and spreading ridges, can be distinguished by various ratios of neon-20, neon-21 and neon-22. Progress includes development of mass spectral peak jumping protocols, gas purification sequences and signal handling electronics which will allow use of the instrument's electron multiplier for all likely isotopic abundances.

Marine Mammal Acoustics (OSU Investigators, Research Staff: David Mellinger, Associate Prof., Sr. Res.; Elizabeth Kusel, Research Associate, Post-doc; Sharon Nieukirk, Sr. Faculty Research Assistants; Sara Heimlich, Faculty Research Assistant; K. Klinck – Temporary Tech; NOAA Collaborator: Catherine Berchok, NMML)

Institute Fellows collaborate with marine mammalogists from NOAA's National Marine Mammal Lab, Scripps Institute of Oceanography and Oregon State University to describe the behavior of vocalizing marine mammals in terms of seasonality, depth in the water column at which they vocalize and assessment of relative abundance estimates.

Offshore cruises in the NE Pacific: Two CIMRS personnel participated in surveys of the Bering/Chukchi/Beaufort Sea in Aug.-Sep. 2010: Elizabeth Küsel and Sharon Nieukirk. These cruises were made, in part, for performing passive acoustic observations of marine mammals using both long-term (1 yr duration) moored autonomous hydrophones and short-term (several-hour) expendable floating sonobuoys. The data from these instruments will be useful for examining long-term changes in both marine mammal distributions and Arctic noise, changes due in part to climate change.

Analysis of baleen whale vocalizations: One year of data collected from recorders deployed in the Bering Sea were analyzed by David Mellinger, Sharon Nieukirk, Karolin Klinck, and Holger Klinck for right (*Eubalaena japonica*) and fin (*Balaenoptera physalus*) whale sounds. They also collaborated with NOAA AFSC NMML on the analysis of other data from the Bering Sea, including data from mooring sites M5 and M8 (deployment/recovery by NMML) in the Bering. Their analysis first employed automatic detection software they developed for these species. A fraction of these detections were checked for verification, with the exact fraction depending on species - 100% for right whales and roughly 5% for fin and humpback whales (which are much more numerous). Thousands of right and fin whale calls were detected, particularly 'upcalls' and 'gunshot calls', as well as humpback (*Megaptera novaeangliae*) whale vocalizations. Nieukirk, H. Klinck, and Mellinger also developed a method for quickly estimating seasonal calling levels of fin whales. Sara Heimlich and Karolin Klinck analyzed a year of bowhead whale (*Balaena mysticetus*) sounds collected, in collaboration with Dr. Catherine Berchok of NMML, from the Beaufort sea. H. Klinck and D. Mellinger helped develop automatic detection and classification

software for this project. Many hundreds of calls were detected, with a clear seasonal distribution. Results from these two studies were presented by Mellinger, Heimlich and Nieukirk at various symposia throughout the year. Manuscripts for publication and reports from the results of these two projects were also produced - see below.

Web page for marine mammal recordings: Sara Heimlich added new sound files of baleen whales (and odontocete species) to the MobySound archive (www.mobysound.org). These include other data sets of baleen whale vocalizations collected in the Bering/Chukchi/Beaufort region by J. Delarue (JASCO) and S.Blackwell (Greenridge Sciences, Inc.) which include bowhead whale (Balaena mysticetus) sounds, walrus sounds, and sei (Balaenoptera borealis), Bryde's (B. edeni) and humpback (Megaptera novaeangliae) whales in the western tropical Pacific. The MobySound archive at www.mobysound.org<http://www.mobysound.org is accessed often by researchers from countries around the world. The website has had more than 1000 unique visitors from January through September 2010. We also operated a website for the Fifth International Workshop on Detection and Localization of Marine Mammals using Passive Acoustics, which we hosted in August 2011 at Timberline Lodge, Mt. Hood, Oregon.

Atlantic autonomous hydrophones: Sharon Nieukirk, David Mellinger, and Holger Klinck finished a publication for fin whale and seismic airgun sounds in the mid-Atlantic. Fin whale calling was present seasonally at all sites, though in amounts that varied from year to year in ways we could not predict. Airgun sounds were also present at all sites, sometimes ubiquitously (i.e., at some sites, 100% of hours in a month had airgun sounds). A manuscript about these results is has been submitted, reviewed, and revised, and should appear soon in the Journal of the Acoustical Society of America. This research was highlighted as an OAR "Hot Item" in July 2010.

Fisheries Oceanography:

Ocean Acidification Cruises on RV Wecoma (33 days) (OSU Collaborator, Peter Zerr, Ship Support; Jack Barth, Professor, COAS; Burke Hales, Assoc. Professor, COAS; NOAA Collaborator: Richard Feely, PMEL)
The Pacific coastline of North America is home to economically important fish and shellfish industries. The potential impacts of ocean acidification on the ecologically and economically important biodiversity of the West Coast are unknown and of great concern to NOAA and other agencies, as well as a variety of other public and private stakeholders. To address these concerns, a partnership was developed with oceanographers at Oregon State University to study both large-scale patterns in the formation of acidified and hypoxic conditions along the Cascadia margin from British Columbia to northern California and smaller-scale patterns on the Oregon continental shelf, where hypoxic and acidified conditions develop each summer as a result of the coupling of large-scale oceanographic processes with regional ecological and geomorphological factors. This large-scale cruise extended from Washington to California, covering the most extensive upwelling regions on the western margin of North America. The high-resolution work provided additional data critical for developing proxy algorithms that will allow the reconstruction of ocean acidification conditions (including pH and carbonate saturation states) from commonly measured parameters such as oxygen and temperature.

The cruises complete a series of transects roughly orthogonal to the Pacific Coast of the North American continent, from northern Washington in the north to southern California in the south. Some of these sections re-occupy stations sampled during the longstanding CalCOFI cruises off the US West Coast. Over the course of the cruise, full water-column CTD stations were occupied at specified intervals along the planned transects. The water collected was analyzed for a variety of physical, chemical and biological parameters. Near surface seawater (temperature, salinity, pCO2, ADCP) and atmospheric measurements (CO2, CFCs, aerosols) were made along the cruise track.

