Annual Progress Report
to
National Oceanic & Atmospheric Administration

NOAA Award# NA11OAR4320091

Reporting period: 7/1/13 – 6/30/14

Oregon State University

## Cooperative Institute for Marine Resources Studies

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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.
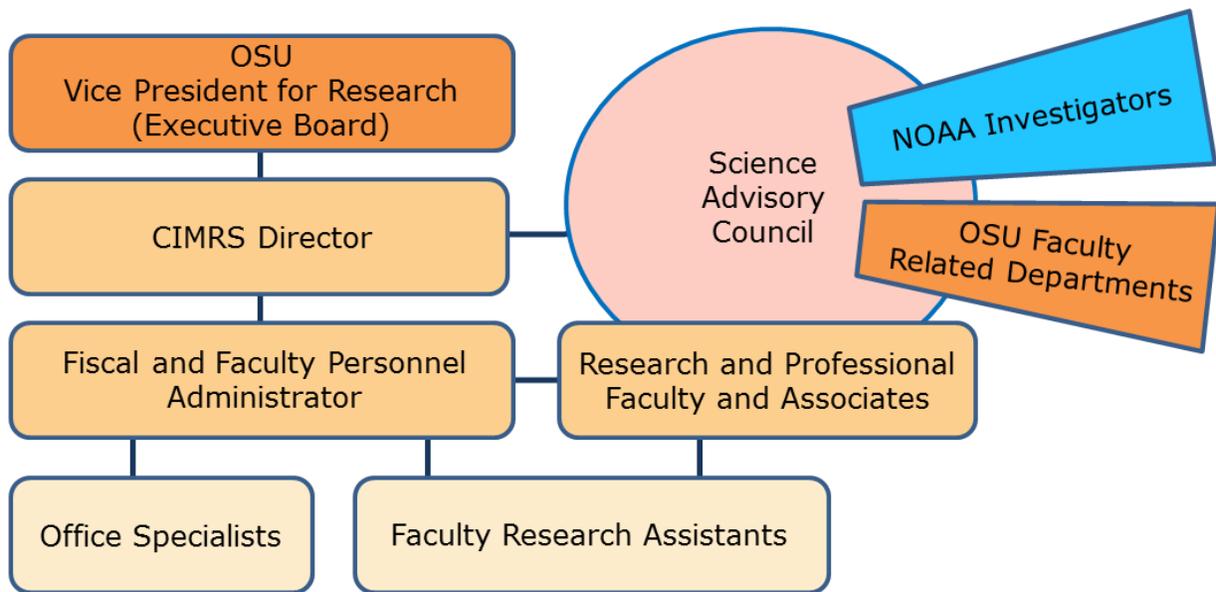
2013/2014 EXECUTIVE BOARD

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Michelle McClure Director, Fishery Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, NOAA	**Michael Banks** (Ex Officio) Director, Cooperative Institute for Marine Resources Studies, Oregon State University

RESEARCH PERSONNEL

The following table describes CIMRS research personnel in FY14

Position Category	# Staff	# B.S.	# M.S.	# Ph.D.
Research Scientist	6	--	--	6
Research Associates	4	--	--	4
Research Assistants	7	7	3	0
Total Support >50%	**17**	**7**	**3**	**10**
Research Assistant < 50%	**3**	**3**	**2**	**0**

CIMRS non-Faculty researchers spent over 76 days at sea in FY14.

ADMINISTRATIVE STAFF

Position	FTE	Supported by Award
Director	0.5	Partial
Administrator	1.0	Partial
Administrative Specialist	0.5	No
Purchasing Specialist	0.5	No
Travel Specialist	0.25	No

2013-2014 PUBLICATIONS
ALL PEER-REVIEWED

Institute Lead Author	NOAA Lead Author	Other Lead Author
6	1	7

TASK 1: ADMINISTRATION, EDUCATION, AND OUTREACH

Director Michael Banks was named chair of the CI Directors'Executive Committee for the current 3-yr term. In this capacity activities included:

- Summer Executive Meeting with NOAA and Sea Grant leadership, 6 August 2013

- OAR update with OAR AA Dr. Bob Detrick, 4 September and 4 December 2013

- Interview with Avery Sen, OAR Senior Analyst NOAA DC, 9 September, 2013

- OAR Senior Research Council & NMFS meeting in Miami, 25 & 26 February 2014

- National CI Directors meeting, Washington DC, 17 & 18 March 201

- Craig McLean OAR update call participation 19 June 2014

- CI Executive Committee spring phone conference 20 June 2014

- Participated in NMFS Northwest Fisheries Science Center, Science Symposium, 25 & 26 March 2014, at NOAA Western Regional Center in Seattle, WA.

In University Service, Dr. Banks' activities included:

- OSU Centers, Institutes and Programs meetings, quarterly

- OSU Provost's Marine Council meetings, quarterly

- Conducted review of CIMRS faculty and staff in November 2013

- Convened meetings for CIMRS coordination and oversight:

    Executive Board, Corvallis, OR (30 June 2014)

    CIMRS Faculty (20 January 2014)

- Engaged in various HMSC/OSU Marine Studies Campus and Building meetings

- Engaged in HMSC Executive Committee meetings, bi-weekly

CIMRS' 5th OAR 'HOT ITEM' was provided to the CI Program Office on 24 March 2014:
"Antarctic's Siren Call: The Sound of Icebergs"
http://ci.noaa.gov/InTheNews/HotItems/TabId/722/ArtMID/1835/ArticleID/10496/Antarctic%E2%80%99s-Siren-Call-The-Sound-of-Icebergs.aspx.

CIMRS Administrator Jessica Waddell attended the Annual CI Directors' Meeting in Silver Spring, MD in March 2014.

Dr. Banks and the CIMRS Administrator have been responsible for submission of 13 proposals under the new Institutional award during the period 10/1/13 – 6/30/14. This is in contrast to 18 proposals submitted under the Institution Award in FY13.

Administrative Program Specialist Hui Rodomsky continued to update and improve the CIMRS website. Ms. Rodomsky contributed to CI Program Office communications by reviewing draft communication plan and providing CI staff with feedback. Ms. Rodomsky also assisted Dr. Banks and Ms. Waddell in numerous administrative tasks such as drafting reports and outreach materials, tracking and maintaining the Institute's publications. Ms. Rodomsky left CIMRS employment on June 6th for full-time employment.

TASK 2

(All projects support NOAA Strategic Plan Goal of Healthy Oceans)

Theme: Marine Ecosystem and Habitat

Amendment 4: Improving Ecosystem-based Fisheries Management and Integrated Ecosystem Assessments by Linking Long-term Climatic Forcing and the Pelagic Nekton Community in the Northern California Current
Funded: $109,075

OSU RESEARCH STAFF: *Lorenzo Ciannelli*, Associate Professor, College of Earth, Ocean, and Atmospheric Sciences; *Caren Barceló*, Graduate Research Assistant, College of Earth, Ocean, and Atmospheric Sciences
NOAA TECHNICAL LEAD:*Ric Brodeur*, Fisheries Ecology, NWFSC

PROJECT BACKGROUND: This project directly contributes to the goal of creating indices of ecosystem properties and processes that reflect the condition of the ecosystem and the potential for changes in the distribution and habitats of the economically and ecologically important fish stocks in the California Current. The Pacific Fisheries Management Council has started to incorporate ecosystem information into fisheries management. This includes a synoptic overview of the status and trends in the abundance of prey for groundfish, with an eye toward implementing more/less conservative fisheries management guidelines when prey are less/more abundant.   This project summarizes changes in the status of the forage base for groundfish over the last ~15 years, thus providing critical ecosystem information for developing precautionary fisheries management guidelines.   Specifically, the project identifies responses of fisheries resources to environmental forcing in order to provide assessors the raw materials to incorporate a climate index in stock-recruitment relationships.

PROJECT PROGRESS: This project aims to develop new indicators that will describe how the pelagic nekton communities in the Northern California Current have responded to climatic forcing during the period 1998-2011, with the twin goals of providing critical ecosystem information for fisheries management and expanding the availability of indicators for Integrated Ecosystem Assessments put together by NOAA. We have currently progressed through year 2 of the proposed research.

In the past FY, Ph.D. student C. Barceló, provided data products to NOAA's Integrated Ecosystem Assessment sections, specifically, the Ecosystem Integrity, Ecosystem Indicators, Coastal Pelagic Fishes and Risk Assessment portions. Specifically, Barceló updated time series of abundance data for top abundant species captured in NOAA-NWFSC's BPA Plume survey data sampled along the Oregon and Washington coasts, evaluated the appropriateness of proposed ecosystem indicators in regards to the BPA plume survey. Barceló also ran multivariate analyses to track the change in overall community composition through the years, which was included in the Coastal Pelagic Fishes section of NOAA's IEA. Barceló presented spatial summary of centers of distribution of forage fishes, change in community composition and overlap statistics with both jellyfish and shark predators in the Northern California Current at the Predators and Preyscape workshop. Barceló is also currently analyzing spatial community

datasets using both BPA-Plume survey and OSU 80s datasets for a community composition shift manuscript.

Professor Lorenzo Ciannelli assisted in the interpretation of results and preparation for presentations.

PUBLICATIONS:

Brodeur, R.D., **Barceló, C**., Robinson, K.J., **Daly, E**., **Ruzicka, J.J**. (In press) Seasonal and interanual variability in the spatial overlap between forage fishes and large medusa *Chrysaora fuscescens* in the northern California Current region. *Marine Ecology Progress Series, Special Issue*.

Amendment 5: Interannual Variability in the Northern California Current: the Influence of Past El Niño Events on Salmon Populations and Pelagic Ecosystem Structure with Analysis of the Potential for Forecasting Future Ocean Conditions
Funded: $121,085

OSU RESEARCH STAFF: *Jay Peterson*, Research Associate, CIMRS; *Jennifer Fisher*,
                                           Faculty Research Assistant, CIMRS
NOAA TECHNICAL LEAD: *Bill Peterson*, Fish Ecology, NWFSC

PROJECT BACKGROUND: The research proposed will examine relationships between El Niño events and resulting variability in SST, sea level, hydrography, and the abundance and species composition of copepods, krill eggs, larvae and adults, ichthyoplankton and small pelagic fishes along with salmon returns, in waters of the NCC. Statistical relationships between El Niño events and physical and biological anomalies will be examined in order to develop a better understanding of the factors which may moderate or exacerbate the influence of El Niño (e.g., the timing of the arrival of physical El Niño signals, duration, and the magnitude of oceanic and/or atmospheric anomalies) on the *biological* components of the ecosystem. Trends for the biological components will be forecasted for 6-9 month time periods from ocean conditions that are testable and relevant to management decisions for fisheries, protected species and ecosystem health components in the California Current. This work directly supports NOAA's Long-term Goals of Climate Adaptation and Mitigation and Healthy Oceans.

PROJECT PROGRESS: FRA Fisher's efforts on this project were to analyze all data to provide results for inclusion in the journal articles and presentations listed below. Research Associate Jay Peterson assisted with web page development of data. The major findings were that the persistence of the lipid-poor, warm water copepod community was strongly positively related to the intensity of ENSO (El Niño Southern Oscillation) events. The response of the copepod community to ENSO events, measured as the arrival of copepod species with warm water affinities, was rapid (lag of zero to 2 months) during Eastern Pacific (EP) events and delayed (lag of five to nine months) during Central Pacific (CP) events. Further, the response of the copepod community to ENSO is sensitive to the phase of the lower-frequency Pacific Decadal Oscillation (PDO), substantiating the similarity in the ecosystem's response to these two atmospheric phenomena.   Web   presentation   of   the   data   can   be   found   at http://www.nwfsc.noaa.gov/oceanconditions (see "Time Series Plots" and "ONI" sections of the

webpage). All physical and biological data are archived in a Microsoft Access database at the Northwest Fisheries Science Center's Newport, Oregon location.

An important publication from this work was submitted to Geophysical Research Letters and is now in the review process at the journal:

Fisher, J.L., Peterson, W.T., and Rykaczewski, R. The impact of ENSO on the pelagic food chain in the northern California Current. Geophysical Research Letters.

PRESENTATIONS:
Fisher, J.L. & Peterson, W. T. (2013) Listen while the copepods speak: how different copepod indices respond to environmental indices in the northeast Pacific (Newport, Oregon, USA). Oral Presentation. PICES Annual Meeting. Nanaimo, BC, Canada. October 11 – 20, 2013.

Peterson, W.T. & **Fisher, J.L.** (2013) The influence of ten El Nino events on pelagic ecosystem structure in the northern California Current. Oral Presentation. PICES Annual Meeting. Nanaimo, BC, Canada. October 11 – 20, 2013.

Amendment 13: Development of an Integrated, Multi-layer GIS Database for US West Coast Groundfish
Funded: $30,000

OSU RESEARCH STAFF: *Chris Goldfinger*, Professor, College of Earth, Ocean, and Atmospheric Sciences; *Chris Romsos*, Faculty Research Assistant, College of Earth, Ocean, and Atmospheric Sciences
NOAA TECHNICAL LEAD:*Waldo Wakefield*, Marine Habitat Ecology, NWFSC

PROJECT BACKGROUND: The Pacific Coast Ocean Observing System is the ecosystem observing backbone of Integrated Ocean Observing System for the California Current Large Marine Ecosystem. The geographic focus is the U.S. Exclusive Economic Zone off the coasts of California, Oregon and Washington with international links to the portion of the California Current Ecosystem occurring in Canadian and Mexican waters. The system provides the information needed for management of fishery resources, protected marine mammals, marine birds, and turtles, and to forecast the ecosystem consequences of fisheries removals, environmental variability and climate change. To meet the needs of the Pacific Coast Observing System that provides ocean information for the sustained use of the California Current Large Marine Ecosystem and the 5-Year EFH Review Phases I and II, the PaCOOS computer server must publish several terabytes of habitat maps and imagery. This is best accomplished by providing access to the data through web map services. Web map services create map images on demand for a client, and as such they are extremely process intensive on the server-side. Phase II of the 5-Year EFH review (*i.e.,* public nominations for EFH changes) will create a large increase in demand for the PaCOOS web map services, specifically for the data catalog and web maps developed under Phase I of the 5-Year review. The existing server did not have the processing capacity to handle data requests under the newly developed PaCOOS technology stack or the

newly consolidated 5-Year EFH Review Data Catalog. This project was specifically designed to increase the capacity of the servers to maintain the functionality of the PaCOOS web map services that are vital to the 5-Year EFH Review.

PROJECT PROGRESS: Software and databases have been migrated over to the new server this year. Progress has been slow due to unexpectedly high workload related to the EFH review that was extended through January 2014. The Phase II report delivered by the EFHRC (Essential Fish Habitat Review Committee) became an item of some controversy in late 2013, triggering extended effort to support completion of that process. The map viewer system is complete and operational, and now hosts the many layers of the EFH Five Year Review. This server deployment has served the Council, its committees and subcommittees and the public now for two years. During that time, Chris Romsos has maintained this system, corrected faults, upgraded datasets and responded to problems as the technical support person for this system throughout 2013-14.

