

Oregon State University Hatfield Marine Science Center 2010 - 2011 Annual Report



Oregon State
UNIVERSITY

RESEARCH

EDUCATION

OUTREACH



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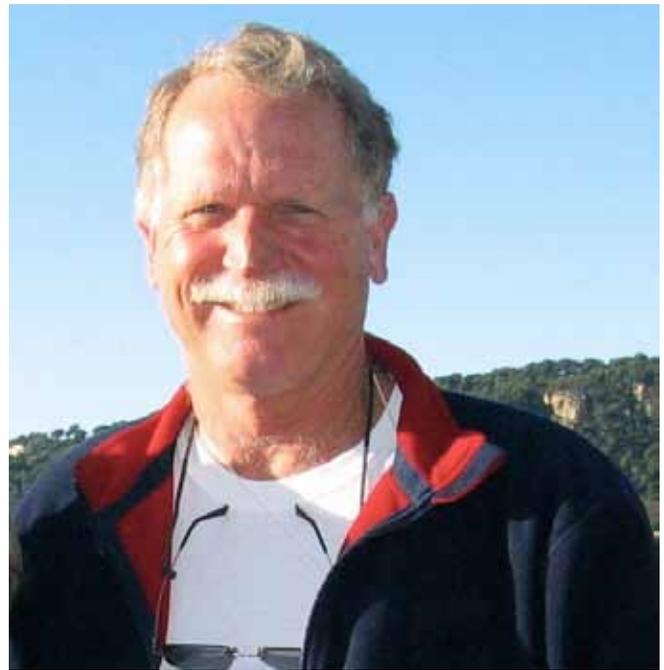
Director's Message

Dr. George W. Boehlert, Director

The past year has seen major growth and changes on the South Beach peninsula in Newport, and HMSC has been intimately involved. The Port of Newport was successful in completing the NOAA Marine Operations Center building and docks -- and transferring them to NOAA. The City of Newport made dramatic improvements in our transportation infrastructure, including an impressive parkway with trails and a new round-about. At HMSC we completed a variety of deferred maintenance projects that have enhanced the campus, but were unfortunately not successful in securing a new OSU research building, continuing to inhibit the growth of our programs. We have also had to close the north half of the HMSC Estuary Trail due to erosion problems, something we hope to fix in the coming year so the public can continue to enjoy this interpretive trail. Finally, a very important event was the closure of HMSC in March in response to the threat of a tsunami from the earthquake in Japan. The experience has led to improvements in our emergency procedures and better locations for evacuation should a local Cascadia earthquake generate a major tsunami.

In HMSC's education programs, Summer 2010 began the seventh year (and third funding cycle) of our National Science Foundation-funded Research Experience for Undergraduates program. This serves as the anchor for a very vigorous summer internship program at the HMSC with nearly 30 interns. The exceptional contributions in mentoring by OSU faculty as well as our agency partners make these programs a success. A landmark event this year was the 30th offering of the spring residential Marine Biology program. This is clearly a capstone event for OSU's marine biology students. Another milestone was reached in spring, when the donor-funded scholarships and awards for graduate student support and research, as celebrated at the Markham Symposium, exceeded \$100,000 for the first time. Oregon Sea Grant continues to distinguish themselves in youth programming and teacher education, including award-winning ocean literacy partnerships, Career Days, day camps and teacher training workshops. They welcomed almost 10,000 K-12 students to the HMSC campus in the past year for marine education programs, including a new program which develops 'real world' research skills through hands-on activities.

Despite a problematic economy, the research programs at HMSC, both OSU and our agency partners, received significant new funding in several areas, including marine renewable energy and climate variability. Plans continued to develop for the Northwest National Marine Renewable Energy Center's offshore test berth site, which will be the first of its kind in the US. OSU's Ocean Observing Initiative at COAS has grown dramatically, and the concurrent development of a regional economic development strategy around infrastructure supporting ocean observing has also gained new momentum. HMSC also hosted a "Rapid Assessment Survey" (RAS) for invasive marine species associated with the Portland PICES (International North Pacific Marine Science Organization) meeting, bringing an international



Hatfield Marine Science Center Director George Boehlert

group of scientists to HMSC. We also enjoyed a 3-month visit from Professor Fred Allendorf (University of Montana), who was a resident at the HMSC as a Lavern Weber Visiting Fellow.

A very important event for HMSC was our external review, which took place in September, 2010. HMSC has only had two formal external reviews in its history, the last in 2000. Our reviewers included three OSU faculty from Corvallis (representing three different colleges), one agency representative, and two marine laboratory directors; the latter included the Past President and President-elect of the National Association of Marine Laboratories. The review team met with diverse groups including agency leaders, faculty, students, and community leaders. Their report included some 28 recommendations designed to improve HMSC's role in the University and its ability to advance OSU's strategic mission. Recommendations were well received and addressed diverse areas including organizational alignment, supporting core research and academic functions, and making strategic infrastructure investments. Action on selected recommendations is being considered by the University administration.

Finally, I would like to acknowledge the outstanding and dedicated faculty, staff and students of HMSC, many of whom have distinguished themselves in their fields over the past year. Several have recently passed on and are sorely missed by the HMSC community; we are honored to recognize Tami Wagner (ODFW), Deb Boylen (NOAA), Alan Cramer (NOAA) and Tim Bellmore (OSU) for their professional achievements, their community involvement and their friendship.

I. RESEARCH

A. Oregon State University



Programs by Stations and Institutes

Coastal Oregon Marine Experiment Station Gil Sylvia, Superintendent

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 unit in Oregon and the largest Agricultural Branch Experiment Station in the United States dedicated solely to coastal and marine issues. COMES was established in 1988 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 12 tenured faculty, 25 staff and research associates, more than 40 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 important to coastal communities and the State of Oregon.

The research programs of COMES encompass six primary areas: *Aquaculture* (Chris Langdon), *Fisheries Science* (David Sampson), *Fishery Management and Policy* (Susan Hanna--emeritus), *Marine Mammals* (Bruce Mate, Scott Baker, Markus Horning), *Marine Economics and Marketing* (Gilbert Sylvia), *Salmon and Marine Fisheries Ecology and Genetics* (Jessica Miller, Michael Banks, Kathleen O'Malley), and *Seafood Science and Technology* (Cristina Dewitt, Jae Park, Yi-Cheng Su). Approximately half of the COMES faculty have joint positions within their academic homes, Oregon Sea Grant, or the Oregon Department of Fisheries and Wildlife. Much of the research involves diverse cooperators including OSU faculty, other national and international research institutes, and industry, state, and federal government including National Marine Fisheries Service and Oregon Department of Fish and Wildlife. COMES also helps sponsor workshops and conferences which further the mission of the Station in supporting wise use of marine resources.