The project *Ocean Acidification Monitoring and Prediction in Oregon Coastal* Waters sought to establish and maintain a program monitoring conditions relevant to ocean acidification, and additional parameters that could be used in synthetic approaches to expand the scope of acidification-relevant information. In the past year researchers Barth and Hales have executed four mooring deployments, one of which was recently recovered and provides exciting data. Another deployment, including sensors on the surface expression of the NH10 mooring and others on its anchor, took place in the fall of 2010, but unfortunately the mooring was lost in an early-winter gale. The sensors near the bottom were unrecoverable, and, although the surface expression sensors were recovered on a Washington beach 200 miles to the north, they were damaged and no data were recovered from them. The remaining two deployments are independent near-bottom packages, one of which sits near the shelf-break in the vicinity of the NDBC46050 weather buoy, and the other sits near the NH10 surface expression. The shelf-break mooring will be recovered in the coming weeks, while the NH10 bottom mooring will be recovered in a couple of months. Deployment of fast-response optodes on the OSU gliders commenced in the summer of 2011, and those preliminary data are currently being processed. Ongoing work is centered on developing a truly hot-swappable instrumentation assemblage, and the beginnings of quality-control and dissemination of this very new data.

Following the loss of the NH10 mooring in December 2010, redeployment commenced in April 2011. With contributions from collaborators Ken Johnson (MBARI) and Mike DeGrandpre (University of Montana), the OSU team deployed a suite of instruments that included two independent pH sensors (a DuraFET-based sensor from MBARI, and a colorimetric SAMI-pH sensor from The University of Montana), a pCO_2 sensor (SAMI-CO2), a UV-based Nitrate sensor (MBARI), Aanderaa optode-based O_2 sensor, and a SeaBird CT unit. The nitrate sensor stopped working shortly after deployment, and the data from the optode have not yet been processed.

Appendix 1 (attached) provides full results to date.

The Effects of Ocean Variability on Marine Survival of Salmonids (OSU Research Staff: Toby Auth, Tristan Britt, Faculty Research Assistants; CIMRS, David Rupp, Research Associate, CIMRS; Shawn Rowe, Assistant Professor, Sea Grant; NOAA Collaborators: Bill Peterson, Ric Brodeur,Rick Brown, Tom Wainwright, NWFSC

As part of the Trophic Ecology Study, Research Associate David Rupp and NOAA colleagues created and evaluated predictive models of salmon productivity based on indices of ocean conditions influencing salmon survival. The skill of the models in making short-lead (i.e., 1 year) forecasts of salmon productivity is an important consideration when evaluating the "value" of the models in improving management. This team conducted a management strategy evaluation (MSE) comparing status quo and alternative harvest management strategies for the Oregon Coast Natural coho salmon stock. The MSE consists of Monte Carlo simulations of annual recruitment, selection of the harvest fishery impact rate based on predefined criteria (i.e., the management strategy), application of the harvest impact rate to determine catch and escapement, and calculation of performance metrics of the management strategy. The management objectives (i.e., performance metrics) and alternative management strategies were determined during multiple meetings held with the salmon management community. A manuscript was produced from this project just published online in Fisheries Oceanography Early View.

As part of the Zooplankton Ecology project, an interactive exhibit was developed for display at the HMSC Visitors Center to communicate how NOAA fisheries scientists forecast salmon populations using Ocean Ecosystem Indicators of Salmon Marine Survival in the Northern California Current.
As many scientists and salmon managers have noted, variations in marine survival of salmon often correspond with periods of alternating cold and warm ocean conditions. For example, cold conditions are generally good for Chinook and coho salmon, whereas warm conditions are not. Information is provided on the Northwest Fisheries Science Center's web site:
http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/a-ecinhome.cfm
This web site contains information of how physical and biological ocean conditions may affect the growth and survival of juvenile salmon in the northern California Current off Oregon and Washington and presents a number of physical, biological, and ecosystem indicators to specifically define the term "ocean conditions" which is an ecosystem wide approach to considering multiple related variables to forecast salmon returns. These metrics can be used to forecast the survival of salmon 1–2 years in advance.

The OSU project team worked together to create a computer based exhibit that allows the visiting public to interact with various indicator data layers, building their understanding of how environmental factors translate into a forecast of how well West Coast salmon populations survive from year to year. The exhibit begins with an attractor mode that shows oceanic salmon, and poses two questions: "How can we predict if this will be a "good" salmon year?" and "How do scientists make predictions about future salmon returns." Once the visitors click on the attractor, they are given a menu with two choices; 1. Beginner: Learn how scientists predict yearly salmon survival by studying ocean conditions, and 2. Expert: Explore ocean conditions and try predicting on your own. Choice 1 is a guided, goal-based experience that steps the user through the basics of how to read satellite data maps, the significance of the two data layers -- Sea Surface Temperature (SST) and Chlorophyll -- and how variations can affect salmon. They are guided to scroll through time, watching how seasons affect ocean conditions. Once they understand these two very basic indicators and the affect they have on ocean salmon, they are encouraged to try predicting whether ocean conditions in the next year will support Good (green light) salmon stocks, Average (yellow light) salmon stocks, or Bad (red light) salmon stocks.

Choice 2 is a goal-based scenario for the user that already is familiar with the material and concepts and wants to simply try further, more difficult, prediction scenarios.

A feature of this section is the collection of visitor usage data. As thousands of monthly visitors use the kiosk, all their choices are recorded, as well as the amount of time spent in each section and how they answered in the prediction sections. These data are a critical tool in the informed design process. The data gathered here, along with visitor surveys, help exhibit staff hone the exhibit content to deliver the best educational experience. On evaluation of the data there were some adjustments to the exhibit have been proposed, basically the inclusion of: an interactive wind data layer, an interactive copepod layer, indicating population as well as health (size), and a forage fish data layer. Work to continue advancing this resource will continue over the coming year.