The final step will be to complete population of the new PaCOOS server with data (in parallel to the EFH system, and sharing many of the databases). Many of the individual datasets that form the backbone of PaCOOS are being revised under BOEM and NSF funding. Therefore, the public presentation of PaCOOS will await finalization of these datasets. A final product to be added in mid 2014 is a Bayesian rock probability model that integrates existing disparate seafloor mapping and subsurface data into a model of probability of rock outcrop in areas where no multibeam data exist. Also to be included in the re-populated PaCOOS server will be new Bayesian invertebrate HSP models created as part of the BOEM study, including one for glass sponge HSP. When ready, these bathymetric, habitat and species specific datasets will be added, the new PACOOS server will be made public, and the project will be complete. At that time, the first generation PaCOOS server and front facing homepage (http://pacoos.coas.oregonstate.edu) will be removed. This switchover/sunset is the final development/implementation step identified through the cooperative agreement and is being supervised or directed by a team of scientists from OSU and NOAA. Although it was hoped that the switchover would be completed by fall 2013, this date had to be revised to fall 2014.

Amendment 16: Multi-beam Mapping of High Coral Bycatch Areas in Northern California and Southern Oregon
Funded: $69,000

OSU RESEARCH STAFF: *Chris Goldfinger*, Professor, College of Earth, Ocean, and Atmospheric Sciences; *Chris Romsos*, Faculty Research Assistant, College of Earth, Ocean, and Atmospheric Sciences
NOAA TECHNICAL LEAD: *Elizabeth Clarke*, Science Synthesis and Coordination, NWFSC

PROJECT BACKGROUND: The objectives of the multibeam surveys are: 1) conduct multibeam mapping of areas near Klamath Canyon as defined by trawl survey coral hotspots; 2) produce high-resolution maps of bathymetry and backscatter for both new data collected during seagoing 2012 operations, and from existing EM 302 data in the vicinity of Mendocino Ridge; 3) characterize key features of surveyed substrates such as complexity, hardness, rugosity, and

slope; and, 4) identify high-confidence targets for visual surveys of deep-sea coral and sponges in areas adjacent to the identified hotspots near Mendocino Ridge and Klamath Canyon.

Data from these surveys will include georeferenced distribution and abundance of demersal corals, sponges, and habitats, samples of corals and sponges for genetic and morphological studies, sediment samples for groundtruthing of seafloor maps, and continuously collected salinity, temperature, oxygen concentration, depth, and location. Resultant data will be added to a comprehensive database of similar data collected elsewhere off California available on the public website PaCOOS West Coast Habitat portal: http://pacoos.coas.oregonstate.edu/.

PROJECT PROGRESS: A plan was developed in mid-2013 to attempt a second cruise with the same objectives as the first. It was decided to focus on ROV dives because not enough resources were available to mount another cruise with the required ship time funds on *Pacific Storm* having been expended. A plan was developed to use the ROV primarily, but to also map the seafloor and shallow subsurface using a Knudsen chirp sub-bottom system to identify seafloor targets from the chirp profiles rather than multibeam data as had originally been planned. The Knudsen 320 BR installed on a vessel of opportunity, the *R/V Point Sur*, can image the surface and shallow subsurface at a spatial resolution of ~ 25 cm vertically operating at a sweep of 2-6 kHz, more than sufficient to image rocky outcrops for investigation. It further can image the subsurface structure that forms the outcrops, providing the context for the formation of the targets and their relationships to the local and regional geology. This alternative strategy was expected to be successful given that the compilation of existing multibeam bathymetry, while not ideal by any means, was sufficient to serve as guidance for the cruise. Prior to the cruise, Chris Romsos acquired and reprocessed all available multibeam data in the target areas and produced backscatter and shaded relief maps to support the cruise. Line plans were generated to best take advantage of these data and the capabilities of the Knudsen chirp system.

The Pt. Sur Cruise was planned for early October, 2013. Preplanning started in August 2013. FRA Chris Romsos created a bathymetry grid (100m x 100m resolution) from the most recent information available in our lab and from the National Geophysical Data Center (NGDC) for the study area. Custom grids were produced to optimize the available data for the water depths of interest for the ROV, ~ 1000m. Romsos then worked with Stian Alesandrini (Pt. Sur marine Technician) to make sure that the Knudsen 320 BR sub-bottom profiler was operational, that it was capable of recording the data, and that we could read the data it produced. We investigated heave compensation for this system, but opted for heave filtering of the data in post processing. We developed a cruise GIS database project for planning and ultimately for use at sea. This period included several conference calls and cruise planning WebEx September 6, 2013. Prior to the Webex new data was added and this updated the cruise GIS to show latest maps and overlays or trawling tracks, coral/sponge occurrences, and other seafloor data for planning of the ROV dive tracks. A final Cruise Planning Call was held Tuesday Sept 24, 2013 at which time Romsos added updates to cruise tracks and datasets were then added to the cruise GIS post call.

Mobilization began for us with Romsos travelling to San Jose and Moss Landing on Monday October 7, 2013. On Tuesday October 8th Romsos mobilized sub-bottom data acquisition station and cruise GIS on Pt Sur. He conferenced with Chief Scientist Lisa Krigsman to develop a new cruise work plan to account for the furloughed science party (Federal shutdown) and the change

in survey equipment (NOAA AUV was secured at a federal facility prior to mobilization). Romsos assisted with mobilization of the Scripps ROV, attended a cruise science meeting (science and crew) where he briefed crew and Scripps Marine Technicians about the study site geology, hazards, etc. The shakedown of equipment occurred on Wednesday October 9th. Romsos assisted on deck during launch and recovery of ROV, assisted with CTD cast, tested Knudsen sub-bottom profiler.   It was found at this time that repair work done to the ROV and umbilical had resulted in the total maximum depth of operation of the ROV was now short of the required depth for the cruise. Therefore, the cruise was cancelled October 10th 2013 due to lack of critical mass for the operations, with the Knudsen sub-bottom system the only operational system available on the vessel. Chris Romsos returned to Corvallis October 11th.

Amendment 22: Coast-wide Genetic Stock Identification – Ecosystem Effects on Adult Chinook Salmon Distribution and Abundance
Funded: $102,767

OSU RESEARCH STAFF: *Michael Banks*, Director, CIMRS; *Jonathan Minch*, Faculty
                                        Research Assistant, Hatfield Marine Science Center
NOAA TECHNICAL LEAD: *Pete Lawson,* Conservation Biology, NWFSC

PROJECT BACKGROUND: Genetic Stock Identification (GSI) is a uniquely useful tool for salmon management because it enables identification of nearly all hatchery and natural origin fish sampled and results are available in a few days. This is in contrast to the traditional Coded Wire Tags, which provide data on about 5 percent of hatchery fish only. Ages of GSI-sampled fish are determined from scales. GSI in combination with fine-scale at-sea sampling allows determination of which stocks are present in the fishery with a high degree of certainty and to map dynamic stock-specific distributions. It is anticipated that 2400 tissue samples will be analyzed from collections of Oregon Chinook salmon from three areas in August and September. Genetics labs from Alaska to California have created a database of genetic microsatellites from Pacific salmonids through a consortium called Genetic Analysis of Pacific Salmonids (GAPS).

PROJECT PROGRESS: The work accomplished under the subaward to the Oregon Salmon Commission (OSC) included 1) fleet management, 2) liaisons and interviews, 3) fishermen, 4) sampling supplies, and 5) database maintenance. The OSC entered into contracts with the fleet manager, liaisons, fishermen and Fish Trax Systems, Inc. (website maintenance) to perform the tasks for this project.
   Fleet management: The fleet manager (also the liaison for Newport) coordinated with the three other port liaisons (Brookings, Charleston, Winchester Bay) through one-on-one training and conference calls to prepare liaisons for distributing supplies and training fishermen for the sampling season. The fleet manager was in daily contact with the liaisons for fish count updates and number of fishermen collecting samples. The fleet manager was in contact with the OSC to ensure that all work stayed within budget guidelines.
   Liaisons: At the end of each fishing trip, the liaisons met each fisherman for an interview to download their GPS track logs, enter them in the database, and restock their supplies (barcode tags, envelopes, batteries, etc.). The envelopes with samples were sent to the lab for processing. Liaisons sent fishermen to sea on a rotating basis to ensure that everyone had equal opportunity

for participation. When at sea sampling, fishermen contacted liaisons daily with an update on the number of fish sampled.

Fishermen: Chinook salmon and associated fine-scale at sea environmental data were collected in Oregon, during the 2013 fishery season in accordance with the West Coast Salmon Genetic Stock Identification Collaboration sampling plan. Of the 47 contracted fishermen, 26 participated in the project by collecting biological samples and fisheries data using standardized sampling protocols. (Because the salmon season was slow, some of the contracted fishermen opted to fish for albacore rather than salmon.) Fishermen collected 2,437 samples from May 15 through September 30, 2013. 662 of the samples were collected in the Northern Oregon Coast, 1,650 in the Southern Oregon Coast and 125 in the Klamath Management Zone. A smaller sampling strategy has been coordinated for 2014 to enable continuation of data collected region. By the end of June, 9 fishermen were contracted and are ready to begin fishing and sampling for this year's project beginning 7/14/14. More contracts are anticipated in early July.

Database Maintenance: The liaisons accessed the database regularly to enter the fishermen information. These data were then available for the lab to access and connect with the biological samples. Fishermen were able to access their own fishing data and compare it with the aggregate throughout the season. Project managers and scientists accessed the data to compare with data from previous years and to see if any patterns were developing. An in-season final report 3/24/14 was prepared and included a summary of each month from May through September with the number of fish sampled and their genetic river of origin. Central Valley Fall Chinook were the dominant component of harvest for each of the five months. This report has been posted to the Pacific Fish Trax website (http://www.pacificfishtrax.org/). This site also includes the public portal for viewing aggregate data by time, regions, fish size and river of origin. Individual fishermen data is available through a specific log-in allowing them to view their own fishing data. The 2013 and 2014 sampling adds to the work that has been completed since 2006. Collecting several more years of data will strength the database and should improve our understanding of the ocean ecology of salmon by integrating stock-specific distribution patterns over space and time with biological and environmental data.

Genetic Characterization using the GAPS database: Work accomplished in this reporting period includes DNA extraction and polymerase chain reaction amplification of the GAPS13 microsatellites to identify most likely source of sampled Chinook. Further analysis includes assessing encounter rates of different stocks as a function of effort and evaluating trends over location, time and years sampled since 2010 (see report copied below). For Oregon waters in 2013, a total of 2,437 samples were collected and provided to the genetics laboratory by Project CROOS participants. Starting 7/1/13, and through the full season, DNA was extracted from a sub-sample 1,928 of these Oregon tissue samples using a silica-based method that utilizes multichannel pipettes, PALL glass fiber filtration plates, and buffer, centrifuge and transfer protocols as described in Ivanova et al. (2006). A panel of 13 microsatellites known as GAPS13 (from Seeb et al. 2007) were amplified from these DNA samples using the polymerase chain and utilizing protocols detailed in Seeb et al. (2007) and multiplex modification protocol developed by Jonathan Minch. This panel includes: *Ogo-2, -4* (Olsen et al. 1998); *Oki100* (Canadian Department of Fisheries and Oceans, unpublished); *Omm1080* (Rexroad et al. 2001); *Ots-3M* (Greig and Banks 1999); *Ots-9* (Banks et al. 1999); *Ots-201b, -208b, -211, -212, -213* (Greig et al. 2003); *OtsG474* Williamson et al. (2002); and *Ssa408* Cairney et al. (2000). Most likely region and run of origin were assessed utilizing the 'assign individual to baseline population' option available in the statistical package ONCOR (Kalinowski 2008

www.montana.edu/kalinowski/Software/ONCOR.htm) and each individual was assigned to the reporting group in which it had the greatest probability. Data for most likely region of origin for Oregon samples were deposited in the Pacific Fish Trax database in near real-time. Analysis has also included historical data from CROOS fisherman and Coded Wire Tag (CWT) data to enable basic comparisons between the stock specific catch per unit effort data in units of fish per boat day.

PUBLICATIONS:
Satterthwaite W.H., Mohr, M.S., O'Farrell, M.R., Anderson, E.C., **Banks, M.A.**, Bates, S.J., Bellinger, M.R, Borgerson, L.A., Crandall, E.D., Garza, J.C., Kormos, B.J., Lawson, P.W., Palmer-Zwahlen, M.L. (2014) Use of genetic stock identification data for comparison of the apparent ocean spatial distribution, size-at-age, and fishery exposure of an untagged stock and its indicator: California Coastal versus Klamath River Chinook. *Transactions of the American Fisheries Society*, 143(1) 117-133 DOI: 10.1080/00028487.2013.837096

Amendment 23: Climate and Habitat Effects on Productivity of Important Alaska Fishery Species
Funded: $97,059

OSU RESEARCH STAFF: *Jessica Miller, Associate Prof, OSU Fisheries and Wildlife, Eric Hanneman*, Bioscience Research Technician, CIMRS
NOAA TECHNICAL LEAD: *Tom Hurst*, Fisheries Behavior Ecology, AFSC

Effects of ocean acidification on Alaskan fishes

PROJECT BACKGROUND: This project directly addresses NOAA Ocean and Great Lakes Acidification Research Plan's goal of evaluating the ecological effects of ocean acidification. Walleye pollock, Pacific cod, and northern rock sole are principle components of the nation's most valuable fisheries. This work evaluates the physiological effects of ocean acidification that could lead to changes in population productivity of these critical resource species.

PROJECT PROGRESS: Bioscience Research Technician Eric Hanneman successfully reared larval and juvenile walleye pollock, northern rock sole and Pacific cod under varying conditions in the laboratory. These juveniles were raised in 100L black cylindrical flat-bottom upwelling tanks for experiments on the effects of ocean acidification on larval growth and development.

Hanneman reared larval northern rock sole in order to examine the effects of ocean acidification on early life stages. In two experiments, northern rock sole were reared at ambient and low pH, and under high and low feeding regimes, in order to investigate the effects of reduced pH and food availability on growth and survival.

Hanneman also contributed to improvements in the husbandry aspects of the research. An experiment was designed to concurrently test the effects of two different rotifer enrichment feeds, and the effects of high and low aeration, on the growth and survival of larval walleye pollock.

Habitat selection of juvenile flatfishes

PROJECT BACKGROUND: This project directly addresses Alaska Fisheries Science Center's Habitat and Ecological Processes Research Program research priority of characterizing habitat utilization and productivity for Essential Fish Habitat. This project is designed to characterize the habitat variables that contribute to variable settlement into nursery areas by Pacific cod and Northern rock sole, an important fishery resource species. The investigation improves understanding of nursery function for rock sole by determining the role of settlement processes in habitat use for this species (Levels 2 and 3 of Essential Fish Habitat information).

