Director’s Message | Dr. Robert Cowen

As I take the helm as the new Director of HMSC, I do so on the shoulders of the Directors before me who have so ably steered HMSC along its course. I wish past Director, George Boehlert, godspeed in his retirement journey and thank him for his ten years of service to HMSC. I thank Janet Webster for her tenure as Interim Director. I also note with sadness the passing of Dr. Lavern Weber on May 5, 2014. Dr. Weber was HMSC Director from 1977-2002 and was a key figure behind all of what HMSC is today. I offer my heartfelt condolences to his wife Pat and his children and grandchildren, but I am comforted by knowing that they recognize how positively influential Lavern was to so many.

Lavern’s legacy was celebrated at the dedication ceremony for the Lavern Weber Study Room in the Guin Library on April 14 at Marine Science Day. We were honored to have Dr. Weber present to hear the many positive remarks commemorating him. I am extremely happy that I had the chance to meet this man who gave so much to HMSC and his community.

Since my arrival in late July 2013, I have had a quick lesson on the vast breadth of scientific, educational, and outreach activities that take place here at HMSC on a regular basis. One of the most rewarding aspects of my position as director is celebrating the many dedicated faculty, staff, students, volunteers and supporters at OSU, at our partner agencies and in the coastal community. In this report, you’ll read about innovative and exciting scientific discoveries that advance many diverse fields of marine research, from fisheries to geology to education.

HMSC is a dynamic institution, and I couldn’t be more excited about HMSC’s future. Building on our many marine-related success stories and those from across the university, OSU President Ed Ray has set his sights on developing a Marine Studies Campus. This Campus would build on all of the many ‘marine-related’ academic and research opportunities, and President Ray has called it “the next big thing” for OSU. This targeted program means great growth opportunities for HMSC with plans suggesting an academic program expansion to accommodate 500 full time students here.

To reach our goals we will be working very closely with the whole coastal community and state, all of our partners and our Friends to meet education and research needs at HMSC. We will be identifying opportunities for enhanced collaborations among the many fine educational and research programs along the coast. We will also be fundraising to build facilities and increase support for faculty and student research and teaching excellence, as well as our great public outreach activities through the Visitor Center. I look forward to this leg of HMSC’s incredible voyage and sharing in all of its great successes.

Thank you for your interest in the OSU Hatfield Marine Science Center. Your help and support are key to our combined efforts to advance our mission here at HMSC to serve the community.
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Dr. Lavern John Weber, 
HMSC Director from 1977–2002

During Dr. Weber’s tenure as its first resident Director, HMSC grew exponentially in both size and stature. He played an integral part in the development of the Center, from both an administrative and a cultural perspective.

Weber was born one of five siblings to Jacob and Irene Weber on June 7, 1933 in Isabel, South Dakota, but in his childhood, his family moved to a small dairy farm in Washington. He began his undergraduate at Everett Community College, and went on to receive a Bachelor of Arts from Pacific Lutheran University in 1958.

In 1969 he served as the acting Washington state toxicologist after spending four years as a faculty member at the University of Washington Medical School after his graduation. His decision to join the faculties of OSU Department of Fisheries and Wildlife and College of Pharmacy changed the course of his research from mammalian systems to physiology and toxicology in fishes. At OSU, he gained his first administrative experience as Assistant Dean of the Graduate School.

Dr. Weber was appointed Director in 1977 and remained in the position until he retired in 2002. During this time, he also served as the Director of the Cooperative Institute of Marine Resources Studies and as the first superintendent of the Coastal Oregon Marine Experiment Station. He oversaw the expansion of the EPA facilities and the addition of new programs in CIMRS and the National Marine Fisheries Services’ Alaska Fisheries Science Center fish behavior, and Coastal Oregon Productivity Enhancement (COPE).

But he was not just an administrator; Dr. Weber liked to teach, and his friendly, informal style in the classroom spilled over into his duties as Director. He set aside time for each member of the staff, holding regular one-on-one meetings over coffee and muffins, in order to listen to their individual concerns. In this way, he kept his finger on the pulse and was able to better understand and surmount the challenges faced by the organization.

He was 80 years old when he passed away on May 5, 2014. Named a Lincoln County Community Legend in 2006, Dr. Weber fostered the culture of collaboration that defines HMSC. He laid much of the foundation for all of the groundbreaking work that takes place here today. The Lavern Weber Visiting Scientist program honors his legacy by bringing researchers from across a diverse collection of fields, agencies, universities, and countries to speak at HMSC and share their knowledge and insight.
I. RESEARCH

A. Oregon State University

Coastal Oregon Marine Experiment Station
Gil Sylvia, Director

Oregon State University’s Coastal Oregon Marine Experiment Station (COMES) includes faculty, staff, and students located at the Hatfield Marine Science Center and the Seafood Laboratory in Astoria. COMES is the largest applied marine research organization in Oregon and the largest Agricultural Branch Experiment Station in the United States dedicated solely to coastal and marine issues. COMES was established in 1989 with support from the Oregon legislature to conduct interdisciplinary and cooperative research to understand, utilize, and sustain Oregon’s marine resources, industries, and coastal communities. Under the leadership of Lavern Weber and an advisory board chaired by Captain Barry Fisher, the Station began with three faculty and a handful of graduate students. Eighteen years later the Marine Experiment Station has grown to include 11 tenured faculty, 15 staff and research associates, more than 35 graduate students, and over $3 million annually in external grants and funds. COMES also works closely with an Advisory Board that includes members representing coastal communities, the fishing and seafood industry, and other businesses and organizations with a stake in supporting research vital to coastal communities and the State of Oregon.

The year 2013-2014 marked a period of solid growth as well as a major celebration. In April, COMES marked its 25th year with a celebration at the Maritime Heritage Museum in Newport. In honor of this occasion COMES established the Founders Scholarship to honor the individuals that helped to found COMES, including Lavern Weber, Joe Easley, Barry Fisher, and Terry Thompson. Christina Dewitt, who joined COMES in January 2011 as the new Director of the Astoria Seafood Laboratory, continues to initiate new national and international programs including lead PI on a proposal to develop a Seafood Research Partnership Program with the University of Alaska and Washington State University. Chris Langdon, Director of the Molluscan Broodstock Program (MBP), continues to work with the shellfish industry and the state to transition MBP into an industry/government supported program, given the loss of federal funding. COMES is also working with the Agriculture Research Service to replace a shellfish genetics researcher who will work cooperatively with the MBP program. COMES continues to work closely with the Marine Mammal Institute and co-administers joint faculty. In addition COMES helped lead the transition of the Seafood Consumer Center/Community Seafood Initiative into a newly reorganized non-profit Fish Trax Systems Inc. focused on developing information and knowledge systems to support fishery and community development (see below).

In 2013-2014 COMES programs generated over $13 million in economic impacts and produced an equivalent 30-40 new jobs for Oregon and Pacific Northwest coastal communities. These impacts are the result of research leading to improved utilization of marine resources, increased production of commercially harvested and cultured seafood, development of value-added seafood products, and improved policies for resource management. COMES published over 60 manuscripts and reports including more than 50 in refereed journals and books. COMES graduated 11 students including 6 MS and 5 Ph.Ds. COMES faculty also gave over 70 presentations and organized a number of major workshops and conferences. For 2013-2014 it is estimated that for each $1 million in state dollar expended, COMES faculty leveraged an additional $2.5 million in federal grants and private support.

COMES “Signature Programs” in 2013-2014 include:

**The Pacific Whiting Project:** Since 1990, COMES has worked to pioneer this seafood industry. COMES research has supported product development, market research, improvements in quality and utilization, and greater benefits from optimizing resource management including conservation of the resource. Today, Pacific whiting is Oregon’s largest fishery (by volume) and generates between $30-$40 million per year in coastal income.
**Fish Trax Systems, Inc. (FTS):** In the spring of 2013 the Seafood Consumer Center/Community Seafood Initiative, a 501 3c, became reorganized as Fish Trax Systems Inc. CSI was a unique partnership between COMES, Craft 3 (formerly Enterprise Cascadia), and the Seafood Consumer Center. SCC/CSI had supported coastal businesses and value-added seafood production, conducted seafood cooking classes, organized consumer and industry workshops, provided more than $2M in investments/loans to coastal seafood companies, and assisted the Oregon Dungeness Crab Commission in certification by the Marine Stewardship Council (MSC). Over time their work increasingly focused on research and development of the comprehensive electronic fisheries information system known as Fish Trax. FTS systems were developed as part of a larger research project known as CROOS (Collaborative Research on Oregon Ocean Salmon – see below). These systems support efforts to collect, share, and transform real-time data to be used to improve research, management, and marketing and support fishing industries and coastal communities in Oregon, the nation, and the world. FTS is now receiving royalty payments from a private company (TerraMar Innovations Inc.) for use of Fish Trax Marketplace. These payments will be used to conduct additional R&D and fisheries research.

**Molluscan Broodstock Program (MBP):** MBP conducts research and outreach with industry partners to improve oyster broodstock and associated economic benefits. Hundreds of millions of juvenile oysters produced in the Pacific Northwest are derived from MPA families housed in COMES facilities. The program is responsible for an annual increase of oyster production exceeding $6 million in farm-gate value.

**OSU Surimi Research and Technology School:** The Astoria seafood laboratory is a world leader in surimi research and education. Surimi researchers have generated millions of dollars in benefits to the Pacific Northwest seafood industry in improved product quality, protein utilization, and recovery. The Surimi Schools trained more than 100 international and domestic students in 2013-2014 in Astoria and throughout the world and led another successful international forum to discuss the status and future of the industry.

**Salmon and Marine Ecology Initiative:** A partnership between coastal and eastern Oregon in salmon ecology research. The program is producing new genetic and ecological research for improving utilization and conservation of salmon and other marine species. The program is responsible for spearheading Project CROOS, Oregon’s largest collaborative fishing research project, which has trained and employed over 150 salmon fishermen in Oregon. CROOS also partners with the California and Washington salmon scientists and industry and collectively works with more than 300 vessels as part of the cooperative West Coast Genetic Stock Identification project (WC-GSI).

**OSU-COMES Seafood Research & Education Center**

**Christina DeWitt, Director**

Dr. DeWitt is currently advising one master’s student, Dustin Keys. Mr. Keys has been evaluating the application of Nano-scale ice to seafood. He will be determining whether this new ice technology has any practical advantages over the traditional icing technologies used by the commercial seafood industry. This past year Dr. DeWitt supervised one post-doc fellow over the summer, Austin Lowder, one M.S. intern, Lin Koh, and two undergraduate interns, Daria Van De Grift (Food Science & Technology) and Jae Heilig (Chemical Engineering). Dr. Lowder is now a post-doc in the department of Animal Science and Ms. Koh is now working for Pacific Seafood Group’s Quality Assurance Division in Clackamas. Aside from the Nano-scale Ice project, interns in Dr. DeWitt’s group are also working on projects on marining injection to improve fish quality and investigating high-pressure low-temperature applications to seafood for pathogen reduction and shelf-life extension. Dr. DeWitt’s group is also working at the request of an Oregon seafood company as a third-party evaluator. The Oregon seafood company is purchasing product from a Washington seafood processor who is making the transition from production of raw, frozen products to cooked, ready-to-eat products. Dr. DeWitt’s group also provided services this past spring for the National Fisheries Institute to evaluate alternative methods for determining net weight of canned tuna.

Dr. DeWitt was asked to participate in a USDA NIFA review panel this past summer, and served on the executive committee for the organization of the Pacific Fisheries Technologists (PFT) meeting in Monterey, CA. She also chaired a session on Emphasizing the Nutritional Benefits of Regular Seafood Consumption, and presented in a session on Methods for Assessing and Improving Seafood Quality in a seminar entitled Vessel Record Form Parameters Needed for Troll-caught Albacore. Dr. DeWitt was a co-PI for a successful grant application led by the University of Delaware to develop and deliver workshops on Seafood and Aquaculture Technology. One workshop was held in Delaware this past spring where she participated in the presentation of a seminar entitled Seafood Safety, Processing and Regulation. Dr. DeWitt is taking the lead on organizing the second workshop, which will be held in Astoria, OR Fall, 2014. Dr. DeWitt was asked to provide seminars to the Washington Association of Food Protection Conference and to the SPA Seafood Processors Workshop. Dr. DeWitt was also invited by Centro Regional de Estudios en Alimentos Saludables (CREASES) in Valparaiso, Chile to give a presentation at the Seminario Internacional CREAS, Nuevos...
Impactos en la Tecnología de los Alimentos entitled Perspective on the Development of and Outcomes from the Institute of Medicine Report: Strategies to Reduce Sodium Intake in the U.S. She also presented at a workshop concerning the operations of the OSU Seafood Research & Education.

Dr. DeWitt has also chaired the teaching committee for the Branch Experiment Stations and helped lead the implementation of the BES Experiential Learning Initiative, which has placed nine undergraduate interns at the Branch Experiment Stations.

Journal publications:

Presentations:
1. 2014 – SPA 76th Annual Seafood Processors Workshop, March 4 – Seafood Topics Du Jour from the OSU Seafood Laboratory
2. 2013 Invited seminar: Seminario Internacional CREAS, Nuevos Impactos en la Tecnologia de los Alimentos. Valparaiso, Chile (Nov 21).

Laboratory, critical research & exciting developments

Abstracts:

Cooperative Institute for Marine Resources Studies (CIMRS)
Michael A. Banks, Director

The OSU/NOAA Cooperative Institute for Marine Resources Studies’ main mission is to bring together research partners from a variety of colleges, departments and agency organizations to address complex multidisciplinary issues relating to the living and non-living components of the marine environment. The Institute thrives because of the vision and commitment of leaders from within the laboratories of its NOAA associates, OSU faculty, and the OSU Research Office. As a result, external research grant funding has steadily increased; graduate student opportunities have diversified; and many more investigators are joining together from a broad range of disciplines to address research problems of environmental, economic and social importance. No other OSU research institute provides this kind of grant administration, personnel support, and review that would normally be provided by an academic department.

Through bridging across Colleges, Institutes, and Departments, the collaborative structure of CIMRS facilitates
new ways in which basic research can be applied to understand factors affecting marine resources and their management. As an integral part of the OSU Hatfield Marine Science Center, in FY14, CIMRS provided an administrative home for 21 research staff and six research faculty working on collaborative projects with NOAA investigators who also serve as OSU courtesy faculty. Recent research highlights include:

1. CIMRS Acoustic Research Recently Featured in Scientific American

2. $2,183,050 raised from external fund sources by CIMRS principal investigators; and

3. 25 peer-reviewed manuscripts published in FY14

Sixteen NOAA Cooperative Institutes (CIs) distributed throughout the nation, including CIMRS, have withstood significant fiscal challenges this year owing to the prevailing national economy. Affirming that the collaborative research provided by CIs is essential for NOAA to execute its core mission and allow the Agency direct access to the nation’s most nimble and cost-effective intellectual resources, CIMRS led a CI Directors’ visit to Capitol leadership within Federal, State & NOAA to champion high value of the CIs and the need for protection from fiscal sequestration. All 16 CIs are still providing their best in research excellence and have committed to making similar Capitol visits on an annual basis.

Significant non-NOAA funding sources in FY14 include the Bonneville Power Administration, National Science Foundation, and Office of Naval Research.

For a comprehensive list of funded research projects, please see the CIMRS Annual Report FY14, available at: http://hmsc.oregonstate.edu/cimrs/research-publications/annual-reports

**Graduate Students supported through Fellowships and Joint Research Projects:** The goals of NOAA’s strategic plan are to build sustainable fisheries, to recover protected species, and to sustain healthy coasts. These goals require the support of sound scientific research to build the knowledge base for maintaining economically viable fisheries and, at the same time, minimize anthropogenic impacts on marine ecosystems:

**Linsey Arnold, 2009-2016**
Project Title: Management Strategy Evaluations for Rockfish
Major Professor: Selina Heppell
NOAA Fisheries Rep: Grant Thompson, AFSC

**Ph.D. Candidate – College of Agriculture Sciences**

Christopher Cusack, 2009-2016
Project Title: Bioeconomic Spatial, Multi-species Fishery Simulator
Major Professor: David Sampson
NOAA Fisheries Rep: Cindy Thomson, SWFSC, Andi Stephens, NWFSC

**Ph.D. Candidate – College of Earth, Ocean, and Atmospheric Sciences**

Caren Barceló, 2009-2015
Major Professor: Lorenzo Ciannelli
NOAA Fisheries Rep: Ric Brodeur, NWFSC

**Marine Mammal Institute (MMI)**
Bruce Mate, Director and Professor
C. Scott Baker, Associate Director and Professor
Markus Horning, Associate Professor
Ari Friedlaender, Associate Professor
Daniel Palacios, Assistant Professor (Senior Research)
Leigh Torres, Assistant Professor
Jim Rice, Stranding Coordinator

The Marine Mammal Institute is an international center of excellence in marine mammal ecology, with an interdisciplinary team that efficiently and comprehensively answers ecological questions through collaboration. Its research mission is to better understand marine mammal conservation and management issues, such as population identity, estimates of abundance, critical habitat assessment, migration patterns, behavior, and interactions with human activities. The Marine Mammal Institute (MMI) is one of the leading academic institutes of its kind and is committed to improving conservation practices and understanding worldwide.

The MMI consists of 30 faculty, staff, and graduate students in six research groups that currently focus on the identification of migrations, seasonal habitats, population genetics, behavior, foraging ecology, physiology, spatial ecology, and health issues. The research focus areas are the Whale Telemetry Group (WTG), headed by Bruce Mate; the Cetacean Conservation and Genomics Laboratory (CCGL), headed by C. Scott Baker; the Pinniped Ecology Applied Research Laboratory (PEARL), headed by Markus Horning; the Bio-Telemetry and Behavioral Ecology Laboratory, headed by Ari Friedlaender; the Geospatial Ecology and Marine Megafauna (GEMM) Laboratory, headed by Leigh Torres; and the Oregon Marine Mammal Stranding Network (OMMSN), coordinated by Jim Rice.

In fiscal year 2014, the Marine Mammal Institute (MMI) hired three new faculty members: Cetacean Ecologist Ari Friedlaender, who has a strong international whale telemetry...
research program; Marine Mammal/Seabird Behavioral Ecologist and Sea Grant Extension Specialist Leigh Torres, who is developing a strong behavioral ecology research program that will also engage stakeholders and the public on management issues; and Ecosystem Modeler Daniel Palacios, who is helping lead the WTG research effort. All MMI faculty are based at the HMSC and have independently funded projects throughout the world. Future plans include priority hiring of faculty specializing in eco-informatics (information and statistical expertise), toxicology, ocean health, electrical engineering, and mechanical engineering.

The MMI works with international and national government agencies, commissions, foundations, trusts, nonprofit organizations, universities, research institutions, and industries such as fishing, shipping, and oil and gas development. MMI’s research is valued and supported by agencies, policy makers, scientists, media, educators, industry, and the general public. MMI researchers present their results through publications, conferences, and meetings, as well as highly visible educational outreach programs that include exhibits in the HMSC Visitor Center, a curriculum to foster the interests of middle-school youth in math and science, public participation in the stranding network, the Whale Watching Spoken Here volunteer program, and travel programs like the annual Baja Gray Whale Expedition to San Ignacio Lagoon, Mexico.

MMI benefits from a close association and collaborative relationship with all of the dynamic programs and agencies that are located at HMSC and is administered by Oregon State University’s College of Agricultural Sciences (CAS). Current MMI faculty and graduate students are appointed through the Department of Fisheries and Wildlife, but additions affiliated with other Colleges are anticipated in the future. A more detailed description of the MMI, by research group, can be found at the MMI website (http://mmi.oregonstate.edu) or under the College of Agricultural Sciences, Department of Fisheries and Wildlife, section of this HMSC report.

Northwest National Marine Renewable Energy Center (NNMREC)
Sarah K. Henkel, Assistant Professor – Senior Research

Program Objective: Activities of the Northwest National Marine Renewable Energy Center that occur at the Hatfield Marine Science Center include evaluating potential environmental, ecosystem, and human dimension impacts of wave and offshore wind energy installations by conducting baseline ecological research on marine habitats and organisms in areas that may be affected by renewable energy development and focusing on the compatibility of marine energy technologies in areas with sensitive environments and existing users.

2013-4 Projects:
• Characterization and Monitoring of Environmental Conditions at the Pacific Marine Energy Center (PMEC) North and South Energy Test Sites: This work includes characterization of baseline acoustics (noise) in the project area, electromagnetic fields, and benthic habitat and organisms at the PMEC-NETS site near Yaquina Head, Oregon, and PMEC-SETS site off South Beach, Oregon. NETS has been sampled since 2010 and sampling at SETS began in 2013. More details about the biological sampling can be found under the Benthic Ecology section below. The NNMREC Adaptive Management Annual Report on all activities is available on the NNMREC website.

Oregon Sea Grant
Shelby Walker, Director

Website: http://seagrant.oregonstate.edu/

Oregon Sea Grant’s mission is to be a catalyst that promotes discovery, understanding and resilience for Oregon coastal communities and ecosystems.

Funding for Sea Grant comes from federal and state appropriations as well as contributions from local governments and industry. The major support is a grant from the National Oceanic and Atmospheric Administration. Program activities are conducted in four thematic areas; ecological, social and economic aspects of coastal development, adaptation to acute or chronic coastal hazards, human and natural dimensions of coastal and marine fisheries, and cultural beliefs, learning and valuation of coastal and marine issues.

Oregon Sea Grant’s competitive research grants program addresses coastal and marine issues of high importance and of potential benefit to society. The program prioritizes socioeconomic and biophysical research that is predictive (rather than explanatory) and meaningful collaboration with industry, agencies, communities, and other stakeholders. In addition, Sea Grant partners with state natural resource agencies, not-for-profit organizations, field labs and others to support undergraduate and graduate students as Sea Grant Scholars and to provide scholars with hands-on experience with important marine and coastal problems.

The program is driven by an ethic of public service, and uses various approaches to engage our constituents. Interactions with a wide range of coastal stakeholders are continuous. An advisory council of coastal community leaders provides external review and counsel to the program. The Sea Grant outreach and engagement program offers professional,
Multidisciplinary and interdisciplinary in operation, the program involves faculty and students in several Oregon institutions of higher education. Recent participants in the program include the University of Oregon, Oregon Health and Science University, Portland State University, Linfield College, and Western Oregon University. In addition, Oregon Sea Grant maintains close relationships with several research facilities on the Oregon coast, including the Hatfield Marine Science Center in Newport and the Oregon Institute of Marine Biology in Charleston.

Research Programs by Academic Unit

College of Agricultural Sciences
Department of Fisheries and Wildlife

Marine and Anadromous Fisheries Conservation Genetics
Kathleen O’Malley, Assistant Professor

The O’Malley lab is dedicated to the study of how genetic and environmental factors interact to shape life history variation of marine and freshwater organisms. The goal is to advance our understanding of the primary processes underlying both neutral and adaptive genetic diversity within and among populations and use this information to improve conservation and management decisions. Kathleen currently directs research projects in five main areas: 1) population connectivity in the marine environment, 2) genetic basis of migration timing, 3) adaptation to a changing climate, 4) mate choice and reproductive success in natural populations, and 5) reintroduction of captive-reared and wild fish. Highlights from some of these projects are described below.

Population connectivity in the marine environment: The Dungeness crab fishery is the most valuable 'single-species' fishery in Oregon. Despite the high economic and social value of this species, no stock assessment work has been conducted on coastal Dungeness crab populations and the commercial fishery is managed based solely on a sex, size, and season strategy. However, there has been increasing interest to collect more data and improve how the fishery is currently managed. In 2014, the O’Malley lab was awarded funds by Oregon Sea Grant to conduct a two-year study evaluating the population genetic structure and diversity of Dungeness crab off the west coast. Tyler Jackson (M.S. Fisheries and Wildlife) was recruited in August 2014 to conduct this research. Understanding the inter-annual variation in genetic diversity among Dungeness crab from a broad geographical range will help inform decisions regarding ocean spatial planning, such as selection of wave energy development sites and marine reserves as well as long term management of Oregon’s most valuable single-species commercial fishery.

Adaptation to a changing climate: This project examines the adaptation of Arctic charr to the extreme polar environment through the study of population biology, physiology, and genetics. Dr. O’Malley has partnered with researchers at the Norwegian Institute for Water Research to execute the project, which is funded by the Research Council of Norway. In August, Dr. O’Malley and her colleagues traveled to Svalbard, Norway to conduct the field work, which included sampling of Arctic charr for genetic analyses in the O’Malley lab.

Mate choice and reproductive success in natural populations: Recent studies have shown that naturally spawning hatchery fish have a lower reproductive success compared to wild fish. This difference may result from lack of sexual selection (i.e. mate choice) in the hatchery. Parental mate choice is based on the premise of genetic compatibility to produce offspring of greater fitness. Previous studies suggest that fish choose mates that are genetically dissimilar at genes critical to immune response using olfactory cues. Consequently, their offspring have increased variation at these immune-relevant genes and are able to mount an immune response against a larger array of pathogens; favoring their overall survival. Amelia Whitcomb, an M.S. student co-advised by Drs. Kathleen O’Malley and Michael Banks, completed her thesis research investigating the genetic characteristics of parental mate choice in naturally spawning hatchery-reared and wild coho salmon and published her results in the Canadian Journal of Fisheries and Aquatic Sciences this March (dx.doi.org/10.1139/cjfas-2013-0501).

Reintroduction of captive-reared and wild fish: Alteration of the physical landscape through hydropower dam construction has adversely affected populations of Pacific (Oncorhynchus spp.) salmon throughout the Northwestern United States. Dams block access to historical spawning habitat and disrupt natural river flows. To mitigate for this habitat loss, hatcheries have been constructed in river systems throughout the Pacific Northwest. More recently, reintroduction programs have been initiated to re-establish natural spawning populations in rivers above dam operations.
The O’Malley lab is using genetic parentage analysis to evaluate the contribution of reintroduced fish to the productivity of at-risk salmon populations and to examine the efficacy of different reintroduction strategies. Melissa Evans, post doc in the O’Malley lab, was hired in August of 2013 to assess two reintroduction programs located on the South Santiam and North Santiam Rivers. The South Santiam and North Santiam reintroduction programs involve only unmarked (NOR) and only marked (HOR) spring Chinook salmon, respectively. This presents an opportunity to compare alternate reintroduction strategies and ultimately determine the efficacy of releasing Chinook salmon above dams in the Upper Willamette River Basin.

**Fisheries Population Dynamics**
**David Sampson, Professor, COMES**

David’s research focuses on quantitative analyses of marine fisheries, with the goal of improving the quality, accuracy, and understanding of the procedures and results that are used in the management of Oregon’s fisheries for groundfish (e.g., flatfish and rockfish). His other research focus seeks to understand the fishers’ activities in fisheries systems, such as their choices of fishing locations and fishing gear.

David’s position is half-funded by the Oregon Department of Fish and Wildlife (ODFW) and one of his main duties for ODFW is service as Oregon’s representative on the Pacific Fishery Management Council’s Scientific and Statistical Committee (SSC). The SSC develops procedures for including science-based information in the Council’s fishery management process, reviews scientific documents brought to the Council, and provides advice to the Council regarding the scientific basis for fishery management decisions. During the year David contributed ideas and text to SSC reports to the Council resulting from five regular meetings of the SSC. He also chaired a week-long stock assessment review panel that reviewed new stock assessments for two deep-water rockfish species, aurora rockfish and rougheye rockfish.

David continued work on a project, funded by the National Marine Fisheries Service (NMFS), which is refining a bioeconomic simulator that mimics the behavior of multiple fish stocks, occupying multiple spatial regions, with harvesting by multiple fishing fleets. Work during the past year focused on the technical issue of how to model the amount of fishing that occurs and its spatial distribution.

David continued to serve as the External Coordinator for the Center for Independent Experts (CIE), which provides independent peer reviews of fishery stock assessments and other forms of marine science to the NMFS. As the CIE External Coordinator, David helps administer all CIE review panels pertaining to Atlantic and Gulf of Mexico resources. His duties include finding suitable candidates for the panels and reviewing and editing the panelists’ reports. During the year David assisted the CIE with the administration of six reviews involving 18 external reviewers.

David began a new project, working as a Visiting Scientist with the Center for the Advancement of Population Assessment Methodology (CAPAM), which is a collaborative project between the NMFS, the Inter-American Tropical Tuna Commission, and Scripps Institution of Oceanography. During three weeks in April and May David visited the NMFS Southwest Fisheries Science Center facility in La Jolla, CA to do preliminary set-up work for a computer simulation experiment to evaluate and compare the accuracy of different techniques to account for spatial structure in fisheries stock assessment data.

During 2013/14 David worked with four graduate students:

- Brandon Owashi, a master’s degree candidate in the Department of Fisheries and Wildlife whose thesis research is exploring the influence of spatial variation on the performance of a data-poor stock assessment method that is used for setting catch quotas by the Pacific Fishery Management Council.
- LaTreese Denson, a master’s degree candidate in the Department of Fisheries and Wildlife whose thesis research is exploring issues associated with conducting age-structured (data-rich) stock assessments that are spatially structured.
- Chris Cusak, a doctoral degree candidate in the Department of Applied Economics, is helping David with the bioeconomic simulator project and his work on the project will provide a basis for some chapters of his PhD thesis.
- Noelle Yochum, a doctoral degree candidate in the Department of Fisheries and Wildlife, is measuring the mortality rates of incidentally caught crabs using the Reflex Action Mortality Predictor approach that was developed by Michael Davis and Al Stoner, formerly at the HMSC with the Alaska Fisheries Science Center’s Fisheries Behavioral Ecology Program.

During Autumn 2013 David taught the 4-credit course “Marine Fisheries,” which uses case studies to examine the different dimensions that influence fisheries, such as fish biology, ocean currents, fishing technology, stock assessment and management. Lectures were given at HMSC and televised to the main OSU campus.

**Marine and Anadromous Fisheries Ecology**
**Jessica A. Miller, Coastal Oregon Marine Experiment Station and Department of Fisheries and Wildlife**

**Program Objectives:** The Marine and Anadromous Fisheries Ecology program examines the life history of marine and
anadromous fishes, particularly Pacific salmon, in order to advance ecological and evolutionary understanding and assist fishery management and conservation efforts. The program incorporates field studies, laboratory experiments, and analytical chemistry. Field studies focus on movements and migration patterns of marine and anadromous fishes and the role that coastal and estuarine habitats play in their early life history. Laboratory studies are designed to test and validate assumptions associated with analytical approaches, such as the chemical composition of fish ear bones (otoliths), which we use to elucidate migratory patterns in marine and anadromous fishes.

Highlights: It has been a productive year for the lab! In collaboration with NOAA colleagues, two studies focused on understanding the role of early marine residence in the survival of Columbia River steelhead and spring Chinook salmon were published. Additionally, in collaboration with South American colleagues, two articles on migratory patterns in an introduced population of rainbow trout in Argentina were published. Manuscripts authored or co-authored by recent graduates José Marin Jarrin, Ruth DiMaria, and Wade Smith, were also published. Jessica was awarded the OSU CAS Briskey Award for Faculty Excellence.

In collaboration with several academic colleagues, Jessica has continued to track Japanese Tsunami Marine Debris (JTMD) arriving on the west coast of the US. As of April 2014, biological samples were acquired from >160 JTMD items, including docks, buoys, skiffs, post and beam timber, and pallets. The majority of the items were collected from Oregon (76), followed by Hawaii and the northwest islands (48), Washington (19), British Columbia (10), California (4), and Alaska (2). More than 200 taxa, including some species known to be invasive, have been identified arriving on these items, including >160 animal and >40 algal taxa. Information on the species’ identity, population structure, reproductive condition, growth histories, genetics, and parasite/pathogen presence from JTMD biota is still being collected.

We are a partner in The Living Marine Resources Cooperative Science Center (LMRSC), a NOAA-funded collaboration to promote under-represented communities in marine science. Through the Center, research support in marine science has been provided for five graduate and three undergraduate students to work at OSU. One of those students was Nichellé Smith, a summer intern from Hampton University, who assisted with an ongoing study to quantify seasonal and interannual variation in the quality and quantity of fats present in the phytoplankton and copepod communities present in the NCC in order to better understand how that variation affects the growth and survival of ecologically important forage fish, such as the northern anchovy (Engraulis mordax).

Current graduate students Erin Fedewa, M.S., and Marisa Litz, Ph.D., are hard at work in the laboratory. Erin, who is partially supported by the competitive North Pacific Research Board Graduate Fellowship, is examining how climate variation influences growth and survival of early life stages of northern rock sole (Lepidopsetta polyxystra) in the Gulf of Alaska. Marisa is characterizing the lipid and fatty acid profiles of prey available to juvenile salmon as they begin their ocean migration with the goal of relating ocean conditions and prey quality to salmon growth, and she was recently awarded the NOAA Educational Partnership Program’s Graduate Research and Training Scholarship!

During the year, Jessica and her students contributed oral and poster presentations at local, regional, and national meetings, including the North Pacific Marine Science Organization’s Annual Meeting in Nanaimo BC, the Ocean Sciences Meeting in Honolulu, HI, and the Columbia River Estuary Workshop: Forging Links in the Columbia River Estuary, Astoria, OR.

Publications (* denotes graduate student, ** denotes undergraduate student):


*Liberoff, A. L., Quiroga, A. P., Riva-Rossi, C. M., Miller, J. A., Pascual, M. A. Accepted. Importance of maternal habitat choice, environment and spatial distribution of juveniles in partially anadromous rainbow trout (Oncorhynchus mykiss) for adoption of alternative migratory tactics. Ecology of Freshwater Fish.


**Marine Fish Ecology**
Selina Heppell, Associate Department Head, Associate Professor; Scott Heppell, Associate Professor

The Heppell Lab group encompasses a diverse group of research projects focused on marine fisheries, fish physiology, and ecosystem studies while emphasizing undergraduate research and education.