The year 2010-2011 marked continued growth of the Station. After a three year search process including a year moratorium on new hires, in January 2011, Christina Dewitt joined COMES as the new Director of the Astoria Seafood Laboratory. She replaced Michael Morrissey who was acting lab director for more than two years while also having a full time job as Superintendent

of the Food Innovation Center in Portland. COMES continues to work closely with the newly formed Marine Mammal Institute and co-administers joint faculty. David Sampson returned back in April 2011 from his two year leave of absence in Italy while Susan Hanna retired from OSU while retaining emeritus status.

Based on the *Oregon Invests* database, in 2010-2011 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 80 manuscripts and reports including more than 60 in refereed journals and books. COMES graduated 15 students including 9 MS and 6 Ph.D's. COMES faculty also gave over 80 presentations and organized 8 workshops and conferences. For 2010-2011 it is estimated that for each \$1 million in state dollars expended, COMES faculty leveraged an additional \$2.5 million in federal grants and private support.

COMES "Signature Programs" in 2010-2011 include:

The Pacific Whiting Project: Since 1990, COMES has worked with industry to pioneer this seafood industry. COMES research has supported product development, improvements in quality and utilization, and greater benefits from optimizing resource management including conservation of the resource. Today, Pacific whiting is Oregon's largest (by volume) and most technically sophisticated fishery and seafood processing operation and generates between \$30-\$40 million per year in coastal income.

Community Seafood Initiative (CSI): CSI is a unique partnership between COMES, Enterprise Cascadia, and the Seafood Consumer Center. CSI supports coastal businesses and value-added seafood production. Since 2002 CSI has assisted numerous fishermen and seafood processors in business and market planning, and provided more than \$2 million in investments and loans to coastal seafood companies. CSI has assisted in developing new value added seafood products, delivered numerous seafood demonstrations, and assisted the Oregon Dungeness Crab Commission in certification by the Marine Stewardship Council (MSC). They also manage an electronic fisheries information system known as North American Fish Trax, which supports real time fisheries management throughout the U.S. and Canada.

Molluscan Broodstock Program (MBP): MBP conducts research and outreach with industry partners to improve oyster broodstock and associated economic benefits. Hundreds of million 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 local seafood industry in improved product quality, protein utilization, and recovery. The Surimi School trained more than 100 international and domestic students in 2010-2011.

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.

OSU-COMES Seafood Research & Education Center

Christina DeWitt, Director

“Sustainability is not just about managing and protecting a resource, it's also about how you utilize that resource.”

– Richard Draves, Vice President
Product Development Group,
American Seafoods Group
at the OSU Surimi Forum,
April 12, 2011.

The OSU Seafood Research & Education Center has a distinguished history of maximizing the utilization and thereby sustainability of the marine resources managed and harvested from the Oregon coast. Research at this facility continues to support the fishing and seafood communities by investigating those processes that improve safety, extend shelf-life and enhance utilization of Oregon's marine resources.

The laboratory currently has 3 research faculty, Drs. Jae Park, Yi-Cheng Su, and Christina DeWitt. These faculty mentor and support 10 graduate students and 1 international undergraduate student intern. This summer, 2 additional graduate students and 1 international graduate student intern will initiate their studies. The laboratory is also hosting two visiting scientists.

Current seafood safety projects initiated by Dr. Yi-Cheng Su are focused on discovering processes that reduce and/or eliminate *Vibrio parahaemolyticus* and Norovirus from oysters. This research is being facilitated by a major investment by the College of Agricultural Sciences and Oregon State University that involved the remodeling and extension of the seafood laboratory's microbiology laboratory. The extension allows the seafood laboratory to expand Biosafety Level 2 pathogen studies to pilot scale conditions. This ability is important for process validation studies that are needed by Oregon processors.

In addition, Dr. Jae Park is conducting research that is focused on enhancing the sustainability and value of seafood products by discovering those processes that increase the shelf-life, quality and nutrition of surimi seafood products. Dr. Park's group is also involved in research to extract further value from Oregon seafood

by investigating the potential of seafood protein recovered from underutilized species and/or processing inefficiencies to reduce the uptake of oil by fried products.

Finally, the new director for the laboratory, Dr. DeWitt, is initiating studies that evaluate the impact of national sodium reduction efforts on the functionality, shelf-life and safety of seafood products.

Faculty and graduate students at the OSU Seafood Research and Education Center have published 8 peer-reviewed journal articles in the current fiscal year. Zachary Reed completed his Ph.D. thesis entitled: Immunological and/or physicochemical characterization of fish myosin. Dunyu Xi completed her M.S. thesis entitled: Application of probiotics and green tea extract in post-harvest processes of Pacific oysters (*Crassostrea gigas*) for reducing *Vibrio parahaemolyticus* and extending shelf life.

In addition to research, outreach is also being conducted by faculty via the OSU Surimi Research & Technology School and the Surimi Forum. These efforts, spearheaded by Dr. Jae Park, have made the seafood laboratory in Astoria the world leader in surimi research and education. The Forum held this year in Astoria had approximately 120 national and international attendees and the School about 40 attendees. Additional outreach efforts are underway to initiate HACCP courses for seafood processors. In addition, efforts to expand faculty activities to include teaching are also being explored.

Cooperative Institute for Marine Resources Studies (CIMRS)

Michael A. Banks, Director

Now in its twenty-ninth year, the OSU/NOAA Cooperative Institute for Marine Resources Studies (CIMRS) develops and offers opportunities for joint research and outreach to a growing community of University and NOAA scientists dedicated to marine science, graduate education, and learning partnerships with regional industries and communities that are dependent on marine resources.

The Institute's 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 and the OSU Research Office. As a result during the past few years external research grant funding has tripled, graduate student opportunities have diversified, and many more investigators from a broad range of disciplines are joining together to address research problems of environmental, economic and social importance. No other OSU research institute provides both grant administration and personnel support and review in the manner as provided by an academic department.