PROJECT PROGRESS: The goal of this research is to determine if the chemical composition of juvenile Pacific cod otoliths ("ear bones") can be used to distinguish among fish from different nearshore "nursery areas" in the Gulf of Alaska. This year's component builds upon work completed last year when we characterized the otolith elemental composition of juvenile Pacific cod collected in 2011 from five nursery areas throughout the Gulf of Alaskan. This year we have completed the polishing and mounting of ~190 otoliths from 2-yr old Pacific cod that were collected in the fishery during 2013 for chemical analysis. These 2-year olds are from the same cohort as the juveniles that were used to develop the geochemical baseline of nursery areas. Therefore, we can determine which, if any, of those five nursery areas contributed fish to the adult population.

Using coastal nursery habitat surveys in stock assessment and forecasting recruitment in gadid fisheries

PROJECT BACKGROUND: A workshop, "Using Coastal Surveys in Stock Assessments," was convened to evaluate the varying concerns of using coastal surveys that employ non-traditional stock assessment gear such as beach seines, visual surveys and small mesh trawls and determine how best to link these data with contemporary assessment approaches. The workshop brought together expertise and time series data from three regions with intensive gadid fisheries and inshore nursery survey data. These three regions are: 1) Gulf of Alaska – beach seine/small mesh trawl, 30+ Years; 2) Newfoundland – beach seine, 40+ Years; and 3) Norway – beach seine (Flødevigen survey), 100+ years. Analysis of catch data across regions is being examined with sequential year class analyses to determine the scale at which recruitment prediction is possible. In addition, the data sets are being used to examine considerations of population connectivity, life history differences, gear biases, estimating natural mortality, and microhabit usage. The proceedings of the workshop and results of analyses will be used in the preparation of a multi-authored manuscript evaluating the justifiability, feasibility and outcome of integrating coastal and offshore survey data for the purposes of stock assessment.

PROJECT PROGRESS: This year's component builds upon work completed last year when we characterized the otolith elemental composition of juvenile Pacific cod collected in 2011 from five nursery areas throughout the Gulf of Alaskan. This year we have completed the polishing and mounting of ~190 otoliths from 2-yr old Pacific cod that were collected in the fishery during 2013 for chemical analysis. These 2-year olds are from the same cohort as the juveniles that were used to develop the geochemical baseline of nursery areas. Therefore, we can determine which, if any, of those five nursery areas contributed fish to the adult population.

An overlooked source of age-0 abundance data for cod species stems from habitat studies in coastal nurseries, often in the form of beach seine data resulting from process studies or bycatch data from state or provincial surveys. Such surveys have been traditionally ignored for the purposes of stock assessment and forecasting recruitment, but where examined, they appear to be good and reliable indicators of both inshore and offshore year class strength. Coastal nursery surveys are also often repeated over the course of a season, and thereby potentially hold more accurate estimates of natural mortality and growth of age-0 fish. However, the justifiability, feasibility and outcome of integrating coastal and offshore survey data for the purposes of stock assessment have not been evaluated, resulting in the creation of a coastal cod working group in 2012.

The coastal cod working group is comprised of 12 members representing expertise and access to data from three regions with intensive gadid fisheries and inshore nursery survey data. These are: 1) Gulf of Alaska – beach seine/small mesh trawl, 30+ Years; 2) Newfoundland – beach seine, 40+ Years; and 3) Norway – beach seine (Flødevigen survey), 100+ years. Annual summer workshops have been held since 2012 to evaluate limitations, develop approaches and analyze coastal time series for the purposes of assessment and forecasting recruitment.
The 2014 workshop at the Hatfield Marine Science Center involved a sub-group (B. Laurel (Alaska-AFSC), R. Gregory (DFO-Newfoundland), D. Cote (Parks Canada-Newfoundland), L. Copeman (Alaska –CIMRS) and L. Rogers (IMR-Norway, via Skype)) focused on analyzing data and writing a peer-reviewed manuscript examining the relative importance of the 3 critical periods in these nurseries---delivery vs post-settlement vs overwintering processes. The analysis used metrics of annual catch abundance and growth potential at each of the corresponding critical periods in the coastal nurseries of each system. The goal was to identify periods of mortality to determine if they were associated with each thermal conditions for growth (e.g., annual temperature variance during larval delivery (e.g., May – June), post-settlement (e.g., July – October), and overwintering (e.g., December – March). The ultimate goal was to identify when recruitment was set during the 1st year of life to guide future analyses and survey design. A draft manuscript will be forthcoming in August.

Amendment 30: Effects of PDO, ENSO, Climate Change on the Northern California Current Ecosystem
Funded: $100,000

OSU RESEARCH STAFF: *Michael Banks*, Director, CIMRS
NOAA TECHNICAL LEAD:*Kurt Fresh*, *Bill Peterson*, Fish Ecology, NWFSC

PROJECT BACKGROUND: This research project is directed at investigating how the variations in the two "flavors" of ENSOs—the so-called Eastern Pacific (EP) and Central Pacific (CP, or modoki) El Niños— have affected ecosystem structure and function in the NCC over the past 50 years. The impact of ENSO events on the NCC has been variable over this time period. Another component of this research is to look at low-frequency physical forcing related to the PDO and NPGO and ecosystem responses. Elucidating the nature of the mechanistic process(es) that link a changing climate, physical drivers operating at a diversity of scales such as PDO and

El Nino, with changes in different ecosystem components such as zooplankton and salmon production is plausible and essential to apply our climate understanding in fisheries management and anticipate whether current statistical relationships between large-scale climate indices and the ecosystem of the NCC can be expected to persist with future climate changes.

PROJECT PROGRESS: In October 2013 the first open announcement posted for the Post-doctoral position that would conduct research in this project. With the lack of qualified applicants the closing date of the position opening was extended and efforts were made to target announcement of the opening to institutions/organizations that were suggested by members of the Search Committee. This produced at least three qualified applicants who were interviewed in mid-December. The Search Committee was unanimous in their selection of the best candidate and the position was offered but declined by the candidate. The Search Committee's recommendation after was not to offer the position to either of the remaining two candidates interviewed. An issue that surfaced (expressed by the candidates) was the lack of secure continued funding for the project. It is anticipated that the position will be re-opened in the next year.

Amendment 32: Long-term Observations of Physical and Biological Oceanographic Conditions in Coastal Waters off Oregon: Hydrography and Zooplankton
Funded: $101,739

OSU RESEARCH STAFF: *Jay Peterson*, Research Associate, CIMRS
NOAA TECHNICAL LEAD:*Bill Peterson*, Fish Ecology, NWFSC

PROJECT BACKGROUND: This project which monitors ocean conditions and zooplankton communities continues to produce a combined northern California Current copepod anomaly index annually. In addition, copepod abundance anomalies are calculated on a seasonal basis (spring, summer, fall) for comparison to sablefish, whiting, rockfish and Chinook and Coho salmon time series of recruitment and survival. CIMRS investigators monitor ocean conditions off the coast of Oregon sampling hydrography and plankton along the Newport Hydrographic Line (44.6°N) on a biweekly basis.

PROJECT PROGRESS: Cruises along the Newport Hydrographic (NH) Line were conducted bi-weekly, with a few exceptions due to inclement weather and sea-conditions or the lack of availability of the research vessel (RV Elakha) in March 2014 due to repairs. There were seven target stations ranging from 1 to 46 km from shore along the NH Line that were sampled. At each station visited, measurements of hydrography (temperature, salinity, depth, dissolved oxygen, fluorescence) were made throughout the water column using a CTD (Seabird Model 19). Water samples were collected for analysis of chlorophyll and nutrient concentration. Zooplankton were sampled using a vertically towed plankton net as well as a larger, obliquely-towed, bongo-style net. The zooplankton samples were preserved and brought back to the lab for analysis. CTD data zooplankton samples chlorophyll and nutrient samples (OSU Analytical Lab) have been processed and analyzed and entered into a Microsoft Access database located in Newport, Oregon.

Theme: Protection & Restoration of Marine Resources

Amendment 8: Refinement and Application of a Bioeconomic Spatial Fishery Simulator
Funded: $125,747

OSU RESEARCH STAFF: *David Sampson*, Professor, Department of Fisheries and Wildlife;
                                      Christopher Cusack, Graduate Research Assistant, College of
                                      Agricultural Sciences
NOAA TECHNICAL LEAD:*Cindy Thomson*, Fisheries Economics Team, SWFSC;
                                      Andi Stephens, Population Ecology, NWFSC

PROJECT BACKGROUND: This project is to refine a generalized bioeconomic simulator that Dr. David Sampson originally constructed during 2009 – 2011 in his role as a Senior Fisheries Scientist at the European Commission's Joint Research Center in Ispra, Italy, while on leave of absence from Oregon State University. The simulator, which is coded in the open-source R language, mimics the population dynamics of one or more fish stocks that occupy a set of spatial regions and are harvested by multiple fishing fleets. The overall goal of the project is to complete a bioeconomic spatial fishery simulator that is more realistic than the current generation of simulation models and to use the simulator to help develop practical solutions to some of the complex problems involved in managing our fisheries. It is intended to be a flexible tool for exploring the effectiveness of fishery management policies in the face of uncertainty. It is distinct from the models that are typically used in guiding fisheries management in that it includes equations for modeling dynamic changes in the fishing operations. Most fisheries models, in contrast, take a strictly biological perspective and treat the mortality generated by fishing as a constant. Also, the simulator takes a more realistic approach than the economic-oriented fisheries models that employ very simple equations for the biomass dynamics of the fish stocks. For the biological components, the bioeconomic simulator uses the standard age-structured dynamics that are used in modern stock assessments, with explicit equations for growth in length and weight, maturation, age-dependent mortality, and the production of annual recruitment.

One aspect of the simulator, which is an important technical advancement over other bioeconomic fisheries models, is in how the simulator handles the aspect of spatial distribution of fishing. Because fish are not uniformly distributed, a skipper's choice of where to deploy his fishing gear is a major economic decision variable. Locations with high densities of fish could produce significant revenue, but the associated costs of fishing in these areas may lessen their desirability. Further, because fishing is a competitive process, locations with high fish densities are likely to attract numerous fishing vessels, which over time will tend to deplete any locally high fish abundance. To maximize profit flow, each fisher must weigh the potential costs and benefits of operating his fishing vessel among a suite of different possible fishing locations. Each location will produce different catch rates and species mixes, which will be partly determined by the operations of other vessels fishing in that location; associated with each location will be different operating costs and potential economic rewards. Most previous bioeconomic fishery simulation models have used historical data to guide the allocation of effort

to spatial regions. Random utility models are often used to determine the spatial proportions for effort. These approaches leave the overall level of effort unresolved.

In the bioeconomic simulator, the fishing vessels within in each fleet have uniform technical characteristics (e.g., catchability, selection, fish prices, and fishing costs) and for each time-step they choose where to fish and their distribution of fishing time (fishing effort) based on their anticipated profits during that step. They compete for fish with each other and with the vessels from other fleets. The spatial distribution of fishing effort is resolved using a Nash equilibrium solution. Under this solution, all fishing vessels produce their maximum profits given the set of choices made by all other fishing vessels for the amounts and distributions of fishing time. It is an equilibrium solution in the sense that no fishing vessel can unilaterally improve its profitability by changing its fishing effort or spatial distribution of fishing.

Another unique aspect of the simulator is in its explicit separation of fishing effort into two constituent parts: (1) the physical vessels and gear used for fishing and (2) the amount of time that they conduct fishing operations. Most bioeconomic fishery models treat fishing effort as a single variable and have a single equation to describe the dynamics of fishing effort, with the rate of entry being proportional to the level of profits. This single-variable approach misses the important feature that the amount of time spent fishing can change rapidly, whereas the number of fishing vessels in a fleet changes more sluggishly.

The work-plan for the project includes an exercise to validate the simulator's innovative approach to resolving the spatial distributions of fishing effort and application of the simulator in management strategy evaluations of two current West Coast fishery issues: the evaluation of alternative rebuilding schedules for overfished rockfish stocks and the issue of how to set appropriate buffers to account for the management uncertainty associated with achieving management targets.

PROJECT PROGRESS: As described in the last project report (covering the period 07/01/2012 to 06/30/2013), one of the refinements to the BioEcon simulator was determined to be very problematic and became the focus of considerable work by the Principal Investigator David Sampson and his Graduate Research Assistant Chris Cusak. At issue was the mechanism within the fishing location choice module for constraining the fishing time during the one-year time-step of the simulator. The approach outlined in the original proposal did not result in a stable algorithm for resolving the spatial distribution of fishing time (effort). Dr. Sampson and Mr. Cusak decided to recast the fishing location choice problem as a constrained optimization problem, with explicit constraints on the amount of fishing time and the amount of catch. These constraints might or might not be binding under any particular set of simulated conditions. Mr. Cusak developed an algorithm that results in a solution for each fleet's fishing time and its spatial distribution.

Mr. Cusak's iterative technique for resolving the distribution of fishing time works as follows. (1) Assign a vector of trial values for fishing time to each of the fleets. Each vector element represents the fishing time exerted in a particular spatial region. (2) With one focal fleet and the fishing time for the other fleets treated as fixed, find the set of fishing time values for the focal fleet that maximize its net revenues subject to any constraints on that fleet's fishing time or

catch. (3) Repeat step (2) for all the other fleets. (4) Repeat steps (2) and (3) as needed, cycling through the full set of fleets, stopping when the changes in fishing time for each fleet are sufficiently small.

This algorithm was implemented in the BioEcon simulator and numerical testing has indicated that it results in solutions that satisfy the constraints and the Nash equilibrium condition (no fishing fleet can unilaterally improve its position). Further, the solutions appear to be unique. Mr. Cusak and Dr. Sampson are currently preparing a manuscript that describes the algorithm and compares it to other published methods for resolving the spatial distribution of fishing effort (e.g., the ideal free distribution approach and the gravity model of Caddy 1975). The manuscript will be submitted for publication in a fisheries science journal and will constitute a chapter in Mr. Cusak's PhD dissertation.

Another activity on which the project team has embarked is in the empirical identification of fishing fleets, which from the perspective of the BioEcon simulator are a set of fishing vessels that have similar attributes and that behave in a similar manner. The primary focus of the planned applications with BioEcon are for the US West Coast fisheries for groundfish, which harvest a diverse set of species, some with healthy status as some that are overfished. However, many fishing vessels that harvest groundfish also engage in other fishing activities. A BioEcon model configured to represent the groundfish fisheries will also need to consider and account for the opportunity cost of fishing and other activities that are not explicitly included in the model. Further, it is important that we understand the extent to which the fleets represented in a BioEcon application reflect the composition of the actual fishing vessels operating along the US West Coast, both in terms of the ports that they operate from and the suite of activities that engage in. Ms. Cindy Thomson compiled data from PacFIN for all vessels operating in the West Coast fishery that have made any landings of groundfish species. These trip-level data will allow the project to conduct analyses that establish the extent to which vessels that fish for groundfish also participate in alternative fisheries (e.g., for species such as crab, shrimp or albacore tuna). Dr. Sampson and Ms. Thomson, with assistance from Mr. Cusak, will conduct a multivariate analysis of the data set to identify potential groupings of fishing vessels that could be treated as fleets in an application of BioEcon. The results from such an analysis, which will almost certainly have important implications for how management of one fishery sector may result in spill-over effects on other fishery sectors, will be written up for publication in a fisheries science journal.