**Research Activities:** This has been another active year, with the Heppell Lab starting new projects and continuing several investigations. Additional species of invertebrate samples were collected for the “Ocean Bioaccumulation Survey for the City of Newport,” a project run in conjunction with the Henkel Lab to evaluate potential contaminants associated with the Georgia Pacific outfall pipe at Nye Beach. Amy Jo Lindsley successfully completed her final field season on rockfish recruitment in Yaquina Bay, while Linsey Arnold and Andrea Jara are launching an online outreach survey in hopes to improve regional fisheries assessment models by increasing cooperative relationships with local fishermen. Help spread the word and check out the survey at http://oregonstate.edu/heppell/PSAsurvey.html. In an effort to broaden our coastal research presence, projects on the southern Oregon coast have been ramping up with continued fish tagging investigations by Tom Calvanese and the deployment of surface velocity profile drifters to study larval rockfish transport pathways by Scott Heppell. For more information see Tom’s website: fishtracker.org. Locally, the Heppell Lab continues to contribute to the Dynamic Revetment Monitoring Program fish sampling along the HMSC estuary path, with the help of a rotating crew of volunteers and undergraduates. This sampling for abundance and diversity will be actively incorporated into coursework this summer as new sampling methods are investigated and validated.

These projects have been funded by Oregon Sea Grant (rockfish and survey), Agriculture Research Foundation (drifters), HMSC (DRP) and HMSC Markham Award (juvenile rockfish).

The Heppell Lab has continued a commitment to cooperative teamwork with faculty, departments and agencies by providing space, time and equipment to several groups that don’t have regular access to space at HMSC. Annaliese Hettinger, a post-doctoral scholar in Bruce Menge’s lab, continues to use space in the lab. Recent OSU graduate Wade Smith, PhD, continues to work in the lab space and remains active in Hatfield community by mentoring CERM student projects involving elasmobranch studies. As our McNair graduate student transitions to the HMSC facilities this fall to begin investigations on ocean acidification and flatfish behavior, Jessica Andrade will be working with Tom Hurst as a major professor. Space and equipment have been provided for new Fisheries and Wildlife Faculty member Fiona Thomas Nash to initiate macroalgal studies this summer with her technician, Jeremy Henderson, and her student, Jen. Field equipment has been utilized by Su Sponaugle for the Marine Biology course, and field collaborations involving English sole in Yaquina Bay are ongoing with CEOAS faculty member Lorenzo Cianelli, his postdoc, Kathryn Sobocinski, and his students Morgan Bancroft and Michelle Stowell.

**Teaching Activities:** Scott and Selina Heppell continue to participate in the Fisheries and Wildlife Fall teaching program, and use HMSC classroom and laboratory facilities for these courses. This year both Scott and Selina participated in Chris Langdon’s Coastal Ecology and Resource Management (CERM) fall course. Scott taught Fishery Biology during the fall term. Additionally, Scarlett Arbuckle taught the fledgling Marine Field Methods special topics course in the fall, which will be offered again this summer and fall of 2014, and Scarlett served as the moderator for the students enrolled in the fall FW407/507 HMSC Seminar.

**Other activities:** Promoting recruitment of marine studies students and volunteers through the Marine Team is growing more active with announcement requests coming through several groups including ODFW, COASST, PISCO, The Coastal Society, and Oregon Sea Grant, as well as OSU departments and faculty. Marine Team will continue to promote student-led research, field opportunities, and activities supplementing class work for both undergraduate and graduate students as it grows. The Heppell Lab also remains active in outreach sponsoring a booth at the Marine Science Day event and leading activities for the Fisheries and Wildlife Club Coastal Discovery Days.

**Marine Fisheries Genetics**
Michael Banks, Associate Professor

Our research in population genetics among Pacific salmon and other West-Coast fishery species seeks to determine how population structuring relates to physical, biological and human components of the environment. We develop methods to resolve differences among hybridized, admixed, or recently diverged populations, and statistical means for determining component estimates that are typically mixtures of various stocks or sub-populations. We apply candidate and population genomic tools to determine how fish sense and use smell (olfaction), electromagnetism (orientation),...
seasonal photoperiod changes (time) and other faculties to achieve their lives, migrate, and interact within changing environment and climate. We also use genetic pedigrees to study population genetics and ecology related to fish and fisheries.

Key moments this year include the graduation of Dr. Renee Bellinger, who is now a postdoc in bioinformatics and climate at the University of Hawaii/Hilo; our first prime-time television feature: KGW Wild Salmon Smarter than Hatchery Fish; and lecturing with PhD student Chanté Davis at Hampton University. Renee’s PhD resulted in conclusive evidence for the first identification of a metazoan magnetoreceptor – how salmon (or any animal) orient and navigate during long-distance migration. We are enjoying preparation of a synthesis of this work for high-profile publication consideration. The television feature was to publicize the press release associated with a peer-review manuscript from MS student Amelia Whitcomb (co-supervised by Dr. Kathleen O’Malley). The press release is available at http://oregonstate.edu/ua/ncs/archives/2014/may/study-finds-wild-coho-may-seek-genetic-diversity-mate-choice

Amelia’s quote captures primary findings: “This is the first study to examine mate choice among wild-spawning fish of both hatchery and wild origin, and the results suggest that greater diversity of immune genes between wild-born pairs of coho salmon may increase offspring survival.” The goal of the Hampton University lectures Chanté and I presented, and workshops we participated in, combined with our attendance at the NOAA funded University of Maryland Eastern Shores Education Partnership Program, was to encourage application of students from diverse backgrounds to take up opportunities at HMSC such as the NSF funded Research Experience for Undergraduates each summer.

A new masters student, William Hemstrom, joined our program from OSU’s Honors College. William is studying population sub-structuring among steelhead of Siletz and Alsea Rivers. His project joins continuing PhD student Chanté Davis, who is studying population sub-structuring among Chinook salmon of the same Siletz River. Increasing need for freshwater has drawn attention to the potential of damming the Valsetz valley (headwaters of the Siletz). Thus this two salmonid species project will determine the diversity of life history expressed among salmon of this system to assess likely impact of such an action. A second PhD student, Nick Sard, is using genetic pedigree to study the full lifetime fitness of spring Chinook restoration above Cougar Dam on the McKenzie River, Willamette Valley.

Peer review publications this year include one in the North American Journal of Fisheries Management entitled: Quantifying the uncertainty of a juvenile Chinook Salmon race identification method for a mixed race stock, one in Animal Genetics entitled: Testing Advances in Molecular Discrimination among Chinook Salmon Life Histories: Evidence from a Blind Test, and the Amelia Whitcomb Canadian Journal of Fisheries and Aquatics Sciences manuscript described above and entitled: Influence of immune-relevant genes on mate choice and reproductive success in wild spawning hatchery-reared and wild coho salmon (Oncorhynchus kisutch).

Shellfish and Fish Aquaculture and Conservation
Chris Langdon

The Aquaculture program at the Hatfield Marine Science Center has prospered recently by successfully addressing several major regional and national research issues. First, over the last six years the West Coast oyster industry has faced a serious seed crisis whereby hatcheries have been unable to rear sufficient seed due to the adverse effects of strong coastal upwelling of acidified water.

We have worked with OSU colleagues to describe how this acidified seawater affects its carbonate water chemistry and consequent shell formation of bivalve larvae. This work has complemented efforts to develop stocks of Pacific oysters that are more tolerant of acidified seawater through long-term genetic selection. The industry-supported Molluscan Broodstock Program (iMBP) has led these selection efforts. Thirdly, we have worked on a large project to determine the effects of the Deepwater Horizon oil spill on the larval stages of a range of invertebrate species, perhaps one of the most serious environmental disasters that the US has faced this century. Lastly, some major breakthroughs have occurred in the laboratory on the use of liposomes to deliver essential nutrients to marine fish larvae, making a significant contribution to overcoming the “bottleneck” in limited seed supplies for marine fish farming. All of these activities have been possible because of the excellent facilities and personnel at the Hatfield Marine Science Center working to address this wide range of aquaculture projects.

Seabird Ecology
Robert Suryan (Ph.D.), Associate Professor – Senior Research, Dept. of Fisheries and Wildlife
Amanda Gladics (M.S.), Faculty Research Assistant, Dept. of Fisheries and Wildlife
Cheryl Horton (B.S.), M.S. Student, Dept. of Fisheries and Wildlife
Amelia O’Connor (B.S.), M.S. Student, CEOAS Marine Resource Management
Jessica Porquez (B.S.), M.S. Student, CEOAS Marine Resource Management
Lucila Fernandez (B.S.), Environment for the Americas Intern
Alessandra Jimenez-Yap (Undergraduate student), NSF Research Experience for Undergraduates Intern
Ian Throckmorton (OSU E-campus undergraduate student), Undergraduate Intern, Dept. Fisheries and Wildlife

The Seabird Oceanography Lab (SOL) at OSU’s Hatfield Marine Science Center (HMSC) is involved in research focusing on marine and estuarine avian ecology and integrated ecosystem studies while providing research opportunities for students and developing educational programs. Now completing its eighth year, SOL continued to expand the breadth of research projects while offering the annual spring course Introduction to Marine Life in the Sea – Marine Birds (BI/FW 111) as well the summer course Ecology of Marine and Estuarine Birds (FW 331). Research conducted by SOL spanned the North Pacific, including projects in Japan, Alaska, and Oregon. During this report period, SOL was awarded over $800,000 in funding, authored/co-authored five publications, two final reports, and gave or contributed to 17 presentations at scientific meetings, seminars, and public forums. The lab’s local field study near Newport, Oregon, was featured in several news stories as were SOL’s studies of albatrosses (see list below). SOL also contributed seabird expertise to marine spatial planning off the Oregon coast, participated in educational and public outreach activities, and worked with the Portland Audubon Society and the U.S. Fish and Wildlife Service to initiate a citizen science program monitoring seabirds at the Cape Perpetua marine reserve. Research projects during the past year included: 1) Foraging patterns and marine habitat use of short-tailed albatrosses (Phoebastria albatrus) and assessing experimental translocation of short-tailed albatross chicks for re-colonization of historical breeding sites in Japan; 2) Seabird tracking and prey patch dynamics near the Pribilof Islands, Alaska; 3) Seasonal patterns in the broad-scale distribution of seabirds and prey in the Bering Sea; 4) U.S. West coast fisheries and seabird interactions; 5) Spatial ecology and biological hotspots; 6) Common murre (Uria aalge) reproductive biology and foraging ecology at Yaquina Head, Oregon; 7) Common murre population dynamics on the Oregon Coast; 8) Marine predator diets in the northern California current and responses to changing foraging conditions; 9) Seabird colony and at-sea distribution along the Oregon coast, 10) Developing an integrated sensor array to detect avian and bat interactions with offshore energy devices; and 11) Developing non-invasive methods to monitor burrow-nesting seabird populations.

Information on these and other SOL projects can be viewed at the SOL website, http://hmsc.oregonstate.edu/seabirdoceanographylab/ Maps and information about past albatross satellite tracking studies can be viewed at http://www.wfu.edu/albatross/ and follow the link to short-tailed albatross studies.

Short-tailed Albatross, Japan: This is a collaborative study between the Yamashima Institute for Ornithology, the Ministry of Environment, Japan, the U.S. Fish and Wildlife Service, and Oregon State University to determine the at-sea distribution and marine habitat use of this endangered species (currently ~3,400 individuals, but thought to have been extinct during the late 1940s). Before this research began, there was little information on the at-sea distribution of this species during the breeding and non-breeding season. The satellite tracking efforts, now in the twelfth year, are filling this knowledge gap and allowing researchers, managers, industry, and governments to make more informed decisions regarding the at-sea conservation of this species.

Another component of this study is the experimental translocation of short-tailed albatross chicks for re-colonization of historical breeding sites. The 2011-2012 breeding season was the fifth and final year of the translocation and hand-rearing project. Most notably, there was a marked increase in visitation of the new colony site by hand- and naturally-reared birds, including two pairs actively engaged in courtship displays. Amid great excitement in Japan, a breeding attempt by a hand-reared bird was observed at the new colony site during 2012-2013. The initiation of the first breeding attempt by a hand-reared bird at the new colony site is a clear success of the translocation project. Unfortunately, however, the egg did not survive. The same pair made a second breeding attempt at Mukojima in 2013-2014, but again, unfortunately, the egg was not viable. In a surprising development, Japanese researchers discovered a short-tailed albatross chick near fledging age on the nearby island of Nakodojima. It is suspected that a translocated bird may be one of the parents. This is the first successful breeding by short-tailed albatrosses in the Ogasawara (Bonin) Islands since before World War II. There is great optimism, based on these breeding efforts, that a new colony will eventually be established in the Ogasawara (Bonin) islands.

Current field efforts are focused on assisting with monitoring hand-reared bird attendance and breeding attempts at the new colony, as well as data analysis and manuscript preparation on satellite-tracking data collected on chicks after fledging (leaving the colony). The primary research questions in these analyses are whether translocated and hand-reared chicks are indeed surviving and whether they are migrating similarly to naturally-reared individuals. During 2013-2014, SOL co-authored a manuscript that was published in Oryx reporting that post-fledging survival and migration for hand-reared chicks is similar to naturally-reared chicks.

These juvenile birds have been tracked into U.S. waters and SOL’s analyses will help evaluate critical habitats for this species and potential fishery interactions. The latter contribution is particularly important because this age class has very different movement and distribution patterns than
adults/sub-adults and therefore overlap a larger variety of fisheries. Some of these data were summarized and analyzed for SOL graduate student Amelia O’Connor’s master’s thesis, which was completed in August 2013.

Additionally, the first rearing of a short-tailed albatross chick on Nakodojima in over 80 years was highlighted in many news articles, for example:
01-n1.htm
http://digital.asahi.com/articles/ASG5F2VVVG5FUTIL005.html?ref=com_alist_photo

**Short-tailed Albatross, Alaska:** SOL research on albatrosses in Alaska includes two main studies: 1) Albatross potential use of molting areas in the Aleutian Islands and 2) Seasonal and age class-specific use of Bering Sea canyon and shelf habitats and overlap with fisheries. Passes among the Aleutian Islands and surface waters over the outer Bering Sea shelf and canyon habitats are important post-breeding foraging areas for short-tailed albatrosses. Use of Bering Sea canyons, however, are non-uniform, with some, such as Navarín Canyon near the U.S. and Russia border, used much more extensively than others. Many of these areas support extensive commercial trawl and longline fisheries. M.S. student Amelia O’Connor conducted a fine-scale analysis of associations between immature short-tailed albatrosses (< 3 years) and fishing vessels. She found that albatross associations with fishing vessels were concentrated along the Bering shelf break, especially near canyons, but were likely due to coincident habitat use rather than vessel attraction. She also found that locations of short-tailed albatross bycatch in fisheries are not always within albatross high use areas. Her analyses were included in a chapter of her master’s thesis, which was completed in July 2013. Results from both of these projects will have important implications for fisheries management, offshore energy development, and other aspects of marine spatial planning, including identification of marine important bird areas. The SOL also conducted a review of new research and information on the biology of short-tailed albatross for a 5-year review, under the Endangered Species Act.

**Seabird tracking and prey patch dynamics near the Pribilof Islands, Alaska:** SOL joined the seabird tracking component of Patch Dynamics study with the Bering Sea Integrated Ecosystem Research Program (BSIERP) – a large-scale study funded by the North Pacific Research Board and National Science Foundation. Investigators with the seabird component are attempting to identify the underlying mechanisms of why seabird (thick-billed murre, *Uria lomvia*, and black-legged kittiwake, *Rissa tridactyla*) breeding population trends have varied among islands over past decades and how they might respond to future climate change in the Bering Sea. Field crews used state of the art tracking devices attached to birds and are now processing these data to determine foraging ranges, time activity budgets, and dive profiles of birds from three colonies with contrasting productivity, population dynamics, and physical settings within the Bering Sea marine environment. These results are then being integrated with at-sea measures of prey fields and biophysical oceanographic measures. Data analysis and synthesis were completed in 2011-2012, manuscript preparation continued in 2012-2013. During 2013-2014, the fourth publication from this study that SOL contributed to was published in PLoS ONE.

**Seasonal patterns in the broad-scale distribution of seabirds and prey in the Bering Sea:** SOL is contributing seabird and data integration programming expertise to broad-scale surveys of seabirds and prey in the Bering Sea. Fisheries acoustic and trawl data have been collected and analyzed by scientists with NOAA Alaska Fisheries Science Center and the University of Washington and seabird distribution data aboard the same ships by the U.S. Fish and Wildlife. Work during 2013-2014 was focused on data analysis and manuscript preparation. This project also is a component of BSIERP with the goal of understanding how environmental variables affect seabird distribution during and after the breeding season and how the birds might respond to climate change in the Bering Sea.

**West Coast Fisheries and Seabird Interactions:** In collaboration with Washington Sea Grant, SOL is working to reduce seabird interactions with commercial fisheries along the U.S. West Coast. As part of this project, data from at-sea surveys and seabird tracking studies were integrated with data on the distribution of fishing effort to determine fishing sectors, areas, and times with the greatest overlap with albatrosses. This analysis identified fisheries and regions most in need of targeted mitigation and found that the longline sablefish fishery north of Monterey was the highest priority. During 2013, a manuscript describing this analysis was published in Fisheries Research.

The 2012-2013 efforts involved outreach to the fleet, including preliminary port visits and distribution of bycatch mitigation streamer lines. In 2013-2014, outreach was expanded to include tables at several industry and public events, a direct mailing to all limited entry sablefish permit holders, and informational meetings with over 30 fishermen at eight West coast ports ( Neha Bay, Westport, Astoria, Newport, Charleston, Port Orford, Eureka, and Fort Bragg). Investigators are working closely with individual vessels to arrange to conduct research on seabird mitigation measure effectiveness and to determine appropriate performance measures for the west coast fleet. Significant progress was made in conducting at-sea observations on board fishing vessels. SOL researchers spent 13 days at sea on three different longline vessels, and collected observations on the
sink rate of — and seabird interactions with — fishing gear. There are commitments from several additional vessel owners to collaborate on the research and data collection that will be continued aboard fishing vessels through October 2014.

Research and outreach with the longline fishery for sablefish on the West Coast will be continued to promote the conservation of seabirds through reduced bycatch, help prevent bait loss for fishers, and thereby increase targeted fish catch-per-unit-effort. Not surprisingly, this is a complex task, but SOL and collaborators are optimistic that research on the unique gear and vessel types in the fishery and minor modifications to seabird bycatch avoidance techniques developed by Washington Sea Grant for Alaska fisheries, will help reduce seabird bycatch in the West Coast longline fisheries.

Spatial Ecology and Biological Hotspots: SOL co-convened a workshop on integrating individual tracking and vessel-based strip transect survey data at the October 2013 North Pacific Marine Science Organization (PICES) annual meeting. Ultimately, SOL and collaborators will produce a PICES report identifying relevant datasets, data holders, and approaches to integrate these large datasets to address North Pacific basin-scale questions of ecology and conservation of marine resources.

Common Murre Reproductive Biology and Foraging Ecology: Yaquina Head is home to over 60,000 common murres during the breeding season — one of the largest murre colonies on the west coast. The Bureau of Land Management manages the Yaquina Head Outstanding Natural Area, located in Newport. SOL continued research and monitoring at this colony during the 2014 breeding season, the eighth consecutive year of data collection. Between SOL studies and those conducted by Dr. Julia Parrish (University of Washington), there is now a 13 year time series at this site, and hopes of continuing this long-term coastal research and monitoring program. The long-term diet data set from this colony along with local and basin-scale environmental metrics were analyzed and included as a chapter in Amanda Gladics’ M.S. thesis, which was accepted for publication in the Journal of Marine Systems during 2013-2014.

During 2014, SOL investigators initiated a new collaboration with researchers at Simon Fraser University, University of Washington, Humboldt State University, U.S. Fish and Wildlife Service, and Point Blue Conservation Science to compile common murre diet data from breeding sites in the central and northern California Current. Using these data, SOL REU intern Alessandra Jimenez-Yap is leading an analysis of spatial and temporal variation in murre diets throughout the California Current. Additionally, SOL is combining the long term diet data at Yaquina Head with stable isotope analysis of murre chick feather samples (2004-2014) to gain additional insights on sources of variability in murre chick-rearing diets. Preliminary analysis of the stable isotope data was presented at a PICES FUTURE (Forecasting and Understanding Trends, Uncertainty, and Responses of North Pacific Marine Ecosystems) meeting in April 2014, and at a workshop on predators and forage fish of the California Current in September 2013.

Seabird colonies at Yaquina Head are quite dramatically affected by both “top-down” forces of predation/disturbance and “bottom-up” forces of varying prey availability and changing ocean conditions. This colony is adjacent to the Newport Hydrographic Line, providing a perfect opportunity for integrating upper trophic level predators into marine ecosystem studies off Oregon. Yaquina Head also is a very popular public attraction viewed by approximately 350,000 visitors annually. Data collected at this site are also included in the annual California Cooperative Oceanic Fisheries Investigations State of the California Current publication.

Common murre population dynamics on the Oregon Coast: There are over 600,000 murres nesting on the Oregon coast, representing 66% of the entire murre population along the U.S. and Canada west coasts. Colony sizes vary by orders of magnitude and there appears to be movement among colonies indicating a meta-population structure. Bald eagle abundance has steadily increased in recent decades and murre colonies have been greatly affected by eagle predation. This is especially true along the northern half of the Oregon coast, where eagles are most abundant. Understanding the overall effect of bald eagle predation on common murre populations will also require understanding region-wide changes in distributions of murres among breeding sites. During 2012-2013, SOL M.S. student Cheryl Horton collected video and on-site observation of bald eagle and secondary predator disturbances at three common murre nesting colonies on the Oregon coast to study murre-eagle interactions. During 2013-2014, Horton analyzed differences in disturbance rates and common murre reproductive success at these case study colonies as a chapter in her master’s thesis, which was completed in June 2014.

Marine Predator Diets and Changing Foraging Conditions: This study is comparing the dietary overlap under varying oceanographic conditions of multiple species of forage fish predators, including common murre (Uria aalge) Chinook and coho salmon (Oncorhynchus tshawytscha and O. kisutch), black rockfish (Sebastes melanops), and Pacific halibut (Hippoglossus stenolepis). Integrating on-going studies of common murres at Yaquina Head with collaborative fisheries research will help detect and understand food web-wide adjustments resulting from biophysical changes in ocean dynamics off the Oregon coast. Sampling for this study was completed in fall of 2011. Data from this project were
analyzed and included as a chapter in Amanda Gladics’ M.S. thesis completed in 2012. During 2013-2014, findings from this study were published in Marine Biology.

**Seabird Distribution and Renewable Energy on the Oregon Coast:** As with terrestrial wind farms, electrical power lines, and mobile phone towers, etc., proper placement of any structure is critical to minimize the impact to resident and migratory birds off the Oregon coast. Working with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration during 2011-2012, SOL finished a report that integrated datasets of breeding colony sizes and locations along the coast with vessel-based surveys of seabird distribution at sea. Results of this project are being used to help inform coastal marine spatial planning decisions and serve as an information gap analysis for planning future studies where data are deficient. The report is available online in OSU scholar archives at http://hdl.handle.net/1957/30569

This work was extended to include new data collection with the Northwest National Marine Renewable Energy Center (NNMREC) at Oregon State University. In 2013-2014, SOL continued surveys from the RV Elakha on the Newport Hydrographic line and expanded efforts to include surveys of NNMREC’s Pacific Marine Energy Center’s North Energy Test Site (PMEC NETS) and the proposed South Energy Test Site (PMEC SETS). The SOL is also helping to characterize the seabird community at the WindFloat Pacific proposed wind energy site off Coos Bay, Oregon. SOL member Jessica Porquez coordinated the field efforts during 2013-2014, and will conduct analyses to characterize the marine bird community and environmental factors affecting their distribution as part of her thesis research.

In both 2013 and 2014 SOL members, Amanda Gladics and Amelia O’Connor, contributed to long-term efforts to survey seabird distribution in the northern California Current by serving as at-sea observers on board a NOAA research cruise on RV Ocean Starr.

**A Synchronized Sensor Array for Remote Monitoring of Avian and Bat Interactions with Offshore Renewable Energy Facilities:** With collaborators in the engineering departments of Oregon State University and University of Washington, SOL completed the second year of a project to design, test, and deploy an integrated sensor array that will continuously monitor interactions (including impacts) of avian and bat species with wind turbines. In contrast to land-based wind facilities, animal casualties in off-shore wind energy installations can only be efficiently assessed over the long term using an on-board detection system with data transmitted remotely to shore-based data processing centers. SOL and collaborators are developing a synchronized array of sensors including accelerometers, contact microphones, visual and infrared spectrum cameras, and bioacoustic monitors. On-board, custom-designed data post-processing and statistical-based software will detect impacts from other disturbances and trigger the event recording. Remote access to the recorded images and sensor data will make it possible to quantify interactions, including collisions, and identify organisms involved to the lowest taxonomic grouping possible. When completed, the sensor array can be used on a single turbine for site characterization or on multiple turbines distributed throughout a wind facility to assess cumulative impacts. It is anticipated that all or parts of the array can be used for a variety of offshore structures, including wave energy devices.

A series of field tests for the sensors were completed in 2013 and 2014. Tests included accelerometers and contact microphones with experimental impacts (tennis balls) on a research turbine at the National Wind Research and Training Center, Mesalands Community College, Tucumcari, NM. Additional testing of avian and bat identification using the stereo optical node with infrared and visual spectrum cameras was conducted in Puget Sound at the Pacific Northwest National Laboratory in Sequim, WA.

**Developing Non-Invasive Methods to Monitor Burrow-Nesting Seabird Populations:** In 2014, SOL and the U.S. Fish and Wildlife Service initiated a three-year project to develop and test non-invasive population monitoring techniques for burrow-nesting seabirds on the Southern Oregon Coast. Whereas populations of surface-nesting seabirds can be monitored using aerial photography and visual counts, monitoring of burrow-nesting species is much more challenging, especially on difficult-to-access offshore islands. This approach combines simultaneous data collection using remote cameras and acoustic recorders that can be deployed for long periods of time, up to an entire breeding season. The study site at Goat Island, near Brookings, OR, supports a large Leach’s Storm-Petrel (Oceanodroma leucorhoa) colony. The remote monitoring systems being tested include near-infrared cameras to capture images of storm-petrels over the colony at night and acoustic recorders to capture calls of these highly vocal birds. The equipment is deployed at the colony from April-September to quantify abundance and activity patterns throughout the nesting season, from arrival to colony departure. SOL and collaborators will deploy the equipment again during 2015, with analysis and manuscript preparation to follow.
The Cetacean Conservation and Genetic Laboratory (CCGL) is committed to a greater understanding of the molecular ecology and conservation genetics of whales, dolphins, and porpoises around the world. Its research on large whales, beaked whales, and dolphins pursues four interrelated themes: reconstructing the past, assessing the present, conserving the future, and discovering new species.

Reconstructing the past of whales and whaling: The CCGL, in collaboration with the South Pacific Whale Research Consortium (SPWRC), is contributing to a comprehensive assessment of humpback whales in the South Pacific (Oceania) and of southern right whales around New Zealand. Results of this work were presented to the annual meetings of the Scientific Committee of the International Whaling Commission (IWC) in June 2013 and May 2014. Based largely on these contributions, the Scientific Committee of the IWC was, this year, able to complete the comprehensive assessment of humpback whales in Oceania, reconstructing the history of decline and near extinction due to the intensive commercial whaling throughout much of the 20th century and the illegal whaling of the Soviet Union in the early 1960s. Angie Sremba has completed the largest survey to date of “pre-whaling” genetic diversity using bones collected from the beaches around the former whaling stations in the South Georgia Islands of the South Atlantic (Sremba et al. 2014).

From DNA extracted from 231 bones, she identified 158 humpback whales (Megaptera novaeangliae), 51 fin whales (Balaenoptera physalus), 18 blue whales (B. musculus), two sei whales (B. borealis) and one southern right whale (Eubalaena australis). This “molecular archive” can be used to reconstruct the genetic diversity of whales killed during the first hunting of these species in the Southern Hemisphere.

Assessing the present status of great whale populations: In the North Pacific, the CCGL is collaborating with the Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH) to describe the population structure and propose Distinct Population Segments (Baker et al. 2013b). This proposal was included in the Biological Review Team’s recommendations for listing status of humpback whales under the US Endangered Species Act.

In collaboration with Ocean Alliance, PhD student Alana Alexander has now completed DNA profiling of more than 600 individual sperm whales using samples collected during the five-year Voyage of the Odyssey. This has provided the first circum-equatorial survey of population structure and genetic diversity in this enigmatic species.

With the support of the Office of Naval Research, Dr. Baker and PhD student Dori Dick helped direct the development of computation tools to better explore and analyze DNA profiles linked to individual identification records of migratory whales and other marine megavertebrates (Dick et al. 2014). Referred to as geneGIS, the tools are implemented in two computational frameworks: 1) as functional enhancements of the web-based software, Wildbook (http://www.wildme.org/wildbook/); and, 2) as a toolbox in the desktop version of ArcGIS 10.1 (http://genegis.org/).

Conserving the future of great whales and dolphins: With support from a Pew Marine Conservation Fellowship, Dr. Baker has helped coordinate a large-scale study of dolphin populations in Oceania, A Pattern of Dolphins (aPOD), in collaboration with his students and members of the SPWRC. In the Solomon Islands, Dr. Baker has worked with his former student, Dr. Marc Oremus, to assess the impact of the live capture of Indo-Pacific bottlenose dolphins and the recent resumption of the traditional “drive-kill” of spotted and spinner dolphins (Oremus et al. 2013). In Hawaii and the Society Islands, PhD student Renee Albertson has found a remarkable degree of isolation among island communities of rough-toothed dolphins, Steno bredanensis. These results may lead to new management actions to mitigate human threats to some local populations.

With funding from the US Marine Mammal Commission and the New Zealand Department of Conservation, Becca Hamner completed her PhD research on the genetic monitoring of the endangered Hector’s and Maui’s dolphins (Cephalorhynchus hectori) endemic to the coastal waters of New Zealand. Using DNA profiling from small biopsy samples, Becca has confirmed the low abundance of the critically endangered North Island Maui’s subspecies (Hamner et al. 2014b) and the genetic isolation between the regions’ populations of Hector’s dolphins around the South Island (Hamner et al. 2012). By confirming the subspecies identity using genetic markers, she was also able to document the potential for “genetic rescue” of the Maui’s dolphin by occasional long-distance dispersal of Hector’s dolphins (Hamner et al. 2014a).

Discovering new species: Members of the CCGL pioneered molecular methods to identify species of the rare and cryptic beaked whales. Using DNA extracted from bones collected in
the remote Gilbert Islands of the Republic of Kiribati. Dr. Baker and his colleagues recently identified three species of beaked whales (Baker et al. 2013a), all of which had been used for human consumption and one of which appeared to be a previously “unrecognized species.”

Further investigation of the unrecognized species identified from the bones collected in the Gilbert Islands resulted in the identification of specimens from Palmyra Atoll in the Line Islands of the Pacific and the Maldives, the Seychelles, and Sri Lanka in the Indian Ocean. This species is now recognized as a resurrection of *Mesoplodon hotaula*, first described in the early 1960s from a single specimen but subsequently synonymized with another recognized beaked whale (Dalebout et al. 2014). With this resurrection, there are now 23 recognized species of beaked whales.

Figure 1: The New Zealand Maui’s dolphin, now considered to be the rarest species or subspecies of dolphin in the world (photo courtesy of Marc Oremus).

**Literature Cited:**


**Oregon Marine Mammal Stranding Network (OMMSN)**

**Bruce Mate, Director**

**Jim Rice, Coordinator**

The Oregon Marine Mammal Stranding Network is a collaborative, largely volunteer organization that comprises members from Oregon universities, state and federal agencies, and the general public. MMI’s Jim Rice has served as coordinator for the three coastal regions (northern, central, and southern Oregon coasts) since 2006 and oversees a network of trained volunteers in the central coast region. The objectives of the OMMSN are to understand the scientific reasons for marine mammal strandings; to provide for the welfare of live stranded and entangled animals (by educating the public to reduce harassment and by disentangling mammals from debris and fishery gear); to advance public education about strandings; and to report data to NMFS for inclusion in a national database used to establish baseline information on marine mammal morbidity and mortality. Stranding events offer a wealth of information about marine mammals to researchers and resource managers including seasonal distribution, toxic contaminant levels, impacts of human interactions, and surveillance of known and emerging diseases. Jim Rice responds to hundreds of stranding events each year and is also actively engaged in public outreach programs, volunteer training, necropsy teaching sessions, and collaborations with the OSU College of Veterinary Medicine by providing pathology samples for analysis and study materials for veterinary students.
Pinniped Ecology Applied Research Laboratory (PEARL)
Markus Horning, Associate Professor; Graduate Student: Sheanna M. Steingass (Ph.D., Dept. Fisheries & Wildlife)
Undergraduate Student: Mee-ya A. Monnin (Dept. Fisheries & Wildlife)

The Pinniped Ecology Applied Research Laboratory (PEARL) is dedicated to the study of ecology, behavioral physiology and conservation biology of pinnipeds (seals, sea lions, and walrus) in polar, temperate, and sub-tropical regions. Long-term PEARL research goals include the integration of diverse approaches to monitor and predict vital rates and population trends of pinnipeds in the North Pacific and polar regions.

- Building on the success of the first generation life-long implanted monitors for marine homeotherms (LHX tags), we completed the development of the next generation of LHX-2 devices, under National Science Foundation funding. This telemetry technology allows remote monitoring of pinnipeds throughout their entire lives to aid in classification of detected mortalities. In addition, LHX-2 tags can detect birth events in female hosts, to provide information on age at first reproduction, and lifetime number of pups born to individual females. LHX-2 development was conducted in collaboration with Wildlife Computers, Inc. (Redmond, WA), with the additional participation of Dr. John Parmigiani from the Computational Mechanics and Applied Design Laboratory (OSU School of Mechanical, Industrial, and Manufacturing Engineering), Dr. William Hanshumaker (HMSC) coordinated education and outreach efforts under this grant. These efforts included the development of a project-specific website and curriculum elements by contractors Seymour Creative Communications and MarEPOsa. Our website (www.sealtag.org) presents a standards-based curriculum for school grades 6–12 with classroom activities that combine engineering principles and our biological research on Steller sea lions. An interactive exhibit on the LHX project is installed at the HMSC Visitor Center. OSU project participants include M. Horning, J. Parmigiani, and W. Hanshumaker.