In FY 11 CIMRS responded to NOAA's RFP for a West Coast

Cooperative Institute to support research facilities in the area of marine resources, which would secure funding for five years, and with favorable review, an additional five years. The final budget request of \$33,760,688 included four research themes: Marine Ecosystems and Habitat, Protection and Restoration of Marine Resources, Seafloor Processes, and Marine Bioacoustics. The collaborative structure of CIMRS facilitates new ways in which basic research can be applied to understand factors impacting marine resources and their management. An integral part of the OSU Hatfield Marine Science Center (HMSC), CIMRS is now administrative home for 37 research staff and 4 research faculty working on collaborative projects with NOAA investigators who also serve as OSU courtesy faculty. Recent research highlights include:

1. CIMRS Right Whale Research featured in NOAA News: http://www.noaa.gov/features/04_resources/greenlandrightwhale.html
2. OAR Hot Item, "Mapping the sound field of an Erupting submarine volcano using an acoustic glider" Haru Matsumoto et al. 2011
3. Over \$900,000 raised from external fund sources and \$26,688 from OSU's Research Equipment and Reserve Fund by CIMRS principal investigators
4. 28 peer review manuscripts in FY 11

For a comprehensive list of funded research projects, please see the CIMRS Annual Report, available at <http://oregonstate.edu/groups/cimrs/pubs-reports.html>

For Collaborative Research with
National Marine Fisheries Service/Northwest Fisheries Science Center.....See Section on NWFSC

For Collaborative Research with
Oceanic and Atmospheric Research Office/Pacific Marine Environmental Laboratory Ocean Environment Research Division/VENTS Program.....See Section on PMEL, Vents Program

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. The CIMRS director works to match qualified students with projects and courtesy faculty based at the Hatfield Marine Science Center.

**PhD Candidates - Department of Fisheries & Wildlife:
Rebecca Baldwin - 2005-2010**

*Using Parasite Community Data and Population Genetics for Assessing Pacific Sardine (*Sardinops sagax*) Population Structure Along the West Coast of North America*

Co-Major Professors: Michael Banks, Kym Jacobson
NOAA Fisheries Rep: Kym Jacobson, NWFSC

Kevin Thompson - 2008-2012

Major Professor: Selina Heppell

NOAA Fisheries Rep: Grant Thompson

Master's Candidate - College of Oceanic and Atmospheric Sciences:

Jesse Lamb - 2008-2011

Comparing the Hydrography and Copepod Community Structure of the Continental Shelf Ecosystems of Washington and Oregon, USA from 1998-2009

Major Professor: Tim Cowles

NOAA Fisheries Rep: William Peterson, NWFSC

Master's Candidate – Fisheries and Wildlife:

James Losee – 2010-2013

Does Interannual Variability of Trophically Transmitted Parasites in Chinook and Coho Salmon Relate to Physical and Biological Processes in the Northern California Current?

Major Professor: Jessica Miller

NOAA Fisheries Rep: Kym Jacobson, NWFSC

Marine Mammal Institute (MMI)

Bruce Mate, Director

The mission of Marine Mammal Institute research is to better understand marine mammal conservation and management issues such as population numbers, critical habitats, migrations, behavior, and interactions with human activities (e.g. fishing, oil and gas development, and shipping). The goal of the Marine Mammal Institute (MMI) is to become the international center of excellence in marine mammal ecology. We envision an interdisciplinary team who can do a more efficient and comprehensive job of answering ecological questions through collaboration. As one of leading academic institutes of its kind, top researchers from around the globe will utilize their combined efforts to continue the legacy of discovery and preservation of critical habits of target species, and understand how they interact with their environment and the human activities affecting them.

The MMI currently consists of 30 faculty, staff, and students. We are comprised of 4 different research groups since the addition of two new faculty in 2006. These research focus areas are the Whale Telemetry Group (WTG), headed by Bruce Mate; the Cetacean Conservation and Genetics Lab (CCGL), headed by C. Scott Baker; the Pinniped Ecology Applied Research Lab (PEARL), headed by Markus Horning; and the Oregon Marine Mammal Stranding Network, coordinated by Jim Rice. Future plans include hiring additional faculty with backgrounds in marine mammal behavior and physiology, as well as expertise in physical oceanography, acoustics, engineering, veterinary medicine, and other specialties.

The Institute is committed to increasing conservation practices and understanding in developing countries, and has a strong diversity component in its hiring and student acceptance policies. The MMI has developed a curriculum to foster the interest of middle-school youth in math and science and promotes highly visible public education programs, which include public participation projects (Oregon Marine Mammal

Stranding Network, Whale Watch Spoken Here, and limited research opportunities). Information is provided via web-based information delivery systems and documentaries for TV.

The Institute works with industries (fisheries, shipping, oil and others) that have potential for endangering marine mammals or are affected by them as they accomplish their work. Agencies, public policy makers, scientists, media, educators, and the general public use MMI's research information.

The MMI also supports the Oregon Marine Mammal Stranding Network. Jim Rice has served as coordinator of this important operation since 2006 and has a network of trained volunteers for the three coastal regions. The OMMSN is under the umbrella of the National Marine Fisheries Service (NMFS), Northwest Marine Mammal Stranding Network under the Marine Mammal Protection Act of 1972. The larger network is comprised of several government agencies and cooperating scientists operating on a volunteer basis. These volunteers respond to strandings either directly or by advising those at the scene on how to proceed. Data collected from strandings become part of a national database used to establish baseline information on marine mammal biology and toxins in the environment. Not all stranding events require or receive a formal response from the volunteers. Jim Rice responds to hundreds of stranding events each year and is also actively engaged in public outreach programs, training volunteers, and collaborating with the OSU College of Veterinary Medicine by providing toxicological samples for analysis and study materials for veterinary students.