Both Toby Auth and Tristan Britt carried out research in support of pelagic and demersal fish habitats. Tristan worked with Mattias Johansson (CIMRS, Research Associate, Post-doc) on the identification of the WEVZ rockfish complex (*wilsoni, emphaeus, variegatus, zacentrus,* 60% of sampled *Sebastes*), to develop methods to enable genetic identification of species. Using fish of known and unknown species ID collected during SAIP cruises from 2005-2011, they utilized cytochrome b mtDNA sequences and other markers to develop and test molecular methods that could separate the species. Tristan participated in several cruises collecting biological samples using bongo nets, CTD, and fishing nets. In the laboratory, she sorted through biological samples collected in the field. Micronekton from all of the SAIP midwater trawl samples collected in 2010 were sorted, identified, enumerated, and measured. Identification of *Sebastes* to species level was completed whenever possible; again, genetics will be a good tool to help determine species that cannot be identified to species by morphology in the lab. Tristan managed and further developed an Access database for invertebrates and juvenile fishes collected as part of the project. She updated indices (NOI, PDO, UI, ET, TGI, and many others) to the database and made other small modifications to prevent data entry errors.
Nekton data (catch and measurement) for 2011 are currently being entered into the SAIP database. There are 482 trawls and over 185 taxa recorded.

A paper has been accepted to the CalCOFI Conference December 2011, "Episodic range expansions of Humboldt Squid (*Dosidicus gigas*) off Oregon and Washington."

Meetings:
Britt, T. 5th International Symposium on Pacific Squid in October, 2010, La Paz Mexico. Presented Humboldt squid findings.

FRA Toby Auth completed sea safety training in April 2011 in preparation for the numerous cruises in which he participates during the field season. From May 12-17, 2011 Toby was Chief Scientist onboard the F/V Miss Sue, conducting four transects (five stations per transect) from Heceta Head to Willapa Bay collecting CTD, bongo, and mid-water trawl collections for water quality, phytoplankton, zooplankton, ichthyoplankton, and juvenile and adult fishes. Along the Willapa Bay transect at 10 stations, they conducted an additional six CTD casts, six mid-water

trawls, and four surface trawls to collect water quality and pelagic organism data for the predator and prey field studies.

Data management is a large part of this project. During the year when Toby is not at sea he is in the lab analyzing samples collected on many different cruises, including ones from the Newport Hydrogrpahic Line. During this period, ichthyoplankton from all (15) of the 2011 January-March NH line (stations 5-25 nm) collected aboard the R/V Elakha from bongo samples were sorted, identified, enumerated, and measured. Data from these cruises, and from late 2010 cruises, were then entered into the database and analyzed for their relation to salmon prey abundances to create a predictive ichthyoplankton index for same-year salmon returns.

Meetings:

Auth, T. Oral presentation at the 2010 Annual CalCOFI Conference in La Jolla, CA (December 2010) entitled, "Analysis of the spring-fall epipelagic ichthyoplankton community in the northern California Current in 2004-2009 in relation to environmental forcing factors

Auth, T. Oral presentation at the 2011 Salmon Ocean Ecology Meeting in Seattle, WA (March 2011) entitled, "Winter ichthyoplankton biomass: predictor of summer prey fields and ultimate survival of juvenile salmon?" Elizabeth A. Daly, Richard D. Brodeur, Toby D. Auth, William T. Peterson, and Edmundo Casillas.

Auth, T. Oral presentation at the 2011 Annual Larval Fish Conference in Wilmington, NC (May 2011) entitled, "Anomalous ichthyoplankton distributions and concentrations in the northern California Current resulting from the 2010 El Niño and La Niña events."

Watershed and Estuarine Processes: (OSU Research Staff: Andrew Claxton, FRA, CIMRS; James, Losee, GRA, CIMRS; NOAA Collaborator: Kym Jacobson, NWFSC)

This summer FRA Claxton is finalizing a draft of a paper titled "Parasitism and habitat use by Chinook salmon (*Oncorhynchus tshawytscha*) in the Columbia River estuary." This paper examines parasite assemblages in Chinook salmon sampled from among different habitats within the Columbia River and estuary. Many habitats within the lower estuary have been heavily altered and the historic mosaic of variable habitat types has been simplified. Wetlands habitats in particular have been reduced by up to 50% compared to historic levels before anthropogenic effects. The CIMRS team compared parasites in salmon among sandy bottom habitats which are now common in the estuary with those collected from salmon in wetlands areas which are now rarer. Parasites within salmon are acquired from the consumption of infected prey items and can function as a tag of previous feeding and behavior. Overall parasite assemblages differed among habitats in the estuary. In particular, parasites that use prey items common in the estuary were most prevalent in salmon from the wetlands which suggests that these habitats which are currently at a small fraction of their historic presence, serve as important feeding grounds for salmon before they leave the estuary.

From June to September FRA Claxton identified 279 unknown nematodes; necropsied 173 stomachs and 27 intestines from Lord Island Salmon, 2006; necropsied 211 stomachs and 230 stomachs from the 2005 beach seine sample; and assisted with statistical analysis for four projects , of which two studies are of *Renibacterium salmoninarum*.

GRA Losee processed the stomach and intestines of ocean-caught juvenile Chinook and coho salmon for trophically transmitted parasites captured during surveys from 2002-2009 (approximately 700 fish). He also photographed and analyzed morphometrics of four species of ocean-caught juvenile Pacific salmon (Chinook, coho, sockeye and chum) in preparation for a diagnostic key to identify these species more accurately at sea.

Meetings:
Claxton, A. et al. Parasite assemblages and Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) habitat use in the Columbia River Estuary in 2004 and 2005. ~ The 86th Annual Meeting of the American Society of Parasitologists. June 1-4, 2011. Oral presentation.

Losee, J. et al. Does Interannual Variability of Trophically Transmitted Parasites in Chinook and Coho Salmon Relate to Physical and Biological Processes in the Northern California Current? 86th Annual Meeting of the American Society of Parasitologists. June 1-4, 2011. Oral presentation.

Salmon Utilization within the Columbia River Estuary (OSU Research Staff: Robert Kennedy, Assistant Professor, Sr. Res., Forest Ecol.& Soc.; NOAA Collaborator, Chris Jordan, NWFSC)

OSU developed maps and new methods to characterize change for the entire Puget Sound watershed for the period 1986 to 2008. OSU researches carried out the following tasks: image analysis, data processing, algorithm development, mapping, GIS analysis; image interpretation, database creation; and statistical evaluation of accuracy and robustness.