- In fall 2013, we initiated Phase 2 of a long-term research project monitoring predation on, and reproduction in, Steller sea lions in the Gulf of Alaska, using 2nd generation LHX-2 tags that were recently developed (funded by the North Pacific Research Board, the North Pacific Fisheries Foundation, and the Pollock Conservation Cooperative Research Center). Expanding on our prior work with 1st generation LHX-1 tags, this project will validate the temperature-based detection of birth events in female Steller sea lions, for future applications of these devices in the western Aleutian Islands, an area of continuing Steller sea lion population declines. Five young female Steller sea lions received LHX tags in April 2014, and we are planning on working with another group of animals in the summer of 2014.

- We have begun a new project to investigate upper trophic impacts of hypoxia on harbor seals as model species off the central Oregon coast. This project is carried out by PEARL Ph.D. student Sheanna Steingass. We are preparing for the deployment of satellite tracking devices on up to 12 harbor seals in fall 2014. This project is supported by the Salty Dog Fund of the Oregon Community Foundation.

PEARL student activities
- PEARL graduate student Norma Vazquez successfully defended her M.Sc. thesis entitled “Spatial and Temporal Distribution of Juvenile Steller Sea Lion (Eumetopias jubatus) Predation Events in the Gulf of Alaska” on August 30, 2013. Norma received support from a graduate research fellowship by the National Science Foundation.

- PEARL graduate student Sheanna Steingass successfully defended her M.Sc. thesis entitled “Foraging Behavior of the Pacific Harbor Seal (Phoca vitulina richardii) in the Pacific Northwest and Potential Impacts of Coastal Hypoxia on Foraging Efficiency” on March 7, 2014. Sheanna received support from the HMSC Mamie Markham 1st Year Student Award and the Marine Mammal Institute. Sheanna is continuing with the PEARL as a Ph.D. student.

- OSU undergraduate student Mee-ya Monnin who twice joined our Antarctic project investigating thermoregulation in Weddell seals is completing her undergraduate honors thesis on the use of three-dimensional photogrammetry to estimate morphometric measurements in Weddell seals. Mee-ya graduated in spring 2014 and defended her thesis on July 10th 2014.

Whale Telemetry Group (WTG)
Bruce Mate, Director
Daniel Palacios, Assistant Professor (Senior Research)
Senior Faculty Research Assistants: Barbara Lagerquist and Ladd Irvine
Faculty Research Assistants: Tomas Follett, Craig Hayslip, Martha Winsor

The Marine Mammal Institute's Whale Telemetry Group (WTG) has pioneered the development and field use of satellite-monitored radio tags to study the movements, populations, prey selection, critical habitats, and dive characteristics of multiple whale species throughout the world.

- The WTG is wrapping up an investigation on the year-round movements of Pacific Coast Feeding Group
(PCFG) gray whales, which were tagged during fall 2009, 2011, and 2012. Many of these whales were tracked to Mexican breeding and calving areas and back to summer foraging areas off California, Oregon, Washington, British Columbia, and Alaska. This work provided information about the importance of areas off the coast of Baja as well as lagoons for the breeding and calving season. Researchers collected valuable data regarding the amount of time that individual whales spend in various parts of their seasonal range. Data from this project will provide an in-depth look at home ranges and core areas in the Pacific Northwest. The Pacific Northwest ranges are particularly relevant to issues such as wave energy, the Makah petition to take gray whales, and the co-mingling with possible western gray whale migrants.

- The WTG continued research on sperm whales in the Gulf of Mexico near the site of the Deepwater Horizon oil spill. The team tagged whales during the spill in 2010 and the three subsequent years (through 2013) in an effort to determine whether there are spill-related changes in the sperm whales’ distributions. Among the deployed tags were our most recently developed advanced dive behavior tags, which will also be used in summer 2014 during Navy-sponsored research on both fin and blue whales in the North Pacific. These tags showed us how sperm whales hunt throughout the day and night for weeks at a time. These insights are helping us plan a future experiment to determine the factual effects of seismic surveys.

- Bruce Mate taught 130 volunteers during a workshop for the Whale Watching Spoken Here program, originated at HMSC and now run by Oregon State Parks. The trained volunteers work at 26 sites along the Oregon coast and help up to 40,000 visitors per year spot gray whales during the annual winter and spring migrations. This is the largest whale watch operation of its sort anywhere in the world.

- The WTG is preparing for 2014 projects including:
  - a two-year comprehensive look at Alaska and Hawaii humpback migrations and habitat hot spots, which is still seeking some added donor support;
  - an examination of the seasonal distributions, dive habits, and feeding efforts of fin and blue whales in Navy operational areas off southern California that may migrate up into the Navy’s NW and Alaska Training areas.

Bio-Telemetry and Behavioral Ecology Laboratory

Ari S. Friedlaender, Associate Professor

Incoming graduate students: Theresa Kirchner (M.S. Dept. Fisheries & Wildlife), Natalie Mastick (M.S. Dept. Fisheries & Wildlife), Erin Pickett (M.S. Dept. Fisheries & Wildlife)

The Bio-Telemetry and Behavioral Ecology Laboratory is focused on using telemetry and bio-logging tools to study the behavioral ecology of marine mammals. Research projects span taxonomic groups and locations and include studies on a range of baleen and toothed whales and dolphins from Antarctica to Alaska. Two of the current research objectives relate to understanding how the foraging behavior of humpback whales in Antarctica is influenced by climate change, and how the foraging behavior of a range of species is affected by anthropogenic sounds (e.g. Navy sonar).

- In November 2013, Ari Friedlaender officially joined the Oregon State University faculty as Associate Professor in the Marine Mammal Institute.
- In December 2013, Ari participated in the National Science Foundation’s Long-Term Ecological Research (LTER) program in Antarctica. Ari and colleagues collected data on the distribution, abundance, and behavior of cetaceans in Antarctica on the LTER annual research cruise.
- Based on the success of work with the Palmer LTER program, Ari Friedlaender was invited to join the program as a Co-Principal Investigator for the next 6-year funding cycle beginning in 2015. The main focus of the research will be to understand how environmental change affects the distribution and behavior of krill predators including humpback whales and Adelie penguins (http://antarcticsun.usap.gov/science/contenthandler.cfm?id=4051).
- In March 2014, Ari Friedlaender was invited to the International Whaling Commission’s Scientific Committee and presented to the Ecological Modeling sub-committee on competition between baleen whales. This presentation led to the development of a new proposal to better understand the ecological roles of different whale species and the likelihood of competitive interactions among species.
- In April 2014, Ari Friedlaender led a multi-institutional and multi-disciplinary research team to study the foraging behavior of humpback whales in the near-shore waters of Southeast Alaska with colleagues from Duke University, Moss Landing Marine Laboratory, Stanford University, Smithsonian Institute, and University of Alaska. As part of a long-term research program supported by the Pacific Life Ocean Foundation, we seek to better understand how humpback whale feeding behavior is affected by the prey on which they feed across a number of feeding locations around the world (including Alaska, Cape Cod, and Antarctica) using multi-sensor suction cup tags.
- Ari Friedlaender led a similar research cruise in collaboration with the National Geographic Society’s Remote Imaging Department and Dr. Dave Wiley of
the Stellwagen Bank National Marine Sanctuary to study the foraging behavior of humpback whales, a program that has been ongoing since 2004.

- In July 2014, Ari Friedlaender and Dr. Jeremy Goldbogen of Stanford University deployed new multi-sensor and video recording tags on humpback whales in the Monterey Bay National Marine Sanctuary. The goals of this work are to engineer new tools to better understand the underwater movement and behaviors of these ocean giants.

Geospatial Ecology of Marine Megafauna (GEMM) Lab
Leigh G. Torres (Ph.D), Assistant Professor, Marine Mammal Institute, Fisheries and Wildlife
Courtney Hann (B.S.), M.S. Candidate, CEOAS, Marine Resource Management
Amanda Holdman (B.S.), M.S. Student, Fisheries and Wildlife
Florence Van Tulder (B.S.), M.S. Student, Fisheries and Wildlife

The ocean is huge, patchy, and dynamic. Our research aims to understand how marine megafauna encounter the resources they need within this challenging habitat. The GEMM lab focuses on the ecology, behavior and conservation of marine megafauna including cetaceans, pinnipeds, seabirds, and sharks. Our research typically examines species–habitat relationships to generate an improved understanding of species ecology and distribution patterns. Often, by filling these knowledge gaps about where marine animals can be found and why certain habitats are critical, conservation efforts can be more directed and effective in order to separate, in time and space, threats and marine animals.

Our research is diverse and global. We use advanced and innovative methods to address three broad areas of research:

- Describe the spatial and temporal distribution patterns of marine megafauna to provide effective management options that reduce space–use conflicts with human activities (e.g., fisheries, vessel traffic, petroleum extraction, marine renewable energy).
- Understand behavioral and spatial responses of marine megafauna and their prey to short-term impacts (e.g., fishing activity, vessel traffic, seismic air gun noise) and long-term environmental variation (e.g., climate change, El Niño Southern Oscillation, prey competition).
- Generate and validate species distribution models of marine megafauna for effective prediction of distribution and habitat use patterns.

Marine megafauna range widely throughout the oceans in search of resources and potentially encounter numerous anthropogenic influences. We incorporate five main components into our geospatial research to understand the distribution, ecology, and threats posed to marine megafauna:

- Space: Where do animals occur?
- Time: When are animals in an area?
- Behavior: What are the animals doing in an area (i.e., feeding, resting, migrating)?
- Habitat: What are the environmental characteristics that determine “good habitat” and how are they limited or changing?
- Scale: What scale of space and time do we use to answer the above questions, and how do the answers change with change of scale?

GEMM Lab is up and running: With the arrival of Dr. Leigh Torres to the Marine Mammal Institute in April 2014, the GEMM Lab has been established at the Hatfield Marine Science Center. The lab space provides work areas for six graduate students, a conference area, and a state-of-the-art video and telecommunications system to enable easy and clear collaboration, data visualization, and science communication.

A new blue whale foraging ground documented in New Zealand: The GEMM Lab led a research expedition in January 2014 that collected observational, behavioral, and oceanographic data to prove the existence of a blue whale foraging ground in the South Taranaki Bight (STB) in New Zealand. The concern is that the STB, which lies between the country’s North and South islands, is home to the country’s largest oil and gas exploration and extraction area, including seven active production platforms and pervasive seismic survey operations due to imminent plans for industry expansion. These activities pose significant threats to feeding blue whales including habitat degradation, vessel strike, displacement from critical prey resources, and acute and prolonged impacts from ocean noise.

Prior to this study, it was thought that blue whales only migrated through New Zealand waters, which is reflected in its listing by the New Zealand Threat Classification System as a Migrant, offering blue whales no distinct conservation protection. Although our previous work proved that blue whales use the STB as a foraging ground, implementation of conservation management strategies is impeded by data gaps including an abundance estimate of blue whales using the STB, information on the significance of this foraging ground relative to other feeding areas, and the spatial and temporal extent of the feeding area. Blue whales have the highest prey demands of any predator that ever existed. To survive, blue whales must have access to reliable foraging grounds to feed on dense prey aggregations. The GEMM Lab is currently planning a comprehensive research program to improve our knowledge of this blue whale population by generating estimates of abundance, residency and distribution in the...
STB. These are the data needed to ensure the protection of these endangered animals and their critical feeding habitat. (Watch a TV news segment on the discovery of this blue whale foraging ground: http://www.3news.co.nz/tvshows/campbelllive/rare-blue-whales-discovered-in-new-zealand-2014020516).

**Whale mAPP for Android launched and tested:** The GEMM Lab is working collaboratively with the Alaska Whale Foundation and Smallmelo Geographic Information Services to produce a citizen science version of “Whale mAPP.” Whale mAPP is a collection of GIS-based web and mobile tools that allow citizen scientists to collect observations of marine mammals. Traditional methods of gathering and managing data to map marine mammal distributions require extensive time and resources. Whale mAPP (http://www.whalemapp.org/) allows anyone to submit and visualize observations that can be used by scientists for research. It is an Android mobile application that utilizes GPS-enabled smartphones to record sightings, track and display boat paths, and collect photographs that are transmitted to a geodatabase.

The GEMM Lab is evaluating citizen scientists using Whale mAPP as a low-cost tool for collecting marine mammal sightings data, and the usability of the data for improving our knowledge of distribution patterns. Data collection is currently underway in Southeast Alaska, with numerous volunteers using Whale mAPP and contributing to the citizen science database. The project will determine the effectiveness of using citizen science data in research efforts by generating and comparing marine mammal (humpback whale, killer whale, Dall’s porpoise) distribution maps based on (1) citizen science data collected via Whale mAPP and (2) standardized survey data. The GEMM Lab will assess the usability of these data to understand marine mammal distribution patterns, determine the education benefits of Whale mAPP, and provide critical feedback to revise the mobile application.

**Field team at Campbell Island for unique winter research expedition:** The GEMM Lab has been collaborating with colleagues in New Zealand and Australia to study multiple marine megafauna at Campbell Island in the New Zealand sub-Antarctic. The team is preparing to depart for Campbell Island in summer 2014 (southern hemisphere winter) to collect data that will lead to an improved understanding of the ecology of the New Zealand sea lions, southern elephant seals, southern right whales, and grey petrels that are resident on Campbell Island during the winter months.

**Department of Agricultural and Resource Economics**

**Marine Resource Economics & Marketing**

Gil Sylvia

Research during the past year has concentrated on seafood marketing, bioeconomic modeling, fisheries management and policy, education of fishery managers, and coastal community development. Outreach and public service has been directed at improving fisheries management, publishing and presenting marketing and management research, and assisting west coast industry and agencies in developing cooperative and cost-effective fisheries research. Many of these interdisciplinary projects include close cooperation with the Astoria seafood laboratory, the Community Seafood Initiative/Fish Trax Systems Inc., Oregon Department of Fish and Wildlife, the Cooperative Institute of Marine Resource Studies, the World Bank, and economists and biologists of the National Marine Fisheries Service.

Research projects include: 1) developing optimal traceability and accountability systems for handling, marketing, and sustaining fisheries and seafood using real-time information systems; 2) developing education programs for fishery managers; 3) conducting industry and consumer surveys to determine perspectives and values for developing seafood traceability systems; 4) exploring approaches to help ports and coastal communities support successful fisheries; 5) developing case studies for improving education in stock assessment and international seafood trade; 6) managing the Project CROOS Group (Cooperative Research on Oregon Ocean Salmon) for using genetic and traceability systems for improving the science and management of ocean salmon; and, 7) developing fisheries bioeconomic models for the country of Ghana, Western Africa region, and the World Bank and FAO.

We continued to work closely on numerous ventures with the formerly named Community Seafood Initiative, now known as Fish Trax Systems, Inc. The focus of Fish Trax, which is a suite of electronic fish information systems using near real-time information, is to support marketing, science, and fishery management (www.pacificfishtrax.com http://www.fishtrax.com https://marketplace.fishtrax.org). A new product called Fish Trax Marketplace, developed by the CSI/FTS is now licensed and commercialized by a small private company (TerraMar Innovations Inc.). Royalties for the use of Fish Trax Marketplace will be used to support marine technology and fishery research. In addition, we are working with a small international group to develop standards for advancing fishery electronic information systems. The highly interdisciplinary CROOS project is ongoing (although on a small scale this year) and is funded...
from a variety of sources and involves COMES faculty, the Oregon Salmon Commission, National Marine Fisheries Service, Oregon Sea Grant, and ODF&W. The project’s goals include using genetic and oceanographic analysis to reduce harvests of weak salmon stocks while avoiding large area closures, developing new approaches for salmon management, and using digital technology for information tracking systems for management and marketing. The project remains the largest collaborative research program ever undertaken by the Oregon salmon industry and involves more than 150 fishermen and vessels. We have developed a larger and more comprehensive West Coast group (West Coast Salmon – Genetic Stock Analysis) conducting genetic salmon research from Washington to Central California. In cooperation with a consulting company (the Research Group, Corvallis) we have developed an integrative bioeconomic fishery model to be used by the World Bank in developing and analyzing investments to reform fishery management in the country of Ghana. The model is designed to be usable by fishery managers and stakeholders. A phase II development is expected to begin no later in 2014 or 2015 including training of managers for using the model.

These research projects have generated over $200K in extramural funding and are supporting three graduate students in the Departments of Agricultural and Resource Economics and Marine Resource Management.

**Publications:**


**Department of Botany and Plant Pathology**

**Gayle Hansen, Associate Professor – Senior Research**

**Mission and Objectives:** During the 2013-2014 academic year, Gayle Hansen, our semi-retired marine botanist, continued with her taxonomic and distribution studies on the seaweeds of Oregon and the outer coast of Washington, but she was also drawn into related studies on the seaweeds of Japan and China. Last summer and fall, Gayle contracted with ODFW to complete a survey of the subtidal seaweeds of Cascade Head Marine Reserve – the 3rd reserve that she has studied. These surveys have made it possible for her to compare the algal diversity of the 3 reserve areas. Early in 2014, a new wave of Japanese tsunami debris began arriving on our shores, and Gayle returned to her studies on the identification of the debris algae. To be certain that her identifications were correct, she worked closely with two Japanese molecular biologists who sequenced many of the species. These collaborations have led to an on-going project comparing NE Pacific algal species with related species in Asia. Gayle’s earlier work on the marine algae of eastern Russia enabled her to meet several Russian and Chinese colleagues who invited her to participate in a project on the algae of Hainan Island, China. Their paper on the seasonality of the algae at this tropical island was just published.

**2013-2014 Research Project Summaries:**

- **The seasonality of macroalgae and Cyanobacteria at Hainan Island, China.** With Eduard and Tamara Titlyanov and other colleagues from Russia and China, Gayle took part in the statistical analysis and manuscript preparation of a four-year study on the macroalgae and Cyanobacteria (149 species) occurring in Sanya Bay, Hainan Island, China. Their intertidal collections revealed a clear seasonality between the rainy and dry months of each year and also seasonal changes in the intertidal zones. During the dry months, more species occurred in all intertidal zones except for the splash zone where only one species survived. Throughout both rainy and dry seasons, the red algae dominated the mid and low intertidal zones while the Cyanobacteria dominated the upper intertidal and splash zones. 44% of the species were seasonal with 37% limited to the dry season and 7% limited to the wet season. Although heavily impacted by human development, the floristic biodiversity of Sanya Bay continues to be similar to that of other unpolluted regions in the Indo-Pacific.

- **Extractive surveys of the subtidal seaweeds and seagrasses in Oregon’s Marine Reserves.** To protect its marine flora and fauna, the state of Oregon recently established five subtidal areas along its outer coast as no-take marine reserves, off-limits to all harvest except as necessary for monitoring and research. Baseline studies of sub-canopy seaweed and seagrass species richness and biomass have now been completed at 3 of these reserves (Redfish Rocks, Otter Rock, and Cascade Head). A depth-stratified (5-15 m) random sampling method was used to investigate each “reserve area” which consisted of the reserve and a nearby comparison area. 30-36 (0.25 m²) quadrats were placed within each reserve area, extracted by divers, and then provided to taxonomists for quantifying species richness and biomass. Gayle studied the seaweeds and seagrasses for all three areas, completing Cascade Head last summer. Together, she found that the reserve areas yielded a total of 137 macrophytic species with a ratio between areas of RR:OR:CH = 63:107:78. Approximately 30% of the
species were common to all three areas, but 50% were found in only one area. Red algae comprised nearly 80% of the species, but the highest biomass occurred among the brown algae. The kelp, Laminaria longipes, dominated Redfish Rocks and Cascade Head. Acid weed, Desmarestia latissima, dominated Otter Rock. Otter Rock had the greatest overall diversity with 107 species and an average of 32 macrophytic species/quadrat. It also had the greatest species uniformity with 21% of the species occurring in >50% of the quadrats. Redfish Rocks was the most species-poor with only 63 species, an average of only 9 species/quadrat, and only 8% of the species extending into >50% of the quadrats. The most prevalent species throughout all three areas was the red alga Callophyllis flabellulata, which occurred in 92% of the sampled quadrats. The reserve with the greatest algal species richness, Otter Rock, is also the smallest reserve at 1.3 square miles.

- **Marine algae on Japanese tsunami debris and the risk of invasion to Oregon shores.** The 2011 Japanese earthquake and tsunami generated massive amounts of debris that washed out to sea, and an unknown amount was picked up by currents crossing the North Pacific. From June 2012 to June 2014, recognizable tsunami debris items have been arriving on the shores of Oregon and Washington that carry hitch-hiking marine biota of Japanese origin. Gayle has studied the marine algae from many of these items and in 2013 used 12 of the most populated debris to evaluate the risk of invasion on our shores. She identified a total of 50 algal species from the debris including 21 brown algae, 18 red algae, 10 green algae, and 1 blue-green. The larger debris items such as floating docks bore the most species, and each new item brought in new Japanese species with 52% of the species occurring on only 1 debris item. Possibly due to the increase in nutrients near our coast, 76% of the species, on arrival, were fertile and dropping spores, increasing the risk of recruitment. Oregon’s pristine near-shore water has moderate temperatures ranging from 7-12º C. Since these temperatures are within the native temperature range of the Japanese species (7-23º C), the conditions here may be appropriate for the Japanese species to become established. However, the current distribution of the species lessens the threat. About 50% of the species are already widespread around the world, 10% occur on both sides of the North Pacific, 30% are Asian species that have already spread to other areas, and only 10% are species still limited to Asia. Of the 50 species, 19 are already in Oregon, but we are still concerned about the 31 that are not yet here. Among these are five marine algal species that are on the Global and Mediterranean Invasive Species Lists and known to be highly invasive: Undaria pinnatifida, Codium fragile subsp. fragile, Grateloupia turuturu, Polysiphonia morrowii, and Antithamnion nipponicum. The risk of invasion from these species and others on the debris seems to be very high. However, the rapid clean-up and removal of debris items from the beaches by Oregon and Washington state agencies has reduced the risk considerably.

- **A vouchered checklist of Oregon’s seaweeds and their local and worldwide distributions.** As a long-term project, Gayle continues to update her database and checklist of vouchered Oregon seaweeds by adding to the list her own new collections and also the collections of Oregon seaweeds at other institutions. This past year, she finalized the voucher specimens of seaweeds gathered during her studies of Oregon’s marine reserves, adding 30 new species distribution records to the known species for Oregon. Her tsunami debris algal vouchers (about 60 algal species) have also been processed for deposit in the main OSU herbarium. This coming year, she hopes to assist students in scanning the OSU algal collections as well as her own donated specimens for posting on the Internet as a part of the NSF-funded Macroalgal Digitization Project.

**Outreach:** This past year, Gayle did a variety of outreach projects on subjects that she was researching. She gave seminars on the “Algae of Japanese Tsunami Debris” and a talk at the annual Pacific Estuarine Research Society meeting on “Extractive Surveys of the Subtidal Seaweeds and Seagrasses of Three Oregon Marine Reserves.” As outreach for these talks, she prepared picture posters entitled: “Some marine algae on Japanese tsunami debris” and “Some common subtidal seaweeds in Oregon’s marine reserves.” The posters were presented at the HMSC open house and the PERS meeting and were provided to interested state agencies and state legislators. At bookstores along the Oregon coast, Gayle continued to sell her poster entitled “Oregon Seaweeds, A Sampler.” This poster shows 40 of the most common native seaweed species from Oregon and was prepared as a useful tool for students and naturalists beginning to learn the seaweed flora. In addition, Gayle led several seaweed walks in the intertidal area at Seal Rock for the general public where she identified and described the algal species and their economic uses. This year she will be joined by a local wild crafter who will add to the discussion by describing his best algal food and beauty lotion recipes.
Antithamnion nipponicum – invasive alga on debris

Codium fragile subsp. fragile – invasive alga on debris

Undaria pinnatifida – invasive alga on debris.

Callophyllis flabellulata – the most widespread alga in our subtidal marine reserves

Neodilsea yendoana – Japanese alga on debris, non-invasive

Leptofauchea rhodymenioides – a red alga on debris, non-invasive
College of Education

Dr. Shawn Rowe, Free-Choice Learning Lead, Oregon Sea Grant; Associate Professor, Science Education, College of Education

Dr. Rowe continued to oversee research and evaluation work by students from programs in science and math education, environmental sciences and marine resource management involving HMSC and Oregon Coast Aquarium visitors. Between July 2013 and June 2014, Rowe and/or students presented research findings from their work at HMSC at the North American Association for Environmental Education, The National Interpretive Association annual conference, the 13th International Public Communication of Science and Technology Conference, the National Marine Educators Association, as well as a half-dozen regional and international conferences of educators and education researchers.

Research efforts: Research continued using the Visitor Center as a laboratory for both exploratory and experimental research. Research in the 2013-2014 academic year was funded by the National Science Foundation, the Oregon Department of Education, and student scholarships from the Holt Marine Education Award and the Mamie Markham Award. Holt award recipient Susan O’Brien began her work exploring the connections between visits to intertidal zones and aquarium touch pools and conservation ideas. Doctoral student Michelle Mileham began work exploring the environmental identities of volunteers and staff working at aquariums. Other students completed projects on developing multi-player games for teaching science concepts (Harrison Baker) or social science concepts (Jenny East), and the learning outcomes from participation in citizen science activities (Barbara Woolven).

Publications:


College of Earth, Ocean, and Atmospheric Sciences

Benthic Ecology and Biogeochemistry
Dr. George Waldbusser

Dr. George Waldbusser’s research group conducts experimental and field work on ocean acidification effects on marine bivalves and interactions between sediment biogeochemistry and benthic organisms.


Conference and academic presentations:


Figure 1. Scanning Electron Microscope images of Pacific oyster larvae at 10, 14, and 16 hours post fertilization showing the rapid calcification of the initial shell. Imaging work was conducted at the EM Facility in the Linus Pauling Center, OSU Main Campus. From Waldbusser et al. in review.

Entering the fourth year of a National Science Foundation-funded project examining the mechanisms of ocean
Acidification effects on bivalve larvae, the project team led by Dr. Waldbusser (with Co-PIs of Drs. Hales, Langdon, and Haley) is making some great progress. The project team has now completed several short-term experiments on several species of bivalve larvae, including native and non-native species of mussels and oysters. Several aspects of this work are in review or preparation for publication, and in short have confirmed our previous work examining the ontology of stable isotopes in larvae, that saturation state is the key variable of importance to bivalve larvae due to their rapid rate of shell formation (Figure 1).

These findings represent a fundamental shift in our understanding of physiological responses of organisms to ocean acidification, as it was previously believed that the physiology was only affected by pH. The diligent work of the team has also shown with our experimental system that pH still plays a role in physiology, just acting on different processes, such as respiration, and those pH thresholds appear to be much lower than the saturation state thresholds we found for shell development and growth. These results help explain the enhanced sensitivity of bivalve larvae to ocean acidification found in Oregon’s coastal waters, for example the oyster seed crisis noted in the Pacific Northwest. The project team has also installed a high-time resolution PCO$_2$/TOC$_2$ instrument at HMSC to run a long-term experimental system in which we can explore the significance of these different components of the carbonate system on larvae throughout their entire larval period. The project team hopes to make these facilities available to other HMSC and outside researchers and would like to bring the instrument online for real-time measures of the chemistry in the HMSC seawater system. Over the past year, several people have contributed to this multi-disciplinary project including graduate students (Elizabeth Brunner, Rebecca Mabardy, Iria Gimenez, Matthew Grey, Steven Pacella, Stephanie Smith), undergraduates (Kevin Kovalchick, Cale Miller), and technicians (Greg Hutchinson), without whom the project would not have been possible. Their hard work and dedication to this project is greatly appreciated.

In conjunction with an Oregon Sea Grant funded project (Co-PIs Langdon and Hales) to develop an ocean acidification stress model of Pacific oyster larvae, graduate students Iria Gimenez and Rebecca Mabardy designed and carried out several experiments to determine how rapid changes in CO$_2$ may result in stress on the larvae. The experiments were informative, but generally inconclusive, and Ms. Gimenez is now setting up experiments in the Whisley Creek Shellfish Hatchery in Netarts, OR to provide the final data needed to validate the stress model. In addition Ms. Mabardy, while in residence at HMSC, carried out a US West Coast shellfish industry survey exploring the perception, understanding, and needs of shellfish growers in relation to ocean acidification.

Waldbusser’s team has begun working on measuring the biogeochemistry and feedbacks of shell aggregations under ocean acidification. Ms. Gimenez was awarded a Robert E. Malouf fellowship to conduct this work at HMSC in a hydrodynamic flume that will be retro-fitted for doing CO$_2$ manipulations. As part of her dissertation work, she will be determining what controls whether shells in oyster reefs are recycled (dissolved) back to the water column or buried. Some preliminary work has been completed on an assembled oyster reef earlier this year to assess the suitability of the flume and measurement capabilities.

Cale Miller and Iria Gimenez led the charge at the HMSC Marine Science Day demonstrating the importance of alkalinity and why ocean acidification is a global problem to be concerned about. Using pH indicator dyes (Figure 2) Dr. Waldbusser oversaw the demonstrations of how quickly pH changes in response to breath in different alkalinity waters. Eager participants in the chemistry demonstration donned lab coats and safety goggles. Dr. Waldbusser conducted the same demonstration at two public events in early 2014 in conjunction with The Ocean Conservancy, The Fort George Brewery’s Science Pub in Astoria, OR, and at McMenamins Mission Theater for Portland’s Nerd Nite.

Lab Group Publications (2013-2014)
Brunner, EL. 2013. Insights from Stable Isotope Dynamics into the Sensitivity of Larval Pacific Oysters to Ocean Acidification. M.S. Thesis, Oregon State University, supervisor, Waldbusser, GG.


Waldbusser, GG and JE Salisbury. 2014. Ocean Acidification in the Coastal Zone from an Organism’s Perspective: Multiple System Parameters, Frequency Domains, and Habitats. Annual Reviews in Marine Science 6: 221-247

Waldbusser, GG, B Hales, CJ Langdon, BA Haley, P Schrader, EL Brunner, MW Gray, CA Miller, I Gimenez. In review. Ocean Acidification: Saturation State Matters Most First

Marine Geochemistry
Dr. Clare Reimers (Professor, CEOAS)

Scientific research in Clare Reimers’ HMSC laboratory is focused on the role of seafloor processes in ocean chemical cycles, the biogeochemical influences of hypoxia and anoxia, and developing new electrochemical tools for ocean observing networks.

During 2013-2014, the Reimers lab completed a NSF-supported project to determine the contributions of individual biogeochemical processes driving oxygen utilization, and carbon oxidation within the benthic boundary layer of the Oregon shelf environment. Of special concern are the influences of varying conditions of bottom water O₂, and turbulence stemming from surface and internal waves, and upwelling/relaxation cycles. A research cruise in July 2013 on the R/V Oceanus completed a series of four cruises designed to gather both spatial and temporal data. Instrumentation designed to measure benthic oxygen and heat fluxes by a technique called eddy correlation was also placed on VENUS, a cabled ocean observatory located in the Salish Sea, coastal waters of British Columbia, Canada. This instrumentation successfully provided real-time data for nearly 9 months, and the deployment was made possible by collaboration with investigators at the University of Victoria and Ocean Networks Canada. Faculty Research Assistant, Rhea Sanders, coordinated the project logistics and data archiving.

The second major Reimers lab project, funded by the Office of Naval Research, continues the development and evaluation of revolutionary microbial fuel cells designed as self-refueling power sources for fixed seafloor sensors (benthic microbial fuel cells BMFCs). These systems harvest power from seafloor chemical gradients, and have been combined with acoustic modems to create autonomous nodes able to transmit sensor data to ocean observatories or to surface vessels. Research Associate, Paul Schrader, is currently working on approaches to add exogenous supplements to natural sediments to enhance BMFC performance.

In 2013 Dr. Reimers became the Project Scientist of the Regional Class Research Vessel Project (http://ceos.oregonstate.edu/ship/rcrv/), an effort that will finalize the design and coordinate the construction of as many as three new coastal research vessels to bolster the marine science research capabilities of the United States. NSF selected Oregon State University (OSU) as the Lead Institution, and funds were awarded with Reimers serving as the Principal Investigator for work through Phase IA-Project Refresh to Conceptual Design Review (CDR) ($2.73M). Following successful completion of CDR in December, 2013, NSF awarded additional funds to support the project to Preliminary Design Review in August 2014, Phase IB ($1.75M).

Science support capabilities for the new class of Regional vessels include:

1. Enhanced station keeping (Dynamic Positioning) for placement and servicing of benthic instrumentation and sample collection.
2. Integrated shallow water acoustic multibeam bottom mapping and sub-bottom profiling systems.
3. Significantly larger aft deck for operational flexibility: (2) 20' laboratory vans may mate to the ship’s house, plus adequate remaining deck space for multidisciplinary operations.
4. State-of-the-art handling systems (frames and winches) to improve efficiency and safety when deploying a wide array of science packages in various sea states.
5. Full-time, high speed satellite connectivity for communications, internet access and data transfer.
7. Low Underwater Radiated Noise (URN) signature for fisheries, acoustics, and marine mammal research and improved habitability.
8. Compliance with latest Academic Fleet standards relating to the Americans with Disabilities Act (ADA) to improve access to the sea.
9. Incorporation of commercially available, practicable and economically viable "Green Ship" technologies.
The project team is working to finalize the design for the 193-foot long, technically enhanced Regional Class ships, and developing a project execution plan to select a shipyard, oversee construction, and coordinate the system integration, testing, commissioning and acceptance, and transition to operations. The total grant is projected to reach $330 million over 10 years if three vessels are built. As part of the project plan, OSU will become the operator of the first vessel and retire the R/V Oceanus, about the time the new research vessels become available.

College of Science

Department of Zoology
Benthic Ecology
Sarah K. Henkel, Assistant Professor Senior Research

Program Objective: The Benthic Ecology Lab at HMSC characterizes invertebrate and fish communities found in and on sedimentary and rocky substrates in order to understand habitat associations and species interactions in the face of broad-scale oceanic change as well as local human activities. Another significant component of Sarah Henkel’s work is public, stakeholder, and political outreach and education on potential ecological impacts of wave energy development in Oregon.