In late May 2014 Dr. Sampson and Mr. Cusak travelled to Santa Cruz to visit with Ms. Thomson and the fishery economists on her staff at the Southwest Fisheries Science Center. Mr. Cusak gave in informal presentation of his solution method for resolving the distribution of fishing effort and there were general discussions of how to bring closure to the project, which as originally proposed would end after two years (30 June 2014).

Due to unforeseen technical difficulties associated with modeling the spatial distribution of fishing, the project has not made as much progress as originally planned with the application of the model. However, the project has developed an algorithm for finding a Nash equilibrium solution for the spatial distribution of fishing effort, even when there are constraints on fishing time or catch, and this is a significant contribution to the art of fisheries modeling.

Amendment 31: Development of Quantitative Tools for Assessing Effects of Anthropogenic Mortality on Marine Turtle Populations
Funded: $84,000

OSU RESEARCH STAFF: *Selina Heppell*, Professor, Department of Fisheries and Wildlife;
                                              Brandon Chasco, Graduate Research Assistant, Department of
                                              Fisheries and Wildlife
NOAA TECHNICAL LEAD:*Eric Ward*, *Eli Holmes*, Conservation Biology, NWFSC

PROJECT BACKGROUND: The goal of the project is to develop quantitative tools to assess the effects of anthropogenic mortality on marine turtle and other protected species populations. Specific objectives are the following:
   1. Extend existing multivariate autoregressive state-space models (MARSS) tools (http://tinyurl.com/b9l9sf2) to include bycatch, stage and age-based population models, and Bayesian analysis
   2. Demonstrate applicability of the extended MARSS package to effects of anthropogenic mortality on marine turtle populations
   3. Apply the extended MARSS tools to other protected species
   4. Provide training, involving NOAA Fisheries, on using the extended MARSS and the web.

PROJECT PROGRESS: During the period from January 1to June 15, 2014, there has been considerable work toward developing an integrated model for estimating growth of protected sea turtle populations. Thus far we have developed an R package that estimates the parameters of a generalized growth model, where the model inputs include both length-at-age and capture-recapture data. This effort represents a novel approach and significant step forward in the estimation of sea turtle vital rates associated with growth and age-at-maturity.

The model has been presented to the scientists of the Southwest and Northwest Fisheries Science Centers, and the R package is currently being tested on NOAA website that contains the Tools for Protected Species. The goal now is to continue drafting the publications describing the novel aspects of our research, and begin allowing sea-turtle scientists with their own data access to the web tools.

Amendment 35: Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) Population Model: Re-Evaluated
Funded: $10,644

OSU RESEARCH STAFF: *Selina Heppell*, Professor, Department of Fisheries and Wildlife;
NOAA TECHNICAL LEAD:*Theresa Conant*, Endangered Species Conservation, Office of
                                              Protected Resources, NMFS

PROJECT BACKGROUND: Project objectives are to update an age-structured model used for population projections in the ESA Recovery Plan for the Kemp's ridley sea turtle. The model results will be incorporated in the 5 year review of the Recovery Plan, due in 2014.

PROJECT PROGRESS: Updates to the baseline model are complete. These include maximum likelihood estimation (replacing sum-of-squares fitting from the 2009 model) and updating the number of nests observed and hatchlings released at the primary Mexican nesting beaches. A maturation ogive (2 parameter) has replaced the knife-edge recruitment to the adult (nesting) stage. The model is unable to fit to nest counts for 2010-2013; a variety of simple updates were attempted, but there is a shift in the population growth rate in 2010 or an unknown number of years prior. The drop in nests observed in 2010 is unprecedented, and lack of population growth since that time suggests a change in survivorship to maturity or adult survival. After discussion with NMFS and USFWS through conference calls, it was decided that final model fitting and updates would wait until the 2014 nest numbers are available, about mid-June.

A new model was also developed that includes variables for remigration interval and reproductive rates for neophyte (first-time) nesters vs. experienced nesters. These are vital rates that have been shown to vary with environmental condition and turtle age; while data do not currently exist to parameterize this more complex model, it may be valuable for exploration of climate change effects on the species.

A final report will be submitted in July 2014. This report will not include hypothesis testing for why the population changed direction in 2010, but will show model fits for a) a single "pulse" perturbation in 2010 that removes adults, subadults, juveniles or hatchlings from the population, and b) a chronic "press" perturbation affecting survival rates for one or more life stages before and after 2010.

PRESENTATIONS:

Heppell, S.S. Data and models indicate dramatic changes in Kemp's ridley population growth rate. *International Sea Turtle Symposium*, New Orleans, LA April 14, 2014.

Amendment 36: Stock Assessment Research Review of Pacific Hake
Funded: $16,399

OSU RESEARCH STAFF: *David Sampson*, Professor, Department of Fisheries and Wildlife
NOAA TECHNICAL LEAD:*Kevin Duffy*, Sustainable Fisheries, West Coast Region

PROJECT BACKGROUND: The coastal stock of Pacific hake (*Merluccius productus*), known commonly as Pacific whiting, annually migrates between U.S. and Canadian waters. The stock is managed jointly by U.S. and Canada under provisions of the Pacific Whiting Treaty, which established: a Joint Management Committee that sets the annual total allowable catch of whiting, a Joint Technical Committee (JTC) that conduct stock assessments and other technical analyses to provide the scientific basis for harvest management decisions, and a Scientific Review Group (SRG) that provides independent peer review of the technical work of the JTC. The SRG

includes two members appointed by the U.S. government, two members appointed by the Canadian government, and two members nominated by the Treaty's Industry Advisory Panel. Dr. Sampson was appointed to the SRG as one of the industry-nominated reviewers.

PROJECT PROGRESS: Dr. Sampson's primary activity for this project was participation in a four-day meeting of the Scientific Review Group that was held at the Watertown Hotel in Seattle, WA on 18-21 February 2014. Additional activities included participation in a telephone conference call on February 7th to review the Terms of Reference for the SRG review and the agenda for the review meeting, preparing for the meeting by reading the draft 2014 stock assessment document and the supporting reports and analyses that had been provided, and contributing text to the SRG's report to the Joint Management Committee, and subsequently finalizing the SRG report by email correspondence.

The 2014 assessment for the coastal Pacific hake stock and related analyses had been conducted during the summer and fall of 2013 by the members of the Joint Technical Committee, consisting of two stock assessment biologists (Allan Hicks and Ian Taylor) from the Northwest Fisheries Science Center, National Marine Fisheries Service, two stock assessment biologists (Nathan Taylor and Chris Grandin) from the Pacific Biological Station, Fisheries and Oceans Canada, and a consulting academic (Sean Cox) from Simon Fraser University. In addition to producing a standard stock assessment, the JTC also reported on a simulation-based evaluation of the performance of the stock assessment process and resulting annual total allowable catch derived from the Treaty's agreed harvest control rule. Both the stock assessment and the so-called Management Strategy Evaluation (MSE) were the subjects for review by the SRG during the February meeting in Seattle.

The review of the stock assessment, which occurred during the first two days of the February meeting, was structured around a series of presentations by JTC members and members of the research survey team who were involved in conducting the hydro-acoustic surveys and working up the survey data for the assessment. The formal presentations included an overview of the 2013 hydro-acoustic survey, summaries of the 2013 U.S. and Canadian fisheries, an overview of the data sources used in the 2014 assessment, an overview of the 2014 Management Strategy Evaluation (MSE) exercise, and an overview of the draft 2014 assessment. Following the presentations there was a general discussion between the members of the SRG and JTC regarding potential issues associated with either the data inputs or how the JTC had chosen to structure the Stock Synthesis assessment model.

Much of the discussion focused on concerns with the method used to spatially extrapolate the acoustic survey data available along the survey transects into the regions in between transects and at their ends. Compared to previous years, the survey estimate this year resulted in a considerable amount of biomass in offshore regions that were not directly surveyed. Also, the SRG was concerned that the estimation approach produced unrealistically low coefficients of variation for the biomass estimates.

There was also discussion of a change that the JTC made to the structure of the Stock Synthesis assessment model. In the Synthesis model configuration used last year fishery selection was modeled using a flexible non-parametric formulation that was time-invariant. Selection-at-age

was not allowed to change through time. This year the JTC incorporated time-variation in the selection coefficients, modeled as a random walk process. The JTC came to the conclusion that this additional complexity was useful and needed because of behavior they uncovered from the MSE analyses. The MSE process generates assessment data based on an operating model that fully specifies the processes for the fish stock dynamics and for generating the random sample data that are then fed into the stock assessment. When fishery selection was modeled in the assessment as time-invariant, but in "reality" was time-varying, there was increased probability that the assessment incorrectly estimated low stock status and resulted in needlessly low catch quotas, and there was increased probability of fishing the stock below the target level.

During the first two days of the review meeting the SRG developed several formal requests to the JTC to prepare additional summary information and conduct some additional analyses, with the goal of clarifying that the assessment model provided a suitable representation of the status of the Pacific hake stock and its likely behavior during the next few years. The JTC was very responsive to the requests for additional information and analyses, and I commend them for their willingness to explain their work and to share with others their understanding of the behavior of this complicated fish stock and its fishery.

The presenters entertained questions during their presentations and the atmosphere during the review was serious but appropriately relaxed. Compared to previous Pacific hake stock assessment reviews, when there sometimes were dueling assessment models, the assessment review process under the Treaty is much less contentious and (in my opinion) is producing assessment results that are more objective, scientifically credible and robust. One positive improvement in the procedures this year compared to last was that staff from the Northwest Fisheries Science Center had been tasked with taking detailed notes of the discussions, which meant that the SRG members could fully concentrate on the presentations and discussion rather than having to act as rapporteurs.

During the morning of the fourth day of the review the SRG, JTC and Advisory Panel advisors discussed the findings and conclusions of the review, formulated recommendations to the Joint Management Committee on harvest management advice and future research activities, and prepared an outline for the SRG report. The review concluded at about 1 pm on February 21st.

The SRG report summarizing the review meeting was prepared jointly by the members of the SRG, with the two co-chairs taking the lead on assembling the draft report and circulating it to the rest of the SRG. On February 23rd Michelle McClure, the U.S. co-chair, posted an initial draft of the report to a Google drive that all SRG members could access, with the aim of finalizing the report by the close of business on February 28th. Each member of the SRG had writing assignments with respect to one or more bullet points outlined in the draft report. Dr. Sampson's assignment was to provide text for a section on topics for further MSE exploration. During that week there was an extensive series of email exchanges between the SRG members regarding the text of the SRG report. Dr. Sampson sent in his final set of comments and suggested edits at about 9:30 am on the 28th. At about 4:30 pm on February 28th Michelle submitted the final version of the SRG report to Miako Ushio for onward posting to the Joint Management Committee.

Dr. Sampson is in full agreement with the findings and conclusions as stated in the Joint U.S.-Canada Scientific Review Group Report, which can be obtained on-line from the following web-site,
http://www.westcoast.fisheries.noaa.gov/fisheries/management/whiting/pacific_whiting_treaty.html.

Documents Reviewed:

Fleischer, G.W., Ressler, P.H., Thomas, R.E., de Blois, S.K., Hufnagle, L.C. and Dezhang Chu. 2013. Pacific Hake Integrated Acoustic and Trawl Survey Methods.

International Joint Technical Committee for Pacific hake. 2013. Status of the Pacific hake (Whiting) stock in the U.S. and Canadian waters in 2014. Draft document dated 02/04/2014.

Theme: Seafloor Processes

Amendment 28: Impacts of Submarine Volcanism and Hydrothermal Venting on the Global Ocean and Deep-Sea Ecosystem
Funded: $955,156

OSU RESEARCH STAFF: *William Chadwick*, *Robert Dziak*, Professors, Senior Research, CIMRS; *Haru Matsumoto*, Assistant Professor, Senior Research, CIMRS; *Andy Lau*, Professional Faculty, Applied Mathematician, CIMRS; *Joe Haxel,* Research Associate, Post-Doc; *Andra Bobbitt, Susan Merle*, Senior Faculty Research Assistants, CIMRS; *Leigh Evans, Matt Fowler, Ron Greene*, Faculty Research Assistants, CIMRS

NOAA TECHNICAL LEAD: *Mark Wetzler,* Ocean Environment Research Division, PMEL

Volcanic and Hydrothermal Event Detection in the Northeast Pacific

PROJECT BACKGROUND: Hydroacoustic monitoring continues to be the primary tool in detecting and understanding the mechanics of submarine eruptions and diking events. When eruptive or magmatic activity is detected, *T*-wave data is used to assess the duration, spatial extent, and style of activity. The response community relies on this information to identify those earthquake sequences that are likely to be associated with eruptions and/or produce significant hydrothermal changes worthy of rapid response. Although not all earthquakes will be deemed worthy of response, an assessment of their character and a description of their position, intensity and duration remains important for interpreting observation made either *in situ* or during ship-based visits to ridge crest hydrothermal sites. By examining earthquakes of various sizes, and at a range of distances from different vent sites, the observation system's sensitivity to these events is better understood. Efforts also focus on examination of the possible remote triggering of seismic events by dynamic stress transients associated with the passage of seismic waves – a process that is poorly understood, particularly in the marine environment.

PROJECT PROGRESS: Professor Robert Dziak performed analysis of 2-year hydrophone record of explosive eruption activity at West Mata volcano, SW Pacific ocean. The hydrophones record a comprehensive cycle of activity at the volcano, ranging from explosive degassing eruptions in late 2009 through to a several month period of decline to eventual cessation of the eruption in early 2011. Synchronous tephra and hydrophone data during the first five months indicate a repeated record of summit explosions followed by an increase of volcanic tephra and debris in the deep water-column, an important process in the construction of the volcanic edifice. We used video and acoustic data to estimate the instantaneous eruption velocity and volume of gas expelled during explosion events. Individual magma gas bubbles observed by an ROV were correlated with short duration (20-30 ms) acoustic pulses recorded on one in situ (~50 m distant) hydrophone. From these data we estimate the weight of magmatic gas within each bubble as 2.1-63.6 kg. These values are consistent with idealized estimates of the weight of a 1-m-diameter sphere of CO_2 gas and steam at 120 Bars pressure. Dziak presented posters at both the December 2013 American Geophysical Union and the 2014 Ocean Sciences meeting. The AGU poster presented research on the termination of eruptive activity and the flux of gas from West

Mata volcano. Assistant Professor Haru Matsumoto continues his development of innovative acoustic technologies for use on fixed and mobile platforms. He is developing a hydrophone for deployment on a winch buoy that can remain submerged for extended time periods, then come to the sea-surface to transmit data back to shore in real-time. Research associate Joe Haxel continued detailed analysis of ocean bottom hydrophone data from caldera of Axial Volcano. Data encompasses a six year time span and thus provides a long-term view of seismic precursor activity at the volcano prior to its eruption in April 2011. Haxel combined seismic record with long-term seafloor deformation record to provide further insights into the flow of magma into the shallow reservoir beneath the volcano's summit prior to eruption. Results have been summarized in manuscript was submitted to the journal Geology in May 2014. Applied Mathematician T-K Lau continues to develop software that allows estimates of gas flux from submarine volcanoes by using hydrophone records of volcanic explosions. This technique has been focused at West Mata volcano in the Lau Basin. Lau also performs daily review of SOSUS records of significant earthquake and volcanic activity from the Juan de Fuca Ridge in the northeast Pacific Ocean. Faculty Research Assistant Matt Fowler assisted Dziak in manuscript and presentation preparation and Matsumoto in construction and development of hydrophone instruments and moorings and new development of acoustic sensors for mobile platforms.