Maps are posted on the anonymous FTP site: ftp.fsl.orst.edu/pub/landtrendr/nmfs

Researchers also began conducting statistical analysis to evaluate possible links between forest disturbance and Coho habitat in the Coast Range of Oregon. In May 2011, they provided NOAA collaborators with a summary report of findings. The finalized report was submitted to NMFS in August 2011.

Meetings:
Kennedy, R. U.S. Bureau of Reclamation workshop on Habitat and Fish Modeling (February 2011) in Portland, OR.

Beyond the Spring Transition: Winter Pre-Conditioning of Ecosystem Dynamics and Implications for Sentinel Species and Fisheries (OSU Research Staff: Bryan Black, Assoc. Prof., Sr. Res., OSU/HMSC; NOAA Collaborators: Steven Bograd, SWFSC; Pete Lawson, NWFSC)

Over the past year, Dr. Black and NOAA colleagues explored wintertime climate variability and found that it was quite distinct from climate patterns in the summer months. This "winter mode" is dominated by high-frequency variability and driven by wintertime sea level pressure between the US West Coast and Hawaii. By contrast, summertime climate, especially summertime upwelling in the California Current, appears to be a function of local atmospheric drivers. Unlike wintertime upwelling, summertime upwelling is subject to long-term increases consistent with the Bakun hypothesis of intensification. Just as importantly, some biological processes (such as rockfish growth and seabird reproductive success) are sensitive to this wintertime climate pattern while others (such s a Chinook salmon growth-increment chronology we developed for this project) are sensitive to the summertime climate patterns. Thus, there is a "summer guild" of biological processes that relate to summertime climate and a "winter guild" of biological processes that relate to wintertime climate. The results of this work were submitted to and published in Global Change Biology. A second manuscript has been accepted following minor revisions at Progress in Oceanography.

BA Black, ID Schroeder, WJ Sydeman, SJ Bograd, BK Wells, and FB Schwing. 2011. Winter and summer upwelling modes and their relevance to climate impacts and ecological response in the California Current Ecosystem. Global Change Biology. doi 10.1111/j.1365-2486.2011.02422.x

SA Thompson, WJ Sydeman, JA Santora, BA Black, RM Suryan, J Calambokidis, WT Peterson, ad SJ Bograd. 2011. Effects of winter and summer upwelling on top predators: a path analytical approach on "bottom-up" trophic mechanisms. (in review, *Progress in Oceanography*)

Impacts of Climate on Long-term Growth Patterns of Yellowfin sole in the Bering Sea: Empirical Modeling and Incorporation into Stock Assessment Models (OSU Research Staff: Bryan Black, Assoc. Prof., Sr. Res.; NOAA Collaborators, Thomas Helser, Mary E. Matta, Thomas Wilderbuer, AFSC)

Over the past year, Dr. Black and NOAA colleagues at the Alaska Fisheries Science Center extended an existing otolith growth-increment chronology for eastern Bering Sea yellowfin sole. The original chronology spanned 1981-2006, and the updated chronology now spans 1963-2006, an unprecedented length for a continuous growth history of a fish species in the Bering Sea. They also related this chronology to more than 7,000 observations of yellowfin sole size (weight and length) in the eastern Bering Sea collected during trawl surveys spanning 1987 and 2006. In so doing, they were able to demonstrate that anomalies in otolith growth, as captured by the otolith chronology, correspond to anomalies in yellowfin sole body size. A manuscript has been completed and will soon be submitted to Marine Ecology Progress Series.

BA Black, ME Matta, TE Helser, and TK Wilderbuer. Otolith biochronologies as multidecadal indicators of body size anomalies in yellowfin sole (Limanda aspera). To be submitted to Marine Ecology Progress Series.

Fisheries Habitat Investigations (OSU Research Staff: Jack Barth, Professor, COAS, Chris Goldfinger, Professor, COAS; Steve Pierce, Research Associate, COAS; Chris Romsos, Faculty Research Assistant, COAS; NOAA Collaborators: Aimee Keller, Waldo Wakefield, NWFSC)

Researchers Barth and Pierce collaborated with NWFSC scientists in the development of protocols for the handling of dissolved oxygen data measured using net-mounted gear, during the West Coast Groundfish Bottom Trawl Survey. They performed quality control on the oxygen data and carefully mapped the near-bottom oxygen throughout the survey region, using gridding methods tuned for this type of data and sampling pattern (thin-plate splines, with knots at the data points: generalized cross-validation to determine degree of smoothing). They also integrated these data with other oxygen data sets analyzed in several ways, including examination of the relationship between the extent of shelf hypoxia and the cumulative upwelling wind stress.

As part of the Exploration of Sponge Reefs project, the Active Tectonics and Seafloor Mapping Lab (ATSML) collected ~100 km^2 high resolution bathymetry data focused on a region on the northern rim of Grays Canon, offshore Washington on the outer shelf. These data were collected in an effort to characterize a region of likely sponge reef habitat observed previously from submersible vehicles. Of interest was an objective to test the ability of the sonar system to map the organisms themselves, if abundant, or identify the habitat they are associated with in order to assess the local and regional abundance of the habitat. In the project exploring the N. Andreas Fault the ATSML collected 572 km^2 and 592 km of high resolution bathymetry and mini sparker seismic reflection data. These data were collected in an effort to characterize and constrain the offshore section of the San Andreas Fault from near Ft. Bragg, CA to Shelter Cove, CA.

The multibeam system, a Reson 8101ER, was mounted on an overboard pole on the vessel Pacific Storm. The Reson Seabat 8101 multibeam operates at 240 kHz, and generates 101 beams per ping, covering an angular sector of up to 150°. The usable angular sector derived from internal quality flags generated by the sonar typically is limited to 125° -130°. The quality of the beams may be influenced by vessel motion, surface noise, bottom hardness and roughness and other factors. The maximum ping rate for the 8101 system is 30 pings per second. The beam widths in both the fore-aft direction and the port-starboard direction are 1.5° and are of equal angular size regardless of whether they are nadir or outer beams. This is because the design of the Seabat 8101 utilizes a curved array, and unlike a flat array, does not require the use of beam steering to generate the non-nadir beams, except in the outer most beams. The curved array allows the system to generate beams that are orthogonal to the transducer face at all orientations. The 8101 is capable of both amplitude and phase detection methods for depth to the seafloor determinations. Typically, for the inner beams, the amplitude detection method is used, while the outer beams utilize phase detection to determine travel time and slant range distance. The 8101 is an unstabilized system, that is, beam steering to keep the fan array directed downward in all vessel attitudes is not performed, as is true of most shallow water systems. In practice this means that vessel rolling can adversely affect swath width, and make the vessel somewhat more sensitive to sea conditions than with a stabilized system. This is a common tradeoff for shallow-water systems as compared to large vessel stabilized systems. The Reson 8101 is optionally pitch stabilized, improving performance along track, and this option was used for all survey work.