Current Research Projects:
- Characterization and Monitoring of Benthic Conditions at Ocean Test Facility Sites for wave energy: This project describes substrate characteristics of the areas designated for testing wave energy devices as well as characterizes seasonal and interannual dynamics of benthic invertebrates and fish. Sampling using a box core and beam trawl has been conducted seasonally since 2010 at the northern site (NETS); sampling followed installation of the facility in 2012 and continues to be conducted to provide context for future testing events. Box core sampling began at the southern site (SETS) in August 2013 and will be conducted through at least October 2014. (Funded by the U.S. Department of Energy)
- Seasonal Patterns in Distribution, Condition, and Feeding Ecology of Juvenile Flatfish: This project follows seasonal and interannual patterns of distributions and abundances of juvenile flatfish in the nearshore. Additionally, their condition and gut contents are examined and gut contents are analyzed using the bomb calorimeter to determine the nutritional quality of commonly consumed prey species.
- Evaluation of Recovery of Ecosystem Structure and Functions within the MOC-P Mitigation Basin, Newport, Oregon: The goal of this project is to evaluate eelgrass recovery along with organism utilization of a replanted eelgrass bed and compare findings to seasonal dynamics at reference beds to determine the ecological success of the replant project.
- Survey of Benthic Communities Offshore the Pacific Northwest: This project focused on describing benthic invertebrates found in both soft and hard substrate habitats on the Outer Continental Shelf. The goal is to establish species-habitat relationships to predict invertebrate communities that may be found in areas targeted for future renewable energy development. Survey methods consisted of high-resolution mapping (conducted by C. Goldfinger – CEOAS) followed by box coring (in soft sediment) and ROV surveys (in rocky areas). The final report for this project will be submitted August 2014. (Funded by BOEM)
- Ocean Bioaccumulation Study: This project analyzed nearshore benthic species for concentrations of heavy metals and organic pollutants that might be attributed to the Georgia Pacific (G-P) outfall pipe adjacent to Nye Beach, OR. Target animals were flatfish (speckled sanddab), Dungeness crab, Crangon shrimp, weathervane scallops, Mytilus mussels, & olive snails. Animals were collected from stations around the outfall pipe (mixing zone stations) as well as stations north of Yaquina Head and south of Yaquina Bay. Organisms were processed for trace metals, PCBs & congeners, phenolics, and PBDEs. Overall, there was little evidence for bioaccumulation of contaminants of concern. Specifically, there was no indication of elevated levels of PCBs, phenolic compounds, or PBDEs in the organisms tested. The final results of this project were presented to City Council May 19, 2014 (Funded by the City of Newport).

Teaching:
- BI 450 – Marine Biology Spring Term: Sarah taught the Marine Conservation and Policy week and served as the lead instructor for the 2-week projects section at the end of the term, supervising 11 projects conducted by 1-3 students each.

Mentees:
- Stephanie Fields: M.S. Marine Resource Management Program. Thesis: Evaluating survey methods to assess benthic macrofaunal responses to dredged material disposal near the mouth of the Columbia River
- Caitlyn Clark: NSF REU (2011) and University Honors College Student (2011-4). Project: Seasonal patterns in condition and feeding ecology of juvenile flatfish
**Marine Ecology**

**Bruce Menge, Distinguished Professor; Sally Hacker, Professor; Mark Novak, Assistant Professor; Francis Chan, Associate Professor, Senior Research.**

**Mission and objectives:** Three of the Corvallis-based labs in the Department of Integrative Biology maintain research activities at HMSC, those of Bruce Menge and Francis Chan, Sally Hacker, and Mark Novak. The research focuses on the dynamics of coastal ecosystems, including marine inner shelf, rocky intertidal, estuarine and sand dune habitats, and species interactions in coastal communities. The research is funded by several sources including private funds from the David and Lucile Packard and the Gordon and Betty Moore Foundations in support of the PISCO project, with Bruce Menge, Jack Barth, and Francis Chan as co-PIs (and Jane Lubchenco as a former co-PI) and Sally Hacker as a Senior Research Associate. Other funding comes from grants from Sea Grant, EPA, NOAA, NSF, and OSU.

**Research projects have several goals:** PISCO is focused on benthic-pelagic coupling in the inner shelf region of the west coast of North America, with the goal of determining the nature, magnitude and consequences of links between oceanographic conditions and processes in the inner shelf region (i.e., 0 to 20 km offshore) and coastal ecological systems in the rocky intertidal and shallow benthos. Using ship-based sampling, moorings, ROV surveys, and direct studies on rocky shores, we study the influence of nutrients, phytoplankton blooms, temperature, oxygen, and waves on patterns of abundance, growth and interactions in intertidal and subtidal ecosystems along the coast. Understanding the impacts of climate change on these ecosystems using long-term datasets developed by PISCO is a primary goal.

Menge, Hacker, and Chan recently completed an NSF-funded project investigating the influence of ocean acidification on coralline algae, specifically common and abundant turf-forming species including *Bossiella plumosa*, *Corallina vancouveriensis*, and *C. officinalis*. The goal was to determine the susceptibility of coralline algae to increasing acidification resulting from increasing CO$_2$ in the atmosphere. The importance of this question is that turf-forming coralline algae facilitate recruitment by habitat-forming intertidal kelps, implying that if abundance of the coralline is reduced or it is eliminated, rocky shores would lose a primary component of low intertidal regions, kelp, and potentially much of the biota associated with it. Research included field observations and experiments, and lab experiments carried out at HMSC in a newly fabricated ocean acidification mesocosm.

The Novak Lab continues its use of one of HMSC’s temperature control rooms for experiments investigating the feeding behavior of Oregon’s native whelks. These predatory snails feed on a variety of different mussels, barnacles, limpets and other snails, and have long been an important set of species with which to study predator-prey interactions. The lab is using video-cameras to record prey preferences and determine how long it takes an individual whelk to feed on each type of prey species (this can take hours to days, depending on the predator and the prey’s size, and the water temperature). These experiments therefore play a key role in determining how predators go about choosing which prey to consume, and how fast they do so, and thereby inform our theory of the processes that stabilize nature’s species rich and complex food webs.

**Activities:** In addition to the ocean acidification mesocosm mentioned above, all of the projects listed above use HMSC laboratory sea water space to stage field work, using space in April-June each year, and to carry out additional experiments in other parts of the year. A post-doctoral fellow, Dr. Annaliese Hettinger, oversees the ocean acidification experiments at HMSC, which also involve graduate students including Elizabeth Cerny-Chipman, Allison Barner, and Chenchen Shen. A Hacker graduate student, Reuben Biel, is conducting beach grass experiments involving mesocosms setup on the HMSC property. The goal of the experiments is to understand how beach grasses respond to elevated temperatures due to climate change. Other personnel involved besides the PIs, postdocs, and students include Angela Johnson, Shawn Gerrity, and Jonathan Robinson. HMSC is also used periodically throughout the year as the base for field studies along the Oregon coast, and the PISCO studies of hypoxia and coastal inner shelf oceanography use the R/V *Elakha* and the R/V *Kalipi*. In addition, Hacker’s studies of eelgrass and mud shrimp species interactions on mudflats adjacent to HMSC, and her studies of dune ecosystems are also based out of the Science Center.

Kyle Coblenz (Ph.D. student, NSF Graduate Fellow, and Mamie Markham Graduate Fellowship) and Isaac...
Shephard (Honors student) of the Novak Lab have been running the experiments in the temperature control room.

**Graduate Students, Postdocs and Research Faculty:**

Francis Chan (PISCO, Associate Professor, Senior Research): focuses on coastal biogeochemistry, ocean acidification and hypoxia. This work is based on cruises on the R/V Elakha and moorings along the coast deployed from the R/V Elakha. See [http://www.piscoweb.org/outreach/topics/hypoxia](http://www.piscoweb.org/outreach/topics/hypoxia).

Annaliese Hettinger (NSF Postdoctoral Scholar): Carried out studies of effects of ocean acidification and other environmental stresses on the eco-physiology of macrophytes.

Jeremy Rose (Menge Graduate Student, supported by an NSF Predoctoral Fellowship and teaching and research assistantships): Jeremy investigated the impact of ocean acidification on intertidal marine invertebrates that form calcified hard parts. He used the HMSC as a staging ground for field studies and for laboratory experiments.

Reuben Biel (Hacker Graduate Student, supported by EPA STAR Fellowship and a Mamie Markham Graduate Fellowship): Reuben studies beach grass systems, focusing on the effects of climate on dune geomorphology and coastal protection. His activities at HMSC include mesocosm experiments studying the effect of temperature on beach grass growth.

Allison Barner (Menge and Hacker Graduate Student, supported by EPA STAR Fellowship and a Mamie Markham Graduate Fellowship): Allie focused on two projects, one investigating the impact of OA on turf-forming coralline algae, and a second on the interactions between turf-forming coralline algae, fleshy turf-forming algae, and intertidal kelp. The OA study utilizes the mesocosm facility at HMSC which permits intensive, mechanistic experiments to be conducted to test the phylogenetic, ecological, and physiological determinants of coralline algae to increases in ocean acidity.

Chenchen Shen (Menge Graduate Student), supported by teaching and research assistantships, and a Mamie Markham Graduate Fellowship: Chenchen investigated how the interaction between molluscan grazers and coralline algae might be influenced by ocean acidification. Predictions of possible effects are complicated by the fact that both corallines and molluscan grazers are calcifiers, so the impacts of acidification must be investigated on both components separately and when they are interacting. This work is being conducted at the OA mesocosm facility at HMSC.

Elizabeth Cerny-Chipman (Menge Graduate Student, supported by teaching and research assistantships and a Mamie Markham Graduate Fellowship: Elizabeth studies how climate change, including ocean acidification, might alter the interaction between whelks and mussels. The organisms are both calcifiers, so face challenges from ocean acidification, but are also sensitive to thermal stress, which is also changing. This work is being conducted at the OA mesocosm facility at HMSC.

Jessica Reimer (Menge and Hacker Graduate Student, supported by teaching assistantship): Jessie investigated the inputs of kelp and other ocean-derived subsidies to sandy beaches, and the relationship between these inputs and the source populations such as rocky shores and estuaries.

Kyle Coblenz (Mamie Markham Graduate Fellowship, Novak Lab): Kyle is using the temperature control rooms to quantify the relationship between prey preference and feeding efficiency of intertidal whelks.

Isaac Shephard (Honors Student, Novak Lab): Isaac is completing his honors project testing the congruence between two methods for estimating the strength of species interactions between whelks and their prey, comparing an observational method (developed by the lab) to inferences based on stable isotope ratios.

**College of Veterinary Medicine**

**Department of Biomedical Sciences**

**Dr. Timothy Miller-Morgan, DVM, Lead, Aquatic Animal Health Program/Extension Veterinarian – Aquatic Species, Oregon Sea Grant Extension; Assistant Professor, Department of Biomedical Sciences and Aquatic Animal Disease Diagnostician, Veterinary Diagnostic Laboratory, College of Veterinary Medicine**

Dr. Miller-Morgan represents the College of Veterinary Medicine’s Department of Biomedical Sciences at the Hatfield Marine Science Center. He also serves as an aquatic animal health/disease professional within the Veterinary Diagnostic Laboratory. His primary duties are to provide clinical services — generally in the area of population health — to ornamental fish retailers, wholesalers, importers, and producers.

He is the first College of Veterinary Medicine faculty to be permanently based at the HMSC. Miller-Morgan is currently
working with Jerry Heidel, Director, Veterinary Diagnostic Laboratory; Luiz Bermudez, Chair, BMS; and Jan Spitz bergen; to develop an aquatic medicine program within the veterinary college.

Miller-Morgan teaches and lectures in a number of courses within the College of Veterinary Medicine, including a lecture in VMB 753, *Veterinary Virology – Introduction to viral diseases of ornamental fish*, a section of VMB 728, *Special Species Medicine*, a course offered to junior veterinary students in which he introduces students to the practice of pet fish medicine as a component of a traditional veterinary practice. He teaches VMB 727, *Ornamental Fish Medicine*, a 40-hour course that teaches senior veterinary students the basic skills they need to begin practicing fish medicine.

Dr. Miller-Morgan was a founding member and executive board member of the new professional veterinary organization the American Association of Fish Veterinarians. The organization was founded to provide a forum for fish veterinarians in North America to connect with colleagues, exchange information and receive continuing education. Furthermore, the organization is partnering with the American Board of Veterinary Practitioners to develop a board specialty in fish medicine. Dr. Miller-Morgan is also a founding member and past executive board member of the World Aquatic Veterinary Medical Association (WAVMA). He currently serves as a member of the international credentialing committee. In this capacity he has been involved in developing international standards for credentialing veterinarians with a core skill set in aquatic animal medicine. In 2013 WAVMA implemented the Certified Aquatic Veterinarian credential. This program certifies veterinarians that have demonstrated basic clinical skills with aquatic animals equivalent to the level expected of graduate veterinarians with traditional terrestrial species.

Miller-Morgan and Heidel are also involved in NOAA-funded collaboration with Washington State University – Vancouver to study optimal collection techniques for yellow tangs collected in the Hawaiian Islands and destined for the ornamental fish trade. Through a partnership with Hawaiian ornamental fishers and exporters multiple collection techniques were evaluated and characterized. This work has dovetailed well with our previous work in this area regarding optimal marine ornamental fish collection and transport. We have developed a one-hour seminar for the industry outlining our key findings and industry recommendations. This seminar has been presented at multiple venues within the US and also in India, Indonesia and Norway.

Dr. Miller-Morgan continues to participate as a Co-PI on a project to investigate Koi Herpes Virus (KHV) Latency. With this project funded by Project KHV of the Associated Koi Clubs of America we hope to characterize the latency state and location of KHV-infected koi. Through this project we refined the diagnostic testing that would allow us to identify clinically healthy fish that are virus carriers, an outcome that helps to significantly reduce risks to koi importers in the United States. Two manuscripts have been published based upon the current findings of this project.

In 2013 Dr. Miller-Morgan began working with Project Piaba; a project based in Manaus, Brazil that aims to facilitate and improve the sustainable ornamental fishery on the Rio Negro. Miller-Morgan’s primary role is to improve and assess the overall fish health management throughout the chain of custody from collection to export, suggest improvements, and develop a train-the-trainer program for individuals identified by the local industry that will become educational resources for the fishers, middlemen and exporters and serve as key contacts with international trade and educational organizations.

Dr. Miller-Morgan continues to work with the University of Hawaii – Aquaculture Program to expand an online training program in aquaculture and aquaponics. This unique and global program, Aquaculture Training Online Learning (ATOLL), is designed to help train entry-level fish farm workers and individuals interested in developing backyard aquaponics systems. Dr. Miller-Morgan developed 4 modules and co-developed three other modules with Dr. Allen Riggs, aquaculture veterinarian for the State of Hawaii. Currently more than 200 students have participated in this course hailing from the U.S., Morocco, Mexico, Brazil, Palau, Costa Rica, Malaysia, Finland, Singapore, Bahamas, Portugal, Chile, Belgium, Zimbabwe, Vietnam, Ecuador, and Russia.

The work to develop best health practices and biosecurity standards in the ornamental pond fish sector of the industry has resulted in several invitations for Dr. Miller-Morgan to speak nationally and internationally at industry meetings about the implementation of such programs. He recently traveled to India, Japan, Indonesia, Singapore, Norway and Brazil to speak to members of the ornamental fish industry, lead workshops and assess biosecurity techniques. The most recent visit to Singapore resulted in the request to become involved in Project Piaba in Brazil. A previous visit to Israel has resulted in collaboration with a large Koi and goldfish producer that has resulted in the development of a paid internship opportunity for OSU undergraduate students with an interest in fish culture and biosecurity. We are currently exploring collaborative opportunities for OSU and Aquarium Science students with the Sentosa Aquarium in Singapore, the Osaka Aquarium in Japan and Hazorea Aquatics in Israel.
B. Federal and State Agencies
Environmental Protection Agency (EPA)

Pacific Coastal Ecology Branch, Western Ecology Division

Office of Research and Development – National Health and Environmental Effects Laboratory
Walt Nelson, Branch Chief

The Newport EPA research laboratory at HMSC is formally the Pacific Coastal Ecology Branch (PCEB), one of three Branches of the Western Ecology Division which is headquartered in Corvallis, Oregon. The mission of PCEB is to provide research support to EPA Program Offices, such as the Office of Water, and to the Regional Offices, such as EPA Region 10 with headquarters in Seattle, WA. The research mission of PCEB is to develop procedures to assess the cumulative and interactive effects of a wide range of human activities on the ecological resources of estuaries of the Pacific Northwest.

The broad research focus for the Pacific Coastal Ecology Branch is to define ecological processes and to develop and evaluate models to predict stress-response relationships for Pacific Northwest estuaries at a range of spatial and temporal scales. PCEB contributes to three of the EPA national strategic research programs. Research is conducted under the Safe and Healthy Communities (SHC), the Safe and Sustainable Waters (SSWR), and Air, Climate and Energy (ACE) Research Plans.

The goal of SHC research is to develop the tools and approaches for estimating the effects of habitat alteration on important ecosystem services associated with tidal wetlands of the Pacific Northwest. One reason that many ecosystems are in decline is that ecosystem services are not clearly recognized as having value to people. As a consequence, the value of ecosystem services may not be adequately considered in management and policy decisions. However, ecosystems are being increasingly recognized as providing significant economic, social, and environmental benefits (e.g. biodiversity, recreation, nursery habitat) to society. Human activities within an estuary (shipping, recreation, aquaculture), or within the lands surrounding the estuary (urbanization, agriculture, logging), may alter estuarine habitats either directly (shoreline alteration, channelization, landfill) or indirectly through such problems as excessive nutrients or introduction of invasive, non-native species. Global climate change may also bring many changes to coastal systems. The alteration of tidal wetland habitats by human actions will also alter the sum of the ecosystem services provided by these systems. Research has been focused on highly valued services such as healthy fish, shellfish, and wildlife populations, and will evaluate the likely changes in terms of these and other ecosystems services resulting from impacts of current and future alterations of tidal wetland habitats. The research is designed to serve as a proof of concept for an ecosystem services approach to improving EPA decision-making by enhancing the ability to identify, quantify and value the ecological benefits of EPA policies with respect to tidal wetlands. The primary products of the research will be generally applicable GIS-based tools capable of estimating the ecosystem services provided by different combinations of habitat types, habitat conditions, and habitat areal coverage in Pacific Northwest estuaries at scales from a single system to the entire Pacific coast.

PCEB research under ACE is focused on evaluating the effects of climate change on estuarine ecosystems. Estuarine species and ecosystems are threatened by global change through increases in temperature, sea level rise, ocean acidification, changes in surface flow from altered precipitation, and altered land use in coastal watersheds. To assess the vulnerability of near-coastal species, an approach is being developed that predicts species’ overall vulnerability to climate change and vulnerability to specific climate stressors based on their biogeographic distributions and natural history attributes. This approach is being applied to multiple invertebrate and fish groups from Baja California through the Beaufort Sea, with the goal to develop a public website both as a decision support tool and for public outreach. A beta version of the Coastal Biogeographic Risk Analysis Tool (CBRAT) was developed in the past year. CBRAT development is a cooperative effort with the USGS, and is being coordinated with other research efforts evaluating the direct effects of sea level rise and resulting changes in salinity and other water quality parameters on estuarine wetlands in the Pacific Northwest.

PCEB research under SSWR is focused on the problem of human activities that have resulted in increased nutrient loading to many of the nation’s surface waters, causing widespread impairment of beneficial human and aquatic life uses. A key priority of the EPA is the development of numeric nutrient criteria for all of the nation’s surface waters. In response to this need, PCEB is developing approaches to aid in the development of numeric nutrient criteria for estuaries, and in development of tools to assess compliance to these protective standards. Research under this task includes developing methods to distinguish “natural” ecological conditions from anthropogenic impacts and development of load-response relationships between nutrients and multiple estuarine biotic endpoints. In addition, the research will
develop tools to examine the interactions between nutrient enrichment and other factors, such as climate change, that may modulate the impact of nutrients on aquatic ecosystems. The application of decision support tools will allow regulators to evaluate the impact of nutrient management scenarios on estuarine water quality and sustainability of estuarine resources.

EPA research staff at HMSC consists of 17 federal employees (including five EPA interns) and 17 technical, facility, and clerical contract support staff. Scientists from the U.S. Geological Survey and the U.S. Dept. of Agriculture, Agricultural Research Service are co-located with EPA scientists. Dr. Gayle Hansen, a marine algologist, is located with PCEB through a guest worker agreement with OSU. Scientists from the Shellfish Program of Oregon Dept. of Fish and Wildlife utilize laboratory space at PCEB. PCEB interacts with the HMSC and wider university community both in research and educational programs. A number of PCEB staff scientists hold courtesy faculty appointments with OSU academic departments, and participate in teaching and serve on graduate student committees.

**National Oceanic and Atmospheric Administration (NOAA)**

**National Marine Fisheries Science**

**Alaska Fisheries Science Center**

**Fisheries Behavioral Ecology Program**

Clifford H. Ryer, Program Manager

Alaska Fisheries Science Center’s Fisheries Behavioral Ecology Program (FBEP) is based in Newport because of the world-class experimental seawater laboratories on the campus of the Hatfield Marine Science Center. The nine members of FBEP staff, and their university collaborators, conduct laboratory research in Newport and field studies in Alaska aimed at understanding the roles that behavior, physiology and ecology play in regulating distribution, abundance, growth and survival of fish species, and their interactions with fishing methods and fishing gear. The overarching goal of the Program is to provide the critical information needed to improve survey techniques, to improve predictions of recruitment, forecast potential effects of climate change and to conserve populations of economically significant marine resource species along with their habitats. Research in the Program during the last year was concentrated in four primary areas, with funding from NOAA initiatives on Habitat, Arctic Research, and Ocean Acidification, and with grants from the North Pacific Research Board.

**Larval fish biology and recruitment:** Larval ecology and recruitment processes continue to be an area of focus for the Program. Over the past several years, the Program has developed the necessary protocols to hold broodstock, collect eggs and rear the larvae of important Alaska fish species including walleye pollock, pacific cod and northern rock sole. As part of the program’s Arctic initiative, arctic cod have recently been added to this assemblage of broodstock species. These species represent a diverse set of life histories and have allowed FBEP scientists to conduct experiments examining how temperature, food availability, prey quality, climate change and ocean acidification impact growth and survival in the first 3 months of life. Experiments are designed under a multi-factorial framework, focusing on critical periods in development (egg, yolk-sac larvae, metamorphosis and settlement) in an effort to understand how behavior, physiology and the environment interact. Currently, FBEP scientists are focusing upon the settlement behavior of northern rock sole, using laboratory experiments to elucidate behavioral shifts in the lab that explain patterns of settlement seen in Kodiak nursery embayments. Continued research in this area will include the development of tools to quantify fish condition (i.e., behavioral and biochemical indices) and integrate age-0 survey data to link these early life history processes with recruitment.

**Fish nursery grounds and predation processes:** Nurseries are geographic areas and/or specific juvenile habitats which disproportionately contribute recruits to adult populations. Often such nurseries are characterized by rapid growth and low juvenile mortality rates. Many species of fish and crab in the Gulf of Alaska, Bering Sea and Arctic Ocean utilize shallow water nursery grounds, which lend themselves to the study of basic ecological, behavioral and trophic interactions between juveniles and their predators. The ultimate goal is to understand and conserve important nursery habitats, to reduce impacts of fishing practices, and to forecast the future health of commercially important resource species in Alaskan waters. Habitat studies are partnered with researchers from Oregon State University, the University of Alaska and NOAA laboratories in Kodiak and Juneau. Current species of interest, with respect to juvenile habitat studies, include northern rock sole, arctic cod, pacific cod, pacific halibut, tanner crab and snow crab. This line of research is particularly germane in the context of our Arctic research program. Arctic ecosystems are already experiencing dramatic changes which effect nursery habitats for keystone Arctic species such as Arctic cod and snow crab. One of the most pervasive effects of accelerating climate change is loss of sea ice and rising summertime water temperatures. The FBEP program is actively researching the potential effects of these changes on the growth and survival of juvenile fish and crabs.
Responses of fishes to ocean acidification: FBEP continues to investigate the impacts of ocean acidification on Alaskan commercial fishery species. It is thought that early life-history stages of fish will likely be more susceptible to possible deleterious effects of decreasing pH. As a consequence research focuses upon egg, larval and juvenile stages of commercially important Alaskan species. On the bright side, the species examined so far are relatively resistant to impacts of ocean acidification, in terms of survival and growth. However, preliminary experiments indicate that the ability of larval and juvenile fish to detect and respond to natural prey may be somewhat impaired by acidification. These behavioral effects of acidification are a growing area of research.

Bycatch Mortality: FBEP continues to investigate the mechanisms that control mortality in fish and crab species when they are discarded from fishing operations involving trawl, longline, and pot gear. Indices of animal condition based upon reflex actions have been developed over the last several years to predict capture-related delayed mortality in pacific cod, pacific halibut, sablefish, snow crabs, Tanner crabs and pacific spot prawns. Importantly, the FBE program is partnered with OSU researchers to examine bycatch mortality in both sub-legal and legal Dungeness crab, which constitutes an extremely important fishery in California, Oregon, Washington as well as Alaskan waters.

Northwest Fisheries Science Center

NOAA Fisheries’ Northwest Fisheries Science Center (NWFSC) has its headquarters in Seattle, and five research stations in Washington and Oregon. The NWFSC’s Newport Research Station is located on Oregon State University’s Hatfield Marine Science Center campus and conducts critical research on groundfish and salmon, and the ecosystems in which they live.

Operations, Management, and Information Division (OMI)

Captain Rick Brown, NOAA (ret.), Resource Management Specialist; Patty George, Administrative Support Specialist; Jim H. Miller, IT Specialist; C. Barry Semple, IT Specialist

NWFSC’s OMI Division provides facilities management and science mission infrastructure support for the NOAA presence at HMSC consisting of the Captain R. Barry Fisher building (BFB), Newport Aquaculture Lab (NAL), Research Support Facility (RSF) and numerous smaller buildings on the site.

During this reporting period (2013/2014), major maintenance projects included the installation of new gutters and new gaskets on the windows of the Newport Aquaculture laboratory. New hardware and replacement support beams to replace rotted wood were installed on the Pole Barn in the Research Support Facility courtyards. New HSPD11 compliant locks were purchased for the exterior doors of all of the NOAA buildings as well as for indoor locks that currently have cipher keys for security. HMSC Facilities and IT are continuing with the installation and troubleshooting of the new door locks.

The OMI Safety and Environmental Compliance Office in Seattle continued to provide lab safety training for staff and students, waste removal, inspections and consultations supporting environmental compliance and safety for the NOAA buildings on the HMSC campus. There were announced inspections by NOAA and NMFS SECO personnel of the NWFSC buildings this reporting period with only minimal findings due to proactive safety inspections, training and compliance that the OMI SECO promotes in the NOAA buildings at the HMSC site. NWFSC OMI staff continued to work closely with OSU to bring all personnel and foreign national visitors that work in the NOAA buildings into compliance with Federal Security identification policies under Homeland Security Presidential Directive 12 with the latest requirements from the Western Regional Security Office.

Conservation Biology Division (CB)

Dr. Peter Lawson; Dr. Laurie Weitkamp

Dr. Peter Lawson and Dr. Laurie Weitkamp represent the Conservation Biology Division (CB) in Newport. Dr. Lawson’s principal research interests focus on effects of climate and habitat change on coastal ecosystems with particular application to the population dynamics of Oregon Coast coho salmon. Recently he has also been studying ocean ecology of Chinook salmon sampled by the commercial troll fishery. Dr. Weitkamp’s primary research interests include the marine and estuarine ecology of Pacific salmon, life history variation, and conservation.

Coho Salmon Ecology: Climate conditions influence both freshwater and marine survival of coho salmon. Dr. Lawson, in collaboration with researchers at the University of Washington and NOAA Fisheries’ Alaska Fisheries Science Center, has developed statistical and simulation models of coho salmon life-history interactions with climate. These models will help improve understanding of the variability in coho population sizes and potential implications of climate change in this species. Ongoing investigations are looking at patterns in climate variability and the implication of these patterns to salmon population viability.

Dr. Weitkamp, with assistance from FE Division, Pacific States Marine Fisheries Commission (PSMFC) and OSU staff, has been leading a project to examine the estuarine
ecology of juvenile salmon in the lower Columbia River estuary. This program documents the abundance and condition (i.e., food, origins, habitat and pathogen loads, length and weight, origins and growth rates) of juvenile salmon and associated fish community in the estuary during the annual spring outmigration (mid April to late June). The condition of salmon caught by this study are being compared to studies sampling salmon both further upstream and in the ocean to document how salmon change as they make the critical transition between freshwater and marine environments and understand factors affecting their survival. Fish abundance and condition, and species composition are compared between years to determine interannual variation in the estuarine fish community and develop an index of juvenile salmon abundance.

**Salmon Harvest Management:** Dr. Lawson continues to provide technical advice to fishery management agencies through the Scientific and Statistical Committee of the Pacific Fishery Management Council (PFMC). Dr. Weitkamp and Dr. Lawson also continued to serve on the Coho Technical Committee of the Pacific Salmon Commission (PSC). As part of her PSC responsibilities, Dr. Weitkamp is leading the US effort to produce descriptions of each U.S. Management Unit with respect to management, fisheries, and hatchery and wild salmon production. A major effort for both the PFMC and the PSC has been to develop methodologies for incorporating genetic stock identification (GSI) in fisheries management. Another management-related project is exploring the relationship of a variety of environmental and climate indicators to the survival and abundance of salmon in the California Current System. Results are being used to improve stock size predictors, which are integral to the process of setting annual fishing seasons.

The Collaborative Research on Oregon Ocean Salmon project (Project CROOS) is a collaboration with fishermen, industry, OSU, Sea Grant Seafood Initiative and others. The project goal is to develop techniques for applying GSI, global positioning system, geographic information system, satellite remote sensing, and other technologies to ocean sampling of Chinook salmon. With the aid of the fishermen, scientists are able to determine exact time and location of capture for each sampled Chinook, along with stock information, oceanographic and biological data, to produce a fine-scale database of fishery catch data. This database will initially be used to improve harvest management of Klamath River and Sacramento River fall Chinook and will provide a new tool for understanding the ocean ecology of Chinook and coho salmon. The project also includes development of a web site, http://www.pacificfishtrax.org, for dissemination of information in near real-time. Applications include management, marketing, and traceability for quality control. Active development includes “portals” to allow fishermen, scientists, managers, and the public useful and appropriate access to the data. Dr. Lawson is the chief salmon biologist for the project. His role has been to advise on study design, consult on database management, advise on web site design, solicit and coordinate biologists and oceanographers collecting and analyzing data. He also serves as liaison between Project CROOS and NOAA Fisheries, extending the project to the entire West Coast. In 2010 Project CROOS sampled the full season weekly from May through September. A parallel effort in California provided the first fine-scale coast-wide picture of salmon stock distributions through a fishing season. Broad-scale sampling continued through 2013.

**Salmon Recovery Planning:** Recovery planning for salmon populations listed under the Endangered Species Act is a complex process involving both scientists and policymakers. NOAA Fisheries recovery teams are creating recovery plans for all listed salmon in several broad geographic areas (for more information about the process, see http://www.nwfsc.noaa.gov/trt/oregonncal.cfm). The first step in this process was to develop biological goals for the recovery of salmonid species, a task that was assigned to “Technical Recovery Teams” (TRTs). Dr. Lawson (co-chair), Dr. Weitkamp, Heather Stout, and Dr. Tom Wainwright (FE Division) and members of the Oregon and Northern California Coast TRT have produced two reports defining populations and biological recovery criteria for listed coho salmon along the coast from the Columbia River to Punta Gorda, California. Team members were from the NOAA Fisheries Northwest and Southwest regions, Oregon Department of Fish and Wildlife, California Department of Fish and Game, U.S. Forest Service, U.S. Department of Interior, tribal agencies, and universities.

![Nine important Chinook salmon stocks occupy distinct habitats off the central Oregon coast](image)

Figure 1. Using data from 2010 we show that stocks off the central Oregon coast are separated by latitude, longitude, and depth. Sampled catch distribution is represented by the orange “heat map” using the FishTrax public portal (fp.fishtrax.org/portal). Samples are currently being collected in Washington, Oregon, and California.
**Fish Ecology Division (FE)**

**Fishery Resource Analysis and Monitoring Division (FRAM)**

**Steve Winter, Outreach Coordinator**

**West Coast Groundfish Observer Program:** The West Coast Groundfish Observer program (WCGOP) is responsible for fishery-dependent data collection on west coast groundfish stocks. The WCGOP trains, coordinates, and manages the data collected by fishery observers who work aboard commercial fishing vessels that operate along the coasts of Washington, Oregon, and California. Observers are assigned as biologists aboard commercial fishing boats, where they collect a wide variety of data, including catch and discard estimates, species composition data, and biological specimens, that is crucial for stock assessments, fisheries management, research, and quota tracking in the catch share fishery.

Since January 2011, the program has managed observer coverage in eleven fisheries, which include nearshore fixed gear fisheries, open access vessels, trawl and fixed gear vessels fishing individual fishing quotas and trawlers targeting pink shrimp. In contrast to some other fisheries, which have coverage rates between 2% and 30%, the West Coast Groundfish Trawl Catch Share program requires 100% observer coverage.

The Observer Program is administered through a cooperative agreement between NOAA Fisheries and the Pacific States Marine Fisheries Commission, with program staff stationed in Morro Bay, Eureka, and Crescent City, CA; Newport and Astoria, OR; and Seattle, WA. Several staff members are stationed at HMSC: Eric Brasseur, who provides gear and other logistical support; training coordinator and debriefer, Christa Colway; and data debriefer/trainers Jason Eibner, Bo Whiteside, and Toby Mitchell.

To ensure that an ample number of qualified and trained observers are available to observe all of the fisheries, the WCGOP conducts multiple three-week training courses for new observers and four-day briefings over the course of the year as needed. The WCGOP also trains FRAM’s survey staff in at-sea safety.