Some of the significant MMI projects from the past year are listed below:

- Bruce Mate (**WTG**) tagged both gray whales and sperm whales in September/October 2010 using satellite-monitored location-only tags and GPS tags. Results from the data collected on the western North Pacific (Russian) gray whales, as well as the significant effort to photo-document the wound healing of tagged Oregon gray whales, has resulted in expanded funding to return to Sakhalin Island off the Russian east coast to tag additional western gray whales during the 2011 summer field season. Last year's field season in Russia was limited to males only. The research team were able to show that the effects of tags applied to gray whales off the coast of Oregon in 2009-10 were very minimal through extensive photographic evidence done in several resighting trips to areas where tags were still transmitting (northern California near Crescent City). Due to these successful resight efforts, Dr. Mate was given approval to tag additional western gray whales again in Russia by the International Whaling Commission and permission was also granted to tag female western gray whales as well.
- Sperm whale research reported in 2010 in the Gulf of Mexico, after the oil spill last spring, was also funded for the summer of 2011. Last year, they successfully tagged 12 sperm whales in about a month's time, while the oil was still flowing and the satellite locations from these tags showed them moving around the edges of the heaviest oil, perhaps to feed on squid "stunned" by oil or dispersant.
- Other projects for the Whale Telemetry Group included

monitoring of pinnipeds during sound exposures from projects taking place at the port for the new NOAA facilities.

- Each year in the fall, Bruce Mate teaches a two-day workshop called "Whale Watch Spoken Here". Hosted by the Whale Watch Center (Oregon State Parks), it provides training to dozens of new volunteers each year. These trained volunteers then work at 26 "Whale Watching Spoken Here" sites along the Oregon Coast to help visitors spot gray whales during the winter and spring annual migrations.
- Scott Baker (**CCGL**), associate director of the MMI received the prestigious Pew Fellowship in 2011. The program provides a three-year stipend to distinguished scientists for conservation projects designed to address critical problems facing the world's oceans. Scott will use the fellowship to study populations of dolphins in the South Pacific.
- Scott Baker's group is currently working on several projects funded by different agencies: National Fish and Wildlife Foundation (*Populations of Hector's Dolphins in Time and Space*); Glacier Bay National Park (*Linking Genetic and Long-Term Sighting Histories of Individual Humpback Whales in a Collaborative Database*); The International Whaling Commission (*Further Analysis of Plausible Stock Structure of Western North Pacific Minke Whales Based on a Comprehensive Dataset of mt DNA Sequences*); The Ocean Foundation (*Genetic Monitoring of the Critically Endangered North Pacific Right Whale*). Scott is also collaborating with Cascadia Research Collective on an Office of Naval Research-funded project to develop gene GIS. This is an important and timely project to provide a valuable tool of use in examining photo-ID and genetics data on whales. He and his research group are also collaborating on this project with Dawn Wright in OSU's Dept. of Geosciences.
- Markus Horning's lab (**PEARL**) received a three-year NSF award (*IDBR: Development of a Miniaturized Implantable Satellite Transmitter to Monitor Survival, Predation and Reproduction in Marine Endotherms*). He is collaborating with OSU School of Mechanical, Industrial and Manufacturing Engineering and Wildlife Computers Inc. Undergraduate and graduate students in the Computational Mechanics and Applied Design Laboratory are participating in the multi-disciplinary integrative application of technological innovation into transformative biological research. At the HMSC, a dedicated education and outreach package will provide linkages between technological innovation and biological research to other scientists, public people of all ages, as well as K-12 school children. The outreach package will utilize an exhibit and will provide specifically developed curriculum elements that meet National Science Education Standards and Ocean Literacy Principles. Curricula will be made available via the project website and to the wider Sea Grant audiences.
- Markus Horning also received another NSF (Polar Programs) award for three years beginning in June of 2011, entitled "*Thermoregulation in free-living Antarctic seals: the missing link in effective ecological modeling*". He will also take an undergraduate intern with him to the field in the first two years and in the third year, the student will gain experience in compiling the results and modeling the data collected from

the first two years' field studies.

Northwest National Marine Renewable Energy Center (NNMREC)

George Boehlert, HMSC Director

Oregon State University is home to the US Department of Energy-funded Northwest National Marine Renewable Energy Center (NNMREC). OSU focuses on wave energy, and our partner the University of Washington is addressing tidal energy. The objectives of the NNMREC are to facilitate device commercialization, inform regulatory and policy decisions, and close key gaps in understanding. The following topic areas are being addressed by Center scientists:

- Development of facilities to serve as an integrated, standardized test Center for U.S. and international developers of wave and tidal energy;
- Evaluation of potential environmental and ecosystem impacts, focusing on the compatibility of marine energy technologies in areas with sensitive environments and existing users;
- Device and array optimization for effective deployment of wave and tidal energy technologies.
- Improved forecasting of the wave energy resource;
- Increased reliability and survivability of marine energy systems.

Dr. Robert Paasch of the College of Engineering is principal investigator of the DOE award and served as NNMREC Center director through the end of June 2011, after which Dr. Belinda Batten will take the role of director. Co-principal investigators at OSU are Annette von Jouanne in Electrical Engineering and George Boehlert at the HMSC.

HMSC-based NNMREC activities over the last year at the HMSC involved i) research on environmental effects of wave energy development in the Pacific Northwest, ii) outreach to the public on wave energy development, and iii) development of the test berth offshore of Newport. Research characterizing benthic habitats (Sarah Henkel), assessment of effects on marine mammals (by the Marine Mammal Institute), potential impacts on seabirds (Rob Suryan), and acoustic characterization of wave energy sites before and after installation (Bob Dziak, Dave Mellinger) have all been initiated in the past year with funding from NNMREC as well as additional funding from BOEMRE, DOE, and the Oregon Wave Energy Trust. In addition, partial funding (with the Port of Newport) allowed research by David Mellinger and the Marine Mammal Institute of the potential effects of noise from piledriving in Yaquina Bay on distributional patterns of pinnipeds in the bay. With significant assistance from Oregon Sea Grant Extension, public engagement has led to agreement for a test berth site off Yaquina Head, and advances have been made by the NNMREC in design of the "mobile ocean test berth" that will be located there. Contributions to the NEPA characterization of the test berth site as well as the basic ecological characterization have also been provided by HMSC scientists. Considerable interest has been expressed by

commercial developers of wave energy devices for testing at the NNMREC site off Yaquina Head. This facility will be the first of its kind in the US and may be operational by late summer 2012.

Oregon Sea Grant Stephen Brandt, Director

Oregon Sea Grant's mission is to develop and support an integrated program of research, outreach, and education that helps people understand, rationally use, and conserve marine and coastal resources. Our activities respond to the needs of ocean users and act to stimulate the Oregon economy.

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 several interdependent and critical topical areas including healthy coastal ecosystems, sustainable coastal development, safe and sustainable seafood supply, hazard resilient coastal communities, and marine education.