The water-column sound speed profile was regularly monitored with a Brooke-Ocean-Technology, Moving-Vessel Profiler (http://www.brooke-ocean.com/mvp_main.html). Sound casts could be taken at any time without stopping the survey or slowing the vessel. This system reliably provided sound-speed data when required, and was typically deployed every 15-30 minutes during survey operations, with somewhat longer intervals used in deeper water. This high frequency of sound speed profiling is highly beneficial to the ultimate quality of this nearshore survey, and in itself provides a secondary dataset of water velocity in the survey areas. The MVP was backed up by a Seabird SBE 19 CTD used when the MVP was down for maintenance or not available. Continuous 'real-time" sound speed measurements were made with a sound-speed probe at the Reson 8101 transducer head, a particularly important place to measure sound speed due to the physics of forming multiple sonar beams.

Vessel motion was measured by an Applanix POS/MV 320 inertial measurement unit during all surveys. This system uses multiple GPS antenna arrayed on the vessel and an inertial system to produce Inertially-Aided Real-Time Kinematic (IARTK) attitude and position data utilizing L1 and L2 carrier phase measurements. The system is used for ships position, heading, and to determine roll, pitch, yaw attitude as well as heave. Additional positioning information is being collected with a NavCom StarFire SF 3050 GPS system. This system is a commercial satellite based differential system known as GSBAS (Global Satellite Based Augmentation System). Access to the system is through a subscription service. This system provides positioning accuracy of ~ 10 cm horizontal, and 15 cm vertical worldwide, and eliminates the need for land based base stations, or location dependent differential signals such as the Coast Guard differential beacon system. The system is used as the primary positioning system, as well as providing high precision vertical control for real time tide data.

Final bathymetric sounding data will be reduced to a tidal datum referenced to Mean Lower Low Water as specified by the NOAA 2009 Specification and Deliverables document available online at http://www.nauticalcharts.noaa.gov/hsd/specs/specs.html. This reduction is accomplished by using verified tidal observations (a NOAA product) from, at minimum, three nearby tide gauges to "correct" depth soundings by accounting for varying tidal stage or varying tidal magnitude during the survey.

Bathymetric data from all surveys are being processed using CARIS http://www.caris.com/products/software.cfm/prodID/1) HIPS/SIPS v. 6.5 (2009, upgraded to version 7.0 in 2010) data processing software in order to produce tide-, motion- and sound-speed-corrected, geo-referenced bathymetry and backscatter imagery. Backscatter mosaics were generated with IVS Geocoder software to additionally produce backscatter mosaics that incorporate geometric and beam pattern corrections, as well as removing artifacts of gain changes and topography during the survey (Fonseca and Calder, 2005; Fonseca and Mayer, 2007). The data are being collected using standard hydrographic protocols (NOAA Hydrographic Manual, 1976; NOAA 2009 Specification and Deliverables, 2009).

The surveys were conducted at speeds of 6-8 knots, depending on weather conditions and other factors such as proximity to the coast, water depth sea state, visibility, and density of crab pots. During sea-trials it was determined that vessel speed within the capabilities of the RV Pacific

Storm had little or no effect on data quality, validating the construction of a massive and deeply placed sonar pole for this project. Standard squat tables were constructed for the changes in vessel pitch at various speeds, and are applied during processing.

All of the processing of the multibeam data was done using a comprehensive hydrographic data processing system, Caris Hips and Sips. Corrections to multibeam data include ships attitude, tide, sound velocity, and ping editing. Now that these data have been combined we have created continuous seafloor bathymetry maps for the entire offshore section of the San Andreas. In addition to bathymetry the Reson 8101R also collects snippets data for use in generating backscatter mosaics. These mosaics have been helpful in mapping out the lithology of the seafloor (i.e., bedrock, sand/gravel, and mud/silt).

Preliminary interpretation of the bathymetric and backscatter data of the sponge reef habitat is underway as of this writing, and awaits the delivery of imagery from the SeaBead AUV, which made dives on the site subsequent to the mapping operations.

The mini sparker seismic reflection profiles have all been processed using Sioseis, a seismic processing package developed at Scripps Institute of Oceanography by Paul Henkart. Processing steps include, bandpass filters, heave filters, and automatic gain control. Nearly all seismic profiles have been interpreted using industry standard software (SMT Kingdom Suite). Interpretations include mapping all faults, folds, unconformities and recent sedimentation.

These interpretations along with products generated from multibeam bathymetry are allowing us to construct a detailed geologic map of the offshore portion of the San Andreas Fault. Preliminary interpretations show that the San Andreas is defined by a narrow zone of high deformation with many small parallel faults on the west side of the main strand. The ASTML team has also mapped splay faults that trend to the northwest and terminate at the San Andreas.

Stock Assessment Improvements (OSU Research Staff: GRA Kevin Thompson; Selina Heppell, Associate Professor, F&W; NOAA Collaborator: Grant Thompson, AFSC)

GRA Kevin Thompson continued work on his dissertation as outlined in his program of study throughout the period. The focus remains on the first chapter directed towards the statistical investigation of the diets of groundfish in the Gulf of Alaska. While portions of this work have been presented previously in posters, more complete analyses were presented orally this year at the annual meeting of the American Fisheries Society (AFS) in Seattle, WA.

Kevin completed, and passed, his written preliminary exam as required by the Department of Fisheries and Wildlife PhD program. Oral examination will be held in October 2011 with the full academic committee participating.

Meetings:

Thompson, K., and S. Heppell. Factors affecting the diets of groundfish in Alaska. American Fisheries Society Annual Meeting, Seattle, WA September 2011.