PRESENTATIONS:
Dziak, R.P. , H. Matsumoto, D. R. Bohnenstiehl, M. Park, W S Lee, **H. Klinck**, **M.J. Fowler**, **T-K Lau, J.H. Haxel, D. K. Mellinger**, K. M. Stafford, Sources of long-term ambient ocean sound near the Antarctic Peninsula. Ocean Sciences ,Honolulu, HI, Feb 2014.

H. Matsumoto, H., et al., "Antarctic's siren call: The sound of icebergs," Polar Science Symposium, Incheon, S. Korea, May 2014

Matsumoto, H., D. R. Bohnenstiehl, **R. P. Dziak**, **J. Haxel**, M. Park, Won-Sang Lee, T-K Lau and M. Fowler, "Contribution of iceberg sounds to the ambient noise budget in the South Pacific Ocean," J. Acoust. Soc. Am. 134, 3974 (December 2013) http://dx.doi.org/10.1121/1.4830480

PUBLICATIONS:
Bohnenstiehl, D.R., **R.P. Dziak**, **H Matsumoto**, J. Condor (2014) Acoustic response of submarine volcanoes in the Tofua Arc and northern Lau Basin to two great earthquakes, *Geophys. J. Int*., 196(3):1657-1675 doi: 10.1093/gji/ggt472

Research on the Near- and Far-field Physical and Chemical Impacts and Consequences to Ocean Ecosystems Caused by Submarine Volcanoes and Hydrothermal Venting
and
Interpreting Digital Seafloor Bathymetry and Imagery, From Ship-based sonar, Deep-Towed Sidescan, Optical Sensors, Submersible and Remotely Controlled Vehicles

PROJECT BACKGROUND: CIMRS researchers study and document interactions between submarine volcanic events and the hydrothermal vent biological community by "detection and response" efforts, often in collaboration with colleagues from NOAA and at universities in the

U.S. and abroad. Volcanic and seismic events are detected on the spreading centers in the NE Pacific by hydroacoustic monitoring and in-situ instruments. Interdisciplinary and inter-agency rapid response efforts have been mounted to these events because they are unsurpassed opportunities for direct observations of the impacts and consequences of deep-sea volcanism. This hydroacoustic monitoring capability is unique to the NE Pacific and the CIMRS collaboration at the Hatfield Marine Science Center in Newport, OR. Many such events have been investigated in the NE Pacific over the last two decades. Axial Seamount remains a long-term research site because it is the only site in the world where a repeatable (and perhaps predictable) cycle of inflation and deflation has been documented at a submarine volcano and because the seamount is a focus site on the regional scale nodes component of the National Science Foundation's Ocean Observatories Initiative (OOI). Monitoring volcano-ecosystem interactions in the NE Pacific and exploration of the consequences of volcanic outputs into the ocean continue to be a focus of CIMRS collaborative research.

CIMRS collaboration has been particularly innovative and productive in the use of repeated sonar mapping for detecting depth changes on the seafloor due to volcanic eruptions. These depth changes can be either positive (due to the addition of erupted material) or negative (due to collapses or landslides on unstable slopes). Documenting and quantifying these changes enables the calculation of eruption volumes and rates, yields opportunities to explore the interaction between constructive and destructive events at submarine volcanoes, and gives insight into the processes of how volcanoes grow underwater.

These projects contribute to the NOAA mission of science, service, and stewardship through the Healthy Ocean Goal of sustaining marine habitats and biodiversity within healthy and productive ecosystems. CIMRS research also supports OAR's main science goal of gaining a holistic understanding and making useful predictions of future states of the Earth-Ocean system. Likewise, CIMRS research falls under 3 of the 5 PMEL research themes: Marine Ecosystem Research, Ocean and Coastal Processes Research, and Research Innovation.

PROJECT PROGRESS: Work under these two projects continued in FY14 with a focus on Axial Seamount in the NE Pacific, NW Rota and South Sarigan Seamounts in the Mariana Arc, and West Mata Seamount in the NE Lau Basin.

Professor Chadwick, Senior Faculty Research Assistant Bobbitt, Faculty Research Assistant Evans and Senior Faculty Research Assistant Merle participated in a research expedition to Axial Seamount on *R/V Thompson* with *ROV Jason*, September 3-19, 2013. Chadwick served as Chief Scientist on the cruise and led geologic studies, Bobbitt and Merle shared data processing and data management duties, and Evans collected and chemically analyzed gas-tight vent fluid samples. Bobbitt also produced a comprehensive cruise report after the expedition and submitted data to the Marine Geoscience Data System for archiving. Research on the cruise included collecting vent fluid and microbial samples from Axial's hydrothermal vents to better understand the microbial ecosystems that form the base of the food chain at seafloor hot springs. OSU researchers collected samples of hydrothermal vent fluid to track changes in chemistry since Axial's 2011 eruption and how those changes may affect the microbial communities that live in the warm chemical-rich waters below the seafloor. OSU researchers used a range of sophisticated samplers to collect vent fluids, gases, microbial mat, and hydrothermal sediments.

The researchers also collected the microbes living in the vent fluids for culturing experiments on board the ship and genetic analysis back on shore.

During the cruise, seafloor pressure measurements were taken to monitor how much the volcano has reinflated since its last eruption in 2011. This was accomplished during a long *Jason* dive (almost 5 days) that repeatedly visited 10 different measurement sites, traversing a total of 65 km. These measurements found that the center of Axial's caldera has risen by 1.2 meters (4 feet) in the last 2 years, the highest rate of uplift observed since measurements started over a decade ago. This means the volcano has already recovered over half of the deflation that occurred during the April 2011 eruption, and suggests that Axial may be closer to its next eruption than previously expected. Continued monitoring will be needed to anticipate Axial's next move, but these results add urgency to the efforts to complete the installation of the cabled observatory at Axial as soon as possible.

Research results from data collected on expeditions from previous years and other on-going work were presented at 2013 Fall Meeting of the American Geophysical Union (AGU) in San Francisco and were published in peer-reviewed journals. The meeting presentations included posters presented by Chadwick, as well as CIMRS co-authorship on four other posters and two oral presentations.

PRESENTATIONS:
Chadwick, W. W., Jr., S. G. Merle, R. W. Embley, N. Buck, J. A. Resing, J. W. Lavelle, and I. Leifer (2013) Bubble Plumes above erupting NW Rota-1 Submarine Volcano, Mariana Arc. Abstract V41D-2841 presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.

Caplan-Auerbach, J., **R. P. Dziak**, **T.-K. A. Lau**, and **W. W. Chadwick Jr**. (2013) Hydroacoustic Recordings of Explosion-Induced Tremor at NW Rota-1 Volcano, Marianas. Abstract V41B-2800 presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.

Dziak, R. P., D. R. Bohnenstiehl, E. T. Baker, **H. Matsumoto**, J. Caplan-Auerbach, C. J. Mack, R. W. Embley, **S. G. Merle**, S. L. Walker, and **T.-K. A. Lau** (2013) Acoustic and tephra records of explosive eruptions at West Mata submarine volcano, NE Lau Basin. Abstract V21C-2733 presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.

Embley, R. W., J. A. Resing, B. Tebo, E. T. Baker, D. A. Butterfield, **W. W. Chadwick, Jr**., R. E. Davis, C. E. J. De Ronde, M. D. Lilley, J. E. Lupton, **S. G. Merle**, K. H. Rubin, T. M. Shank, S. L. Walker, R. J. Arculus, **A. M. Bobbitt**, N. Buck, F. C. Tontini, P. V. Crowhurst, E. Mitchell, E. J. Olson, V. Ratemeyer, S. Richards, K. K. Roe, P. Keener, A. Martinez, C. Sheehan, and R. Brian (2013) Hyperactive hydrothermal activity in the NE Lau basin revealed by ROV dives. Abstract V21C-2738 presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.

Lupton, J.E, M. D. Lilley, D. A. Butterfield, J. A. Resing, R. J. Arculus, K. H. Rubin, R. W. Embley, **L. Evans** (2013) Gas Chemistry of Hydrothermal Systems of the Northern Lau Basin - New Results. Abstract V21C-2735 presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.

Nooner, S. L., **W. W. Chadwick, Jr**., and S. C. Webb (2013) Vertical Seafloor Geodesy at Two Mid-ocean Ridge Sites: Recent Results and Lessons Learned. Abstract G14A-04 presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.

Soule, S. A., B. Boulahanis, A. T. Fundis, D. A. Clague, and **W. W. Chadwick, Jr**. (2013) Syn-eruptive CO2 degassing of submarine lavas flows: constraints on eruption dynamics. Abstract V41D-2842 presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.

Tamura, Y., R. W. Embley, A. R. L. Nichols, O. Ishizuka, **S. G. Merle**, **W. W. Chadwick, Jr**., R. J. Stern, T. Sato, D. A. Wiens, and P. J. Shore (2013) ROV Hyper-Dolphin Survey at the May 2010 Eruption Site on South Sarigan Seamount, Mariana Arc. Abstract V31G-02 presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.

PUBLICATIONS:

Chadwick, W. W., Jr., D. A. Clague, R. W. Embley, M. R. Perfit, D. A. Butterfield, D. W. Caress, J. B. Paduan, J. F. Martin, P. Sasnett, **S. G. Merle**, and **A. M. Bobbitt** (2013) The 1998 eruption of Axial Seamount: New Insights on submarine lava flow emplacement from high-resolution mapping, *Geochemistry, Geophysics, and Geosystems*, 14(10), 3939-3968, doi:10.1002/ggge20202.

Clague, D. A., B. M. Dreyer, J. B. Paduan, J. F. Martin, **W. W. Chadwick, Jr**., D. W. Caress, R. A. Portner, T. P. Guilderson, M. L. McGann, H. Thomas, D. A. Butterfield, and R. W. Embley (2013) Geologic history of the summit of Axial Seamount, Juan de Fuca Ridge, *Geochem. Geophys. Geosyst.,* 14(10), 4403-4443, doi:10.1002/ggge.20240.

Lupton, J., and **L. Evans** (2013): Changes in the atmospheric helium isotope ratio over the past 40 years. *Geophys. Res. Lett.,* 40(23) doi: 10.1002/2013GL057681, 6271–6275.

Geist, D., G. Bergantz, and **W.W. Chadwick, Jr**. (in press): Galápagos magma chambers. In The Galápagos: A Laboratory for the Earth Sciences, N. d'Ozouville, D. Graham, E. Mittelstaedt, and K. Harpp (eds.), *Geophysical Monograph,* American Geophysical Union, Washington, D.C.

de Ronde, C. E. J., S. L. Walker, R. G. Ditchburn, F. C. Tontini, M. D. Hannington, **S. G. Merle**, C. Timm, M. R. Handler, R. J. Wysoczanski, V. M. Dekov, G. D. Kamenov, E. T. Baker, R. W. Embley, and J. E. Lupton (In press) The anatomy of a veiled submarine hydrothermal system, Clark volcano, Kermadec arc, New Zealand, *Econ. Geol.*

de Ronde, C.E.J., **W.W. Chadwick, Jr**., R.G. Ditchburn, R.W. Embley, V. Tunnicliffe, E.T. Baker, S.L. Walker, V.L. Ferrini, and **S.M. Merle** (In Press): Molten sulfur lakes of intraoceanic arc volcanoes. In Volcanic Lakes (Advances in Volcanology), D. Rouwet, F. Tassi, and J. Vandemeulebrouck (eds.).

Embley, R.W., **S.G. Merle**, E.T. Baker, K.H. Rubin, J.E. Lupton, J.A. Resing, **R.P. Dziak**, M.D. Lilley, **W.W. Chadwick, Jr**., T. Shank, **R. Greene**, S.L. Walker, **J. Haxel**, E. Olson, and T.

Baumberger (In Press) Eruptive modes and hiatus of volcanism at West Mata seamount:, NE Lau basin: 1996-2012. *Geochem. Geophys. Geosyst.*

Embley, R.W., Y. Tamura, **S.G. Merle**, T. Sato, O. Oshizuka, **W.W. Chadwick, Jr**., D.A. Wiens, P. Shore, and R.J. Stern (In Press) Eruption of South Sarigan Seamount in the Commonwealth of the Northern Mariana Islands: Insights into hazards from submarine volcanic eruptions. *Oceanography*.

Theme: Marine Bioacoustics

Amendment 24: Fin Whale Vocalization Behavior in Response to Long-term Variations in Deep Ocean Ambient Sound across the North Pacific
Funded: $56,308

OSU RESEARCH STAFF: *Robert Dziak*, Professor, Senior Research, CIMRS; *Joseph Haxel*, Research Associate / Post-Doc, CIMRS; *T.K. Andy Lau*, Professional Faculty, Applied Mathematician, CIMRS

NOAA TECHNICAL LEAD: *Jason Gedamke*, Ocean Acoustics, Office of Science and Technology, NMFS

PROJECT BACKGROUND: Utilizing the efficient propagation of acoustic energy through the water column, marine mammals have evolved to use sound as a means for communication, navigation, and stalking prey. Earlier studies have shown fin whale vocalizations have strong seasonality in the North Pacific with the majority of detected calls occurring during the winter months. In this study, CIMRS researchers investigate patterns in fin whale vocalizations as an ecosystem response to variations in the ambient noise field over a nearly 20-year acoustic record in the North Pacific.

Fin whales produce a down-sweeping vocalization, approximately 1s in duration, in the 15-40 Hz band. Long sequences of these vocalizations are apparently produced only by males and have been identified as 'song'. A time series of fin whale vocalization activity derived from continuous passive acoustic recordings over the last two decades in the North Pacific is used to examine relationships between ambient noise conditions and fin whale call behavior.

This project is aligned with NOAA's long-term strategic goal for *Healthy Oceans*, with the sustainability and health of productive ecosystems reflected in the long-term vocalization behavior of fin whales in response to anthropogenic acoustic stressors related to commercial shipping activities.