Oregon Sea Grant's very competitive grants program is the pre-eminent marine research enterprise funding research in academic institutions throughout Oregon. This research addresses issues of high importance and societal relevance, and places priority on prediction (rather than explanation) and meaningful collaboration with industry, agencies, communities, and other stakeholders.

The program provides professional, technical, and public education, as well as Extension services through the Sea Grant Extension program. In addition, Sea Grant supports undergraduate and graduate students as Sea Grant Scholars to study important marine and coastal problems.

Everything the program does, finally, is driven by an ethic of public service, and the program uses various approaches to engage our constituents. The users of Oregon's marine resources are key contributors to the program. An advisory council of marine industry and coastal community leaders provides external review of program emphasis and continued progress. Oregon Sea Grant Communications works collaboratively with program Extension faculty and educators to engage, inform, and assist a range of stakeholders, such as K-12 teachers and students, community and industry groups, and state resource managers, by developing and providing research-based information. Communications deploys a wide range of media tools, including, as appropriate, print, digital, and electronic media. The communications specialists cooperate with other information offices at Oregon State University and with colleagues in the national Sea Grant network.

Multidisciplinary and interdisciplinary in operation, the program involves faculty and students in several Oregon institutions of higher education. Recent participants in the program also include

the University of Oregon, Oregon Health and Science University, Portland State University, and Eastern Oregon University. In addition, Oregon Sea Grant maintains close relationships with several research facilities on the Oregon coast: the OSU Seafood Laboratory in Astoria, the OSU Hatfield Marine Science Center in Newport, and the Oregon Institute of Marine Biology in Charleston. Sea Grant manages the Visitor Center of the Hatfield Marine Science Center as a public science learning facility and learning laboratory.

Web site: <http://seagrant.oregonstate.edu/>

Research Programs by Academic Unit

College of Agricultural Sciences

Department of Botany and Plant Pathology

Gayle Hansen, Courtesy Associate Professor - Senior Research

Mission and Objectives: During the 2010-2011 academic year, Gayle Hansen continued her research on the distribution and taxonomy of west coast seaweeds. In addition to updating her Oregon checklist, Gayle's ultimate goal has been to provide comprehensive floristic accounts of the seaweeds and seagrasses inhabiting targeted areas along the coast in Alaska, Washington, and Oregon.

Research: Oregon's Historical Baseline Data for Seaweeds: As a herbarium botanist, Gayle relies heavily on the distributional information provided by specimens of pressed marine algae held by herbaria around the world. By studying these specimens, checking their identifications, and recording the label information from these specimens as well as her own extensive collections, she has compiled a database on the occurrence and distribution of seaweeds along our coast. Her database now contains entries from over 12,000 specimens collected from 1805 to the present time.

Oregon's Marine Floral Biodiversity: As a part of preparing the distribution database, Gayle has collected and vouchered (as herbarium specimens) seaweeds and seagrasses from numerous sites along the Oregon coast. This past year, she worked primarily on the following projects:

1. The biodiversity of 3 rocky intertidal beaches on the central coast of Oregon. Using data from both historical and present-day collections, her studies have revealed that up to 220 species of seaweeds and seagrasses occur on each of these beaches. These counts indicate that Oregon's central coast is a hot spot of biodiversity for west coast macrophytes.
2. A preliminary study of Oregon's introduced marine species. As a part of the PICES Rapid Assessment Study of Introduced Species, Gayle and Takeaki Hanuda, a marine molecular botanist from Kobe University in Japan, collected seaweeds and seagrasses from 3 Oregon estuaries. Through historical, morphological, and molecular study,

- they determined that 6 of the 54 species they found were introduced. During the study, they also characterized the species of *Ulva* involved in Oregon's green tides and discovered a newly introduced species to the area.
3. The biodiversity and biomass of subtidal species at Oregon's pilot marine reserve at Redfish Rocks. Two years ago, Gayle provided a preliminary checklist of the seaweeds of Redfish Rocks. This year, ODFW employed her to analyze seaweed biodiversity and biomass from extractive quadrat sampling at depths of 10-14 meters inside and outside the new marine reserve. During the study, 66 species of seaweed were found with up to 25 species occurring in a single 0.25-m² quadrat. Moreover, *Laminaria longipes*, discovered as a new record for Oregon during her last survey, appears to be the dominant midstory kelp in the area.
4. Molecular biological studies of Oregon's seaweeds. Gayle continues to provide material of Oregon's problematic seaweeds to molecular biologists around the world for sequencing and use in their phylogenetic studies. This past year she has been working primarily with Show-Mei Lin of National Ocean University in Taiwan to examine the red alga *Hymenena* along our coast. Also, she has worked with Hiroshi Kawai and Takeaki Hanuda, both from Kobe University in Japan, to characterize a new-to-science green alga from our outer coast.



Above: *Laminaria longipes*, a new midstory kelp from Redfish Rocks

Outreach: As the local expert on seaweed taxonomy, Gayle identified seaweeds for local residents and scientists periodically throughout the year. Also, she continued to sell her poster, Oregon Seaweeds -- a Sampler. This poster, which includes pristine illustrations of 40 of our local seaweeds, is available for purchase at the HMSC, Yaquina Head, and South Slough bookstores as well as various gift shops along the coast.

Department of Fisheries & Wildlife

Ecological and Conservation Genetics of Fishes

Kathleen O'Malley, Assistant Professor

The Ecological and Conservation Genetics Laboratory (ECGL) is dedicated to the study of how genetic and ecological factors interact to shape life history variation among natural populations of marine and freshwater fishes. The goal is to better understand the primary processes underlying this diversity in threatened and endangered species distributed along the West coast. The ECGL employs cutting-edge techniques for high-throughput genomic

analysis to develop conservation strategies aimed towards retaining genetically healthy populations in threatened habitats.

One primary research area focuses on the genetic mechanisms and environmental cues that influence the timing of migration in Pacific salmon both as out-migrating juveniles and returning adults. One recently published study indicated that circadian rhythm genes, which sense changes in photoperiod (day length) and mediate seasonal behaviors, influence the adult migration timing of two Pacific salmon species, Chinook and chum salmon. A second recently published study also showed that this same set of genes influence growth and migration timing in juvenile coho salmon. These studies were conducted in collaboration with Drs. Jeff Hard and Michael Ford at the Northwest Fisheries Science Center, Seattle, Washington as well as Dr. Kerry Naish at the University of Washington.