DNA Analysis of Humpback Whales from Oceania (OSU Research Staff: Professor Scott Baker; FRA Debbie Steel; NOAA Collaborator: Phil Clapham, NMML)

This project involves genotyping at 10 microsatellite loci, sex identification and sequencing of the mtDNA control region (approximately 450 bp) for 216 samples from the Bering Sea and the Western Gulf of Alaska. To identify replicate samples, within and between regions, the DNA profiles of the Bering Sea and the Western Gulf of Alaska samples were matched to the 1,856 regional individuals represented in the 2,188 samples previously analyzed by *geneSPLASH.* Matching of replicate genotypes provides an improved description of regional return and migratory destinations. Mitochondrial DNA haplotypes were used to describe distinct population segments.

DNA samples extracted by colleagues at SWFSC were sent to Oregon State University on 15 September 2010. In addition to molecular identification of sex and sequencing of the mitochondrial (mt) DNA control region (460 bp), all samples were analyzed for the set of 10 microsatellite loci used during the previous SPLASH analysis. Following a quality control review, 25 samples with less than 8 microsatellite loci were identified as poor quality (PQ) and were excluded from further analyses. Of the 186 samples remaining, 23 were identified as within-region/within-dataset replicates, 14 within BER and 9 within WGOA. A further 12 samples were identified as within region matches to the original SPLASH dataset (7 within BER and 5 within WGOA). After all within-region replicates were removed a total of 219 individuals from BER and 157 individuals from WGOA remained.

The genotypes were compared to all previously identified SPLASH individuals and 6 new between-region matches were discovered; 1 male from BER to Ogasawara (OG); 1 male from BER to Eastern Aleutians (EAL); 1 male from WGOA to Hawaii (HI); 1 male from WGOA to Mexico Baja-California (MX-BC); and 1 male and 1 female from WGOA to Northern Gulf Of Alaska (NGOA). This brings the total number of matches from WGOA and BER to other regions to 14; 3 from WGOA to NGOA, and 1 from WGOA to Mexico Revillagigedo (MX-AR), 1 from WGOA to MX-BC, 1 from WGOA to HI, 1 from BER to OG, 2 from BER to EAL, 1 from BER to HI, 2 from BER to MX-AR (1 of these was then resampled in Mexico Mainland) and 1 from BER to MX-BC. The overall F:M sex ratio for BER was 1.38:1 and for WGOA was approximately 1:1. When separated by year, however, stronger biases are evident. In 2004 in BER there is a slight female bias, 1.12:1; this bias is much stronger in 2005, 1.6:1. In 2004 in WGOA there is a female bias, 1.36:1, but in 2005 it switches to a strong male bias, 1:1.85.

Stock Structure of NP Minke Whales (OSU Investigators/Research Staff: Professor Scott Baker; Faculty Research Assistant Debbie Steel; NOAA Collaborator: Paul Wade, NMML)

The intent of the proposed analyses was to evaluate plausible stock hypotheses as outlined in the ongoing discussions of the In-depth Assessment of western North Pacific common minke whales by the scientific committee of the International Whaling Commission. To establish plausibility, analyses included tests of Hardy-Weinberg equilibria, exact tests of differentiation and Analyses of Molecular Variance (AMOVA) to investigate differences in mtDNA haplotype frequencies, microsatellite loci and sex for various geographic and temporal strata. Dr. Baker attended the pre-meeting of the In-depth Assessment prior to the meeting of the Scientific Committee in

Tromso, Norway and the ongoing meeting of the In-depth Assessment subcommittee during the meeting. In advance of the meetings, Dr. Baker, FRA Debbie Steel and NOAA colleagues prepared three reports for consideration by the Subcommittee (SC/63/NPM15, SC/63/NPM16, SC/63/NPM17). This work extended the previous contributions to the In-depth Assessment as presented at the intersessional meeting in December 2010, in Busan, Korea (SC/D10/NPM1, SC/D10/NPM2_r1, SC/D10/NPM3, SC/D10/NPM4).

Publications:

Debbie Steel and C. Scott Baker (2011) Genetic identity of North Pacific minke whales from Korean bycatch and market surveys, with comment on quality control review. Report SC/63/NPM15 to the Scientific Committee of the International Whaling Commission, Tromso, Norway.

C. Scott Baker, Beth Slikas, R.L. Brownell Jr. and Paul Wade (2011) Stock structure of western North Pacific minke whales based on mtDNA haplotypes from Korean 'bycatch' and Japanese 'bycatch' and scientific whaling, in relation to Hypothesis III. SC/63/NPM16 to the Scientific Committee of the International Whaling Commission, Tromso, Norway.

Beth Slikas and C. Scott Baker (2011) Investigation of Hardy-Weinberg equilibria and population differentiation in North Pacific minke whales, based on microsatellite genotypes of Japanese 'bycatch' and scientific whaling. SC/63/NPM17 to the Scientific Committee of the International Whaling Commission, Tromso, Norway.

Seabird Bycatch Avoidance for West Coast Groundfish Fisheries (OSU Research Staff, Rob Suryan, Asst. Prof., Sr. Res, OSU/HMSC; NOAA Collaborators: Kim Rivera, Alaska Region, and Shannon Fitzgerald, AFSC)

Recognizing that the distribution of endangered short-tailed albatross (*Phoebastria albatrus*) overlaps the U.S. West Coast fishing grounds, NOAA Fisheries and the U.S. Fish and Wildlife Service initiated a process under the Endangered Species Act (ESA) to evaluate and minimize the effect of West Coast groundfish fisheries on this species. New regulations to minimize seabird mortality in West Coast fisheries could emerge from this process. Furthermore, a recent analysis of data from the West Coast Groundfish Observer Program indicates that black-footed albatross (BFAL) are being incidentally killed in West Coast longline fisheries (NMFS, Northwest Fisheries Science Center 2008). BFAL are being considered for listing under ESA. A determination of their status is expected by the end of this year.

Dr. Suryan completed all albatross distribution and U.S. West Coast fisheries overlap analyses and is currently working to produce a draft manuscript. In April 2011 an endangered short-tailed albatross was killed in an observed longline fishery off Oregon. He provided results of preliminary analysis to NOAA fisheries during their follow-up consultation with the U.S. Fish and Wildlife Service.