PROJECT PROGRESS: Hydroacoustic recordings from the U.S. Navy's Sound Surveillance System (SOSUS) hydrophone arrays in the North Pacific have been archived since September 1991 by CIMRS Oregon State University and NOAA Pacific Marine Environmental Laboratory Ocean Acoustics program in Newport, Oregon. This data set provides a unique multi-decadal continuous time series of regional deep ocean sound throughout the North Pacific. Continuous estimates of fin whale vocalization energy have been calculated from the fin frequency band ranging from 19-22 Hz. Lower frequency bands shared with blue whales were avoided to minimize contamination of the fin whale signal. Furthermore, median daily averaged spectral energy values from 1-50 Hz were removed from the daily time averaged spectra to "normalize" levels, removing acoustic energy contributions to the fin band outside of those of the targeted species. The remaining acoustic energy in frequencies from 19-22 Hz are summed and attributed to the daily average of vocalization energy.

The fin whale index (FI) time series was calculated for each of the 11 SOSUS hydrophone arrays as a measure of the acoustic energy level and vocalization behavior resulting from fin whale calling activity within the fin whale frequency band recorded by each receiver array. Early results indicate FI time series have a strong seasonal signal within each array allowing researchers to quantify the 20-year averaged migration of fin whales in the North Pacific with temporal resolution on the time scale of days. Furthermore, FI time series' levels appear to be increasing over the 20-year record at particular sites possibly indicating a growth in animal abundance or rising calling intensities over time. Meanwhile, the 40 Hz frequency band is used as a measure for the anthropogenic influence of commercial shipping on ambient noise levels at each receiver. The 40 Hz time series' also show a strong seasonal dependence, often out of phase with FI values. Further research will include empirical orthogonal function (EOF) analysis of the FI time series to compare spatio-temporal patterns of fin whale calling variability with 40 Hz noise levels.

Research Associate J. Haxel organized processing techniques, data analysis/interpretation of results and preparation of results for oral presentation at Ocean Sciences meeting. Professor R. Dziak assisted data analysis and interpretation of results. Applied Mathematician T.K. Lau organized, processed SOSUS archive data and developed software for fin whale calculation.

PRESENTATIONS:
Haxel, J.H., Dziak, R.P., Mellinger, D.K., & Lau, T.K. (2014) Patterns of fin whale vocalization and ambient sound levels in the North Pacific. Presented at the biennial American Geophysical Union/ Association for the Sciences of Limnology and Oceanography Ocean Sciences Meeting. Honolulu, HI. February 23 – 28, 2014. Oral presentation.

Amendment 26: Pinniped Acoustic Controlled Exposure Study: PACES Phase II
Funded: $69,946

OSU RESEARCH STAFF: *Holger Klinck*, Assistant Professor, Senior Research, CIMRS

NOAA TECHNICAL LEAD:*Jason Gedamke*, Ocean Acoustics, Office of Science and
Technology, NMFS

PROJECT BACKGROUND: The Pinniped Controlled Exposure Study (PACES) aims to develop and test a new methodology by using an animal-borne active acoustic tag to conduct controlled sound exposure experiments on free-ranging, naïve marine mammals in their natural habitat. Controlled sound exposure experiments are essential to evaluate the effects of anthropogenic noise on marine mammals and can help scientists and regulators understand the behavioral responses and physiological consequences to anthropogenic noise (i.e. naval sonar sounds and seismic airgun pulses), but currently available data are very sparse, limiting the ability for regulating agencies to make informed decisions. Specific goals of PACES – Phase II are to continue and complete a detailed analysis of all data collected during the Phase I field trials and to develop an improved tag design with potential for longer term deployments and deployment on cetacean species of interest.

PROJECT PROGRESS: Preliminary analysis included initial inspection of passive recordings for successful exposures and syncing the timing of exposures across multiple archival tag system and components (behavioral, passive acoustic, and depth sensor) while accounting for time drift of the behavioral recorder. Ongoing analysis will utilize randomization tests to investigate statistical significance of observed changes in dive behavior. The Journal of Experimental Biology has been identified as the target publication journal and the manuscript writing has begun.

Tag improvements have been made over the last 12 months and are ongoing. The new version of the tag will have an integrated depth sensor, eliminating the need for an external depth recorder, and will combine several of the components implemented separately in the prototype tag into one potted, rechargeable system. Tag improvements will include capabilities for deployments of up to three months and exposure triggers by dive depth and state rather than just time. Preliminary results were presented at the 166th Meeting of the Acoustical Society of America in San Francisco in December 2013 (Fregosi *et al.* 2013).

PRESENTATIONS:
Fregosi, S., Klinck, H., Horning, M., Mellinger, D. K., Costa, D. P., Mann, D. A., Sexton, K., et al. (2013) Use of an animal-borne active acoustic tag to conduct minimally-invasive behavioral response studies, J. Acoust. Soc. Am., **134**, 4044–4044. Abstract. 2-6 December 2013, San Francisco, CA.

Amendment 27 & 34: Advanced Methods for Passive Acoustic Detection, Classification, and Localization of Marine Mammals
Funded: $150,575

OSU RESEARCH STAFF: *David Mellinger*, Associate Professor, Senior Research, CIMRS;
                        Yang Lu, Research Associate, Post-Doc, CIMRS
NOAA TECHNICAL LEAD:*Jonathan Klay*, Computing and Network Services, PMEL

PROJECT BACKGROUND: Over the last decade, significant progress has been made in the development of marine mammal passive acoustic detection, classification, and localization (DCL) algorithms and software. The proposed project brings together leaders in the field in a focused collaboration to develop advanced DCL methods and to implement them in widely-used and critical software. Methods for detecting and classifying clicks from odontocetes and tonal sounds from odontocetes and mysticetes (whistles and moans, respectively) are tested using data sets drawn from candidate species that produce these signal types. Advanced localization algorithms are being developed with a focus on species that produce highly directional echolocation clicks; these make traditional multi-sensor localization difficult, whether it used sonobuoys, cabled arrays, and or arrays of floating recording buoys. To be maximally beneficial to the community, these new advanced algorithms must be widely available in multiple software systems. This project develops standardized interface specifications for detection, feature extraction, classification, and localization that will make adding new DCL methods relatively simple for both this project and the wider marine mammal DCL community.

PROJECT PROGRESS: Progress in FY14 is presented in the categories of datasets, detection and classification algorithm development, software interfaces, the subcontract, and presentations associated with this work.

I.   Datasets

One component of this research is to assemble standardized datasets specialized for automatic detection, classification, and localization (DCL). Such datasets should include multiple recordings of the species of interest so as to provide "common ground" data for training, testing, and comparing of DCL detection/classification algorithms.

The specialization involved comprises two things that distinguish such datasets from ordinary marine sound archives:

1) The recordings must be of variable quality. One obviously wants some very clear recordings – i.e., with high signal-to-noise ratio (SNR). Not as obviously, one wants very unclear (low-SNR) recordings, as these provide the "hard cases" that truly test a DCL technique. In particular, interference often comes from other species that may be similar acoustically and/or taxonomically to the target species. DCL methods used in the real world will encounter sound with such low-SNR characteristics, and must perform acceptably well with it.

2) The recordings must have metadata labels. Labels indicate where in the recordings the desired calls are. For some call types such as baleen whale stereotyped calls and odontocete clicks, labels can be time-frequency boxes surrounding each call. For some call types such as odontocete whistles, labels are frequency contours surrounding a long, continuous vocalization. Label made in this project are as accurate as humanly possible, meaning that a human checks all calls (and non-calls). This results in relatively small amounts compared to automatically-screened recordings, but the data are of the highest quality and don't suffer from uncertainty about the correctness of the labels. Labels can include a "maybe" label for questionable calls; for such calls, one doesn't want to use the call for training a DCL method, and also don't want to count either finding or missing the call as a bad result when testing a technique.

Extant data were extracted from existing recordings; no new marine recordings were made. These recordings were labeled for this project and placed on a project FTP site. This site is unclassified, but it is open only to project participants, not to the public, because of the navy origin of some of the recordings. Extant datasets include the following:

Mysticete (baleen whale) datasets:
- Blue whale (*Balaenoptera musculus*) 'D' calls from southern California.
- Blue (*Balaenoptera musculus*) sounds from the Southern California Offshore Range.
- Humpback (*Megaptera novaeangliae*) sounds from the Southern California Offshore Range.
- Fin (*B. physalus*) sounds from the Southern California Offshore Range.
- Minke whale (*B. acutorostrata*) 'boing' calls from Hawaii.

Ziphiidae (beaked whale) datasets:
- Cuvier's beaked whale (*Ziphius cavirostris*) clicks from southern California.
- Cuvier's beaked whale clicks from the Bahamas (AUTEC).

- Cuvier's beaked whale (*Ziphius cavirostris*) clicks from the Southern California Offshore Range.

Other odontocete (toothed whale, dolphin, and porpoise) datasets:

- Sperm whale (*Physeter macrocephalus*) clicks from the Bahamas (AUTEC).
- Bottlenose dolphin (*Tursiops truncatus*) clicks from southern California.
- Spinner dolphin (*Stenella longirostris*) clicks from Hawaii.
- Common dolphin (*Delphinus delphis*) clicks from southern California.
- Risso's dolphin (*Grampus griseus*) clicks from Southern California
- Melon-headed whale (*Peponocephala electra*) clicks from the Bahamas (AUTEC).
- Killer whale (*Orcinus orca*) clicks and whistles from the Southern California Offshore Range.

Localization dataset

- Minke whale (*B. acutorostrata*) 'boing' calls from Hawaii.

II. Detection and classification (DC) algorithm development

DC may be broken down into stages:

1) *Time-frequency representation*. Calculation of a time-frequency representation (TFR) such as a spectrogram, wavelet-gram, Wigner-Ville representation, etc. In this project we are using the spectrogram.
2) *Conditioning*. This modifies the TFR to make the overall sound level constant, flatten the noise spectrum, remove some types of unwanted noise, etc. An example method used in this project for flattening the noise spectrum is spectrum equalization; and example method for noise removal is median (or other percentile) subtraction to lessen the intensity of clicks.
3) *Detection / segmentation*. In this step, identification is done of the times and frequencies at which sounds of interest occur. Clicks were detected by summing across frequencies and applying an energy threshold. Whistles were identified using the algorithm of Mellinger et al. (2011); briefly, it identifies peaks in the spectrum at each time step, tracks these peaks over time, and identifies any that persist long enough as detected whistles.
4) *Feature extraction*. Acoustic characteristics are measured of the time/frequency regions detected in the previous step. Whistles were characterized by minimum and maximum frequency, mean energy-weighted frequency, mean energy-weighted time offset, inflection points, etc., while clicks were characterized using cepstral coefficients in the method of Roch et al. (2011).
5) *Classification*. This step labels detected sounds with category labels, such as species names. A new aspect of this project is that features from both clicks and whistles are combined in the classification. Classification here is done using random forests, an expansion of classification and regression trees (CART).

A spectrogram correlation method was also used for whistle classification: the research group developed a new feature extraction method for whistles called highly-parallel multi-kernel correlation. First, whistles identified by the detection stage above are normalized to remove background noise and to equalize differences in frequency response across different recording systems. An example of the spectrum of a common bottlenose dolphin whistle before and after

normalization is shown in Fig. 1. Next, a series of kernels are generated for cross-correlation with the spectrogram of the whistle detected by Silbido; each kernel corresponds to a certain rate of frequency modulation (i.e., a certain slope) of the whistle at each instant. Fig. 2 shows one of these kernels and its corresponding feature map, which is the result of cross-correlating it with the normalized spectrogram. Since each kernel contains equal-strength positive and negative regions across each vertical time-slice in the spectrogram, it does not respond to echolocation clicks, as they do not produce a significant value in the correlation. (The maximum correlation result across the series of kernels gives the detected whistle, as in Fig. 3.) Features for use in classifiers are calculated by producing histograms of the kernel cross-correlation results and picking peaks in the kernels, with each peak corresponding to one rate of frequency modulation. These features represent the occurrence of certain FM rates; other features are appended to represent the frequency range of the whistle. Classification error spectrogram correlation method using random forest classifier with 100 trials of randomized 3-fold cross validation experiment were conducted, the mean error is 0.34.
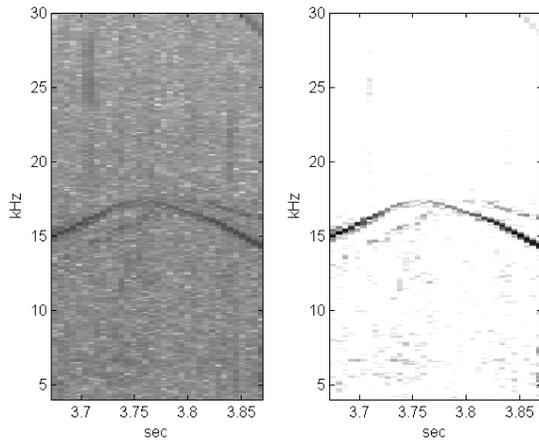

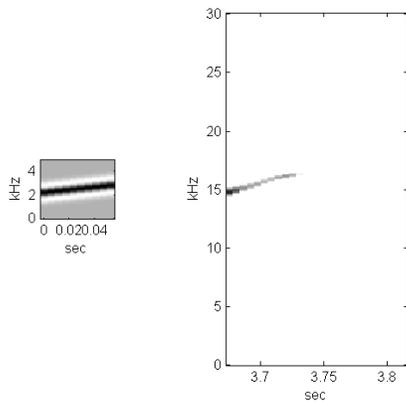Figure 1: Original and normalized spectrum of a common bottlenose dolphin whistle.

Figure 2: (left) Spectrogram correlation kernel for the frequency modulation rate of -12 kHz/s. (right) Result of applying kernel to normalized spectrogram of Fig. 5.
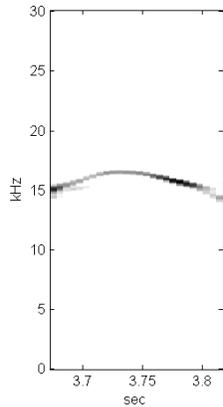
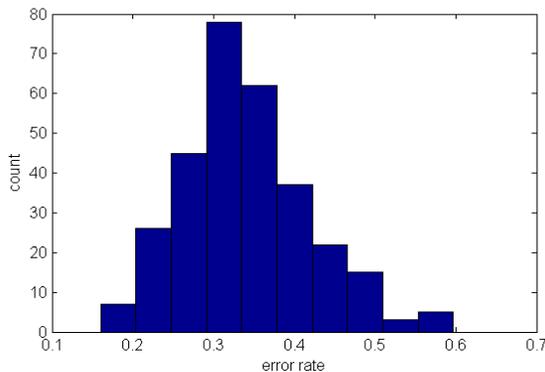Figure 3: A detected whistle after combining all kernel correlation results

Figure 4: Histogram of classification error of spectrogram correlation method for 100 independent trials of 3-fold cross validation experiment. Mean (err)=0.34. Total number of features=25

III.   Software Interfaces

OSU researchers have collaborated with Marie Roch and colleagues from San Diego State University (SDSU) on developing applications programming interfaces (APIs) so that plug-ins for detection, classification, and localization can be developed. Chris Marsh of SDSU has developed an interface for detection in audio streams and implemented it for Ishmael and PAMGUARD. So far one detection method has been applied using this interface, namely a matched filter detector.