**Resource Surveys:**

**Groundfish Bottom Trawl Survey:** Each year the West Coast Groundfish Bottom Trawl Survey team conducts a survey along the continental shelf and slope off of the Washington, Oregon, and California coasts. The annual survey provides snapshots of groundfish stock, including changes in relative abundance and distribution as well as a look at groundfish stocks over time.

The survey results are critical for fishery managers, who use the information, along with other stock-related data, to make decisions on the continued viability of the fishery, such as the setting of catch shares, bycatch levels, and protected habitats. Several members of the survey team: biologists Keith Bosley, John Buchanan, Aaron Chappell, Dan Kamikawa, and Doug Draper are stationed at HMSC.

Chartered fishing vessels from the West Coast commercial fishing industry are used for the survey. This approach takes advantage of the skills of fishing captains, who are familiar with the challenges of fishing in the waters off the West Coast, and fulfills the cooperative research provisions of the Magnuson-Stevens Sustainable Fisheries Act. Newport-based fishing vessels Last Straw and Excalibur and the F/V Noah’s Ark from Brookings, OR conducted the 2013 survey. The annual survey begins with at-sea safety training and orientation at HMSC.

Utilizing a stratified random site selection design with stations from 55 meters to 1,280 meters in depth, the 2013 Survey sampled 497 stations with 472 successful tows. Catches were sorted by species, aggregate or other appropriate taxonomic level and then weighed using an electronic motion-compensated scale. More than 525 distinct fish and invertebrate species (or groups) were identified within the survey area. Biological sampling included determination of sex as well as collection of lengths, weights, otoliths, maturities and stomachs. Summaries indicate that 17,660 individual weights and 67,292 length measurements were taken for fish and 682 individual weights and 731 carapace widths were taken for crabs. Gender was recorded for 64,098 fish specimens and 17,643 otoliths or age structures were collected. Gender was also recorded for 729 crab specimens. Due to unanticipated furloughs, we lost 18 sampling days and about 72 stations — all south of Monterey Bay, CA. The survey was also reduced from four to three vessels in 2013 because of budget cuts.

The 2014 groundfish survey began in late May, aboard the fishing vessels Noah’s Ark and Last Straw on the first pass of the survey. The Excalibur and Ms. Julie (home port Coos Bay, OR) will conduct the second pass from August through late October.

**Integrated Hake Acoustics Survey:** FRAM's Fisheries Engineering and Acoustic Technologies (FEAT) team investigates advanced sampling technologies on an ongoing basis, such as AUVs and multi-beam technology that provides a larger sample volume and broadband technology that delivers a much wider spectrum, higher spatial and temporal resolutions, and a significantly improved signal-to-noise ratio. They work to develop new sampling devices that are non-extractive and which integrate both acoustic and optic information on fish distributions.
The FEAT team conducts the joint U.S.-Canada integrated acoustic and trawl survey of Pacific hake. Covering the area from San Diego up to Canada, this survey is the primary data source for the U.S.-Canada Pacific hake stock assessment. The 2013 survey was conducted in partnership with the Southwest Fisheries Science Center's biannual sardine survey, making it the first Joint Pacific Hake-Sardine Integrated Acoustic-Trawl Survey.

Scientists use conventional narrow-band, split-beam technology on the acoustic survey. The 2013 Joint Hake-Sardine Survey began in June and ran through August aboard the NOAA Ship Bell M. Shimada and the Forum Star. Acoustic transducers mounted on a retractable centerboard at the bottom of the Bell M. Shimada collect acoustic data on hake, and the biomass estimates are then verified by trawl catches. An echo-integration technique, based on the linearity principle, is used to relate acoustic intensity with the number of fish in the sample volume.

Along with members of the Southwest Fisheries Science Center and the Pacific Marine Operations Center, the FEAT team was awarded the Gold Medal award for designing and executing the first joint survey of Pacific hake and Pacific sardine with Canadian and industry partners at considerable cost savings. The Gold Medal is the highest honorary award in the Department of Commerce, given for distinguished performance characterized by extraordinary, notable or prestigious contributions that impact the Department's mission. NWFSC staff included Joint Survey Team members Larry Hufnagle, Rebecca Thomas Einhorn, Dezhang Chu, Alicia Billings, John Pohl, Julia Clemons, Steve de Blois, and Lisa Bonacci; and support staff Anne Baxter, Jeff Bash, Mary Breaker, Allan Hicks, Ian Taylor, Ian Stewart, Cassandra Donovan, Peter Frey, Doug Draper, Aaron Chappell, Dan Kamikawa, Victor Simon, and Chris Grandin.

Both surveys (Hake and Sardine) use similar acoustics technology to detect schools of fish: fishing or sampling to confirm the acoustic signal and species. The ground truthing (fishing or sampling to confirm the acoustic signal and species) for hake takes place during daytime midwater trawling; for sardine, the ground truthing takes place at night with a pelagic trawl. In addition, the FEAT team carries out post-cruise analyses of the collected data. The scientific team in Newport includes scientists Julia Clemons, Alicia Billings, Doug Draper, Cassandra Whiteside, Eric Brasseur, and Dan Kamikawa.

In general, stock assessments estimate productivity, current status, and allowable catch levels for West Coast groundfish resources, along with past and near-future trends in abundance. For species that have been declared overfished, staff members conduct rebuilding analyses, which involve projecting the status of resources into the future under a variety of alternative harvest strategies. These analyses provide information to policymakers about the tradeoffs between levels of catch and the length of time needed to rebuild these species. The assessment and rebuilding data are peer-reviewed and provide the scientific basis for the management of the groundfish fisheries off the U.S. West Coast, including the setting of Overfishing Limits (OFLs) and Allowable Biological Catches (ABCs), as mandated by the Magnuson-Stevens Act and its subsequent amendments.

Assessments for four species, which were led by Population Ecology staff, were reviewed in two panels during July, 2013: longspine and shortspine thornyheads in one, and rougheye and aurora rockfishes in the other. Assessments for several other species, the majority of which were led by Population Ecology staff, were reviewed earlier in 2013, while assessments for two other species were reviewed in August, 2013. A new assessment for Pacific hake was reviewed in February, 2014. West Coast groundfish assessment documents and review reports can be found at the Pacific Fishery Management Council (PFMC) website [http://www.pcouncil.org/groundfish/stock-assessments/]. Additionally, throughout the last quarter of 2013, Program staff updated catch data for models used to assess species in prior years, and produced a large number of 10-year projections to support the development of a long-term Environmental Impact Statement by the PFMC. In June, 2014, the PFMC adopted a preliminary list of species to be assessed in 2015, with a final decision due in September. Currently, the Program expects to be involved in assessments of Pacific hake, sablefish, petrale sole, kelp greenling, along with five rockfish species: darkblotched, canary, widow, black, and China.

In 2013, National Marine Fisheries Services (NMFS) conducted the first of a series of annual reviews of scientific programs in each region of the country. Last September, a panel of experts reviewed data collection efforts that support stock assessments for West Coast groundfish. In addition to NMFS staff from the NW and SW Fishery Science Centers,
the review also included representatives from the Oregon and Washington Departments of Fish and Wildlife, as well as Pacific States Marine Fisheries Commission. The panel recognized the NWFSC staff’s ‘high caliber and depth of expertise’ and commended the ‘extraordinary efforts to provide the fishery independent and fishery dependent data needed to support West Coast groundfish stock assessment and management.’ Members of the Population Ecology Program work closely with FRAM’s survey and observer programs, as well as state agencies, to help insure that data collection is well-aligned with assessment needs.

The NWFSC’s second programmatic review was held in June 2014, and focused on how groundfish stock assessments are prioritized, conducted, and reviewed on the West Coast. The Review Panel’s Chair noted, “Through outstanding science expertise, and open communication with the Council, industry and other partners, the Center has grown its assessment capabilities and is currently striving to assemble and refine them to meet current and future fisheries and resource stewardship demands.” Background materials, presentations, review comments, and NWFSC responses from both the 2013 and 2014 program reviews are available on the NWFSC webpage, www.nwfsc.noaa.gov.

In addition to preparing stock assessments, the Population Ecology Program conducts a variety of research focused on improving fishery science and management. These projects included efforts to increase the efficiency and accuracy with which assessment inputs are assembled and processed, to develop and test new methods for coping with and describing uncertainty in stock assessments.

In addition to their stock assessment work, Population Ecology members at HMSC participated in a wide variety of research projects. They collaborated with analysts from OSU and the Southwest Fisheries Science Center to create a multispecies, bio-economic model for evaluating management tradeoffs. They led and contributed to OSU and HMSC courses on the Stock Synthesis assessment software and the R programming language. They collaborated with an OSU group in applying data-moderate and data-poor methods for regional management in Oregon. They also contributed to national coral reports and stock assessment reporting, supported efforts to evaluate the ability of advanced sampling technologies (e.g., autonomous underwater vehicles, remotely-operated vehicles) to measure habitat-specific densities of various demersal fishes, and compiled and analyzed fisheries data in support of the PFMC 5-yr review of Pacific coast groundfish essential fish habitat.

Cooperative Fish Ageing Project: The Cooperative Ageing Project (CAP) provides direct support for U.S. West Coast groundfish stock assessments by providing ages derived primarily from otoliths, fish ear bones that can be read in much the same way as tree rings.

Pacific coast groundfish, particularly rockfish, can live to be more than 100 years old. These long-lived species commonly reach their maximum length within the first 20-30% of their maximum lifespan, which can limit the usefulness of individual fish-length data. Although otoliths (and other ageing structures) are more difficult to collect and read than recording fish lengths, they usually can yield accurate age readings, which are critical for understanding fish lifespans, rates of fish growth and mortality, year-class strength, and the vulnerability of segments of each stock to fisheries and survey monitoring.

Housed at HMSC, the project is funded by FRAM through a grant to the Pacific States Marine Fisheries Commission. The CAP team routinely provides 20,000 to 30,000 ages annually. Ageing specialists located at HMSC include Patrick McDonald (leader), Nikki Atkins, Brooke Higgins, Tyler Johnson, Betty Kamikawa, Lance Sullivan, and Cassandra Whiteside. Since July 2013, the CAP team provided ages for the 2014 Pacific hake assessment and several other species that are expected to be assessed over the next 5 years that includes; petrale sole, Dover sole, sablefish, Pacific hake, darkblotted rockfish, canary rockfish and Pacific Ocean perch. In addition to ageing, they began prepping spiny dogfish spines and vertebrae for future ageing efforts. The preparation of these samples involves thawing the sample, cooking the sample so any tissue can be gently removed and then desiccating the sample for storage. More than 2000 dogfish structures have been prepped since July 2013.

In addition to routine ageing efforts, ageing specialists participate in FRAM-directed surveys and collaborate with stock assessment scientists and staff from other ageing labs to improve current ageing methods, evaluate alternate ageing approaches, and better understand uncertainty associated with age determination.

Age reading can be a laborious and time-consuming task, especially when the structures being read were collected from old fish. Furthermore, in some species the annual rings can be difficult to distinguish from other markings on the otolith. CAP continues to work with NWFSC assessment scientists to investigate the use of more rapid age-determination methods, using otolith morphometrics (weight and/or size). Possible benefits of this approach include faster ageing and less reliance on subjective interpretation. Reducing subjectivity should increase consistency, in some cases, may improve the overall precision of age estimates. In support of this research, and to expedite future implementation of these methods, CAP staff routinely weigh all otoliths before the otoliths are aged.
Additionally, the CAP team continued to provide age data for vermillion and sunset rockfish caught from FRAM’s Southern California Shelf Rockfish Hook and Line Survey. The ages will provide information to compare growth between the two stocks and shed light on potential biological differences that may support managing the stocks separately.

**Marine Habitat Ecology:** The Marine Habitat Ecology (MHE) team is responsible for conducting fish habitat studies off the U.S. West Coast. In addition, the team works with agencies, academia, and the fishing industry to develop and evaluate fishing gear modifications that reduce the impacts of fishing on bycatch species and marine habitats. Located at HMSC, the team is made up of Waldo Wakefield, Mark Lomeli, and Matthew Yergey; the latter two are collaborators from the Pacific States Marine Fisheries Commission.

Over the last year, the MHE team continued ongoing work with NW and SW Fisheries Science Center scientists, scientists and managers from academia, the NOAA Fisheries Regional Office, and the Pacific Fishery Management Council (PFMC) in support of the Council’s required periodic 5-year review of Essential Fish Habitat (EFH) for the 91 species of Pacific coast groundfishes managed under the groundfish fisheries management plan. In Phase I of the review, new and relevant information was compiled and summarized, and coast-wide maps were updated for (1) bathymetry and interpreted groundfish habitat types, (2) the distribution and extent of commercial fishing effort (as potential impact to EFH), (3) the distribution and relative abundance of biogenic habitat (i.e., sponges and corals), and (4) spatial management boundaries. This complete body of information, in the form of a written report and supporting Internet data catalog, was presented to the PFMC, its advisory bodies and the public at the Council’s September 2012 meeting. NMFS conducted an analysis of the information in the Phase I Report, and delivered a Synthesis Report to the Council in April 2013. During Phase II of the process, the Council solicited proposals to modify EFH and Habitat Areas of Particular Concern (HAPC). The Council accepted the EFHRC Phase 2 report, thus formally ending the Phase 2 process.

Towards the next step in Phase 3, the Council requested that the Northwest and Southwest Fisheries Science Centers investigate the question of essential fish habitat effectiveness, accuracy, and completeness, and present their findings to the Council late in 2014, when the Council is tentatively scheduled to initiate a fishery management plan amendment, including alternatives for refining elements of groundfish EFH. This 5-year review represents a major update of the groundfish habitat assessment for the California Current and will have research and management applications well beyond satisfying the regulatory guidelines associated with EFH.

In collaboration with the Pacific States Marine Fisheries Commission, the MHE team is conducting a fishing vessel-based survey of young-of-year groundfishes along the Newport Hydrographic Line, a long term cross shelf sampling line off of Newport, OR. The NWFSC’s comprehensive groundfish bottom trawl survey was not designed to quantitatively sample the young-of-the-year (YOY) life history stage. The project, begun in 2012, examines the distribution, abundance, and behavior of this critical life-history stage of these ecologically and commercially important species with respect to seasonality and across a depth gradient. This research is important for several reasons: the study area may act as nursery habitat for a variety of juvenile groundfish species, the area has seen an increase in periods of low dissolved oxygen over the past 50 years, and the area is a test site for alternative energy development.

This work addresses gaps in year class strength in stock assessments, increases the understanding of impacts of increasing hypoxia on these vulnerable early life history stage fish, and acts as a baseline in marine spatial planning. The project benefits significantly from collaboration with the local fishing industry, which provides outreach opportunities concerning the early life stages of commercially important groundfishes and their habitats. Sampling is conducted biweekly from May to September with monthly sampling during fall and winter, as close as possible in time to ongoing NWFSC zooplankton and ichthyoplankton surveys. Juveniles are collected with a 2-m wide x 0.5-m high video beam trawl system and then flash frozen. A high-definition video camera system equipped with scaling lasers provides a video image of the seafloor and associated fauna. This project is part of ongoing collaborations with Dr. Lorenzo Ciannelli’s lab in the College of Earth, Ocean and Atmospheric Sciences at Oregon State University on the effects of hypoxia on juvenile groundfishes.

Through key regional collaborations with the Pacific States Marine Fisheries Commission, Oregon Department of Fish and Wildlife, Alaska Fisheries Science Center, and the fishing industry, the MHE Team has been able to pursue a wide-ranging array of conservation engineering projects relevant to reducing bycatch in the west coast groundfish and ocean shrimp trawl fisheries. In the past several years, these projects included: 1) Reducing Chinook salmon, eulachon, rockfish, and Pacific halibut bycatch in midwater and bottom trawl fisheries using BRDs, 2) Providing loaner video camera systems to the fishing industry, and 3) Examining selectivity characteristics of codends that differ in mesh size and configuration in the bottom trawl fishery. Much of our current work has been in response to the fishing industry’s concerns over catches of overfished rockfishes and Pacific halibut IBQ (Individual Bycatch Quota) allocated in the Pacific Coast Groundfish Trawl Rationalization Catch Share
Program. The trawl rationalization program, begun in January 2011, established formal Annual Catch Limits (ACLs) and individual catch share quotas. In addition to ACLs, fishing opportunities may also be limited by hard caps or IBQs for non-groundfish species (e.g., Pacific halibut). Bycatch of overfished and prohibited species in the west coast groundfish trawl fishery has the potential to constrain the fishery such that a substantial portion of the available harvest may be left in the ocean.

To learn more about FRAM (Fishery Resource and Analysis Monitoring), visit us at www.nwfsc.noaa.gov/research/divisions/fram.

**Oceanic and Atmospheric Research Division**

**Pacific Marine Environmental Laboratory (PMEL) Acoustics Program**

Dr. Bob Dziak, Director

The Acoustics Program performs marine acoustics research and develops marine acoustic technology in support of NOAA’s long term goals of healthy oceans and resilient coastal communities and economies. By coordinating with other federal agencies, academic institutions and international researchers the Acoustics Program leverages the knowledge and skillsets of partners to efficiently meet its mission objectives and contribute to the larger community.

The Acoustics Program’s primary goals are:

1. To acquire long-term data sets of the global ocean acoustics environment
2. To identify and assess acoustic impacts from human activities and natural processes on the marine environment
3. To develop “Next Generation” acoustic tools, techniques, and technology and transfer from research to operations

The Acoustics Program HMSC staff within the OSU’s Cooperative Institute for Marine Resources Studies (CIMRS) includes PIs Bob Dziak, Joe Haxel, Holger Klinck, Haru Matsumoto and Dave Mellinger. The research support staff includes both federal and CIMRS employees, Matt Fowler, Sara Heilmlich, Jonathan Klay, Andy Lau, Sharon Nieukirk, Anna Semple and Lu Yang.

2013-2014 highlights of Acoustics research endeavors and accomplishments include:

**Anthropogenic ambient noise impacts:** In FY14 we began deployment of the Ocean Noise Reference Station Network, which will be a collaborative project with all of the NMFS science centers, the National Ocean Service Sanctuary and the U.S. Park Service to deploy long-term hydrophone moorings in the fisheries research areas (i.e., Bering Sea, Southwest, Southeast, Northeast US coasts, Pacific Islands), near marine sanctuaries and at two national parks (Glacier Bay, AK and American Samoa). The goal of the project is to create the first comprehensive network to study long-term noise in the US EEZ.

We began an effort to use the archived US Navy SOSUS hydrophone data to study fin whale vocalization behavior in response to long-term variations in deep-ocean ambient sound across the North Pacific. The project, sponsored by the NOAA/NMFS Office of Science and Technology, will use data from the PMEL SOSUS hydrophone data to address the time and space scales of variability in ambient sound levels (1-125 Hz) from both man-made and natural sources from 1991 to present. Fin whale vocalization behavior (frequency, structure, abundance) will also be investigated to see if these factors are affected by variations in the ambient sound field.

We continued our European (Fram Strait) and U.S. (Chukchi Sea) Arctic hydrophone deployments, in collaboration with the Alfred Wegener Institute (AWI - Germany), and the NOAA/AFSC. Our goal is to extend our time-series observations of anthropogenic noise levels (ship noise, airguns for oil exploration) and the distribution of endangered blue, fin, sei and bowhead whales. This Arctic work, and the SOSUS study above, is important because we are establishing some of the first baseline ambient sound levels in these regions and are assessing potential man-made noise impacts on endangered cetacean species.

To broaden our acoustic coverage of the Arctic, work began on the ONR funded Arctic winch project. The winch is a subsurface mooring that is capable of coming to the surface to provide passive-acoustic as well as environmental measurements in near real-time via satellite transmission. The sensor will feature a low-frequency and a broadband omnidirectional hydrophone which will allow us to study anthropogenic and natural ambient noise levels, as well as marine mammals, in the deployment area. The instrument will also be equipped with environmental sensors (CTD and fluorometer) to collect oceanographic profiles on a daily basis. This part of the project will be conducted in close collaboration with the PMEL Eco-FOCI group, and the first long-term deployment is anticipated for summer of 2015 (northern Bering Sea).

We continued our investigation of the ambient noise levels in the south Atlantic, and Southern Ocean near the Antarctic Peninsula, to quantify the seasonal baseline noise levels due to ice breakup (icebergs, sea ice) and meteorological processes (wind, waves, seasonal temperature) and their relation to the distribution of threatened baleen whale populations. These data were originally collected from 2005-2010 in collaboration with the Korean Ocean and Polar Research Institute. Ambient noise levels are lowest during
the austral winter months (due to the freezing of sea ice) and highest during spring-summer when the thaw cycle breaks sea ice apart. Blue and fin whales vocalizations are most common when sea ice cover is lowest during the austral summer-fall months. Blue whale calls are also present, at some level, year-round and are a nearly continuous component to the ambient sound field. The noise spectra do not show significant anthropogenic sources (ships and airguns), likely due to low coastal populations and the difficult marine conditions of the Southern Ocean. A paper summarizing these results was submitted to the journal *PLOS ONE*.

Two U.S. Department of Energy supported projects involving acoustic measurements of noise radiated by the construction and operation of wave-energy conversion buoys will begin in fall 2013. The first project includes an initial characterization of ambient sound levels from both natural and anthropogenic sources, in support of the Northwest National Marine Renewable Energy Center’s (NNMREC) plans for a grid connected South Energy Test Site (SETS) off South Beach (Newport), Oregon. The second project is focused on measuring acoustic impacts from an operational wave energy converter at NNMREC’s North Energy Test Site (NETS) including detection and localization of vocally active marine mammals before, during and after device testing. This work is important because we are assessing noise impacts, from energy production, on endangered cetacean species.

**Volcano-seismic processes and fluxes:** The Axial Seamount ocean-bottom hydrophone array built by the Acoustics Program is used to monitor for seismic precursors to eruptions at this submarine volcano. This work is in collaboration with the EOI group and complements the OOI cabled observatory effort that will soon place permanent, real-time seismometers on the summit of Axial. Our studies of the Axial precursory seismic phenomenon have shown that a short-term (days to hours) forecast of an impending eruption is possible, which may facilitate real-time observations of the next Axial eruption via the cabled observatory.

Over the past few years, we have successfully developed acoustic methods to estimate the amount of CO$_2$ gas expelled from NW Rota-1 submarine volcano. We found that the CO$_2$ released by NW Rota-1 was roughly equal to 1% of the CO$_2$ release from all arc volcanoes on land. We will continue to quantify gas fluxes from submarine volcanoes by focusing on the West Mata volcano as part of an NSF funded project in the Lau basin. Preliminary estimates show that individual eruptions of gas at West Mata release between 1.1-31.8 kg of steam and CO$_2$ over durations of 20-30 ms. Volcanic tephra (recorded using E. Baker’s MAPRs) and hydrophone data recorded synchronously show a repeated record of summit explosions followed by down flank debris flows, an important process in the construction of the volcanic edifice.

We also plan, this year, to recover 8 hydrophones moored in the equatorial Atlantic Ocean. This is an NSF sponsored project to test earthquake predictability (retrospectively) on Atlantic Ocean transform faults, a phenomenon that is unique to ocean faults. This Atlantic data will also be used in the future to assess anthropogenic noise impacts (above section) and the distribution of cetacean populations off the coasts of Brazil and west Africa; regions where little previous data exists.

Several Acoustics program scientists are involved in the NSF-sponsored Cascadia Initiative, which is a community-wide project to install 70 ocean bottom seismometers across the Juan de Fuca plate. The goal is to investigate the structure and dynamics of the Cascadia Subduction zone, which poses a significant earthquake hazard to the Pacific Northwest. Acoustics personnel performed Chief Scientist duties on three OBS recovery/re-deployment cruises in 2013-2014.

**Marine Mammal Acoustical Assessment:** We continued development of acoustic data-collection platforms and improving analysis methods for studying a variety of marine mammal species. Our collaboration with researchers at the University of Washington has led to deployments of an acoustically-equipped Seaglider™ on numerous occasions. Data from planned deployments in Navy relevant areas off Guam/Saipan, Kauai, and in the Gulf of Alaska in 2014 will be used to examine the presence of cetaceans, particularly beaked whales. The Navy supports our beaked whale detection work because their fleet exercises have lead to strandings of these species.

We worked with a NOAA-Advanced Sampling Technology Working Group (ASTWG) funded project in collaboration with NOAA/NWFSC on the development of a real-time detection system for endangered resident killer whales. This project will involve imbedding our acoustic detection technology on a PMEL PICO buoy. In collaboration with the NOAA Wisdom Program (weather service) and the NOAA Unmanned Aircraft Systems Program (UASP), we have been provided with a small, unmanned surface vehicle (http://uas.noaa.gov/news/Emily.html). We will equip this USV with a passive acoustic recording system and will test its capability to autonomously monitor marine mammals and ambient noise levels off Newport.

Algorithms for detecting and classifying whistles and clicks of odontocetes (beaked whales, dolphins and porpoises) were also developed and improved. Progress was made on estimating the population density of marine mammals from acoustic data off Portugal (fin whales) and Hawaii (false killer whales). We are implementing these algorithms into the
user-friendly software package Ishmael to make them easily accessible to researchers worldwide.

OAR/NMFS Ocean Noise Reference Network is a cooperative program between PMEL, National Ocean Service, National Marine Fisheries, and the Park Service. The goal is to create the first comprehensive network to study long-term noise in the US EEZ and two National Parks (Glacier Bay and the National Park of American Samoa).

**Pacific Marine Environmental Laboratory (PMEL) Earth-Ocean Interactions Program**

**Bill Chadwick, Director**

The mission of the Earth-Ocean Interactions (EOI) Program is discovering, measuring, understanding, and predicting ecological impacts of natural chemical, biological, and geological processes between the solid Earth and Ocean. The EOI Program contributes to NOAA’s objective of achieving a holistic understanding of marine ecosystems by exploration and research on hydrothermal vents, their impacts on the global ocean, and their unique chemosynthetic biological communities. This includes ecosystem characterization, resource assessment, environmental observation, and technology development. EOI staff at HMSC include Bob Embley and John Lupton (NOAA), Bill Chadwick, Susan Merle, Andra Bobbitt and Leigh Evans (CIMRS). Additional EOI staff (both federal and cooperative institute) are stationed at the NOAA/PMEL offices in Seattle.

**Accomplishments of the Earth-Ocean Interactions Program in 2013-2014 include:**

- EOI investigators led a research expedition to Axial Seamount on R/V Thompson with ROV Jason, September 3-19, 2013. Axial Seamount has been a long-term study site for the EOI Program for many years, because it is the most active submarine volcano in the NE Pacific and is an ideal site to study the interrelations between volcanic activity, hydrothermal chemistry, and microbial ecology in a dynamic environment. This year’s cruise included time-series vent fluid and microbial sampling to better understand the microbial ecosystems that form the base of the food chain at seafloor hot springs. Another project continued a time-series of seafloor pressure measurements to monitor how much the volcano has reinflated since its last eruption in 2011. These measurements found that the center of Axial’s caldera has risen by 1.2 meters (4 feet) in the last 2 years, indicating the volcano has already recovered over half of the deflation that occurred during the April 2011 eruption, which means Axial may be closer to its next eruption than expected. More information on the cruise is available at: axial2013.blogspot.com. Axial Seamount is also a focus site for the Ocean Observatories Initiative (OOI) and EOI researchers have developed and built instruments that will be part of the regional cabled observatory in the NE Pacific, which is scheduled to come on-line within the next year.

- Another expedition with EOI participation was on the NOAA ship Hi’ialakai in the northern Mariana islands, May 11-20, 2014. This expedition focused on Maug island, which is a flooded caldera where volcanic CO₂ vents directly into a shallow coral reef ecosystem. Preliminary work shows that gradients in pH are created around the CO₂ vents and they have a strong impact on the health and distribution of coral species around the vents. This site is an extraordinary natural laboratory where the effects of ocean acidification on marine ecosystems can be studied. This work is being conducted in collaboration with the NOAA Coral Reef Ecosystem Division (CRED) of Pacific Islands Fisheries Science Center (PIFSC). In addition to the research at Maug, the cruise was able to locate the source of seismic signals produced by an underwater eruption in the area between April 24 and May 8. A multibeam sonar survey over the summit of Ahyi Seamount showed dramatic depth changes from the previous survey in 2003, indicating that Ahyi was the source of the eruption sounds. CTD casts around Ahyi also found hydrothermal particle plumes coming from the summit. Additional investigation on this event will take place during an upcoming expedition to the area in the fall of 2014.

- Three talks or posters were presented by EOI researchers at the 2013 Fall Meeting of the American Geophysical Union, and EOI personnel were co-authors on six more.

- A paper was published in the journal Geochemistry, Geophysics, Geosystems presenting the results of geologic mapping of the lava flows that were erupted at Axial Seamount in 1998. The paper used ship-based multibeam
sonar, high-resolution bathymetry (collected with an autonomous underwater vehicle), sidescan sonar imagery, and submersible dive observations to map four separate 1998 lava flows that were fed from 11 eruptive fissures and interpret the emplacement history and structure of the lava flows.

• A paper in Geophysical Research Letters compared helium isotope ratios in samples of marine air over the past 40 years to demonstrate that atmospheric helium is still a valid standard for terrestrial helium isotope measurements.

• A paper in review in the journal Geochemistry, Geophysics, Geosystems focuses on a study of the recent eruptive history at West Mata seamount in the NE Lau basin. This submarine volcano is noteworthy as one of only two sites in the world where deep-sea eruptions have been witnessed. This paper reviews the volcano’s eruptive activity between 1996-2010 based on repeat mapping and ROV observations and reveals that several previously unknown eruptions had taken place during that time interval.

• Another paper in press in a special issue of Oceanography on Submarine Hazards presents evidence of depth changes at South Sarigan seamount in the Mariana arc, where an eruption in 2010 from ~200 m depth produced a gas and ash plume that breached the sea surface and rose to 20,000 feet into the atmosphere. This is one of the first cases where a wide range of pre-and post-eruption observations allow characterization of such an event on a shallow arc volcano, and the study has important implications for natural hazards.

• Molten sulfur lakes found on several Mariana seamounts is the subject of another paper that is in press, as part of a new book on Volcanic Lakes. These sulfur lakes were all found in hydrothermal areas, where the volcanoes provide both the sulfur (as a magmatic gas) and the heat (to keep the sulfur molten, even underwater!). The sulfur lakes are found in volcanic craters and are associated with dense biomasses of chemosynthetic biological communities.

• A paper in preparation focuses on the imaging of CO₂ bubble plumes from actively erupting NW Rota seamount in the Mariana arc. This paper shows that mid-water multibeam sonar data can image the bubble plumes in three dimensions and compares a time-series of their size, shape and intensity to ocean currents, ROV observations, and hydrophone data to show that the bubble plumes accurately reflect the variation in the style and strength of eruptive activity on the seafloor.

• The NOAA/PMEL Helium Isotope Laboratory here in Newport has continued work on gases in submarine volcanic rock and water-column samples from a variety of sites around the world. Since helium-3 is a conservative tracer and is only produced in the Earth’s mantle, it is an excellent indicator of hydrothermal activity and one of the main tools for identifying new vent sites.

U.S. Department of Agriculture (USDA)

Agricultural Resource Service (ARS)
Vacant, Research Geneticist
Brett Dumbauld, Aquaculture Ecologist

The Agricultural Research Service is the federal scientific research agency responsible for solving agricultural problems of national importance and developing solutions to a wide range of problems related to food and agriculture. ARS generally makes long-term commitments of resources to problems unlikely to have solutions with the quick commercial payoffs that would attract private funding. Since 2003, the ARS mission at HMSC has been to work with the shellfish aquaculture industry in the Pacific Northwest region to address issues such as summer mortality in oyster growing areas, to develop genetically improved stocks of commercially important shellfish, and to develop an improved understanding of the ecology of bivalve shellfish aquaculture in the estuarine environment, reduce mortality due to pests, and insure environmentally compatible shellfish culture practices. The USDA supports two research programs at HMSC, a shellfish genetics program and a shellfish ecology program, both currently led by Brett Dumbauld.

The Shellfish Ecology Program has two primary objectives:

1) Develop effective population control strategies for two species of burrowing shrimp (Neotrypaea californiensis and Upogebia pugettensis) that cause substantial damage to oyster crops in Oregon and Washington and establish protocols for identifying sources of juvenile oyster mortality that constrain aquaculture production in West Coast estuaries.

2) Quantify the spatial extent and follow the trajectory of aquaculture practices on intertidal estuarine habitats like eelgrass and open mudflat, examine the functional role of these habitats including aquaculture for fish and invertebrates, and assist the shellfish industry in developing farming practices and farm plans that are compatible with the habitat requirements of these species.

This past year, the Shellfish Ecology Program’s accomplishments include:

Monitoring burrowing shrimp populations in four coastal estuaries and examining aspects of population dynamics that might be beneficial in designing integrated pest management practices to control them for shellfish aquaculture: The average density of both mud and ghost shrimp at long term monitoring locations has declined over time and ongoing mapping efforts in Yaquina Bay, OR and
Willapa Bay, WA suggest that shrimp populations have also declined in size and extent. A collaborative project with Dr. John Chapman at HMSC indicates that increased prevalence of an introduced parasitic bopyrid isopod coincided with the decline in abundance of mud shrimp. These isopods effectively eliminate egg production in infected female mud shrimp and this reduced reproduction likely contributed to recorded population collapses in many estuaries from Washington to California. Declines in ghost shrimp populations, however, cannot be attributed to parasites, so we are tracking annual recruitment to these shrimp populations and its contribution to subsequent year class strength to discern what other factors influence population trends. Recruitment of both shrimp species to Washington estuaries has been low since the mid 1990’s, and this correlates directly with population declines there. Substantial recruitment of ghost and mud shrimp occurred to Oregon estuaries in 2010 and 2011 respectively, but not to our long-term monitoring sites in Washington estuaries. Recruitment patterns were reversed in 2012 and 2013 with fairly substantial recruitment of ghost shrimp to Willapa Bay and lower levels in Oregon estuaries. We have been unable to directly relate recruitment patterns to larval abundance and ocean conditions, but there is a window of opportunity after recruitment occurs before the shrimp become problematic for oyster culture and it is clear the shellfish industry will experience years when it is more critical to control shrimp than others. We are tracking survival of the 2011-2013 year classes of shrimp to estimate their contribution to shrimp populations in both estuaries and are actively working with the integrated pest management coordinator hired by the shellfish industry to develop and test tools including small venturi pump samplers for improved recruitment sampling in order to establish an industry monitoring program. These results are important because they imply that in addition to finding alternatives to the current use of pesticides to control adult shrimp on shellfish beds in Washington state, a basic understanding of recruitment and the population ecology of burrowing shrimp as pests is essential to meeting the goal of integrated pest management on aquaculture beds.