Ongoing work in genetic aspects of migration timing include a three year study funded by the California Department of Water Resources to distinguish the federally listed threatened spring Chinook salmon from the more abundant fall run. Faculty research assistant Brandon Jones has completed the data collection and a manuscript is now in prep describing the genetic differences between spring and fall run Chinook salmon in the Feather River, CA.

A recently formed collaboration with the Norwegian Institute for Water Research has provided funding to investigate the genetic mechanisms influencing Arctic charr migratory patterns. This research will complement ongoing studies examining the genetic differences of temporally divergent runs of Atlantic salmon in Norway and Ireland (collaboration with the Irish Marine Institute) as well as offer a comparative genomics perspective to the studies conducted on Pacific salmon.

A new student, Amelia Whitcomb, has begun her masters training looking at the genetic characteristics of mate choice in coho salmon in the wild (co-advised by Dr. Michael Banks). A collaborative project with the Oregon Hatchery Research Center and NOAA is being developed to extend this research to the laboratory and investigate how mate choice affects offspring fitness.

Selection of the 'Acquisition of a Next Generation Sequencer for Marine Genomics' proposal (PIs Kathleen O'Malley, Scott Baker and Michael Banks) by OSU's Agricultural Experiment Station Strategic Investment Fund enabled installment of a 454 Junior Genome Sequencer into the HMSC Marine Genomics lab. This instrument has proven invaluable to a number of graduate students and postdoctoral students conducting genomic studies on marine organisms including gray whales, krill and salmon and will be the primary tool used by Amelia for her graduate work.

Dr. Fred Allendorf, the Lavern Weber Visiting Scientist, spent three months interacting with faculty and students in the Marine Genomics Program at HMSC and is now a member of Amelia's graduate committee. Kathleen and Fred co-taught a 2-credit course for graduate students entitled Genetics and Management of Exploited Populations. In addition, Fred and Kathleen

submitted a proposal for support from the Cooperative Institute for Marine Resources (CIMRS), Michael Banks, Director: Application of Evolutionary Models to Selective Effects of Fishing and Climate Change on Marine Species to continue research collaborations in the future.

Kathleen serves on the graduate committee for five students and three of these individuals successfully completed their Research Review this year and have begun data collection and analysis. A Bioinformatics Workshop organized by Kathleen and lead by Chris Sullivan from OSU's Center for Genome Research and Biocomputing (CGRB) provided an excellent opportunity for students and research faculty at the HMSC to learn about the computational resources and tools available through the Center. Similarly, Kathleen helped organize a Fish Genetics Workshop for Oregon Department of Fish and Wildlife's staff to learn about current genetics projects and how the work relates to hatcheries and hatchery practices.

Fisheries Population Dynamics

David Sampson, Professor, COMES

David returned to Oregon in mid-April 2011 (and to the HMSC in May) and ended his two-year leave of absence from OSU. While he was away from Oregon he worked as a Senior Fisheries Scientist for the European Commission at their Joint Research Center (JRC) in Ispra, in northern Italy near Milan. His activities described in this annual report took place mostly in Europe. At the JRC David worked in the Maritime Affairs Unit of the Institute for the Protection and Security of the Citizen as a member of the FISHREG Action, a group of about 25 fisheries scientists and economists who provide technical advice and policy support regarding various aspects of European fisheries science and management.

During summer 2010 David attended several conferences in Europe, presenting papers at the biennial meeting of the International Institute of Fisheries Economics and Trade in Montpellier, France and at the Fishery Dependent Information Conference in Galway, Ireland. He also presented a poster at the Annual Science Conference of the International Council for the Exploration of the Seas in Nantes, France. During October he served as chair of a review group of 12 experts, from European Union countries plus Norway and Canada, who met for a week in Brussels to conduct a "Review of needs related to surveys". The group, which evaluated over 100 fisheries research surveys that had been proposed for funding under the European Union's Data Collection Framework, developed a ranked list of priority scorings for consideration by the Directorate General for Maritime Affairs and Fisheries when making decisions to fund future fisheries research surveys.

The focus of David's research work at the JRC was the construction of a general-purpose bioeconomic simulation model. He used the model, which is multi-species, multi-fleet and spatially explicit, to simulate the behavior of a set of "balance indicators" that have been proposed for use in European fisheries management. The model was also the centerpiece of a proposal

that David prepared with Jim Wilen (UC Davis) and submitted to West Coast Sea Grant. The preproposal was prepared and submitted while David was still in Italy; the full proposal was submitted in late May, after David's return to Oregon. If funded the project will refine the bioeconomic simulator and apply it to two West Coast fishery management issues: (1) how to set annual catch targets that have adequate buffers for management uncertainty and (2) how to set trip-limit regulations so that catch allocations are achieved without needless loss of fishing opportunities or other inefficiencies.

While David was away from OSU he continued to serve as the External Coordinator for the University of Miami's Center for Independent Experts, which provides independent peer reviews of fishery stock assessments and other forms of marine science to NOAA Fisheries. As the CIE External Coordinator, David helps administer all science 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.

Upon returning to Oregon David again took on the role of being Oregon's representative on the Scientific and Statistical Committee (SSC) of the Pacific Fishery Management Council. He attended the June meeting of the SSC in Spokane, WA.

During the 12-month reporting period David supervised one graduate student, Gladys Macaosip, a Fulbright Scholar from the Philippines and a Masters Degree candidate in the Department of Fisheries and Wildlife. Gladys conducted research to identify the fish species currently residing in Lake Lanao in the Philippines and analyze traits that have evidently allowed certain fish species to successfully invade this lake. Early in the 1990s Lake Lanao was the home of 16 endemic species of cyprinids, but many of these species now appear to be extinct. Gladys successfully defended her thesis in June.

During autumn 2010 David taught the e-campus version of his OSU course "Dynamics of Marine Biological Resources".

Invasive Species

John Chapman, Research Associate
No report submitted this year.

Marine and Anadromous Fisheries Ecology

Jessica A. Miller, Assistant Professor

Program Objective: The Marine and Anadromous Fisheries Ecology program at HMSC 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), that we use to elucidate migratory patterns in marine and anadromous fishes.