IV.   Subcontract

Dr. Marie Roch led the component of this project under a subcontract to SDSU. includes the above-mentioned applications programming interface (API) and detector, as well as work on clustering and classification of odontocete sounds and the effect of instrument type on classification.

SDSU's work on whistle classification has focused on improving automated clustering of whistles. The root cause of tepid results from hidden Markov model whistle classifiers was attributed to problems with the initial categories used to build the clusters, and effort was focused on improvements to clustering whistle components from individual species. To this end, SDSU abandoned their former clustering method based on Deecke and Janik's ARTWARP. While the dynamic time warping algorithm used by Deecke and Janik is a good approach for contour

alignment, it was hypothesized that modifications to the feature extraction would be beneficial. To that end, a distortion function was developed that better captured the differences between shapes of whistles. Traditional methods operate purely on frequency content. SDSU computed derivatives of the contour and then normalized the features using a Z-score transform with the hypothesis that if shape is what really matters, two similar whistles at different frequencies should have low dissimilarity scores. A graph was constructed where each weighted edge represented the similarity between whistle components and the open-source package Gephi was used to organize the graph using a spring model and subsequently cluster the results (Fig. 5). These new clusters represent an improvement over the previous clustering method and were then used to train the hidden Markov models.
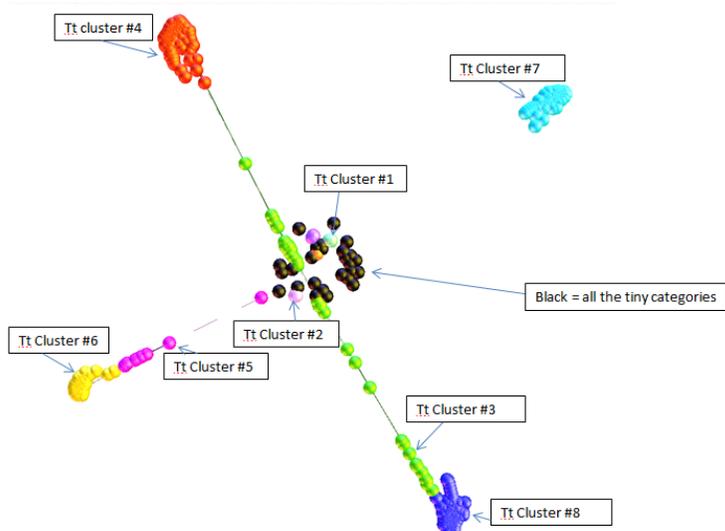

Figure 5: Similarity graph for whistle components, using a spring model to cluster the results.

To determine the impact of instrument and site variability, two species were selected that are relatively easy to classify due to distinct patterns in many of their echolocation clicks identified in previous work (Soldevilla et al., 2008). Risso's (*Grampus griseus*) and Pacific white-sided (*Lagenorhynchus obliquidens*) both have a series of spectral peaks and notches that enable excellent classification performance. Over 300,000 echolocation clicks were collected on autonomous high-frequency acoustic recording packages (Wiggins and Hildebrand, 2007) from six different sites throughout the Southern California Bight. Nine different series of preamplifiers were used across the deployments.

SDSU began with a modification of a standard Monte Carlo method for evaluating classifier performance. Typically, echolocation click features are grouped from each acoustic encounter and ensure that they are all in the training or test data. A baseline mean error rate of 2.7%±2.5σ was obtained using the methods from Roch et al. (2011b). However, when the experiments were further constrained such that preamplifiers or sites were not split across the training and testing partitions (which also implies that acoustic encounters are not split), the error rate rose significantly to 20.9±18.1σ when partitioned by preamplifier and 25.9±28.1σ by site, increasing the error rate by nearly an order of magnitude. The preamplifier differences were unexpected given that the spectra were adjusted for a calibration of the preamplifier.

In previous work, it was found that noise compensation methods were ineffective, and it was hypothesized that weak echolocation clicks undetected by the signal processing chain may have been admitted to the noise estimation algorithm, thus contaminating the noise estimate. In this

work, SDSU established a weaker click detection threshold that was used for finding areas unlikely to contain echolocation clicks. Using the new noise estimates, the error rates fell significantly (Fig. 2) with the preamplifier grouped error rate falling to $1.7 \pm 2.3\sigma$ and by site to $9.4 \pm 16.7\sigma$. While more work remains to be done to diminish the effects of site variability, this work shows that noise compensation techniques can be extremely effective at diminishing the effects of instrument and site variability.
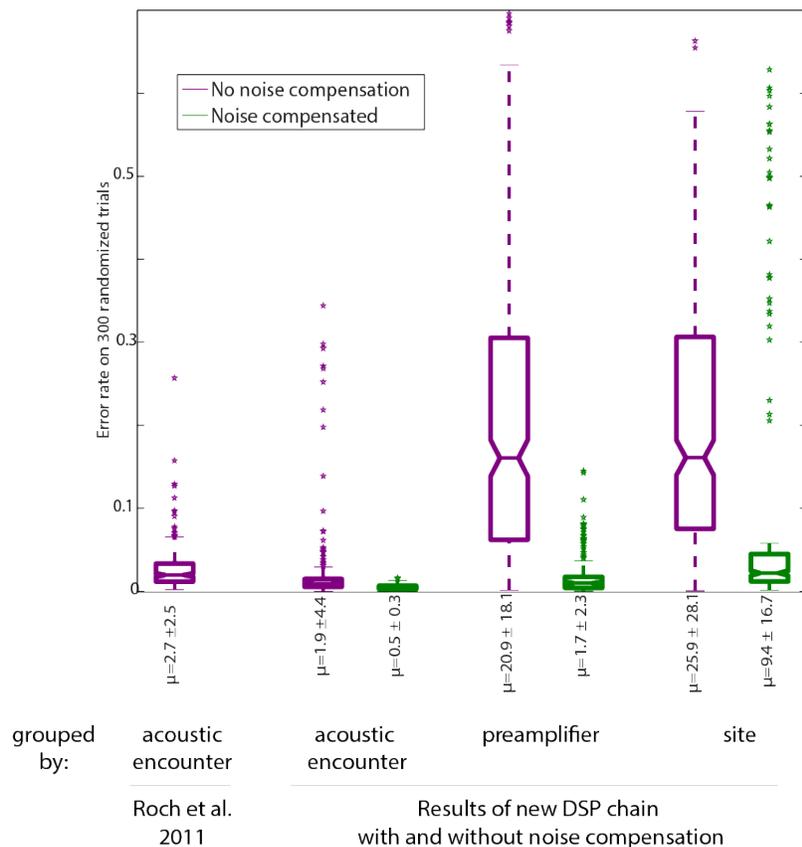

Figure 6: Error rates of 300 randomized echolocation click classification experiments comparing the baseline method and partitioning of the train/test data by encounter, preamplifier, and site with the new DSP chain, with and without noise compensation.

PRESENTATIONS:

Roch, M.A., S. Baumann-Pickering, D. Hwang, H. Batchelor, C.L. Berchok, D. Cholewiak, J.A. Hildebrand, L.M. Munger, E.M. Oleson, S. Rankin, D. Risch, A. Sirovic, M.S. Soldevilla, S.M. Van Parijs. 2013. Tethys: A workbench for bioacoustic measurements and environmental data. J. Acoust. Soc. Am. 134:4176(A). Acoustical Society of America Conf. 2-9 December 2013, San Francisco.

Stinner-Sloan, J., M.A. Roch, S. Baumann-Pickering. 2013. The effects of site and instrument variability on recognizing odontocete species by their echolocation clicks. J. Acoust. Soc. Am. 134:3987(A). Acoustical Society of America Conf. 2-9 December 2013, San Francisco.

Amendment 29: Real-time Acoustic Observing System for Marine Mammals
Funded: $79,000

OSU RESEARCH STAFF: *Holger Klinck*, Assistant Professor, Senior Research, CIMRS

NOAA TECHNICAL LEAD:*Brad Hanson*, Conservation Biology, Northwest Fisheries Science
Center, NMFS

PROJECT BACKGROUND: The goal of this project is to develop a small, easy to deploy, and
cost-efficient near-real-time acoustic observing system which can be used by NOAA/NMFS
Centers and other users to acoustically monitor the marine environment and specifically
endangered marine animals in real-time. The system is largely built on existing proven
technology. The surface buoy (only 1.4 m in diameter) is based on the successful NOAA/PMEL
PICO buoy design (Meinig 2008). The acoustic recorder and detector unit will be deployed on a
standard Ocean Bottom Hydrophone (OBH) platform also routinely manufactured by
NOAA/PMEL. In year one the necessary hard and software components were acquired,
modified, assembled and tested. In year two moorings will be built, deployed in the field and
tested. (Figure 1)

PROJECT PROGRESS: The hardware development of the prototype controller unit and
acoustic recording/detection system (Figure 2) has been completed. This unit will be used to
acoustically monitor the underwater soundscape in the deployment area. The onboard detector is
screening the incoming signal for signals of interest (e.g., killer whale vocalizations) in real-time.
Information on acoustic detections is compiled in a logfile which is sent every hour to the surface
buoy using the acoustic data link established with two underwater modems. We are currently
developing and testing the software of the controller unit. We anticipate that this task will be
completed in summer 2014. The detection algorithm has already been implemented on the
acoustic recording/detection system. The completion of this task is covered by the FY13 grant
and not dependent on FY14 funding.

The hardware development of the controller unit for the surface buoy (Figure 3) has been
completed. This unit is communicating with the bottom-moored acoustic system via an
underwater modem data link. This unit is communicating with the bottom-moored acoustic
(Figure 2) via an underwater modem data link. This unit furthermore controls an Iridium satellite
modem - which has already been acquired and tested - to transfer scientific and engineering data
back to shore.

The software to establish communication between the two units via underwater modem data link
and to shore via Iridium satellite link is being developed currently. It is anticipated that this task
will be completed in the spring 2014.The completion of this task is covered by the FY13 grant
and not dependent on FY14 funding.

The hardware development of the low-noise audio pre-amplifier (Figure 4) has been completed.
This component was optimized for the high-frequency hydrophone. This frequency response of
the hydrophone and pre-amplifier (50 Hz to 50 kHz) covers the frequency range of all

vocalizations produced by killer whales (pulsed calls, whistles, and echolocation clicks) as well as numerous other marine mammal species.

The low-noise, high-frequency hydrophone (Figure 5) has been acquired and tested. The underwater modems (Figure 6) to establish a communication link between the bottom and surface units has been acquired and tested (Note: surface and bottom units are identical).

All custom-made electronic components have been successfully developed, built, and tested. Commercially available components (hydrophone, underwater modem, Iridium modem) have been acquired and tested. The pressure housing and the batteries for the acoustic recorder/detector unit has just recently been ordered. Researchers are currently in the process of developing the necessary software to control and operate each of the components. They anticipate that this task of system integration will be completed by late summer of 2014. After completion of the software development the next step would be to assemble the bottom-unit and surface buoy mooring and to deploy it for a first field trial off the WA coast with an anticipated deployment in late fall 2014.
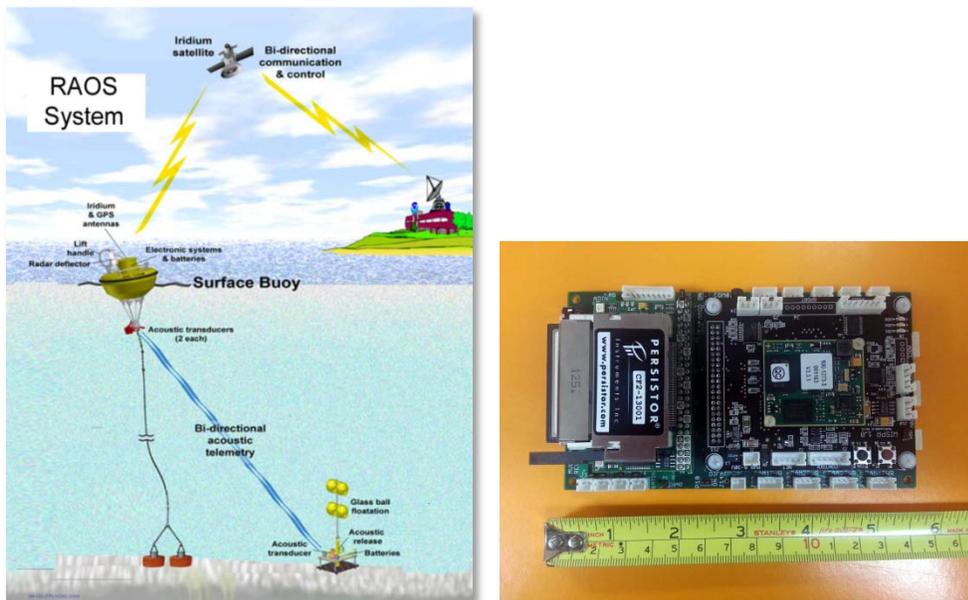

Figure 1: Schematic RAOS system. Figure 2: Controller unit including the acoustic recording/detection system

Figure 3: Surface controller unit.
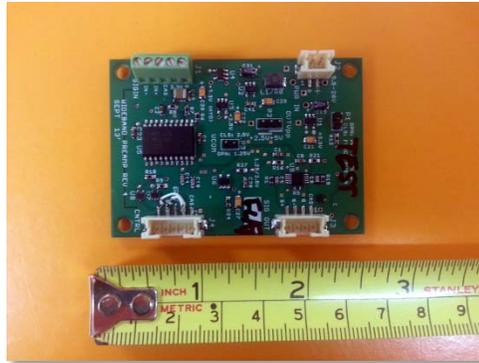
Figure 4: Low-noise audio pre-amplifier.

Figure 5: Hydrophone

Figure 6: Underwater modem.

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TASK 3

(Projects under Task 3 support NOAA Strategic Plan Goal of Resilient Coastal Communities and Economies)

Theme: Protection and Restoration of Marine Resources

Amendment 14: Developing a Pilot Marine Debris Monitoring Program in Oregon
Funded: $47,981

OSU RESEARCH STAFF: *Jamie Doyle*, Extension Marine Community Development
                        Educator, Oregon Sea Grant
NOAA TECHNICAL LEAD:*Sherry Lippiat*, Marine Debris Program, NOS

PROJECT BACKGROUND: In partnership with Surfrider Foundation, SOLV, and Oregon Shores Conservation Coalition CoastWatch Program, Oregon Sea Grant, this project aims to develop and implement a pilot marine debris monitoring program in Oregon. Focus is on

recruiting and training volunteers, analysis of debris, development of an Oregon database framework for volunteers reporting debris, adapting a data card, and increasing usage of data cards in Oregon during beach clean-ups. It is expected that these collaborations will establish a partnership framework within Oregon to continue long-term monitoring.