Examining juvenile oyster mortality and growth: Shellfish growers report substantial differences in growth and unexplained losses immediately after planting their crops. We are collaborating with the MBP program, the Whiskey Creek shellfish hatchery in Netarts, Oregon, and Dr. George Waldbusser (CEOAS) to examine growth and survival of oysters from high yield MBP families and those from wild stocks along estuarine gradients focusing on the potential effects of acidified high PCO2 water.

Examining the functional role of oyster aquaculture in the estuarine ecosystem: Results of surveys we conducted with underwater video and fish traps suggest that most fish and invertebrates, including juvenile English sole and Dungeness crab which use coastal estuaries as nurseries, are found in greater abundance in structured intertidal habitats including oyster aquaculture and eelgrass, than in open unstructured mudflats. We expanded this work to examine use of the introduced eelgrass Zostera japonica and intertidal clam aquaculture beds in both Willapa Bay and Yaquina Bay, Oregon in 2013 and 2014. Preliminary results suggest that shiner perch, staghorn sculpin, three-spine stickleback and Dungeness crab were most abundant and there was a significant difference in habitat use. Trends suggest that shiner perch and staghorn sculpin were more abundant in both seagrass habitats, but catch was too low and variable to detect significant differences. Results of separate surveys for juvenile Dungeness crab suggest they settle in highest numbers in structured habitats and that more settle in native eelgrass than Z. japonica, but survival is low in all of these substrates. Shore crabs (Hemigrapsus oregonensis and H. nudus) may also limit initial settlement and survival where they are abundant. Aerial photography of Willapa Bay, Washington was used to create an intertidal aquatic vegetation GIS layer. Extensive ground-truthing and mapping was conducted to produce burrowing shrimp and sediment layers and improve an existing intertidal bathymetry layer. Interviews with shellfish growers were used to produce a current aquaculture use layer, and we also digitized an 1892 map to create a historic native oyster layer for this estuary. We used additional GIS layers for intertidal elevation (MLLW), cumulative wave stress, salinity, distance to the estuary mouth, and distance to the nearest channel to quantify the distributions of eelgrass and aquaculture as predictors in models used to quantify the total impact of bivalve aquaculture on eelgrass at the landscape scale. Impacts for each bed were quantified over three years to determine whether they were chronic or transitory in nature. While oyster harvest methods had demonstrable effects on eelgrass over time at the individual bed scale, oyster aquaculture reduced eelgrass cover by less than 1% in any given year over the whole estuary. Since eelgrass is widely viewed as essential nursery habitat for commercially valuable fish like English sole and salmon, this research will be useful for permitting decisions regarding both current and proposed expansion of sustainable aquaculture operations in West Coast estuaries.

The objective of the Shellfish Genetics Program is to employ both traditional quantitative genetics and molecular genetics to gain knowledge that can be used to improve breeding stocks for Pacific Northwest shellfish aquaculture. The program has worked in close collaboration with the Molluscan Broodstock Program (MBP), a USDA-funded oyster breeding program working to improve economically important traits such as growth rate/efficiency, reproduction, survival, disease resistance, and product quality until its recent loss of funding and we expect to continue that collaboration as other industry and state resources are
acquired and as the program adapts to examine the effects of climate change on oysters.

This past year, the Shellfish Genetics Program’s accomplishments include:

Estimating the additive genetic, non-additive genetic and environmental covariance matrices for larval and field performance in currently available germplasm of the Pacific oyster using a multi-year animal model approach: Oyster breeding currently relies on lengthy and labor-intensive field trials for selective breeding and focuses entirely on yield during grow-out. This research is designed to incorporate larval performance and product quality into breeding objectives using molecular testing and a rigorous evaluation of the genetic (co)variances of these characters. Washington Sea Grant funding enabled a large breeding experiment to be performed in collaboration with the University of Washington and Taylor Shellfish in order to address the issue of exposure of larval and juvenile oysters to acidified ocean water which is currently one of the most significant threats of global climate change to Pacific oyster production on the US West Coast. Oyster broodstock from six families were obtained, conditioned and spawned with half of the resulting larvae exposed to elevated carbon dioxide. Larval performance and survival to juvenile seed was assessed and conditions experienced in both parental and larval phase appeared to carry over to the juvenile seed stage. Sub-samples of the surviving progeny were genotyped using microsatellites to determine parentage and assess potential differences in survival due to family, treatment, and life history stage. Data is currently being analyzed.

Developing a collaboration with other university researchers to apply “next generation” DNA sequencing and advanced bioinformatics and identify gene expression differences between high-reproductive effort and low-reproductive effort individuals of Pacific oysters: Genes identified by this work will provide candidate genes for subsequent qPCR analysis and QTL mapping, and will be informative for marker-assisted selection. In addition, several pools of larvae, challenged with Vibrio tubiashii, a pathogen associated with recent Pacific oyster larval mortality events, were analyzed with next-generation sequencing to identify differential gene expression between treatments as well as potential allele frequency changes before and after treatment.

U.S. Fish and Wildlife Service

Oregon Coast National Wildlife Refuge Complex
Roy W. Lowe, Project Leader

The Oregon Coastal Field Office supports U.S. Fish and Wildlife Service (USFWS) employees from the National

Wildlife Refuge System and the Division of Ecological Services. Oregon Coast National Wildlife Refuge Complex personnel are responsible for operations and management of six National Wildlife Refuges (NWR or Refuge) and two Wilderness Areas spanning the Oregon coastline. The refuges include three estuarine refuges (Bandon Marsh, Nestucca Bay, and Siletz Bay); two marine refuges (Three Arch Rocks and Oregon Islands); and a small old growth forest refuge at Cape Meares. In 2013-14, the Oregon Coast Refuge Complex had nine permanent employees, of which seven were stationed at the HMSC in addition to a temporary Biological Technician, a term Office Clerk and two Environmental Education Interns. Two of the Complex’s permanent employees were stationed at the Refuge Complex’s South Coast Office in Bandon, along with a term Restoration Biologist, a Biology Intern, and numerous volunteers. Refuge staff focus primarily on six priorities: 1) land acquisition, 2) habitat management and restoration, 3) biological surveys, 4) monitoring, 5) research, and 6) environmental education and outreach.

The Refuge Complex has an active land acquisition program at Nestucca Bay Refuge. On September 5, 2013, the Nature Conservancy in Oregon and the U.S. Fish and Wildlife Service reached an agreement with the Jesuit Novitiate in Sheridan, Ore., to conserve the 102.53-acre Jesuit property located on Cannery Hill overlooking Nestucca Bay. Ownership of the property was transferred to the Service from the Jesuits. The property will be protected as a part of the 1,203-acre Nestucca Bay National Wildlife Refuge. Combined with the adjacent 90-acre Harder property acquired on May 31, 2013, the entire Cannery Hill North Peninsula is now protected for wildlife and outdoor recreation. The property, located at the confluence of the Nestucca and Little Nestucca rivers, contains upland forest, shoreline, and tideland habitats and is now known as the Two Rivers Peninsula Unit of the Refuge. Wildlife using this area includes migratory songbirds, bald eagles, peregrine falcons, bobcat, black-tailed deer, and many other species. Shoreline and tideland habitats are used by a variety of estuarine fish including coho and Chinook salmon. Funding for the permanent protection of this site was made possible by a National Scenic Byways grant to The Nature Conservancy through the Federal Highway Administration and Oregon Department of Transportation.

Since the completion of construction of the largest tidal salt marsh restoration project in Oregon at Bandon Marsh NWR in 2011, monitoring of the effects of the restoration on the local wildlife and ecology have been ongoing. During the reporting year USFWS staff and contractors collected field data on fish use, water quality (temperature and salinity), and ground water level fluctuation. Data was collected from within the restoration site at Ni-les’ tun Unit and the reference site within the Bandon Marsh Unit for comparison to each
other, and with similar data collected at both sites before the restoration occurred. In addition, in cooperation with Oregon Department of Fish and Wildlife, an adult salmon trap was operated for six months in Fahys Creek on the refuge, and weekly spawning surveys were conducted to monitor the recovery of salmonids post restoration of this stream. Preliminary results of all these monitoring efforts show that fish and wildlife have responded to the restoration of tidal influence to the marsh in dramatic and positive ways, including large increases in shorebird and waterfowl visitation, juvenile salmon and other estuarine aquatic species using the constructed tidal channels, and increased coastal cutthroat trout spawning in Fahys Creek.

The restoration work at Bandon Marsh NWR, along with its strategic value due to its location within a large estuary on the Oregon Coast, has raised its profile within the conservation science community. Accordingly, USFWS has issued Special Use Permits to several research groups to conduct studies on refuge lands. The Service considers this an excellent method to leverage internal efforts to obtain ecological information that can aid refuge management programs. The following projects were active in the reporting year:

- University of Pennsylvania - Foraminifera response to salt marsh restoration
- Portland State University - Shifting habitat mosaics in estuaries driven by climate change
- US Geological Survey - Sea-level rise effects on salt marshes and endemic wildlife over the tidal range gradient of the Pacific coast

In summer 2013, it became clear that the salt marsh mosquito population on the newly restored tidal marsh within the Ni-les’tun Unit of Bandon Marsh NWR was abnormally high, and the Service determined that this increase was largely the result of the recent tidal marsh restoration activities that inadvertently created abundant mosquito breeding habitat in pools and depressions in the high marsh. After intensive monitoring throughout the summer, the Service cooperated with Coos County in September 2013 to apply a larvicide to the Ni-les’tun Unit to reduce the mosquito population on the Refuge, and committed to collaborating with public health officials and mosquito control experts to solve the problem of inflated mosquito populations on the Refuge. The Service developed a comprehensive Integrated Marsh Management (IMM) approach, which focuses on a long-term strategy of eliminating the majority of the salt marsh mosquito breeding habitat. The Service will extend existing tidal channels to the breeding pools so they drain with each tide cycle and no longer retain water long enough for mosquitoes to complete their development into flying adults. To manage mosquito numbers until the long-term strategy to eliminate breeding habitat could be implemented and become effective, the Service also made the decision to use the larvicide Bti to prevent mosquitoes from developing past their aquatic life stages and hatching into flying adults. Bti treatment has taken place throughout the spring and summer of 2014, as determined necessary through frequent monitoring, and the habitat manipulation to reduce mosquito breeding sites began in mid July 2014. In March 2014, a wildlife intern based in Bandon was hired for a seven-month period to help conduct the mosquito monitoring required to implement the IMM approach.

At Nestucca Bay NWR, the 35-acre coastal prairie restoration project continued with a focus on exotic species control in several restoration units, forb seeding and plug planting in Area 2, native grass seeding in the “remnant prairie,” and an ecological burn in Area 3 in preparation for native grass seeding. The Jane Goodall Environmental Middle School also visited the site twice to engage in stewardship activities. In late October and November, Viola adunca plugs were planted throughout Area 2 and in the “remnant prairie.” In Area 2, 101 patches of 100 violets were planted, and in the “remnant prairie,” 10 patches of 99 violets were planted, for a total of 11,000 violets. Violets were planted densely with the intention of creating a virtually uninterrupted carpet of violet leaves within each patch, to meet the future needs of the Oregon silverspot butterfly larvae. This project is a partnership between the USFWS, the Institute for Applied Ecology (IAE), and several dedicated volunteer and school groups to convert degraded grasslands from non-native pasture grasses to native coastal grasses and forbs with an emphasis on the species and structure required to support the federally listed threatened Oregon silverspot butterfly.

USFWS personnel conducted annual aerial surveys of surface nesting seabirds (e.g. common murre, Brandt’s cormorant, and double-crested cormorant) at colonies on June 3-4, 2014. Digital photographs are taken of each colony from the air and the breeding populations of each species are estimated by counting the birds in the photographs. These data are entered into the Oregon Seabird Colony Computer Database to aid in seabird research. In June 2014, USFWS in cooperation with National Oceanic Atmospheric Administration (NOAA) initiated a study that implemented Unmanned Aircraft Systems (UAS) to photograph seabird colonies. Photographs were taken of murre and cormorant colonies at Chapman Point near Cannon Beach and a double-crested cormorant colony at Bolon Island near Reedsport. Photographs taken by the UAS were compared to photographs taken from a helicopter to determine quality. The UAS photographs are comparable in quality and birds and nests can be counted from images taken by the UAS. A cormorant survey from Yaquina Bay to Depoe Bay was conducted July 2014 by boat to document breeding bird abundance and colony locations. An annual aerial survey of California brown pelicans was conducted on September 12-13, 2013 along the Oregon coast.
and SW Washington Coast to estimate the summer population before fall migration. A Leach’s storm-petrel monitoring study at Goat Island, Oregon Islands National Wildlife Refuge was initiated April 2014 and will continue through September 2015. The purpose of this study is to develop non-invasive methods to monitor burrow-nesting Leach’s storm-petrel populations. A combination of remotely operating cameras and acoustic recorders is used to quantify storm-petrel activity within study plots. Six subspecies of Canada goose including the delisted Aleutian Canada goose and dusky Canada goose, a species of special concern, were monitored and counted in the Nestucca Valley from mid October 2013 to mid April 2014. Also, a special monitoring effort to document the presence of previously marked Semidi Islands Aleutian Canada goose was conducted at Nestucca Bay. USFWS biologists also surveyed wintering black brant at Oregon central and north coast estuaries. The Refuge Complex continued (fifth year of study) to conduct tufted puffin research at Haystack Rock in Cannon Beach, and recruited a volunteer to assist with the project. This project is an applied ecological study that advances knowledge and tests new techniques for assessment of a declining, at-risk, seabird species. Haystack Rock is part of the Oregon Islands NWR and this project will provide the refuge with additional data needed to assess seabird status and conservation issues within the refuge. The project will also yield results that may be important to the USFWS as the agency has been petitioned to list the tufted puffin as an endangered species. An electronic data logger and two staff gauges were installed at Nesikowin Marsh unit of the Nestucca Bay National Wildlife Refuge July 2013. The staff gauges indicate water depth and the data logger records water depth, water temperature, and other associated parameters (battery voltage, time, date, etc.). These data will aid in determining water flow and fluctuation within the marsh.

The Environmental Education program continues to reach out to new schools and more students. This year, Oregon’s annual Junior Duck Stamp Competition received 325 artwork entries from public, private, and home schools across the state. The 2014 Oregon “Best of Show” winner was Jordan Lei, a 15-year old who attends the Jiao Ying Chinese Culture and Art School in Portland. He submitted an oil painting of a Hooded Merganser, entitled "Sentinel." Jordan’s Conservation Message was "Conservation is the only way to make up for our past, alter the present, and bring hope to the future."

The Shorebird Superhero Program was conducted in Coos, Benton and Lincoln counties in 2014 reaching 600 4th and 5th grade students. Students learned about the importance of estuaries, shorebird behavior, adaptations, migration, and conservation and ended the program with a field trip to Yaquina Estuary or Bandon Marsh Refuge. We were fortunate to have outstanding weather and hundreds of shorebirds for the field trips. With a growing population of Latino students in Lincoln County Schools we recognized the opportunity to incorporate Spanish into the Shorebird Program and did so with a variety of vocabulary words and activities.

Volunteers are a crucial part of the work at the Refuge Complex. The program continues to grow and expand, with volunteers in multiple positions including maintenance, biological work, interpretation, environmental education, and administration. A total of 157 refuge volunteers gave 13,537 hours of their time in 2014, which is valued at $289,015.

Newport Field Office
Laura Todd, Field Supervisor

The Newport Field Office (NFO) for Ecological Services is co-located with the Oregon Coast National Wildlife Refuge Complex at HMSC. The NFO administers the Ecological Services program of the U.S. Fish and Wildlife Service on the Oregon coast with a staff of four permanent employees and various volunteers throughout the year. The responsibilities of the NFO include administration of the Endangered Species Act; such as listing, recovery, private and state lands conservation for listed species, candidate conservation, consultation with Federal agencies, and technical assistance with non-Federal entities. The Oregon Coastal Program is also administered out of this office with staff co-located at the Bandon Marsh National Wildlife Refuge. The purpose of the Coastal Program is to provide funding and technical assistance to support habitat restoration assessment, habitat restoration projects, and public education. In addition to these main functions, the NFO also occasionally assists with National Environmental Policy Act responses, wetland dredge/fill permit responses, planning efforts, spill responses, and a variety of technical assistance requests.

In 2013-2014, the Newport Field Office celebrated a number of accomplishments:

- Completed restoration and habitat assessment projects under the Coastal Program which enhanced or restored: stream and riparian habitats; wetlands and uplands. These projects were all implemented according to the Oregon Coastal Program Strategic Plan, which was finalized in 2012 (http://www.fws.gov/oregonfwo/FieldOffices/Newport/CoastalProgram/CoastalProgram.asp).
- Improved the population numbers and distribution of the threatened Oregon silverspot butterfly with the assistance of numerous volunteers and land management partners, by releasing pupae and caterpillars at three locations on the central Oregon coast with a staff of four permanent employees and various volunteers throughout the year. The responsibilities of the NFO include administration of the Endangered Species Act; such as listing, recovery, private and state lands conservation for listed species, candidate conservation, consultation with Federal agencies, and technical assistance with non-Federal entities. The Oregon Coastal Program is also administered out of this office with staff co-located at the Bandon Marsh National Wildlife Refuge. The purpose of the Coastal Program is to provide funding and technical assistance to support habitat restoration assessment, habitat restoration projects, and public education. In addition to these main functions, the NFO also occasionally assists with National Environmental Policy Act responses, wetland dredge/fill permit responses, planning efforts, spill responses, and a variety of technical assistance requests.

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The purp...
Consists of about 60 permanent and more than 60 seasonal or temporary positions. The program budget is comprised of funds from federal grants (25%) and state sources (75%).

**Fisheries Policy, Management and Regulation:** The Oregon Department of Fish and Wildlife is authorized by the State Legislature and the Oregon Fish and Wildlife Commission to manage commercial and recreational fisheries and other marine species, such as marine mammals, in Oregon. This includes fishery management, policy development, and implementation at the local, state, regional and international scale. Generally, the MRP’s involvement extends from the innermost margin of estuaries to 200 miles offshore. Changes and achievements during the last year include:

- In 2013, Oregon had the most valuable commercial catch in our history (dollar value of landed fish), with revenue generation dominated by the state-managed Dungeness crab and pink shrimp fisheries. Pacific whiting (a.k.a. hake) was by far the largest fishery in landings (by weight).
- During the past year, Oregon’s commercial nearshore fishing fleet was faced with potential reductions in the allowable harvest levels of several important species, including kelp greenling, due to changes in the stock accounting methods. MRP staff educated industry members on the issue. Significant public comment was generated, motivating the Pacific Fishery Management Council’s (PFMC) Scientific and Statistical Committee to re-examine the kelp greenling stock assessments. The result was a determination that the assessments were not viable, and no changes to harvest levels are warranted in 2015 or 2016. In 2013, the Oregon commercial pink shrimp fishery was re-certified as sustainable by the Marine Stewardship Council (MSC). While the certification was an industry-led initiative, ODFW played an important role in the recertification process by providing research results from many years of fishery bycatch reduction work on fishing gear design, population dynamics modeling, and committing to continue this work into the future. Other Oregon commercial fisheries certified by the MSC include: Pacific whiting, Dungeness crab, albacore, and (new in 2014) groundfish trawl. The groundfish trawl certification was for the West Coast fishery (including California, Oregon and Washington) and was sponsored in part by Oregon’s Trawl Commission. With this certification, the vast majority of Oregon’s commercial ocean landings (by volume) are now certified as sustainable.
- ODFW initiated a public outreach campaign this year to increase the use of descender devices by sport fishermen, to release prohibited rockfish species at depth and increase survival rate. This “no floaters” campaign has been successful in raising awareness and increasing the use of these devices. ODFW and an angler education group received a grant to purchase more than 4,000...
descending devices of two different types for distribution to private anglers and charter captains. ODFW also partnered with Utah’s Hogle Zoo; as part of their conservation efforts, the zoo purchased an additional 200 devices of a third type for distribution. Finally, ODFW worked with Oregon Sea Grant, the Hogle Zoo and several angler education groups on outreach materials, including how-to videos, stickers and informational handouts. These activities, along with a new mortality rate used to calculate the survival of fish released at depth, should encourage anglers to use descending devices more frequently, and lead to an overall reduction in bycatch mortality. In the future, it may result in more fishing opportunities through descender device use “credits” in the PFMC fishery allocation process.

**Fisheries Monitoring and Assessment:** The MRP continues to monitor catch and effort in commercial and recreational marine fisheries for finfish and shellfish in the ocean, on beaches, and in the estuaries. Progress over the last year includes the following:

- Work is currently underway to compile a new technical report that will summarize the status of Oregon’s recreational and commercial bay clam fisheries. The report will present time-series data about trends in sport catch and effort over the past five years, and include maps of clam abundance, a summary of the commercial bay clam fisheries, and other related topics. Findings from the report will be used to evaluate temporal trends in harvest effort and help guide future adjustments to the regulations used to manage the bay clam fisheries. A similar synthesis report was completed for Oregon’s recreational crab fishery, in 2012, and is available on our website.

- The commercial fishery for red sea urchins in Oregon is a state-managed fishery. Harvest activity is concentrated on Orford Reef (southern Oregon coast), where more than 50 percent of the statewide harvest is currently concentrated. New surveys of red urchin populations at this site indicate that the density of adult urchins continues to decline and the level of recruitment has been consistently low. Consequently, concern has been raised about sustainability of the urchin population and viability of the commercial fishery. MRP staff worked directly with the commercial urchin divers to identify a series of management options to decrease harvest pressure on the urchin population, and the Oregon Fish and Wildlife Commission took action in March 2014 to reduce the total number of permits over the next two years through attrition. This proactive management step is coupled with new fishery-independent surveys in 2014 and 2015 to gain further information about the size/age structure of the red urchin populations along the southern Oregon coast.

- Beginning in 2014, the agency required a special combined sport abalone-and-scallop permit. The permit is issued at no cost to recreational harvesters with the requirement that they provide detailed records about their harvest activities. For red abalone, the harvesters must provide ODFW with information about the date, location, number of abalone collected, shell size, depth, and relative abundance observed during each collection trip. Similar information is required for the sport harvest of scallops. Over the past five months the agency has issued more than 200 of the sport scallop-and-abalone permits. Information gathered from the harvest record cards will inform management of the abalone and scallop fisheries.

**Research and Resource Assessment and Inventory:** The MRP conducts research and resource assessments in a number of areas, including marine reserves (ecological and socioeconomic), fishery gear (bycatch reduction), estuarine habitat (and species), marine mammal populations, and groundfish populations and movement. In addition to this primary role in research activities, the MRP collaborates on a variety of projects with other agencies (both state and federal), academia, and non-governmental organizations. More recently, these projects have also included an increasing focus on data management and data access across institutions and states. In the past year, the MRP’s research activities have included:

- Nearshore habitat evaluation: the MRP’s Marine Habitat staff focused on supporting the development of ecological baselines for the Cascade Head Marine Reserve (and associated marine protected areas and comparison areas), by evaluating video data from prior years’ remotely operated vehicle surveys. Staff prepared a preliminary report summarizing demersal fish and benthic invertebrate abundance, diversity and associations with bottom habitat type in the area. In addition, they initiated an assessment of the distribution and ecological role of benthic invertebrates that create biogenic habitats in the shallow nearshore zone. Previous work has largely addressed biogenic habitats in deep waters on the outer continental shelf and slope. The examination of shallow systems will add to our understanding of important nearshore ecological resources and the factors that structure fish communities in Oregon's marine waters.

- Nearshore species research: MRP staff have developed a visual assessment tool that we call the “video lander:” essentially a crab pot with video equipment that can be easily deployed for video snapshots of nearshore environments. One 2013 study evaluated how bait influences the fish viewed using this survey tool. In the same study, researchers also evaluated the utility of a stereo video system to estimate fish length. Staff also continued movement studies of demersal rocky reef
fishes and completed some sampling to extend cage-survival studies of rockfish with barotrauma to much deeper waters. 2014 studies are focused on evaluating the long-term survival, health and behavior of yelloweye rockfish that have experienced capture-related barotrauma.

• Bycatch reduction research: MRP staff finished field studies of footrope modifications aimed at further reducing the bycatch mortality of eulachon in the shrimp trawl fishery. Another planned study in collaboration with the Pacific States Marine Fisheries Commission will evaluate whether eulachon bycatch in shrimp trawls can be reduced by making portions of the trawl system, including bycatch reduction devices, more visible to eulachon.

• Pinniped control: MRP staff monitor the status of seals and sea lions (pinnipeds) in Oregon by conducting studies of pinniped population biology, examining pinniped interactions with marine and anadromous fishes and providing information on these issues to government entities and the general public. In the past year, this group has initiated predation control work at Willamette Falls on the Willamette River and continued work at Bonneville Dam on the Columbia River, sites where California sea lions and Steller sea lions aggregate each spring to consume listed salmonid stocks and declining sturgeon stocks.

• Pinniped assessment: Over the past year, MRP staff have been conducting aerial surveys of pinniped populations, resulting in mapping products such as an online map of Steller sea lion haul-outs in Oregon (viewable at http://bit.ly/1elxH3H). This map is designed to call attention to the recent delisting of the eastern stock of Steller sea lions under the federal Endangered Species Act (a success that is in part attributed to MRP staff efforts), and show places along the Oregon coast where they might be observed.

• Shellfish and Estuarine Habitat Assessments (SEACOR): SEACOR continued a two-year study (2013-2014) of shellfish populations and estuarine habitats throughout Netarts Bay, an important estuary for recreational and commercial clammers. During the spring of 2014, staff conducted bathymetric surveys of the estuary using a new ship-based acoustic system to determine tidal elevations in intertidal habitats. This new bathymetric assessment tool will have multiple applications for the MRP to evaluate estuarine and nearshore resources, which are traditionally difficult to assess because of the shallow depth of these habitats. Data from the quantitative surveys will be used by the Shellfish Program to better manage the commercial and recreational clam fisheries in this estuary, to investigate decadal changes in subtidal clam populations, evaluate the role of subtidal spawning stock populations in sustaining intertidal populations, and to provide recommendations for future commercial endeavors. Visit the recently-updated website for reports, clam maps, and other information produced by the SEACOR project at http://www.dfw.state.or.us/mrp/shellfish/seacor/maps_publications.asp.

• ShoreZone Habitat Mapping: MRP staff, working collaboratively with the Oregon Department of Land Conservation and Development (DLCD), continued work on a project to map Oregon’s ocean and estuary shoreline habitats using the ShoreZone mapping protocol. Used extensively in Washington, Alaska, and British Columbia, ShoreZone is a coastal habitat mapping and classification system in which aerial imagery is collected specifically for the interpretation and integration of geomorphic and biological features of the intertidal zone and nearshore environment. The aerial photos may be viewed at http://www.coastalatlas.net/shorezone/. This product was completed by June 2014 and will be useful in a number of marine resource management arenas.

Marine Resource Management: The MRP is involved in many marine resource management issues that relate to ecosystem function and protection of Oregon’s marine resources and habitats. In the past year, MRP staff have been involved in a number of such issues, including:

• Seastar Wasting Syndrome along the Oregon Coast: Many species of seastars along the West Coast (from Baja to Alaska) are dying in great numbers due to a peculiar disease that results in formation of lesions, rapid fragmentation of the body, decay, and death. The Seastar Wasting Syndrome (SWS) was initially noticed in Washington and California in 2013, and has since spread to populations of seastars in Oregon. During the spring of 2014, MRP staff and scientists from multiple academic institutions conducted numerous surveys of sea star communities in the rocky intertidal zone, in sub-tidal habitats, and in the bays and estuaries to document the spread of the disease and to collect samples of diseased individuals for further analysis. MRP staff will be
working with these collaborators to better understand the disease, document its spread, and track the recovery of seastars along this coast.

- Marine Reserves: MRP staff continue to implement five marine reserves in Oregon, as legislatively mandated in 2009 and 2012. Harvest prohibitions are now in effect for four of the five sites: Cascade Head (2014), Otter Rock (2012), Cape Perpetua (2014) and Redfish Rocks (2012). Harvest prohibitions at a fifth, and final marine reserve site at Cape Falcon will begin on January 1, 2016, after two years of baseline data are collected at the site. The program includes development of management plans, monitoring activities (both ecological and socioeconomic), enforcement (in conjunction with Oregon State Police), and outreach. In the last year, the reports for baseline studies of Otter Rock and Redfish Rocks were completed and the data collection for baseline studies of Cascade Head and Cape Perpetua were also completed (final baseline reports will be completed in 2015). Baseline data collection began in May for the Cape Falcon site and will continue through the end of 2015. All reports, supporting materials, and general information about the Marine Reserves Program are available on the Oregon Marine Reserves website (www.oregoncocean.info/marinereserves/).

- Marine Spatial Planning and Renewable Ocean Energy: For close to a decade, MRP staff have been involved in developing policy for and mitigating impacts of renewable ocean energy projects off of Oregon’s coast, including both research (e.g. National Northwest Marine Renewable Energy Center, or NNMREC, at OSU) and commercial developments (e.g. WindFloat off the coast of Coos Bay). This involvement includes representing the state’s fish and wildlife interests on siting committees, and conducting analysis of impacts of potential projects. We are currently working with DLCD in the development of a Geographic Location Description (GLD) under provisions of the Coastal Zone Management Act. A GLD will allow the state to review certain federal permit and license activities in a defined area of Federal waters for consistency with the state’s enforceable policies within their Coastal Zone Management Program. While the MRP’s primary role in marine spatial planning has been to evaluate the ecological aspects of Oregon’s interests, we also have a strong interest in any impacts of development on fisheries and are playing an active role fostering conversations between developers and fishermen to try to reduce conflict between these user groups.

- Invasive species: The non-native colonial tunicate Didemnum vexillum (native to Asia) has become established in the shallow sub-tidal zone at two locations along the Oregon coast, the Charleston Marina and the Umpqua Triangle. MRP staff have been working in cooperation with the Oregon Invasive Species Council and volunteer scuba divers to monitor the persistence and spread of this species along the Oregon coast. Spread of this species in sub-tidal habitats is a concern because the tunicates can overgrow native communities on a variety of natural substrata (i.e., bedrock, boulders, gravel, underwater structures, mooring lines, shellfish populations, aquaculture lines, kelp, fishing gear, boat hulls, floating docks, pilings, etc.). Colonies have already become established along the coastline at several other locations (Puget Sound, California, British Columbia, Alaska, New England, New Zealand). MRP are working on an action plan to address the spread of colonies attached to dock pilings and jetty boulders.

- Non-native species on Japan Tsunami Marine Debris (JTMD): Over the winter and spring of 2014, ODFW shellfish biologists continued to assess the ecological risk due to non-native species attached to floating debris generated by the Japanese Tohoku tsunami (March 2011). Derelict vessels generated by the tsunami continue to land on Oregon’s coast. The submerged surfaces of these vessels are heavily colonized by a diverse mixture of cosmopolitan species (i.e. pelagic gooseneck barnacles) and non-native species (i.e. mussels, acorn barnacles, oysters, chitons, sponges, seaweeds, etc.). MRP staff continue to collect biological samples from JTMD that will be used to better understand the origin of the debris, to characterize colonization on the debris and to continue to assess the risk of these non-native species on Oregon’s native species.

Education, Outreach and Mentorship: MRP staff members regularly participate in a variety of public education and outreach events. Over the past six months, outreach activities have included student mentorship (internships, participating in graduate student committees, etc.), delivery of seminars and guest lectures, establishment of interpretive displays and participation in public events and festivals including the Saltwater Angler’s Show (Salem), Oregon Coast Sportsman’s Expo (Newport), Hatfield Marine Science Center’s Marine Science Day (Newport), and several others coastwide. Over the past year, the MRP has expanded our use of online surveys to gather public input on fisheries management issues, held numerous public meetings and convened advisory groups on a number of resource topics. This past year, MRP-sponsored student mentorship activities included projects related to marine reserves, shellfish biology, fishery management, human development impacts, and marine policy. We look forward to continuing to sponsor projects each year, as funding and opportunity allow.

C. HMSC Visiting Scientists

**HMSC Visiting Scientists**

Maryann Bozza, HMSC Program Manager
Internships at HMSC

II. EDUCATION

Internships at HMSC

Drs. Alyssa Joyce and Pierre De Wit, from the Sven Lovén Center for Marine Sciences, Gothenburg University, Sweden, came to HMSC in September 2013 as Lavern Weber Visiting Scientist Fellows. The purpose of their visit was to work with Dr. Chris Langdon in studying the effects of ocean acidification (OA) on oyster larvae by comparing the performance of larvae from different groups of broodstock oysters under controlled laboratory conditions by measuring the physiological (Joyce and Langdon) and genetic (De Wit) responses. These laboratory experiments are expected to provide a better understanding of the effects of OA on larval physiology and provide genetic tools that can be used to evaluate the degree of stress in larvae exposed to OA conditions.

In August 2013, students from all over the world met at HMSC for the North Pacific Marine Science Organization (PICES) summer school on “Ocean Observing Systems and Ecosystem Monitoring”. The summer school consisted of lectures from various HMSC and OSU staff, laboratory demonstrations of ocean sensors, an introduction to ocean observing platforms, and fieldwork on the R/V Elakha to deploy ocean-observing equipment. PICES is made up of 6 member nations, with students from each at the Summer School (USA, Canada, Russia, China, Korea, Japan). HMSC and the OSU College of Earth, Ocean and Atmospheric Sciences hosted the event.