Students and lab personnel: New students arrive and two students finish their MS! **Andrew Claiborne, MS**, recently joined the laboratory to examine the timing of size-selective mortality in Chinook salmon and explore whether hatchery fish are differentially affected by size-selective mortality. **James Losee, MS**, also joined the laboratory and is determining whether the parasite community present in juvenile Chinook and coho salmon is related to ocean conditions and if parasite communities can be an indicator of future survival. **Londi Tomaro, MS**, finished her MS in December. She quantified the role of juvenile growth and migratory behavior on the survival of mid-upper Columbia River spring-run Chinook salmon. **Ruth DiMaria, MS**, will complete her MS in July 2011. She is examining the spatial structure and source contributions of Pacific cod recruits in the southeastern Bering Sea, Alaska. **José Marin Jarrin, PhD**, is continuing to investigate the role of surf zones in the early life history of Chinook salmon. **Jacci Zappa and Lori Boatright** provided efficient and enthusiastic laboratory assistance for several on-going research projects. Finally, **Kristen Gloeckler**, a participant in the HMSC Research Experience for Undergraduates, recently joined the laboratory for the Summer of 2011 to help us describe an interesting and undescribed pattern in the concentration of barium in rockfish otoliths. An apparently cyclic pattern of barium concentrations across the otolith growth axis may be related to variability in ocean conditions, such as upwelling, and could thus provide a proxy of prior ocean conditions.

Dr. Miller co-taught FW474/574-The Early Life History of Fishes in Fall 2010. A greater scientific understanding of the mechanisms affecting fish population is needed to develop sustainable management strategies for renewable ocean resources. Understanding fish early life stages is an important component of sustainable management. Therefore, the primary goal of this class is to present the challenges that fishes experience as they move from the egg stage through recruitment to the adult population. Topics that are addressed include: egg and larval dispersal and transport, metamorphosis and settlement, size-selective and density-dependent mortality, feeding, growth, and predation. The course includes lecture, laboratory and discussion sessions and is offered to students at both the HMSC and Corvallis campuses.

Current and recently completed projects:

- Factors influencing early marine survival in fall- and spring-run Columbia River Chinook salmon. (Funded by the Bonneville Power Administration)
- Larval source contribution and dispersal histories of Pacific Cod in the Bering Sea. (Funded by North Pacific Research Board)
- Acquisition of new instrumentation! A new laser ablation-inductively coupled plasma mass spectrometer for the study of high-resolution records in Earth materials will be in place at OSU by August 2011. This instrument is a key component for much of the lab's research projects and allows us to

measure the chemical composition of various hard parts, such as fish otoliths and shark cartilage. (Funded by the National Science Foundation)

- This new grant will allow Jose Marin Jarrin to expand the scope of his dissertation research and examine the impacts of climate change on growth and migration of juvenile Chinook salmon. (Funded through an Oregon Conservation Strategy Implementation Grant)
- Determination of the maternal origin of *Oncorhynchus mykiss* from Washington coastal streams. (Funded by Channel and Forest Metrics, Inc.)
- Nursery areas, natal origin and natural elemental signatures: implications for connectivity and conservation of shark and ray populations (completed July 2010). (Funded by the National Science Foundation)
- Effects of temperature and salinity on the otolith incorporation of Sr/Ca and Ba/Ca in juvenile Chinook salmon (completed May 2011).

Awards:

Washington County Fly Fishers, Andrew Claiborne
Oregon Council Federation of Fly Fishers Scholarship, Andrew Claiborne
Markham Scholarships, Andrew Claiborne and James Losee
Henry Mastin Graduate Fund, Jose Marin Jarrin
Thomas G. Scott Grant Scholarship, Ruth DiMaria
H. Richard Carlson Scholarship, Ruth DiMaria

Marine Fish Ecology

Selina Heppell, Associate Professor
Scott Heppell, Assistant Professor

This year, the Heppell Lab had two major projects running through our lab at HMSC. The first project focused on rockfish movements and habitat use in an MPA at Redfish Rocks near Port Orford, Oregon. The second project dealt with the incorporation and detection of elemental signatures in the vertebrae of young of the year sharks and rays. We have also been finishing up our analytical work on a Pacific ocean perch (POP) project, which had fieldwork based in the Gulf of Alaska. These projects have been funded by Oregon Sea Grant (rockfish), the National Science Foundation (skates and rays) and the Alaska Fisheries Science Center and the North Pacific Research Board (POP). In addition to work being performed by graduate students in the Heppell lab, Dafne Eerkes-Medrano, a graduate student of Bruce Menge in Zoology, has been using our laboratory as a base of operations for experimental work she is conducting on intertidal organisms from the Oregon coast.

On-going student projects based at HMSC include:

- Laboratory and field work to determine if elemental signatures incorporated into the vertebrae of young-of-the-year sharks and rays provide distinct, site-specific markers.
- Estimation of seasonal rockfish settlement in Yaquina Bay, Oregon.
- Biological monitoring for dynamic revetment of HMSC shoreline trail (Fall 2011).
- Laboratory study of the effects of diet on lingcod skin and

flesh coloration.

- Analysis of the diet and distribution of Humboldt squid in Oregon.

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, they taught Fishery Biology and Marine Conservation Biology, and participated in the Coastal Ecology and Resource Management course. Wade Smith taught two weeks of the Marine Biology course in spring term.

Marine Fisheries Genetics

Michael Banks, Associate Professor

Our primary mission focuses on the application of genetic principles toward improving understanding of population processes among Pacific salmon and other West Coast fishery species as this relates to the physical, biological and human 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 also apply candidate and population genomic tools to better our understanding of the genetic associations of fish migration as this relates to smell (olfaction), space (orientation) and time as well as how these and other life history traits relate to the genetics among stocks, environment and climate.

The lab has enjoyed substantial technological boosting this past year with the installation of Oregon's first 454 genome sequencer at HMSC. This was enabled through a collaborative effort with Kathleen O'Malley and Scott Baker and our selection for a Provost/Research office/Ag Exp Station strategic investment including match support from COMES, MMI and CIMRS. This little beast (not much larger than a microwave) increases our DNA sequencing capacity more than 1000-fold, providing terabits of genome data in just a few days. As a result we have forged increasing linkages with OSU's Center of Genome Research and Bioinformatics. In concert, all bench space in the COMES Marine Fisheries Genetics Laboratory is absolutely full: students, post docs and professional researchers abound – including others awaiting any vacancy.