PROJECT PROGRESS: Following public workshops held in the spring of 2013 to create awareness of and interest in monitoring beach debris, the Oregon Marine Debris Team (OMDT) which includes SOLV, Surfrider Foundation, Washed Ashore, Oregon Shores Conservation Coalition CoastWatch Program, and Oregon Sea Grant involvement, developed a community grants program. OMDT partner group CoastWatch took the lead in this, and their roles include: implementing the community grants process, recruiting applications for the community grants, coordination and training new community teams, and ongoing point of contact and liaison with the community teams. The community grants would be structured such that a group would receive $500 to help them with monitoring a site over two years. They would receive $250 the first year and $250 the second year. The OMDT purchased general supplies for marine debris clean-ups, to be used by any OMDT member groups during clean-ups (pick-up sticks, measuring tape, first aid kit, collapsible buckets, and glove).

The community grants program had a call for proposals in fall 2013 which ended in January of 2014. OMDT identified 10 areas within which a group could propose a specific site. The areas were designed to provide geographic distribution in Oregon, as well as to be adjacent to the five new marine reserves in Oregon. As of June 10, there are eleven community teams (note, there were three existing monitoring sites that were incorporated into this, but that had already been reporting monitoring data for some time. OMDT is working with those sites to maintain monitoring, and they received a community grant to help do so).

CoastWatch will be continuing to work on getting all teams fully trained and uploaded their data. (See Appendix A for details on the Site Descriptions.)

Amendment 20: Evaluating Possible Changes in Sperm Whale Habitat Use Near the Deepwater Horizon Site, Tagging, Indications of Population Health, and Wound Healing on Sperm Whales
Funded: $1,361,740

OSU RESEARCH STAFF: *Bruce Mate*, Professor, Marine Mammal Institute; *Barbara Lagerquist*, Senior Faculty Research Assistant, Marine Mammal Institute; *Tomas Follett*, *Craig Hayslip*, *Ladd Irvine*, *Martha Windsor*, Faculty Research Assistants, Marine Mammal Institute; *Adrienne Copeland*, *John McClung*, *Ken Serven, Sheanna Steingass*, Research Technicians.
NOAA TECHNICAL LEAD: *Tony Penn*, Damage Assessment Center, NOS

PROJECT BACKGROUND: Tagging of sperm whales in 2010 and 2011 has revealed a SW-NE oriented oblong area around the Deepwater Horizon site that was not used, suggesting a food web effect in that area. Because whales are large enough to cope with one-year long natural changes in biomass productivity (such as El Niño events), damages to their food chain may not show up as consequential until the changes have been in place for multiple years or they move to

other areas. Tracking activities were limited to tagging just 4 whales by poor weather and a hurricane in 2012, so additional tagging work was conducted during July 2013. This research attempted to locate and tag sperm whales on either side of the unused region to determine if whales are using the area and the relative abundance of prey in that area. A new tag style was also deployed to examine the fine scale diving behavior of the sperm whales and how it may change over time.

PROJECT PROGRESS: The OSU Marine Mammal Institute (MMI) attached implantable satellite tags (location only style and Advanced Dive Behavior Tags) to sperm whales in the northern Gulf of Mexico (GOM) during the summer of 2013 as part of a continuing effort to identify possible effects of the Deepwater Horizon oil spill on the GOM sperm whale population as part of the National Resource Damage Assessment (NRDA) process. The cruise was conducted from 8 July to 6 August, 2013 with the goal of tagging sperm whales in the northern Gulf of Mexico with satellite monitored radio tags while also measuring the prey field with EK60 echosounders using 38 kHz, 70 kHz and 120 kHz pole-mounted transducers. The cruise was conducted from the *M/V Jim Bordelon*, a 110' oil rig supply vessel based in Houma, LA. OSU research staff arrived in Houma on 5 July to start mobilization. Two MMI rigid-hulled inflatable boats, used for tagging, had been shipped in advance to Houma by flatbed truck, along with other tagging equipment. The boats, echosounder transducers, and one passive acoustic array were all installed on the ship prior to departure. Passive acoustic monitoring was conducted by subcontractor Continental Shelf Associates, Inc.

The *Jim Bordelon* departed on 8 July for a planned 30-day cruise with a 1-day return to port after two weeks for re-supply and crew change. Faculty Research Assistant Ladd Irvine acted as chief scientist for the cruise and applied the tags to the whales. The other Faculty Research Assistants and Research Technicians filled the roles of biopsy sampler, photographer, small boat operator, and visual observers. Five volunteers donated their time to help with visual observations, spotting whales from the bridge of the ship and relaying the information to the tagging boat. The cruise surveyed a large portion of the north central Gulf of Mexico collecting information on sperm whale distribution both visually and using passive acoustics, as well as recording the biomass density with the EK60. A total of 22 tags were deployed on sperm whales during the cruise (12 location only style and 10 Advanced Dive Behavior Tags). Five of the whales had been tagged in previous years: one from 2003, two from 2011, and one each from 2010 and 2012, allowing for inter-annual comparisons of the movements of the whales. Photographs were taken of all whales encountered to add to the existing GOM sperm whale ID catalogue and to identify previously tagged whales as a part of an ongoing project to evaluate wound healing at the tagging site after the tags come off the whales.

In 2012, FRA Irvine and Faculty Research Assistant Martha Winsor assisted Professor Bruce Mate to prepare a draft NRDA final report to detail the results of sperm whale tracking from 2010 and 2011. The draft report was circulated to NRDA trustees and British Petroleum for comment and has been finalized. One of the primary findings was an apparent ~4000 km^2 infrequently used area (void) running NE-SW between two groups of tagged whales which included the Deepwater Horizon site. It was likely that two subpopulations of sperm whales had been tagged, but it was unknown if the void was an established difference in habitat preference between the populations pre-2010 or a consequence of the Deepwater Horizon oil spill. FRAs

Irvine and Winsor are currently finishing analysis of the 2013 sperm whale tracking data and revising the original NRDA final report to include all four years (2010 – 2013) data and results. The researchers aim to submit research findings from the NRDA study for publication in a peer reviewed journal by mid-August 2014.

Research Technician Copeland analyzed the EK60 data from 2012 and summarized the general biomass results in an MMI internal report that was completed in summer 2013. The final model showed that biomass was lower when sperm whales were present, suggesting that there may be a prey depletion effect where whales are present. Copeland also collected additional EK60 data during the 2013 expedition.

During winter 2013 and spring 2014, Faculty Research Assistant Hayslip isolated all photographs of previously tagged whales from the 2013 cruise and all previous sperm whale cruises to study the possible physical effects that the implantable satellite tags have on the whales and how the tag sites heal once the tags come off. The images will be sent to marine mammal veterinarians for their opinions on the wound site, and the results will be presented.

PRESENTATIONS:
Irvine, L., Mate, B., & Winsor, M. (2013) Long-term tracking of foraging effort and other dive behaviors for wide-ranging sperm whales. Presented at the Society for Marine Mammalogy biennial conference. Dunedin, New Zealand. December 9 – 13, 2013. Poster presentation.

Amendment 33: Pacific Northwest Fishing Community Oral Histories: A Collaborative, Educational Project for Researchers, Students, and Community Members
Funded: $5,500

OSU RESEARCH STAFF: *Flaxen Conway*, Professor, College of Earth, Ocean, and Atmospheric Sciences; *Sarah Calhoun*, Graduate Student, Marine Resources Management, College of Earth, Ocean, and Atmospheric Sciences

NOAA TECHNICAL LEAD:*Suzanne Russell*, Conservation Biology, Northwest Fisheries Science Center, NMFS

PROJECT BACKGROUND: Oral histories are a methodology to collect previously undocumented and unique, in-depth information. Oral histories capture and preserve the heritage and culture of an individual, family, community of place, or a community of interest that spans over several places. Oral histories can identify key issues and concerns, identify and record an individual's or a community's inherent and observed knowledge, and inform the public, local community leaders and members, and management entities. This project is a collaborative process that engages students and teachers at the high school level, university graduate students, and faculty and agency researchers, thereby providing an educational experience to a broad range of project participants and community members. The intent of the project is to collect come oral histories now and, with each of these groups, set up a system for the continued collection of oral histories over time.

Professor Flaxen Conway has provided guidance to graduate student Sarah Calhoun; and with NMFS NWFSC Social Scientist Suzanne Russell, they have initiated, trained, and are mentoring the oral history program with local high school students near Astoria and the local non-profit Newport Fishermen's Wives group in Newport, Oregon. The idea is that this program will establish a foundation to collect oral histories over the long term. Calhoun is gaining experience working with mentors and community members and students, and has been integral in establishing an effort that will conduct, transcribe, and catalogue interviews, manage photos and videos, as well as contribute to the development of outreach materials.

PROJECT PROGRESS: Work on this project started in mid-June 2014. S. Calhoun will be supported hourly on this project during the summer months to coordinate with the Newport Fishermen's Wives and others in the collection and transcription of interviews.

APPENDIX A: MARINE DEBRIS SITE DESCRIPTIONS

Oregon Marine Debris Monitoring Teams

Site: Crescent Beach   **CoastWatch mile #:** 316
Site description: 84318 Ecola State Park Rd, Cannon Beach, OR 97110
45.922005, -123.977436
Date established: 4/16/14
Team leaders/Points of contact: Tracy Sund
Preliminary training (date): 4/16/14
Secondary training (date):
Site log-in set-up on NOAA MD-MAP (date):
 Desired username: Crescent Beach
 Desired password: CoastWatch1
Report log (dates):
Funding:
Notes: Have not requested funding because they are still getting organized. They are teaming up with Chapman Beach team to share funding and tools

Site: Chapman Beach   **CoastWatch mile #:** 315
Site description: 84318 Ecola State Park Rd, Cannon Beach, OR 97110
45.911452, -123.968578
Team leaders/Points of contact: Robin Risley
Preliminary training (date): 4/16/14
Secondary training (date):
Site log-in set-up on NOAA MD-MAP (date):
 Desired username: NCannonBeach
 Desired password: CoastWatch1
Report log (dates):
Funding:
Notes: Have not requested funding because they are still getting organized. They are teaming up with Crescent Beach team to share funding and tools

Site: Cape Falcon Marine Reserve: Arch Cape   **CoastWatch mile #:** 306
Site description: 45.793691, -123.967890 Clatsop Ln, Arch Cape, OR 97102
Date established: 4/15/14
Team leaders/Points of contact: Al Maslowski, Lianne Thompson
Preliminary training (date): 4/15/14
Secondary training (date): 6/10/14
Site log-in set-up on NOAA MD-MAP (date):

Desired username: Cape Falcon
Desired password: Surfrider1
Report log (dates):
Funding: $250 and a Garmin
Notes: e.g.: Team has preliminary data, have done 1 monitoring, May 10,2014, waiting for login verification to input data

Site: WestWind-Cascade Head MR	**CoastWatch mile #:** 247

Site description: Knight County Park Otis, OR 97368 45.040529, -123.993732
Date established: in discussion with them at this time
Team leaders/Points of contact:
Preliminary training (date):
Secondary training (date):
Site log-in set-up on NOAA MD-MAP (date):
Report log (dates):
Funding:
Notes:

Site: Otter Rock Marine Reserve	**CoastWatch mile #:** 225

Site description: 124.06427 44.7611
Date established: 2/11/14
Team leaders/Points of contact: Virginia Tardaewether
Preliminary training (date): 2/11/14
Secondary training (date): 3/11/14
Site log-in set-up on NOAA MD-MAP (date):
> Desired username:cscormd
> Desired password:beach2014

Report log (dates):
Funding: $250 no garmin needed
Notes: one on one instruction adding information to the website 5/21/14

Site: Otter Rock Marine Reserve 68th street	**CoastWatch mile #:** 221

Site description: 262-298 NW 68th St, Newport, OR 97365
44.687449, -124.066967
Date established: 2/10/14
Team leaders/Points of contact: Lisa Prendergast
Preliminary training (date): 2/10/14
Secondary training (date):
Site log-in set-up on NOAA MD-MAP (date):
Report log (dates): 3/15/14, 4/22/14, 5/18/14
Funding: $250 GPS
Notes: Good support team

Site: Muriel O Ponsler   **CoastWatch mile #:** 182

Site description: Muriel O Ponsler Memorial State Wayside

Florence, OR 97439 N 44.171635 W 124.11733

Date established: 04-13-13

Team leaders/Points of contact: Jonathan Hornung, Brittany Getz

Preliminary training (date): 1/26/14

Secondary training (date): 3/23/14

Site log-in set-up on NOAA MD-MAP (date):

Report log (dates):

4/13/13,9/12/13,10/20/13,11/07/13,12/12/13,1/26/14,2/23/14,3/23/14,4/20/14

Funding: $250 and a Garmin

Notes: Team's original leader move away, with a little regrouping and retraining, they are up and running great.

Site: Tahkenitch   **CoastWatch mile #:** 158

Site description: Tahkenitch Creek/Oregon Dunes Overlook Gardiner, OR 97441 43.833815, -124.150017

Date established: 2/12/14

Team leaders/Points of contact: Andy Marohl

Preliminary training (date): 2/12/14

Secondary training (date): 5/22/14

Site log-in set-up on NOAA MD-MAP (date):

     Desired username: Tahkenitch

     Desired password: StreamTeam7

Report log (dates):

Funding: $250

Notes: Team settling in, have data and waiting for login access. Will get GPS currently sharing Muriel Ponsler GPS

Site: Seven Devils Wayside   **CoastWatch mile #:** 111

Site description: North of Two Mile Creek Light patches of vegetation Coos County

OR 43.237373, -124.390906

Date established: 5/23/14

Team leaders/Points of contact: Mike Mueller

Preliminary training (date): 2/16/14

Secondary training (date): 5/23/14

Site log-in set-up on NOAA MD-MAP (date):

     Desired username: Seven Devils

     Desired password: CoastWatch1

Report log (dates): waiting for login access

Funding: $250 and a garmin

Notes: It took many trips and visit to different beaches to find the site satisfying the criteria needed for monitoring. This site was the best.

Site: Redfish Rocks Marine Reserve   **CoastWatch mile #:** 46
Site description: Retz Creek
Date established: 05-08-12
Team leaders/Points of contact: Tyson Rasor
Preliminary training (date): self-trained
Secondary training (date):
Site log-in set-up on NOAA MD-MAP (date):
Report log (dates): 06-08-12 monthly to 4/15/14
Funding: Will be determined by continuation of the two year contract.
Notes: this team started a year before OMDT got started and set up for other monitoring sites, are burning out and in need of fresh blood. Currently recruiting for that team

Site: Gold Beach   **CoastWatch mile #:** 28
Site description: Gold Beach OR 42.40536 -124.42589
Date established:7/2/12
Team leaders/Points of contact: Dave Lacey
Preliminary training (date): self-trained
Secondary training (date): 1/21/14
Site log-in set-up on NOAA MD-MAP (date):
Report log (dates): 07-02-12, 09-23-12, 12/15/12,1/22/13,2/18/13,3/25/13,6/25/13
Funding: $250
Notes: Have sent message query regarding lack of reports. I know they've done the surveys

APPENDIX B: OTHER AGENCY AWARDS

PI Name	Project Title	Lead NOAA Collaborator	Awarding Agency	Funding Amount
M. Banks	Ocean Survival of Salmoniids	Kurt Fresh NWFSC	Dept of Energy/ BPA	$251,435