Captain Don Walsh, famous for a lifetime of pioneering experiences in ocean exploration, delivered a special evening lecture at HMSC in November: “Lunch on Board the Titanic – Two Miles Deep in the Atlantic.” Through photos and anecdotes, Walsh shared his experience diving on the RMS Titanic in 2001 in the MIR submersible to a captivated audience of well over a hundred people. Earlier in the day, he presented a research seminar chronicling the history of undersea exploration, describing the evolution of manned vessels designed to probe the oceans’ depths. Walsh, who serves as an OSU Courtesy Professor, made history co-piloting the bathyscaphe Trieste in 1960 to the ocean’s greatest known depth, the Challenger Deep in the Mariana Trench, at a depth of 35,840 feet. The historic dive received worldwide attention. It also remained a world record dive for 52 years until James Cameron piloted his Deepsea Challenger to the same place in 2012. While in Newport, Walsh also inspired the Oregon Coast’s youngest generation of explorers when he visited Newport Intermediate School on Friday, November 15.

Internships are recognized as one of the best learning experiences a young person can have in preparing for almost any profession. For those contemplating careers in marine science education, research, or resource management, HMSC is an ideal place for an internship experience. Beyond the practical hands-on experience offered, interns at HMSC uniquely benefit from the many opportunities for interaction with scientists, educators, and resource managers representing a wide range of expertise. In 2013-14, thirty-three students took advantage of internship opportunities offered by OSU and partner agencies at HMSC.

Students secured positions by applying directly to the researcher or agency hosting the internship, or by applying to the growing number of internship programs at the center, including the NSF-funded Center for Ocean Science Education Excellence Pacific Partnerships (COSEE-PP) Promoting Research Investigations in the Marine Environment (PRIME) program, and the NSF-funded “Research Experience for Undergraduates” (REU) program. Twenty students were selected (from 290 applicants through a competitive application process) to participate in the REU program, which paired each student intern with a faculty mentor to work on a defined research project over a 10-week period during the summer of 2013. Four community college students participated in the COSEE-PP PRIME at HMSC. Two OSU undergraduate students participated in the state-sponsored Professional and Managerial Internships in State Employment (PROMISE) program with the HMSC Academic Programs. Four undergraduate students participated in the Oregon Sea Grant Undergraduate Scholars Program at HMSC. Three undergraduate students interned through the EPA Growing Research Opportunities program (GRO). One student intern was supported at HMSC by the NOAA-supported Living Marine Resources Cooperative Science Center (LMRSC). In addition several OSU undergraduate students participated in a number of HMSC-associated internships: Yaquina Head Outstanding Natural Area-BLM, ODFW, OSU Free-Choice Learning, HMSC Facilities and the OSU Aquatic Animal Health Program.

Six HMSC REU student interns and eight CEOAS REU student interns from the Summer 2013 program presented research posters at a scientific meeting. Of the HMSC interns, two presented at the 2014 Ocean Sciences Meeting in Honolulu, HI (*), two presented at the 2013 Western Society of Naturalists Meeting in Oxnard, CA (*), one presented at the 2014 Pacific Estuarine Research Society Meeting (†) in Newport, OR, one presented at the Council for Undergraduate Research REU Symposium in Arlington, VA (†), and another REU intern presented to the Cell/Molecular Biology Department at her home institution (†). In addition, one of the COSEE PP PRIME interns presented at the Heceta Head Coastal Conference (†).
Adams, Julia*; Brodeur, R.: Feeding ecology of juvenile chinook (Oncorhynchus tshawytscha) and coho (O. kisutch) salmon based on diet and stable isotope analyses

Andrus, Avery†; Gray, M.; Langdon, C.: Validating a novel technique for evaluating the feeding physiology and behavior of oyster larvae

Baker, Robinº; Lewis, N.; Henkel, S.: Assessing infaunal invertebrate communities among replanted and natural Zostera marina beds

Chace, P. J.*; Sanders, R. D.; Reimers, C. E.: Measuring benthic oxygen and nutrient fluxes in Oregon continental shelf sediments with seasonal variation

Herber, Shelbyˇ; Fisher, J.; Shaw, T.; Peterson, J.; Morgan, C.; Peterson, W.: Differences in larval availability and settlement across invertebrate taxa to the public pier in Yaquina Bay, OR

Tobosa, Laurenº; Hurst, T.: Effects of elevated CO₂ on growth rates of larval northern rock sole (Lepidopsetta polyxystra)

Coleman, Natalie◊; Bosley, K.; Dumbauld, B.: Gastric Mill Rings as a Method for Age Determination in Burrowing Shrimp

During the summer at HMSC, many students gain research experience at sea. For example, several students had an opportunity to participate in bi-monthly cruises aboard the 54-ft coastal research vessel Elakha. Julia Adams and Chris Hager (FROSTI cruise) accompanied their mentors, Ric Brodeur and Kym Jacobson, respectively, on research cruises.

At the end of the 10-week program, all of the REU interns prepared and delivered written reports and oral presentations of their research projects at a symposium attended by faculty, staff, and graduate students. Students also participated in weekly brown-bag lunch meetings at which they discussed their research experiences and plans, gave tours of their research labs, participated in workshops on R software and science communication, and attended a weekly research seminar series.

**Student Awards and Scholarships**

Scholarships and awards totaling $76,304 were given by HMSC represent an important source of financial support for undergraduate and graduate student education and research in marine science. These funds come from generous private donations to HMSC’s student programs. The 20th Annual Markham Research Symposium (named for the Mamie L. Markham Endowment, which annually awards two years of financial support for approximately nine students pursuing research at HMSC) was held on June 18, 2014. Students who had made significant progress towards completion of their research gave brief presentations. Those students being awarded new monies for 2014-15 year (FY15) displayed posters detailing their proposed research. Marisa Litz won the Best Presentation award, and Morgan Bancroft and Renee Albertson tied for Best Poster.

All awardees are listed below with their major professors in parentheses.

**Markham Award**
Kyle Coblentz (Novak)
Iria Gimenez Calvo (Waldbusser)
Jessica Porquez (Suryan)
Nicolas Sard (Banks)
Sheanna Steingass (Horning)
Michelle Stowell (Ciannelli)
Rory Welsh (Vega-Thurber)

**Crebbin Award**
G. Renee Albertson (Baker)
Sophie Pierszalowski (Baker)

**Holt Award**
Morgan Bancroft (Ciannelli)

**Jones Award**
Noelle Yochum (Sampson)

**Reynolds Award**
Sophie Pierszalowski (Baker)

**Robinson Award**
Evan Durland (Langdon)

**Wick Award**
Renee Bellinger (Banks)
Yuka Kobayashi (Park)
Dongwha Sohn (Ciannelli)

**Course Descriptions**

HMSC offers a wide range of courses within the interdisciplinary field of marine science through Oregon State University. Oregon State University offers courses at HMSC in Biology, Fisheries and Wildlife, Science and Math Education, Statistics, Oceanography, Veterinarian Medicine and Zoology. The courses are open to undergraduate students, graduate students and professionals, and generally attract 20-35 students per term. The OSU academic year follows a traditional quarter term system beginning with fall, winter, spring and summer. Summer term is the least impacted. At HMSC, the intensity of the academic year is converse beginning with spring (marine biology
concentration), summer (marine & environmental studies concentration), fall (fisheries & wildlife concentration) and winter, the least impacted term. Summer 2013 marked the first pilot of a full 8-week summer session term at the center including the addition of the first College of Earth, Ocean and Atmospheric Sciences (CEOAS) courses, OC 332 – Coastal Oceanography and GEO 365 – Introduction to Geographic Information Systems. Note: * = use of Interactive Television (ITV), online or online hybrid course. For enrollment numbers, see Section V.

**Summer 2013 Courses:**

*BI 150. INTRODUCTION TO MARINE BIOLOGY* (Cheung)(4 credits)
An introduction and overview of marine life in the sea.

BI/FW 302. BIOLOGY AND CONSERVATION OF MARINE MAMMALS (Albertson)(4 credits)
An examination of the biology of whales, pinnipeds, and other marine mammals, including general adaptations to a marine existence; systematics and biogeography; reproduction; diving physiology; communication and echolocation; feeding and migratory behavior; and marine mammal/human interactions; including conservation issues.

FW 499. SPECIAL TOPICS IN FISHERIES AND WILDLIFE: Field Techniques for Marine Mammal Conservation (Albertson-Gibb) (1 credit)
This course provides hands-on data collection and analysis related to marine mammal conservation issues. Students will learn to use computer software programs for data organization and analysis after field collection from marine mammals.

FW 499. SPECIAL TOPICS IN FISHERIES AND WILDLIFE: Ecology of Marine & Estuarine Birds (Suryan)(4 credits)
This course explores the amazing diversity of marine and estuarine birds and their life histories. As birds are often sentinels of their aquatic environments, the "canaries in a coal mine," the course will also explore the aquatic world in which these birds live, learning how environmental variation, including climate change, affects bird populations. The course includes field trips and self-directed laboratory and field investigations. Topics discussed will include life histories, biogeography, foraging ecology, migration, oceanography and marine food webs, human interactions, and conservation.

GEO 365. INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS (Garza)(4 credits)
Introduction to the principles of geographic information systems (GIS) and experience using a widely popular geographic information system for spatial data input, analysis, and display.

OC 332. COASTAL OCEANOGRAPHY (Fram)(3 credits)
Physics, geology, biology and hydrology of coastal oceans. How coastal waters respond to forcing by heating, cooling, winds, tides, waves, rain, evaporation, river runoff, and freezing. Geography equilibrium cells as sources and sinks of sediment. Rocky shore, beach, mudflat, estuarine, and coastal biotic communities; animal migrations. Law of the Sea rights and responsibilities of coastal states. Fisheries and mariculture in coastal seas. Pollution and coastal ocean resources. Using a matrix to define environmental problems; pathways that pollutants take through the coastal ecosystem.

Z 461/561. MARINE AND ESTUARINE INVERTEBRATE ZOOLOGY (Kirk)(4 credits)
Comparative survey of eight major invertebrate phyla and many lesser-known phyla. Areas of emphasis will be 1) invertebrate identification, 2) natural history (diversity, habitat, feeding, behavior), and 3) comparative anatomy (adaptive significance of morphological structures). Laboratories and field trips will strongly supplement lecture material.

**Fall 2013 Courses:**

*FW 407/507. MARINE SCIENCE SEMINAR* (Arbuckle)(1 credit)
See list of seminar series speakers.

FW 419. THE NATURAL HISTORY OF WHALES AND WHALING (Alexander)(3 credits)
Addresses the natural history of whales as a unique example of adaptation in an evolutionary lineage, and the history of whaling as a general example of the failings of international resource management.

*FW 426/526. COASTAL ECOLOGY AND RESOURCE MANAGEMENT* (Langdon)(5 credits)
Study the ecology and management of coastal marine and freshwater ecosystems as well as natural resources, emphasizing experimental (participatory) learning in a field station setting.

FW 454/554. FISHERY BIOLOGY (Heppell)(4 credits)
Principles and methods used in studying the biology of fishes; ecological requirements of freshwater and anadromous fishes; principles and practices in sport fishery management.

*FW 465/565. MARINE FISHERIES* (Sampson)(4 credits)
A global perspective on commercial fish and shellfish harvesting with emphasis on fishing technology and policy issues.
FW 499. SPECIAL TOPICS IN FISHERIES AND WILDLIFE: MARINE FIELD METHODS (Arbuckle)(2 credits)

FW 590. COASTAL POPULATION GENETICS AND CONSERVATION (Banks/O’Malley)(6 credits)
Hands-on application of molecular population genetics in coastal fishery management and conservation, study design, DNA extraction, PCR, analysis techniques, paper review and write-up.

*FW 599. SPECIAL TOPICS IN FISHERIES AND WILDLIFE: ANIMAL ECOLOGY & SPACE USE (Moriarty) (1 credit)

*FW 599. SPECIAL TOPICS IN FISHERIES AND WILDLIFE: GRADUATE ORIENTATION (Pierson) (1 credit)

*FW 599. SPECIAL TOPICS IN FISHERIES AND WILDLIFE: TEACHING PRACTICUM (Edge) (1 credit)

OC 599. OREGON COAST MATH CAMP (Chelton)(3 credits)
This program combines an intensive review of applied mathematics with scientific lectures and field trips exploring the coastal environment.

**Winter 2014 Courses:**

BI/FW 111. INTRODUCTION TO MARINE LIFE IN THE SEA (Cheung)(1 credit)
A field-focused learning experience, this inquiry based course is a basic overview of the marine life and environment on the Oregon coast, including rocky shores, sandy beaches, mud flats, bays, estuaries, and watersheds. Through lectures, lab and field experiences, students will examine important marine organisms in their habitat, exploring their ecological niches and adaptations to their environments along the Oregon coast.

*FW 407/507. Fisheries & Wildlife Seminar (Staff) (1 credit)

BI/FW 111. INTRODUCTION TO MARINE LIFE IN THE SEA: Marine Birds (Suryan)(1 credit)
A field-focused learning experience, this inquiry based course is a basic overview of the marine mammals on the Oregon coast.

BI/FW 111. INTRODUCTION TO MARINE LIFE IN THE SEA: Marine Mammals (Albertson)(1 credit)

BI 450. MARINE BIOLOGY (Hacker)(16 credits)
A comprehensive lecture and laboratory introduction to the flora and fauna of the marine environment approached from the level of the organism to ecosystem. Ecological patterns and processes characteristic of marine communities will be emphasized.

VMB 727. ORNAMENTAL FISH MEDICINE (Miller-Morgan) (2 credits)
To provide advanced instruction in the common aspects of ornamental fish medicine to fourth year veterinary students. To provide background in husbandry of ornamental fish so that students will be able to discuss husbandry problems with owners of these species. To discuss practice management as it relates to incorporating ornamental fish into a practice.

**Miscellaneous Courses of Note at HMSC**
ALS 199 – U-Engage: Marine Science – Lunar Forces, Edible Sea Vampires and Other Curiosities of the Sea (Cheung)(2 credits) 2013 Fall Term

**Hatfield Student Organization (HsO) Activities**

**Co-Presidents:** Renee Bellinger & Matthew Gray
**Vice President:** Sophie Pierszalowski
**Secretary:** Marisa Liz
**Treasurer:** Erin Fedewa
**Communications Officer:** Alana Alexander & Nick Sard
**Campus Liaisons:** Sophie Pierszalowski & Erin Fedewa
**Historian:** Morgan Bancroft
**Donut Chair:** Nick Sard & Renee Bellinger
**Faculty Co-Advisors:** Itchung Cheung & Sarah Henkel

**Activities:** Student Professional Development, HMSC Community Building, HsO Holiday Raffle, HMSC Donut Break, HsO Travel Awards, Welcome BBQ for new students

2013 Summer HsO Welcome BBQ
Aquatic Animal Health Program
Dr. Tim Miller-Morgan

The Aquatic Animal Health Program (AAHP), supported by Oregon Sea Grant and the College of Veterinary Medicine, has completed a busy tenth year solidifying existing programs and expanding into new areas. Tim Miller-Morgan is the program lead and extension veterinarian overseeing this program. The program has two key areas of focus: 1) Programmatic support in terms of animal husbandry and health management of Sea Grant facilities and programs at the Hatfield Marine Science Center. Further, in this capacity the program provides a multitude of hands-on training opportunities for OSU students, Aquarium Science Students and industry professionals. 2) Outreach to the ornamental fish industry in Oregon, nationally and at an international level.

Colleen Newberg, our Senior Aquarist, and Sidney Stetson, our Research Aquarist, provide the backbone of our programmatic support at HMSC. Colleen manages the animal exhibits in the Visitor Center, Education Wing and the teaching and research laboratory at HMSC. Sidney Stetson manages the husbandry of our teaching and research animals and supports the AAHP and Free Choice Learning (FCL) projects involving live animals. Both provide mentoring to students and professionals who train at our facilities. Bethany Cronin, Paul Hoffman and Greer Brander-McCaffrey serve as our student aquarists. All of these individuals also assist Dr. Miller-Morgan with outreach and education.

The Ornamental Fish Health Initiative is the major outreach initiative within the AAHP. The purpose of the Ornamental Fish Health Initiative (OFHI) is to provide educational programming and service to the ornamental fish industry in Oregon, and is designed to assist wholesalers, retailers, and hobbyists with the successful rearing, husbandry, and health care of ornamental aquatic animals in the aquarium or pond environment.

We continue to disseminate health and husbandry information to the ornamental fish industry through our new blog, Words from a Wet Vet, http://blogs.oregonstate.edu/wetvet/ and our updated website, http://seagrant.oregonstate.edu/extension/fishhealth/index.htm. Dr. Miller-Morgan also frequently consults with local ornamental fish producers, importers, retailers, and hobbyists on health and husbandry issues, USDA Accreditation, and health inspections for interstate and international animal shipments. These consultations originate not only in Oregon, but come from areas throughout the Pacific Northwest and the nation. In addition, recent consultations with stakeholders in Norway, Brazil, India, Japan, Indonesia, Malaysia, Singapore and the Netherlands continue to give an international flavor to the program. Dr. Miller-Morgan travelled overseas a number of times in the past year to lead and co-instruct a number of workshops related to fish health management and biosecurity within the ornamental fish industry. Dr. Miller-Morgan travelled to the state of Kerala, India to lead farmer/exporter training sessions at the Sustainable Ornamental Fisheries Conference in Kochi, Kerala, India, the International Ornamental Fish Technical and Trade Conference, Jakarta, Indonesia to lead a fish health management workshop for marine ornamental fish exporters, and to Oslo and Bergen, Norway to run two workshops for ornamental fish retailers. Miller-Morgan continues to work with local koi, goldfish, and aquarium clubs.

Dr. Miller-Morgan began working with Project Piaba; a project based in Manaus, Brazil that aims to facilitate and improve the sustainable ornamental fishery on the Rio Negro. Miller-Morgan’s primary role is to improve and assess the overall fish health management throughout the chain of custody from collection to export, suggest improvements, and develop a train-the-trainer program for individuals identified by the local industry who will become educational resources for the fishers, middlemen, and exporters and serve as key contacts with international trade and educational organizations.

Dr. Miller-Morgan has coordinated, co-coordinated and instructed in multiple industry and veterinary professional seminars and workshops throughout the year, including: Advanced Koi Health Management for Hobbyist and the Pond Professionals, Point Defiance Zoo and Aquarium, Tacoma, WA; International Zoo, Exotic and Wildlife Medicine Workshop – Fish Medicine Session, HMSC, Newport, OR; Koi Health Basics Workshop for hobbyists and new pond professionals, Point Defiance Zoo and Aquarium, Tacoma, WA.

The AAHP continues to consult with ornamental fish importers, wholesalers and retailers regarding emerging health management issues and development and implementation of biosecurity protocols within these facilities. We are currently working with a number of ornamental fish facilities in the Pacific Northwest, Brazil, India and Southeast Asia.

The Ornamental Fish Health Program’s teaching and research laboratory continues to host numerous students from the Oregon Coast Community College Aquarium Science Program who seek hands-on training in fish and invertebrate husbandry and health management. These students participate in one of three guided learning programs under the supervision of Colleen Newberg and Sid Stetson: Volunteer Aquarist Aides (20 hour minimum), Practicum Experiences (50 hour minimum), or Internships (400 hour minimum). In the past year we have provided these learning experiences for 23 Volunteer Aquarist Aides (1482.5 total hours), four practicum students (206.5 hours) and four interns.
and hands
summer Day Camps at HMSC, providing field experiences
During the summer of 2013, Oregon Sea Grant ran six
investigated watershed connectivit
conservation efforts, explored the Yaquina Bay Estuary, and
learned about ongoing marine mammal research and
through high school students. At these events, students
HMSC campus. A total of 218 students attended these
programs where they toured research vess
HMSC during the 2013-
2014 school year, serving 186 pre-K through high school students. At these events, students
learned about ongoing marine mammal research and
conservation efforts, explored the Yaquina Bay Estuary, and
investigated watershed connectivity and how it relates to
marine debris.

Two day-long Home School Day events were also held at
HMSC during the 2013-2014 school year, serving 186 pre-K
through high school students. At these events, students
learned about ongoing marine mammal research and
conservation efforts, explored the Yaquina Bay Estuary, and
investigated watershed connectivity and how it relates to
marine debris.

During the summer of 2013, Oregon Sea Grant ran six
summer Day Camps at HMSC, providing field experiences and
hands-on programming for a total of 84 campers.

Oregon Sea Grant staff also partnered with other precollege
programs at OSU (4-H, STEM Academy, Gear Up, CAMP) and at other organizations (Upward Bound, Boys and Girls
Club) to provide additional field experiences for middle and
high school aged youth during the summer.

Oregon Sea Grant staff coordinated the annual Newport
Schools Science Fair, which was held in March 2014 and
involved 27 teachers and 800 students in grades K-5. Forty
science mentors from OSU, HMSC and partner agencies
volunteered in classrooms to help students with science fair
projects for the 8 weeks leading up to the community event at
HMSC, which drew an audience of 850 people.

Student Engineering Design Challenges: Oregon Sea Grant
partnered with the Oregon Coast Regional STEM Center, the
Northwest National Marine Renewable Energy Center
(NNMREC), and Oregonians for Renewable Energy Progress
(OREP) to host the first Oregon Coast Renewable Energy
Challenge at HMSC in April 2014. For this event, students
worked in class and at afterschool programs to design and
build model wind and/or wave energy devices, which they
brought to HMSC to test in wave tanks and a wind tunnel.
Thirty-two teams of 4th-8th grade students from the Oregon
cost participated in the event, where industry representatives
served as engineering judges. At the event, Dr. Rob Suryan
also gave a presentation to attendees on his research around
monitoring offshore wind energy devices for potential
impacts to seabirds, which generated a lot of interest among
participants and was very well received.

Oregon Sea Grant staff also coordinated the Third Annual
Oregon Regional MATE ROV Competition, held in Lincoln
City in May 2014. Several hundred elementary through
college students participated in the Oregon Regional MATE
ROV program creating student-built underwater robots of
increasing complexity. Twenty-two of these teams then
participated in the Oregon Regional MATE ROV
competition which was made possible through the support of
45 volunteers, including many researchers and staff from
OSU, HMSC, and partner agencies. Two Oregon teams
advanced to the MATE International ROV Competition,
which was held at Thunder Bay National Marine Sanctuary
in Michigan at the end of June 2014.

Educator Professional Development: For the third year,
Oregon Sea Grant staff partnered with the Oregon Coast
Aquarium (OCA), the Lincoln County School District, and
other partners to hold a two-day professional development
event for teachers and administrators in October. Held on the
HMSC campus and at OCA, the COASTALearning
Symposium reached over 300 educators and included
breakout sessions, field trips, and hands-on workshops with
topics ranging from management of coastal resources to how
to conduct field-based research with students.

Sea Grant Youth and Family Marine Education
Tracy Crews, Marine Education Manager

Youth and Family Programs: During the 2013/14 year, 8861
K-14 students and other youth participated in marine
education programs hosted by Oregon Sea Grant at the
Hatfield Marine Science Center, including 152 Community
College students. These students participated in hands-on
programs ranging from short classes in the field and wet labs,
to multiple days worth of programming. Activities focused
on highlighting current research at HMSC as well as
engaging students in dissections, data collection, and
engineering marine-technology devices.

In addition to the 1-2 hour labs that are offered at HMSC for
groups, four Careers in Science Investigation programs were
held for high school and middle school students on the
HMSC campus. A total of 218 students attended these
programs where they toured research vessels and labs, and
learned from HMSC staff about ongoing research.
Participants also helped conduct a salmon shark necropsy and
collected data with researchers on shellfish in the Yaquina
Bay estuary.

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Symposium reached over 300 educators and included
breakout sessions, field trips, and hands-on workshops with
topics ranging from management of coastal resources to how
to conduct field-based research with students.
III. RESEARCH AND EDUCATION SUPPORT

Oregon Sea Grant coordinated several other professional development workshops at HMSC as well, serving over 150 teachers from Oregon and adjacent states. At these workshops, participants learned about topics ranging from marine debris to ocean exploration to climate change and associated impacts. Some workshops focused on marine technology and the engineering design process, where teachers worked to design, build, and test model wave energy devices and remotely operated vehicles (ROVs). Others focused on coastal field experiences and data collection techniques. Teachers left each of these workshops with a plethora of materials and resources they could use with students in their classrooms.

In addition to teacher professional development, Oregon Sea Grant provided trainings for several dozen informal educators on rocky intertidal ecosystems. Participants included interpretive interns and volunteers from the Bureau of Land Management’s Yaquina Head Outstanding Natural Area and staff from the Oregon Parks and Recreation Department.

**Oregon Coast Quests:** In August, Oregon Sea Grant’s 5th Edition of *The Oregon Coast Quests Book* received the APEX Award for Excellence in the “one-of-a-kind education and training publication” category. During 2013/14, 300 books were distributed to the public and more than 1000 additional signatures were collected in the log books of hidden Quest boxes. School groups, camp groups and the visiting public heavily utilized the three self-guided Quests located on the HMSC campus to learn about estuarine habitats, environmental sustainability and patterns in science.

**Oregon Coast Regional STEM Hub:** In February 2014, Oregon Sea Grant, in partnership with the Oregon Coast Aquarium, Lincoln County School District, and Tillamook School District, was awarded funding by the Oregon Department of Education to establish the Oregon Coast Regional Science, Technology, Engineering, and Mathematics (STEM) Hub, which is officially housed at HMSC. The STEM Hub involves over 40 partners from K-12 education, higher education, informal education centers, government, and industry. The STEM Hub serves teachers and students from Astoria to Brookings, Oregon, connecting in and out-of-school activities, and leveraging resources to provide world-class STEM learning opportunities for K-14 educators and students in communities along the Oregon Coast. In addition to raising student test scores and graduation rates, the Hub aims to ensure that Oregon Coast students are prepared for the future as skilled employees and engaged citizens capable of facing global and regional issues.

**HMSC Director’s Office**

*Maryann Bozza, HMSC Program Manager*

The HMSC Director’s Office, reporting to the OSU Research Office, manages the 49-acre HMSC campus and promotes interdisciplinary and interagency collaboration and cooperation. Director’s Office functions include strategic planning and annual reporting, administration of the numerous interagency partnerships and committees that contribute to campus-wide mission, policy and strategic decisions, and maintenance of HMSC’s infrastructure including IT, buildings and seawater system infrastructure.

FY2013-14 was an exciting year as HMSC welcomed a new Director, Dr. Robert (Bob) K. Cowen. Dr. Cowen was previously the Robert C. Maytag Chair of Ichthyology at the University of Miami’s Rosenstiel School of Marine and Atmospheric Science and the Associate Dean for Research. He had served on the faculty at the University of Miami since 1998, and before that he was a member of the faculty of State University of New York at Stony Brook. He received his Ph.D. from the Scripps Institution of Oceanography in San Diego, California. Dr. Cowen has extensive experience in marine science, including coastal fish ecology, fishery oceanography, larval transport, and marine organism population connectivity from both the Atlantic and Pacific Oceans. His experience is an asset for HMSC as OSU launches the university-wide Marine Studies Initiative (MSI).

HMSC’s Marine Science Day event was held on Saturday, April 12, 2014 on the HMSC campus. Two thousand visitors of all ages enjoyed special interactive displays highlighting a broad array of marine research. This annual open house took visitors behind-the-scenes to meet scientists and educators from the coast’s growing marine science community, including Oregon State University and the federal and state agencies of HMSC. The science on display ranged from the natural history of Oregon’s native marine species to topics such as hypoxia, plankton ecology and ocean acidification. Marine Science Day was also a chance to celebrate the OSU Coastal Oregon Marine Experiment Station (COMES), which is celebrating its 25th anniversary this year.

Other activities included the following Science on Tap presentations:

- **October 7, 2013:** Creatures from Japan via tsunami docks, floats and boats – and how to identify them, by Dr. Ralph Breitenstein, HMSC Volunteer Researcher
- **January 29, 2014:** The reach of ocean acidification into Oregon waters: lessons from the lab to the shore, by Dr. Annaliiese Hettinger, OSU Department of Zoology
- **February 19, 2014:** Predation by bears on salmon: Behavior, ecology and evolution, by Dr. Tom Quinn, University of Washington.
For a list of seminars presented at HMSC, see Section V.

Guin Library
Janet Webster, Librarian

The Marilyn Potts Guin Library continues to be an outstanding resource for the HMSC community of students and researchers, the larger OSU community and the state. Our focused collection brings together information on the science and management of marine and estuarine resources of the Northeast Pacific and coastal Oregon. While much is now available digitally, the print collection provides access to unique material.

The biggest change this past year is the successful renovation of the 25 year-old building. Funded by the HMSC Director’s Office and the OSU Libraries, we added meeting rooms, replaced the carpet and opened up learning spaces for library users. The total cost was $350,000 including design, engineering, construction and furnishings. The design process started in the winter of 2012 with focus groups and conversations. The common needs identified were more meeting space, better access to natural light and continuation of the current “look and feel.”

Construction started in January of 2014 with the placement of plastic sheeting walls to contain the dust generated by demolition of walls. By Marine Science Day on April 12, 2014, we were done enough to dedicate one of the new meeting rooms in honor of our former director, Lavern Weber. Dr. Weber thoroughly enjoyed the celebration of his contribution to HMSC and we were pleased too. His presence lives on in the Guin Library.

The Weber Room is set as a classroom, yet has movable furnishings to accommodate many configurations. Both this room and the newly configured Carol and Barry Fisher Room are fully equipped with technology for conferencing and teaching. An additional room was added where we used to have journals displayed. This is a more informal space that is used on a first-come, first served basis.

Library staff has been removing outdated and unused material from the collection over the past two years. We used the freed-up collection space to give the remaining collection room to breathe. Additional space was reconfigured for more reading and study areas by the south windows. The art collection has been rehung and everything looks great.

Notable activities and events:
- The Oregon Estuaries Bibliographies Project added Siletz Bay and the Yachats River. Links to digital items are included. [http://guin.library.oregonstate.edu/oregon-estuaries](http://guin.library.oregonstate.edu/oregon-estuaries)
- Judy Mullen maintains the HMSC Bibliography that documents all types of publications by students, faculty and agency staff located at HMSC. [http://hmsc.library.oregonstate.edu/](http://hmsc.library.oregonstate.edu/)
- Sheanna Steingass, an HMSC graduate student, created a well-received library display on tsunami debris.
- Susan Gilmont was recognized for her 35 years of service to the OSU Libraries and Janet Webster for her 25 years of service.

IV. PUBLIC OUTREACH & EXTENSION

OREGON SEA GRANT FREE-CHOICE LEARNING EDUCATION PROGRAM

Sea Grant, Visitor Center
Shawn Rowe, Free-Choice Learning Lead, Oregon Sea Grant

Public Programming: The Visitor Center (VC) attracted just under 150,000 visitors from July 2013–June 2014. We continue to attract visitors from all over the world, but nearly 90% of visitors came from the Pacific Northwest and over three hours drive from Newport. Public programs included special events, speakers, and public necropsies for Shark Day, Fossil Fest, and Whale Watch Week. These programs bring in large numbers of visitors during winter months when tourist traffic is usually low. Special public programs were offered each month. The current schedule can be viewed online at: [http://hmsc.oregonstate.edu/visitor/exhibits-and-events](http://hmsc.oregonstate.edu/visitor/exhibits-and-events). Sea Grant VC volunteers and staff also participated in the 2014 Marine Science Day activities as well as the Lincoln County Science Fair. We continued also to offer daily educational programming consisting of guided tours of the Yaquina estuary, animal feeding demonstrations, and daily auditorium research programs.

New Exhibits: Sea Grant staff, working with external funders, HMSC staff, OSU and HMSC faculty, and outside vendors created new exhibits and exhibit areas for the Visitor Center including exhibits on Oregon Trawl industry history, current practice, and management (funded in part by the Oregon Trawl Commission); new Aquatic Animal Health and Ornamental Fish exhibits including a new coral reef tank and nursery and a temperate reef tank; and new exhibits on Biomedical research using fish, new exhibits utilizing the Ideum Multi-touch table, and a new exhibit on...
the destructive force of tsunami waves. A new collaboration with UNAVCO resulted in the installation of the NSF-funded exhibit, Monitoring a Shifting Earth (http://www.unavco.org/highlights/2014/hatfield.html). Not only will the Cyberlab camera system be used for summative evaluation of the exhibit, but it will also be used to create a separately funded research project built on the exhibit and its content to develop replications of the exhibit nationally.

**Gift store:** The newly remodeled gift store opened in time for spring break in March 2014. The store is operated by an independent outside contractor, Wildlife Trading Company, which operates stores in many zoos, aquariums, and science centers nationwide.

**Donation kiosk:** After almost two years of research and contract negotiations with the university, state offices and agencies, and kiosk vendors, a new donation system that allows visitors to make donations of any amount via credit or debit card was installed and operational by early spring. We anticipate that this will raise the per visitor donation substantially in the coming year.

**Research** – Further development and deployment of cyberlab data collection infrastructure and tools: Beta testing of a human observation system for automatically and remotely collecting data for research on learning in informal contexts was carried out with NSF funding this year. Our VC-wide effort to install cameras, face detection, and audio capture linked to computer and handheld-based user information were all successful over summer 2013. By January 2014, the camera and audio system were in use by visiting scholars and outside researchers for data collection. By June 2014, all systems had been linked in preparation for full deployment in summer 2014.

**Visiting scholars:** NSF funding allowed us to host four visiting researchers on three new topics for stays from three to eight days to create or carry out research using Cyberlab technologies. **Four research projects** using various elements of the Cyberlab infrastructure had begun or been submitted to the OSU IRB for summer 2014 work (OSU research IRB approvals and/or determinations of exemption are attached).

- Phipps, Molly (Phipps Consulting): Affect and Emotion in Live Animal Encounters is a project to explore affective components of public interactions around and with a giant pacific octopus. This project employs the Cyberlab camera and audio system at the Octopus Tank area of the Visitor Center.
- Stofer, Katie and Anthony, Lisa (University of Florida): Understanding Museum Visitor Learning. This project focuses on visitor use of two exhibits – the Magic Planet spherical display system, a multitouch wall and the multitouch table. Aspects of visitor/computer interface, visitor use of gestures, and visitor understanding of visualizations are being explored. The project employs the Cyberlab camera system, audio system, and touch table/touch screen tracking software as well as interviews.
- Kate Haley-Goldman (Audience Viewpoints): Open Exhibits. This project represented a partnership to install and test content developed by Ideum Open Exhibits and SSI for formative and summative evaluation in situ. Cyberlab cameras and audio system were paired with evaluator observation and interviews.