Presentations:

Guy, T.J., S.L. Jennings, E.F. Melvin, R.M. Suryan. 2010. Overlap of North Pacific albatrosses with West Coast groundfish fisheries. World Seabird Conference, Victoria, B.C., Canada.

Climate and Habitat Effects on Productivity of Alaska Groundfishes and Crabs (OSU Research Staff: Louise Copeman, Research Associate, Post-doc, CIMRS; Whiney Clerf, Courtney Danley, Faculty Research Assist., CIMRS; Ruth DiMaria, Graduate Student; NOAA Collaborator: Tom Hurst, AFSC)

The oceanographic regimes of the Bering Sea and Gulf of Alaska vary on several time scales in response to regional climatic fluctuations. Imposed upon this variation is the potential for longer-term climate changes, possibly increasing nearshore water temperatures. Such warming trends have already been observed in the Gulf of Alaska and Bering Sea. In addition, the threat of ocean acidification has the potential to cause significant disruptions in marine ecosystems through direct impacts on resources species and alteration of lower trophic level dynamics. Historical climate cycles have been linked to major shifts in composition of the valuable groundfish community. At sub-population scales, local habitat conditions determine the distribution and survival by effecting distribution and nutritional condition. CIMRS researchers are pursuing research along a number lines to explore the climate and habitat factors that influence population productivity of Alaskan fishery resource species.

In FY11, research was focused on four primary topics related to climate and habitat influences on Alaskan fishery resources. Experiments on the responses of walleye pollock eggs and larvae to anticipated patterns of ocean acidification suggested that anticipated changes in environmental pH may not have negative direct effects on these stages. Study of the spatial variation in energetic condition factor of juvenile Pacific cod suggested that variation among years was greater than variation among regional nurseries or habitat types (sand vs. vegetated). Work on fatty acid composition of Alaskan red king crabs was tracked through a juvenile molt stage and demonstrated significant differences in concentrations of essential fatty acids between wild and cultured crabs. Finally, experiments explored the habitat selection of early post-settlement tanner crabs and how habitat occupation influenced vulnerability to piscine and decapod predators. These experiments demonstrated the importance of polychaete worm tubes (a seasonally ephemeral epi-benthic feature) as a potential predator refuge.

Faculty Research Assistant Danley participated in experiments examining the responses of walleye pollock eggs and larvae to anticipated patterns of ocean acidification. Danley was responsible for maintenance of high-density prey cultures and experimental culture of fish larvae. Danley also conducted experiments describing the habitat selection and predator refuge value of a suite of habitat types for early post-settlement tanner crabs.

Faculty Research Assistant Clerf examined the energetic condition of juvenile Pacific cod from two sites Alaska nursery sites (Cooks Bay and Anton Larsen Bay) and habitat types (open vs. vegetated). Wet, dry weight, and hepatosomatic (liver) condition factors were measured for fish collected over 4 years. Condition factors were also examined from fish exposed to various levels of pH associated with ocean acidification.

Graduate student DiMaria analyzed otoliths of walleye pollock for the effects of environmental pH on incorporation of trace elements in to the calcium carbonate matrix. Otoliths were

sectioned, polished, and elemental composition was determined with laser-ablated inductively-coupled plasma mass spectrometry at Oregon State University's W.M. Keck Collaboratory.

Post-doctoral researcher Copeman performed lipid class analyses on juvenile king crabs, tanner crabs, and Pacific cod. King crab work focused on comparison of hatchery reared to wild caught crabs; tanner crab and Pacific cod work focused on spatial variation in fatty acid composition in relation to potential nutritional sources.

Meetings:
RA Copeman attended the Alaska Marine Science Symposium in Anchorage, January 2011, presenting results on fatty acid uptake in juvenile Pacific cod." Importance of prey quality to North Pacific marine fish larvae: a test case with Pacific cod."

Publications:
Copeman, L., et al. 2011. Rate of uptake of nearshore fatty acid biomarkers in Pacific juvenile gadids (*Gadus macrocephalus* and *Theragra chalcogramma*) as a function of temperature and tissue type. Submitted to *Canadian Journal of Fisheries and Aquatic Sciences.*

Copeman, L., et al. 2011. Lipid classes in crabs: Total lipid, lipid classes and fatty acids of newly settled red king crab (*Paralithodes camtschaticus*): comparison of hatchery-cultured and wild crabs. Submitted to *Journal of Experimental Marine Biology and Ecology.*

Steller Sea Lion Resights at Sea Lion Caves, Oregon (OSU Research Staff, Marcus Horning, Assoc. Prof., F&W; FRA Kim Raum-Suryan; NOAA Collaborator: Tom Gellatt, NMML)

The objective of this project was to collect Steller sea lion branded animal resight data at Sea Lion Caves (122º 8´N, 44º 7´W on the central Oregon Coast), using existing installations of remote recording video cameras and direct field observations. Cameras were operational for 258 days from 24 November 2009 to 29 September 2010. During this period, researchers recorded 1274 resights of 98 known individuals (61 F, 37 M). All identifiable individuals but one were branded at St. George Reef, California (n = 21) or Rogue Reef, Oregon (n = 76). One subadult male, 0 008, observed on 1 and 2 July 2010, was branded at Bonneville Dam, Oregon. Researchers also recorded 132 resights of 56 known individuals (41 F, 15 M) in the field on seven separate occasions from January through August. Thirty-nine of these 56 individuals also had been recorded via remote video. The project is completed and all objectives were met.

2010-2011 Publications
All Peer-Reviewed

Institute Lead Author	NOAA Lead Author	Other Lead Author
23	4	10

Auth, T.D. 2010. Importance of far off-shore sampling in evaluating the ichthyoplankton community in the Northern California Current. *Calif. Coop. Ocean. Fish. Invest. Rpts.* 50: 107-117.

Auth, T. D., R.D. Brodeur, **H.L. Soulen,** L. Ciannelli, W.T. Peterson. 2011. The response of fish larvae to decadal changes in environmental forcing factors off the Oregon coast. *Fisheries Oceanogr.* 20(4): 314-328.

Baldwin, R. E., M. Rew, M.L. Johansson, M. A. Banks, K.C. Jacobson. 2011. Population structure of three species of Anisakis nematodes recovered from Pacific sardines (*Sardinops sagax*) distributed throughout the California Current System. *J. Parasitology* 97 (4): 545-554 10.1645/GE-2690.