**New citizen science efforts:** Two new grant-supported research programs substantially increased Oregon Sea Grant's efforts to support public participation in science research regionally. In October Oregon Sea Grant was awarded an NSF Advancing Informal Science Education Full Development award in partnership with University of Washington and the Coastal Observation and Seabird Stranding Network (COASST) to develop a marine debris citizen science protocol spanning COASST’s current range from northern California through Alaska. Co-Pi Shawn Rowe will be heading up a four-year project to study recruitment and retention of adult volunteers in regional citizen science efforts. A related study funded by the West Coast Sea Grant programs and partnering UW and OSG with University of California, Davis seeks to create and validate a model of factors influencing participation and engagement of adult volunteers in the existing COASST sea bird monitoring citizen science project.

**HMSC Visitor Center Volunteers**
Becca Harver, Coordinator

During fiscal year 2013/2014, volunteers contributed an amazing 10,941 hours of service to Visitor Center operations. New volunteers were recruited throughout the year by word of mouth, posting fliers, and by using newspaper ads. This recruitment method enabled us to add 24 individuals to the volunteer corps.

Volunteers are critical to the success of the Visitor Center. They greet many of the 150,000 annual visitors, orient them to the Center, and provide educational information related to live animals, exhibits, and general marine science. Volunteers also contribute to daily operations by assisting with animal husbandry duties, creating and updating display signage, assisting in exhibit maintenance and development, assisting in administrative duties, and creating and presenting talks for the public and fellow volunteers. Long-time volunteers are also integral to the process of training new recruits.

Additionally, throughout the summer of 2013, 13 volunteers contributed 204 hours of service interpreting at Port Dock 1 on Newport’s Historic Bayfront. Port Dock 1 volunteers
aided in alleviating visitor safety issues and educated visitors about topics including: working waterfronts, history of the area, and natural history information related to California sea lions and other wildlife. Volunteers led guided walks along the estuary trail. Their enthusiasm for life-long learning and desire to share information created memorable experiences for visitors.

Monthly meetings and training sessions were held throughout the year to provide volunteers with new information and to enhance communication between volunteers and staff members. Training topics included (among others): wave energy development along the Oregon Coast, Tufted Puffins, blue whale tracking, and interpretive techniques. In February 2014, 20 volunteers participated in an all-day training session about marine invertebrates featuring presentations by six HMSC marine scientists and educators. Volunteers’ efforts were recognized on a daily basis and were also celebrated at a summer barbecue at Dr. Bill Hanshumaker’s home, a holiday potluck in December, at the annual Volunteer Appreciation Dinner in April, and throughout National Volunteer Appreciation Week (April 6-12).

**Civic Activities**

Maryann Bozza, HMSC Program Manager

HMSC is an active member of the local and regional community. Locally, we engage the Oregon Coast community through outreach, including news media, a Visitor Center volunteer program and a local radio program. HMSC is also engaged in public processes, through partnerships with Lincoln County School District, the Port and City of Newport, Lincoln County and a number of local organizations.

Collectively, we serve as a marine science resource for state and national leadership, partner with marine industries including fisheries and ocean renewable energy, and serve on regional, national and international advisory boards including the West Coast Governor’s Agreement on Ocean Health, the International Whaling Commission, and the Governing Council and several working groups of PICES, the International North Pacific Marine Science Organization.

The reputation of the Hatfield Marine Science Center in the community is enhanced by employees’ active involvement in a wide range of civic and philanthropic activities. Throughout Lincoln County and beyond, faculty, staff, students and agency employees alike are known in their local communities for their volunteerism and service to schools, charitable and public service organizations, local government, youth recreation and sports, and in the visual and performing arts communities. Many boards and elected bodies had HMSC personnel serving in leadership positions in 2013-2014, including Oregon Coast Council for the Arts, Newport Symphony, Pacific Community Health District Foundation, City of Newport, Waldport City Council, Economic Development Alliance of Lincoln County and Yaquina Bay Economic Foundation.

Schools are a particular area of focus for HMSC researchers and staff volunteering their time, and volunteer activities during 2013-2014 included many HMSC scientists who served as mentors for teachers and students and organized a science fair hosted by the HMSC Visitor Center. Other HMSC community activities included a food pantry fundraiser and an HMSC-hosted blood drive.

As a visible and respected institution, the HMSC is also seen as a place for civic engagement, providing meeting space for various community-oriented meetings throughout the year. Visitors included elected officials and their staff for briefings on marine topics of interest to their constituents and leadership of federal and state agency partners.

**Friends of HMSC**

Maryann Bozza, HMSC Program Manager

The Friends of Hatfield Marine Science Center is a membership organization of donors and supporters of HMSC’s research, outreach and education mission. Financial contributions from the Friends provide support for a wide range of programs, including public lectures, a newsletter (http://hmsc.oregonstate.edu/upwelling-newsletters) and other outreach activities, which serve to communicate HMSC research and marine science issues to a broad audience. Donations of volunteer time by members combined with financial contributions support a wide range of innovative marine science education programming for the general public and targeted audiences.

The Friends of HMSC remain a key source of support for graduate student research at HMSC. In total, almost $90,000 was awarded this year to students in a diversity of departments and colleges within Oregon State University. All of these funds originated from private donations to the Hatfield Marine Science Center’s programs over the past several decades; they now reside in endowments that will provide perpetual support to these important programs.
### V. SEMINARS, COURSES AND INTERNSHIPS

**Seminars Presented at HMSC from July 2013 to June 2014**

<table>
<thead>
<tr>
<th>DATE</th>
<th>CATEGORY</th>
<th>EVENT TITLE/NAME</th>
<th>PRESENTER</th>
<th>HMSC CONTACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/11/13</td>
<td>Thursday Seminar</td>
<td>Spatial variation in ecosystem functions and services of seagrass beds along the Pacific Rim regions</td>
<td>Masakazu Hori: Fisheries Research Agency; Masahiro Nakaoka: Hokkaido University; Jun Shoji: Hiroshima University</td>
<td>Ric Brodeur</td>
</tr>
<tr>
<td>7/18/13</td>
<td>Thursday Seminar</td>
<td>Dietary supplementation of water-soluble nutrients to marine fish larvae via enriched live prey.</td>
<td>Matt Hawkyard: OSU Department of Fisheries and Wildlife, Doctoral Student</td>
<td>HMSC Academic Programs</td>
</tr>
<tr>
<td>7/18/13</td>
<td>Thursday Seminar</td>
<td>Physical factors affecting the spatial distribution of bivalve assemblages</td>
<td>Stephanie Labou: OSU Marine Resource Management, Masters Student</td>
<td>HMSC Academic Programs</td>
</tr>
<tr>
<td>7/25/13</td>
<td>Thursday Seminar</td>
<td>Tracking climate change in the northern California current pelagic ecosystem: Response of zooplankton in the Oregon Upwelling Zone to large-scale climate forcing with thoughts on the looming problems of hypoxia and ocean acidification</td>
<td>Bill Peterson: NOAA NWFSC, Oceanographer</td>
<td>HMSC Academic Programs</td>
</tr>
<tr>
<td>7/31/13</td>
<td>Student Defense</td>
<td>Distributions and fishery associations of immature short-tailed albatrosses, Pheobastria albatrus, in the North Pacific</td>
<td>Amelia O’Connor: Marine Resource Management, Masters Student</td>
<td>Rob Suryan</td>
</tr>
<tr>
<td>8/1/13</td>
<td>Thursday Seminar</td>
<td>From the intertidal to the ocean deep: A landscape of possibilities in Marine Ecology</td>
<td>Corey Garza: California State University Monterey Bay, Assistant Professor</td>
<td>HMSC Academic Programs</td>
</tr>
<tr>
<td>8/8/13</td>
<td>Thursday Seminar</td>
<td>Calling behavior of Southeast Alaskan humpback whales (Megaptera novaeangliae): Classification and context</td>
<td>Michelle Fournet: HMSC, Graduate Student</td>
<td>HMSC Academic Programs</td>
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<td>8/8/13</td>
<td>Thursday Seminar</td>
<td>Gene-based approaches to identifying magnetite-based magnetic sensory receptors</td>
<td>Renee Bellinger: HMSC, Graduate Student</td>
<td>HMSC Academic Programs</td>
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<tr>
<td>8/15/13</td>
<td>Thursday Seminar</td>
<td>Research Ethics Faculty Mentor Panel</td>
<td>Scott Baker, Bill Peterson, Clare Reimers, Gil Sylvia &amp; Janet Webster</td>
<td>HMSC Academic Programs</td>
</tr>
<tr>
<td>8/28/13</td>
<td>General Seminar</td>
<td>Sounding the ocean: Animals teach us how they make their living</td>
<td>Kelly Benoit-Bird: College of Earth, Ocean and Atmospheric Sciences, Associate Professor</td>
<td>Dudley Chelton</td>
</tr>
<tr>
<td>Date</td>
<td>Type</td>
<td>Title</td>
<td>Speaker</td>
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<tr>
<td>8/29/13</td>
<td>General Seminar</td>
<td>Beach processes and coastal erosion hazards</td>
<td>Paul Komar: Oregon State University College of Earth, Ocean and Atmospheric Studies, Professor Emeritus</td>
<td>Dudley Chelton</td>
</tr>
<tr>
<td>9/12/13</td>
<td>Thursday Seminar</td>
<td>Energetic waves at Agate Beach: Measuring wave runup under extreme conditions</td>
<td>Julia Fiedler: Scripps Institution of Oceanography, PhD Student</td>
<td>HMSC Director’s Office</td>
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<tr>
<td>10/3/13</td>
<td>Thursday Seminar</td>
<td>Sequencing the uncultured: New insights in the mechanisms of microbial carbon fixation and manganese oxidation at hydrothermal vents</td>
<td>Rick Davis: Oregon Health and Science University</td>
<td>Bill Chadwick</td>
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<tr>
<td>10/10/13</td>
<td>Thursday Seminar</td>
<td>Intrinsic chemical tags: potential tracers of environmental history and natal origin in shark and ray populations?</td>
<td>Wade D. Smith: OSU Department of Fisheries and Wildlife</td>
<td>Jessica Miller</td>
</tr>
<tr>
<td>10/17/13</td>
<td>Thursday Seminar</td>
<td>Corals with malaria? The evolution and ecology of coral-associated apicomplexans</td>
<td>Nate Kirk: OSU Department of Zoology, Postdoc</td>
<td>Scarlett Arbuckle</td>
</tr>
<tr>
<td>10/23/13</td>
<td>General Seminar</td>
<td>How are people and communities impacted by marine reserves? Baseline socioeconomic monitoring</td>
<td>Hilary Polis: Oregon Department of Fish and Wildlife, Contractor</td>
<td>Stacy Galleher</td>
</tr>
<tr>
<td>10/24/13</td>
<td>Thursday Seminar</td>
<td>ISIIS: A new window to assess the predator/prey environment for larval stages of fish</td>
<td>Bob Cowen: HMSC, Director</td>
<td>HMSC Academic Programs</td>
</tr>
<tr>
<td>10/31/13</td>
<td>Thursday Seminar</td>
<td>Science serving society: Reflections on my four years in D.C</td>
<td>Jane Lubchenco: OSU, Former NOAA Administrator</td>
<td>Bill Chadwick</td>
</tr>
<tr>
<td>11/7/13</td>
<td>Thursday Seminar</td>
<td>Beyond essential fish habitat: Using spatial models to link habitat information to single- and multi-species management of fish communities along the US West Coast</td>
<td>Ole Shelton: NOAA Fisheries NW Fisheries Science Center</td>
<td>Waldo Wakefield</td>
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<tr>
<td>11/12/13</td>
<td>General Seminar</td>
<td>Going the last seven miles: Looking backwards at the future</td>
<td>Don Walsh: International Maritime Inc.</td>
<td>Bill Chadwick</td>
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<tr>
<td>11/21/13</td>
<td>Thursday Seminar</td>
<td>The influence of key Antarctic zooplankton on food web dynamics</td>
<td>Kim Bernard: OSU College of Earth, Ocean and Atmospheric Sciences</td>
<td>Michael Banks</td>
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<tr>
<td>12/5/13</td>
<td>Thursday Seminar</td>
<td>Population replenishment of reef fishes: Connections across life stages</td>
<td>Su Sponaugle: OSU Department of Zoology, Professor</td>
<td>Sarah Henkel</td>
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<tr>
<td>12/12/13</td>
<td>Thursday Seminar</td>
<td>Monitoring marine mammal populations using acoustics: Opportunities and challenges</td>
<td>Danielle Harris: University of St. Andrews</td>
<td>Dave Mellinger</td>
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<tr>
<td>12/19/13</td>
<td>Student Defense</td>
<td>Characterization of ecosystem structure and function recovery within the NOAA MOC-P mitigation</td>
<td>Nate Lewis: CEOAS, Student</td>
<td>OSU Department of Earth, Ocean, and Atmospheric Sciences</td>
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<tr>
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<tr>
<td>1/9/14</td>
<td>Thursday Seminar</td>
<td>Collaborative scientific diving on the Central Oregon Coast</td>
<td>Vallorie Hodges: Oregon Coast Aquarium</td>
<td>HMSC Director's Office</td>
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<tr>
<td>1/11/14</td>
<td>Public Event</td>
<td>Shark Day</td>
<td>N/A</td>
<td>Oregon Sea Grant</td>
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<tr>
<td>1/16/14</td>
<td>Thursday Seminar</td>
<td>Measuring ambient noise levels and the acoustic impacts of wave energy conversion off the Oregon Coast</td>
<td>Joe Haxel: OSU/CIMRS and NOAA/Pacific Marine Environmental Laboratory</td>
<td>Bob Dziak</td>
</tr>
<tr>
<td>1/23/14</td>
<td>Thursday Seminar</td>
<td>Habitat associations and behavior of yearling Chinook salmon during early ocean migration</td>
<td>Brian Burke: NOAA Fisheries</td>
<td>Michael Banks</td>
</tr>
<tr>
<td>1/29/14</td>
<td>Science on Tap!</td>
<td>The reach of ocean acidification into Oregon waters: Lessons from the lab to the shore</td>
<td>Annaliese Hettinger: OSU Department of Integrative Biology, Postdoctoral Scholar</td>
<td>HMSC Director's Office</td>
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<tr>
<td>1/30/14</td>
<td>Thursday Seminar</td>
<td>Innovations in fishing: How we change the way we fish and the way we think</td>
<td>John and Sara Skamser: Foulweather Trawl, Newport, Oregon</td>
<td>NOAA NWFSC</td>
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<tr>
<td>2/13/14</td>
<td>Thursday Seminar</td>
<td>Monitoring and control of biological invasions: The case of lionfish</td>
<td>David Kling: OSU Department of Applied Economics</td>
<td>Gil Sylvia</td>
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<tr>
<td>2/19/14</td>
<td>Science on Tap!</td>
<td>Predation by bears on salmon: Behavior, ecology, and evolution.</td>
<td>Tom Quinn: School of Aquatic &amp; Fishery Sciences, University of Washington</td>
<td>HMSC Director's Office</td>
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<tr>
<td>2/20/14</td>
<td>Thursday Seminar</td>
<td>Variation in marine migration patterns of Puget Sound salmon: Small cuts at the knotty problem of residency</td>
<td>Tom Quinn: School of Aquatic &amp; Fishery Sciences, University of Washington</td>
<td>Ric Brodeur</td>
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<tr>
<td>2/27/14</td>
<td>Thursday Seminar</td>
<td>Mapping and analysis of benthic biodiversity patterns on the US West Coast: Results of a graduate student team project</td>
<td>Susan Piacenza and Selina Heppell</td>
<td>Tom Hurst</td>
</tr>
<tr>
<td>3/1/14</td>
<td>Thursday Seminar</td>
<td>Fishery selectivity and its relevance to fishery management and stock assessment</td>
<td>David Sampson: OSU Coastal Oregon Marine Experiment Station and OSU Department of Fisheries and Wildlife</td>
<td>N/A</td>
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<tr>
<td>3/6/14</td>
<td>Thursday Seminar</td>
<td>A comparison of bulk estuarine turnover time methods to particle tracking timescales using a model of the Yaquina Bay estuary</td>
<td>Emilie Lemagie: OSU College of Earth, Ocean, and Atmospheric Sciences</td>
<td>Jim Power</td>
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<tr>
<td>3/20/14</td>
<td>Thursday Seminar</td>
<td>Patterns and processes of straying by anadromous Pacific salmon</td>
<td>Peter Westley: School of Aquatic and Fishery Sciences at University of Washington</td>
<td>Melissa Evans</td>
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<tr>
<td>4/3/14</td>
<td>Thursday Seminar</td>
<td>Modeling the melting mantle at mid-ocean ridges</td>
<td>Trish Gregg: OSU/CEOAS</td>
<td>Bob Dziak</td>
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<tr>
<td>4/10/14</td>
<td>Thursday Seminar</td>
<td>Scientists are people too: My role as filmmaker at sea in Greenland</td>
<td>Saskia Madlener: CEOAS, Marine Resource Management, Grad Student</td>
<td>Bill Chadwick</td>
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<tr>
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<td>Event Description</td>
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<td>4/12/14</td>
<td>Public Event</td>
<td>Marine Science Day</td>
<td>N/A</td>
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<tr>
<td>4/17/14</td>
<td>Thursday Seminar</td>
<td>Predicting habitat suitability: GIS-linked bayesian belief networks for marine spatial planning and decision support</td>
<td>Chris Goldfinger and Chris Romsos: OSU/CEOAS</td>
<td>Jim Power</td>
</tr>
<tr>
<td>4/24/14</td>
<td>Thursday Seminar</td>
<td>Coherent structures and larval dispersal in the California Current system</td>
<td>Cheryl Harrison: OSU College of Earth, Ocean, and Atmospheric Sciences, Postdoctoral Researcher</td>
<td>Rob Suryan</td>
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<tr>
<td>4/26/14</td>
<td>Public Event</td>
<td>Fossil Fest</td>
<td>N/A</td>
<td>Oregon Sea Grant</td>
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<tr>
<td>5/1/14</td>
<td>Thursday Seminar</td>
<td>Low life: A glimpse at deep-earth zombies</td>
<td>Rick Colwell: OSU College of Earth Ocean and Atmospheric Sciences</td>
<td>Bill Chadwick</td>
</tr>
<tr>
<td>5/8/14</td>
<td>Thursday Seminar</td>
<td>Common murres at Yaquina Head: Upper trophic level indicators of changing marine climate or just eagle snacks?</td>
<td>Rob Suryan: OSU Department of Fisheries and Wildlife, HMSC</td>
<td>Bill Chadwick</td>
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<tr>
<td>5/10/14</td>
<td>Public Event</td>
<td>Spring bird blitz: Why birds matter</td>
<td>N/A</td>
<td>Oregon Sea Grant</td>
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<tr>
<td>5/13/14</td>
<td>General Seminar</td>
<td>Euryhaline fishes and their evolutionary potential</td>
<td>Eric Schultz: University of Connecticut, Professor</td>
<td>Su Sponaugle, Bob Cowen</td>
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<tr>
<td>5/15/14</td>
<td>Thursday Seminar</td>
<td>Mangroves and the deep blue C: Exceptionally valuable ecosystems in exceptionally vulnerable times (or a cautionary tale on how you can act globally by eating locally)</td>
<td>Boone Kauffman: OSU Department of Fisheries and Wildlife</td>
<td>Marisa Litz</td>
</tr>
<tr>
<td>5/21/14</td>
<td>General Seminar</td>
<td>Thirty years of Vents Program discoveries</td>
<td>Steve Hammond: NOAA’s Pacific Marine Environmental Laboratory</td>
<td>HMSC Director's Office</td>
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<tr>
<td>5/22/14</td>
<td>Thursday Seminar</td>
<td>OMSI's Coastal Discovery Center</td>
<td>Nancy Stueber: OMSI, President</td>
<td>HMSC Director's Office</td>
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<tr>
<td>5/29/14</td>
<td>Thursday Seminar</td>
<td>Using genetic tools to inform salmon conservation and management</td>
<td>Melissa Evans: OSU Fisheries and Wildlife and Coastal Marine Experiment Station</td>
<td>Kathleen O'Malley</td>
</tr>
<tr>
<td>6/5/14</td>
<td>Thursday Seminar</td>
<td>Oregon Coast Regional STEM Hub</td>
<td>Tracy Crews: Oregon Sea Grant</td>
<td>HMSC Director's Office</td>
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<tr>
<td>6/12/14</td>
<td>Thursday Seminar</td>
<td>The recovery and threats to whales off the US West Coast: Insights from long-term collaboration and new techniques</td>
<td>John Calambokidis: Cascadia Research, Research Biologist</td>
<td>Scott Baker</td>
</tr>
<tr>
<td>6/18/14</td>
<td>Public Event</td>
<td>20th Annual Markham Research Symposium: Presentations by HMSC scholarship and award recipients</td>
<td>N/A</td>
<td>HMSC Academic Programs</td>
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### Courses offered at HMSC from July 2013 to June 2014

#### Summer 2013

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<tr>
<td>BI 150 4</td>
<td>Introduction to Marine Biology (Cheung)</td>
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<tr>
<td>BI 302 4</td>
<td>Biology and Conservation of Marine Mammals (Albertson)</td>
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<td>Biology and Conservation of Marine Mammals (Albertson)</td>
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<td>FW 499 1</td>
<td>Field Techniques in Marine Mammal Conservation (Albertson)</td>
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<td>FW 499 4</td>
<td>Ecology of Marine and Estuarine Birds (Suryan)</td>
<td>32</td>
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<tr>
<td>GEO 365 4</td>
<td>Introduction to Geographic Information Systems (Garza)</td>
<td>12</td>
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<tr>
<td>OC 332 3</td>
<td>Coastal Oceanography (Fram)</td>
<td>18</td>
<td>6</td>
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<tr>
<td>Z461/561 4</td>
<td>Marine &amp; Estuarine Invertebrate Biology (Kirk)</td>
<td>32</td>
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**Total** | 54 | 186 |

#### Fall 2013

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<tr>
<td>FW 407* 1</td>
<td>HMSC Research seminar (Arbuckle)</td>
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<td>FW 507* 1</td>
<td>HMSC Research seminar (Arbuckle)</td>
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<tr>
<td>FW 419 3</td>
<td>Natural History of Whales and Whaling (Alexander)</td>
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<tr>
<td>FW 426* 5</td>
<td>Coastal Ecology and Resource Management (Langdon)</td>
<td>45</td>
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<tr>
<td>FW 454 5</td>
<td>Fishery Biology (Heppell)</td>
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<tr>
<td>FW 465/565* 4</td>
<td>Marine Fisheries (Sampson)</td>
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<tr>
<td>FW 499 2</td>
<td>Marine Field Methods (Arbuckle)</td>
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<tr>
<td>FW 526* 5</td>
<td>Coastal Ecology and Resource Management (Langdon)</td>
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<tr>
<td>FW 554 5</td>
<td>Fishery Biology (Heppell)</td>
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<tr>
<td>FW 465/565* 4</td>
<td>Marine Fisheries (Sampson)</td>
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<tr>
<td>FW 590 6</td>
<td>Coastal Population Genetics and Conservation (Banks/O'Malley)</td>
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<tr>
<td>FW 599* 1</td>
<td>Animal Ecology and Space Use (Moriarty)</td>
<td>10</td>
<td>1</td>
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<tr>
<td>FW 599* 1</td>
<td>Graduate Orientation (Pierson)</td>
<td>19</td>
<td>1</td>
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<tr>
<td>FW 599 * 1</td>
<td>Teaching Practicum (Edge)</td>
<td>11</td>
<td>11</td>
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<tr>
<td>OC 599 3</td>
<td>Math on the Beach (Chelton)</td>
<td>21</td>
<td>7</td>
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</table>

**Total** | 119 | 351 |

#### Winter 2014

<table>
<thead>
<tr>
<th>Credit</th>
<th>Course Title</th>
<th>2013-2014</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI 111 1</td>
<td>Introduction to Marine Life in the Sea (Cheung)</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>FW 111 1</td>
<td>Introduction to Marine Life in the Sea (Cheung)</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

**Total** | 23 | 23 |

#### Spring 2014

<table>
<thead>
<tr>
<th>Credit</th>
<th>Course Title</th>
<th>2013-2014</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI/FW111 1</td>
<td>Intro to Marine Life in the Sea: Marine Mammals (Alexander)</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>BI/FW111 1</td>
<td>Intro to Marine Life in the Sea: Marine Birds (Suryan)</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>BI 450 16</td>
<td>Marine Biology (Hacker)</td>
<td>352</td>
<td>22</td>
</tr>
<tr>
<td>VMB 727 2</td>
<td>Ornamental Fish Medicine (Miller-Morgan)</td>
<td>16</td>
<td>8</td>
</tr>
</tbody>
</table>

**Total** | 72 | 410 |
Note: * = use of Interactive Television (ITV), online or online hybrid course.

**Summer 2013 Internships at HMSC:** Not listed are BLM interns (3), EPA GRO undergraduate interns (3), ODFW intern (1), Aquatic Animal Health Program (2), Free Choice Learning intern (2) and a HMSC Facilities intern (1).

<table>
<thead>
<tr>
<th>REU Interns</th>
<th>Undergraduate Institution</th>
<th>Faculty Mentor</th>
<th>Project Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Julia Adams</td>
<td>Wellesley College</td>
<td>Ric Brodeur</td>
<td>Feeding ecology of juvenile coho and chinook salmon in the northern California Current System based on diet and stable isotope analyses</td>
</tr>
<tr>
<td>Avery Andrus</td>
<td>Grand Valley State University</td>
<td>Chris Langdon</td>
<td>Validation of a novel technique for evaluating the feeding physiology and behavior of bivalve larvae</td>
</tr>
<tr>
<td>Robin Baker</td>
<td>University of Idaho</td>
<td>Sarah Henkel</td>
<td>Assessing infaunal invertebrate communities among replanted and natural <em>Zostera marina</em> beds</td>
</tr>
<tr>
<td>Amanda Brophy</td>
<td>Southern Oregon University</td>
<td>Ted Dewitt</td>
<td>Comparison of denitrification rates and potential among salt marsh habitats in the Pacific NW</td>
</tr>
<tr>
<td>Peter Chace</td>
<td>Monmouth University</td>
<td>Clare Reimers</td>
<td>Measuring benthic respiration rates and nutrient inventories of Oregon Continental Shelf sediments</td>
</tr>
<tr>
<td>Chris Hager</td>
<td>Augustana College</td>
<td>Kym Jacobson</td>
<td>Trophic interactions of marine parasites and prey items of chinook and coho salmon</td>
</tr>
<tr>
<td>Shelby Herber</td>
<td>Western Washington University</td>
<td>Bill Peterson</td>
<td>Daily high tide biological variability in the nearshore due to physical oceanographic parameters forcing along the Newport, Oregon coast</td>
</tr>
<tr>
<td>Laurelyn Perry</td>
<td>Portland State University</td>
<td>Jessica Miller</td>
<td>Is young-of-the-year northern anchovy, <em>Engraulis mordax</em>, growth related to the composition and or quality of lower trophic levels in the Northern California Current (NCC)?</td>
</tr>
<tr>
<td>Lauren Tobosa</td>
<td>California State University, Monterey Bay</td>
<td>Tom Hurst</td>
<td>Effects of elevated CO₂ on growth rates of larval northern rock sole</td>
</tr>
<tr>
<td>Misti Colombo</td>
<td>Lane Community College</td>
<td>Brett Dumbauld</td>
<td>Matching mouth part morphology with DNA fingerprints: examining differences between two species of burrowing shrimp</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROMISE Interns</th>
<th>Undergraduate Institution</th>
<th>Faculty Mentor</th>
<th>Project Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mike Machado</td>
<td>Oregon State University</td>
<td>Itchung Cheung</td>
<td>Program Specialist</td>
</tr>
<tr>
<td>Elisabeth Alleman</td>
<td>Oregon State University</td>
<td>Maryann Bozza</td>
<td>Web Development</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HMSC COSEE PP PRIME Interns</th>
<th>Undergraduate Institution</th>
<th>Faculty Mentor</th>
<th>Project Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Institution</td>
<td>Faculty Mentor</td>
<td>Project Title</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------------------------</td>
<td>---------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Natalie Coleman</td>
<td>Portland Community College</td>
<td>Brett Dumbauld/Katelyn Bosley</td>
<td>Age-Determination and Population Dynamics of Burrowing shrimps in Yaquina Bay, Oregon</td>
</tr>
<tr>
<td>Ella Deck</td>
<td>Lane Community College</td>
<td>Waldo Wakefield/Matt Yergey</td>
<td>Characterization of the nearshore soft sediment fish community of the central Oregon coast</td>
</tr>
<tr>
<td>Katlyn Haven</td>
<td>Chemeketa Community College</td>
<td>Waldo Wakefield/Matt Yergey</td>
<td>Characterization of the nearshore soft sediment fish community of the central Oregon coast</td>
</tr>
<tr>
<td>Luc Frauen</td>
<td>Mount Hood Community College</td>
<td>Mitch Vance/Steve Rumrill</td>
<td>Shellfish Effort and Catch Surveys in Oregon’s Central Coast Estuaries</td>
</tr>
<tr>
<td>Renee Renn</td>
<td>Portland Community College</td>
<td>Jim McManus/Brian Haley</td>
<td>Using a Multicollector Inductively Coupled Plasma Mass Spectrometer (MC-ICPMS) to study the chemistry of marine sediments</td>
</tr>
<tr>
<td>Sea Grant Summer Scholars Intern</td>
<td>Undergraduate Institution</td>
<td>Faculty Mentor</td>
<td>Project Title</td>
</tr>
<tr>
<td>Chelsea Burger</td>
<td>Michigan State University</td>
<td>Patrick Mirick</td>
<td>Not Available (N/A)</td>
</tr>
<tr>
<td>Patrick Cousineau</td>
<td>Oregon State University</td>
<td>Brittan Huntington</td>
<td>N/A</td>
</tr>
<tr>
<td>Sarah Heidmann</td>
<td>Oregon State University</td>
<td>Brett Dumbauld</td>
<td>N/A</td>
</tr>
<tr>
<td>James Kralj</td>
<td>University of Wisconsin</td>
<td>Ted DeWitt/Cheryl Brown</td>
<td>N/A</td>
</tr>
<tr>
<td>Living Marine Resources Cooperative Sciences Center (LMRCSC) Interns</td>
<td>Academic Institution</td>
<td>Faculty Mentor</td>
<td>Project Title</td>
</tr>
<tr>
<td>Jessica Porquez</td>
<td>Oregon State University</td>
<td>Jessica Miller</td>
<td>N/A</td>
</tr>
</tbody>
</table>
VI. PUBLICATIONS

**HMSC PUBLICATIONS: 2014**

(HMSC authors in bold; HMSC Grad students have asterisk*; Grad students at OSU Seafood Lab have two asterisks**)  


Erhardt, A. M.; Reimers, Clare E.; Kadko, D. and Paytan, A. Records of trace metals in sediments from the Oregon shelf and slope: investigating the occurrence of hypoxia over the past several thousand years. Chemical Geology. 2014. v.382: 32-43. doi: 10.1016/j.chemgeo.2014.05.029


Hannah, Robert W.; Rankin, Polly S. and Blume, Matthew T. O. The divergent effect of capture depth and associated barotrauma on post-recompression survival of canary (Sebastes pinniger) and yelloweye rockfish (S-ruberrimus). Fisheries Research. 2014. v. 157: 106-112. doi: 10.1016/j.fishres.2014.04.007 http://hdl.handle.net/1957/51023


Litz, Marisa N. C.; Emmett, Robert L.; Bentley, P. J. ; Claiborne, Andrew M. and Barcelo, Caren. Biotic and abiotic factors influencing forage fish and pelagic nekton community in the Columbia River plume (U.S.A.)


McCann-Grosvenor, Kristina; Reimers, Clare E. and Sanders, Rhea D. Dynamics of the benthic boundary layer and seafloor contributions to oxygen depletion on the Oregon inner shelf. Continental Shelf Research. 2014. v. 84: 93-106. doi: 10.1016/j.csr.2014.05.010

McCann-Grosvenor, Kristina; Reimers, Clare E. and Sanders, Rhea D. Dynamics of the benthic boundary layer and seafloor contributions to oxygen depletion on the Oregon inner shelf. Continental Shelf Research. 2014. v. 84: 93-106. doi: 10.1016/j.csr.2014.05.010

McCann-Grosvenor, Kristina; Reimers, Clare E. and Sanders, Rhea D. Dynamics of the benthic boundary layer and seafloor contributions to oxygen depletion on the Oregon inner shelf. Continental Shelf Research. 2014. v. 84: 93-106. doi: 10.1016/j.csr.2014.05.010


Parks, S. E.; Cusano, D. A.; Stimpert, A. K.; Weinrich, M. T.; Friedlaender, Ari S. and Wiley, D. N. Evidence for acoustic communication among bottom foraging humpback whales. Scientific Reports. 2014. v. 4 (article no. 7508). doi: 10.1038/srep07508  http://hdl.handle.net/1957/54989


Shafer, Deborah J. and Kaldy, James E. Comparison of photosynthetic characteristics of the seagrass congeners


Sylvia, Gil; Cusack, C. and Swanson, J. Fishery cooperatives and the Pacific whiting conservation cooperative: Lessons and application to non-industrial fisheries in the Western Pacific. Marine Policy. 2014. v. 44: 65-71. doi: 10.1016/j.marpol.2013.08.005


Yin**, Tao; Reed, Z. H. and Park, Jae W.  Gelling properties of surimi as affected by the particle size of fish bone. LWT - Food Science and Technology. 2014. v. 58 (2): 412-416. doi: 10.1016/j.lwt.2014.03.037 http://hdl.handle.net/1957/52675


VII. BUDGETS

Budget information was not available for this reporting cycle.