Bi, H., L.R. Feinberg, C.T. Shaw, and W.T. Peterson. 2011. Estimated development times for stage-structured marine organisms are biased if based only on survivors. *J. Plankt. Res*.33 (5):751–762. doi:10.1093/plankt/fbq138.

Black, B. A., R.J. Allman, I.D. Schroeder, M.J. Schirripa, 2011. Multidecadal otolith growth histories for red and gray snapper (*Lutjanus* spp.). *Fish. Oceanogr.* 20 (5): 347-356 10.1111/j.1365-2419.2011.00588.x2011.

Black, B. A. I.D. Schroeder, W.J. Sydeman, S.J. Bograd, P.W. Lawson. 2010. Wintertime ocean conditions synchronize rockfish growth and seabird reproduction in the central California Current ecosystem. *Canadian J. Fish. & Aquat. Sci.* 67 (7): 1149-1158.

Black, B. A., J.B. Dunham, B.W. Blundon, M.F. Raggon, D. Zima. 2010. Spatial variability in growth-increment chronologies of long-lived freshwater mussels: Implications for climate impacts and reconstructions. *Ecoscuence* 17 (3): 240-250.

Brodeur, R.D., **E.A. Daly,** C.A. Benkwitt, C.A. Morgan, and R.L. Emmett. 2011. Catching the prey: Sampling juvenile fish and invertebrate prey fields of juvenile coho and Chinook salmon during their early marine residence. *Fisheries Res.* 108:65-73.

Chadwick, W. W., Jr., R. P. Dziak, J. H. Haxel, R. W. Embley, and **H. Matsumoto. 2011.** Submarine landslide triggered by volcanic eruption recorded by in-situ hydrophone. *Geology* (in press).

Chadwick, W.W., Jr., S. Jonsson, D.J. Geist, M. Poland, D.J. Johnson, S. Batt, K.S. Harpp, A. Ruiz. 2011. The May 2005 eruption of Fernandina volcano, Galapagos: The first circumferential dike intrusion observed by GPS and InSAR. *Bulletin of Volcanology* 73 (6): 679-697 10.1007/s00445-010-0433-0.

Copeman, L.A., B.J. Laurel. 2010. Experimental evidence of fatty acid limited growth and survival in Pacific cod (*Gadus macrocephalus*) larvae. *Marine Ecology Progress Series* 412:259-272.

Daly, EA., C. E. Benkwitt, R.D. Brodeur, **M. Litz, L.A. Copeman**. 2010. Fatty acid profiles of juvenile salmon indicate prey selection strategies in coastal marine waters. *Mar. Biol.* 157 (9): 1975-1987.

Deardorff, N. D., K. V. Cashman, and **W. W. Chadwick, Jr**. 2011. Observations of eruptive plumes and pyroclastic deposits from submarine explosive eruptions at NW Rota-1, Mariana Arc, *J. Volcanol. Geotherm. Res.* 202(1-2): 47-59. doi:10.1016/j.jvolgeores.2011.01.003.

DeRonde, C., G. Massoth, D. Butterfield, B. Christenson, J. Ishibashi, R. Ditchburn, M. Hannington, R. Brathwaite, J. Lupton, V. Kamenetsky, I. Graham, G. Zellmer, **R. Dziak**, R. Embley, V. Dekov, F. Munnik, K/ Lahr**, L. Evans**, K. Takai. 2011. Submarine hydrothermal activity and gold-rich mineralization at Brothers Volcano, Kermadec Arc, New Zealand. *Miner Deposita* DOI: 10. 1007/s00126-011-0345-8.

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CIMRS Outreach Activities

Educational and scientific outreach is important in all aspects of CIMRS research. Websites are a venue that reach an enormous audience. CIMRS investigators feature their collaborative research efforts in the fields of fisheries oceanography, geophysical and acoustic monitoring of spreading centers, ocean exploration, and bioacoustic monitoring of large cetaceans at several sites hosted by NOAA and CIMRS. One award winning website (http://www.pmel.noaa.gov/vents) features educational curricula, video clips of in situ seafloor experiments, and animated 3-dimensional fly-through movies of seafloor ridges.

The Visitor Center at OSU's Hatfield Marine Science Center also lends a convenient outlet for educational displays and programs which may be viewed by 150,000 attendees annually This year exhibits were updated and renovated with large screen format for Patterns of Sound and Sounds of the Seas. Considerable collaborative effort was extended to Sea Grants' Ocean Quest 09 program, teaching summer interns about the latest underwater eruptive events at NW Rota in the Kermadec-Tonga Trench and sharing exciting videos with the public. NOAA's Teacher-at-Sea Program and the Ocean Exploration Program have helped sponsor educators on land and at sea who together present and interpret research activities for the general public. CIMRS investigators have also collaborated with Sea Grant Educational staff to design and prepare interactive exhibits. At the "ROPOS Exhibit", visitors can pilot a remotely operated vehicle to the seafloor and back with a joystick while viewing computer-generated and real video clips of the seafloor. Another exhibit "Sensing the Sea" allows visitors to "experiment" with sounds propagating through a salt water tank, simulating physical, biological, and anthropogenic sound that researchers monitor in the global oceans.

The newest still-developing exhibit "Sensing Salmon Runs" is an interactive display of the data collected by OSU and NOAA collaborators to predict future salmon runs in the Pacific Northwest. The exhibit display provides this information in ways that will engage the public in a free choice learning experience. Data used for the "predictions" include Pacific Decadal Oscillation phase, MEI El Nino Index, Sea Surface Temperature, upwelling, copepod abundance and type, dates of spring transition, etc.

CIMRS researchers provide valuable volunteer hours at K-12 Science Fairs and related activities throughout the year.

CIMRS faculty and NOAA colleagues also provide submissions to the NOAA, OAR "hot items" publishing venue for rapid distribution of new and exciting research discoveries. This year's contribution:
CIMRS and JISAO Researchers Discover Eruption at Axial Volcano can be viewed at http://www.nrc.noaa.gov/ci/

APPENDIX 1 – OCEAN ACIDIFICATION MONITORING AND PREDICTION IN OREGON COASTAL WATERS