One new PhD student, Nick Sard (from SUNY Fredonia) joins a Cougar dam Chinook pedigree project along with Jennifer Britt, a new Faculty Research Assistant. This project, in collaboration with Marc Johnson and others at ODFW, involves the passage of naturally reared and hatchery Chinook over the wall at Cougar enabling their spawning and rearing in previously unavailable habitat in tributaries above the reservoir. Overarching goals are to evaluate alternate hatchery/wild, location and timing of relocation strategies for the adults along with proof of concept pedigree evaluation of returns to a new trapping facility installed at the base of Cougar. Perfect match of returns to DNA profiles of parents passed above the wall in previous years demonstrates full life-time success of making this new habitat available.

A second new student, Chanté Davis (from Moss Landing Marine Laboratories), initiates a population structuring and life history diversity study of Chinook and Steelhead of the Siletz River in collaboration with Stan Van der Water and colleagues of the Confederated Tribes of the Siletz. Research into genetic and life history diversity of krill continues through collaboration with Bill Peterson (Fish Ecology Group, NWFSC/CIMRS) and post doc Mattias Johansson, researcher Angie Sremba and NSF REU student Liz Duda (from Pomona College). This group is burning much time with the genome sequencer, isolating krill's first microsatellites and constructing full mtDNA genomes for several PNW krill species. Research developing genetic markers for fine-scale resolution among life history stocks of California's Central Valley Chinook continues with Assistant Professor Kathleen O'Malley and Faculty Research Assistants David Jacobson and Brandon Jones. We are currently summarizing pleasing results from a blind test of these tools for population identification of individuals.

Professional Faculty Renee Bellinger and new Faculty Research Assistant Jonathan Minch continue to forge ahead with ProjectCROOS, and the Coast-wide Genetic Stock Identification Collaborative, a project that thrives through the active collaboration of Chinook fisherman, agencies and scientists. Despite strong competition from tuna in warmer near-shore waters in recent weeks, we continue to sustain a better annual catch record than for the same time last year. The tremendous scope of sampling collaboration, near-real-time analysis and reporting through the internet in this project is unprecedented anywhere in the world – you should check it out: <http://pacificfishtrax.org/>.

Two recent publications for our study of hatchery/wild fitness comparisons among coho of the Umpqua drainage continue to affirm lesser fitness of hatchery offspring and point to behavioral or other events involved in spawning as most likely candidate mechanisms. In accord, MS student Amelia Whitcomb, is developing her project using next-generation sequencing to study genetic aspects of mate choice in coho salmon (co-advised by Dr Kathleen O'Malley). Recent graduation of Dr Rebecca Baldwin marks the finishing of the eighth graduate student from our program (5th PhD). Manuscripts from Becca's research that appear among our 2011 publications describe the application of community and population genetics studies of parasites found in sardines, and how these findings might be utilized to resolve the elusive migration and population status of sardines themselves.

MMI - Cetacean Conservation and Genetic Laboratory (CCGL)

C. Scott Baker, Professor; Jennifer Jackson, Postdoctoral Fellow; Debbie Steel, Faculty Research; Becca Hamner (PhD), Renee Gibb (PhD), Angie Sremba (MSc), Alana Alexander (PhD), graduate students; Ursula Gonzalez (PhD), visiting graduate student, University of Baja California (Sur), Mexico, Emma Carroll (PhD), visiting graduate student, University of Auckland, New Zealand.

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. Our research on large whales and dolphins is pursuing three inter-related themes:

- Reconstructing the past,
- Assessing the present, and
- Conserving the future.

Reconstructing the past of whales and whaling: To improve our understating of the impact of hunting on the abundance of whales and the ecological role of whales before human exploitation, the CCGL is contributing to a Comprehensive Assessment of humpback whales in the South Pacific and southern right whales around New Zealand. A Comprehensive Assessment seeks to bring together available data, including catch records and current abundance, to reconstruct the history of populations before, during and after the cessation of whaling. By integrating genetic information on the minimum size of populations during exploitation (the Nmin), we have improved the fit of population dynamic models typically used by the International Whaling Commission. Results of this work were presented to the annual meeting of the Scientific Committee of the International Whaling Commission in Agadir, Morocco (June 2010) and Tromso, Norway (June 2011).

As part of our efforts to reconstruct the history of whale populations, Angie Sremba completed her study of 'ancient DNA' from whale bones collected on the shores of South Georgia Island in the South Atlantic. These bones are the remnant of the world's most active whaling stations. From 1904 to 1965, a total of more than 175,000 whales were killed, driving local populations of humpback, blue and fin whales to extinction. The results of Angie's MSc work will be used to estimate the former genetic diversity of these populations and their minimum size at the time of the 'exploitation bottleneck'.

Assessing the present status of great whale populations: To assess the present status of great whale populations, the CCGL is involved in three large-scale, collaborative studies. In the North Pacific, we are collaborating with the *Structure of Populations, Levels of Abundance and Status of Humpbacks* (SPLASH). To date, we have completed sequencing of the mtDNA control region and microsatellite genotypes for more than 2,000 individual humpback whales representing nine feeding grounds and eight breeding grounds in the North Pacific. These results were used extensively by the Biological Review Team established to review the listing under the US Endangered Species Act.

In the South Pacific, the population structure and migratory interchange of humpback whales is under investigation in collaboration with members of the South Pacific Whale Research Consortium. Scott and Debbie, as Chair and Officer of the Executive Committee of the Consortium, helped to convene the 11th annual meeting at the South Pacific regional Environment Program, Apia, Samoa, in February 2011.

Conserving the future of whales and dolphins: With funding from the Marine Mammal Commission, Becca Hamner has been continuing her PhD research on the endangered Hector's and

Maui's dolphins, endemic to the coastal waters of New Zealand. Using both mtDNA and a suite of microsatellite loci, she has confirmed the genetic distinctiveness of the critically endangered North Island Maui's subspecies and the genetic isolation between the regions populations of Hector's dolphins around the South Island. The results highlight the importance of maintaining corridors for the low levels of dispersal that maintain diversity in each regional population. In February 2011, Becca and Scott returned to New Zealand to collect samples from Hector's dolphins in Cloudy Bay.

Conservation policy and media outreach: In May 2010, Scott was invited to join the Biological Review Team (BRT) for humpback whales, implemented by the National Marine Fisheries Service, under the US Endangered Species Act. The BRT is charged with defining Distinct Population Segments of humpback whales and reviewing the status of each segment. This review continued into 2011, with further work on a draft review now in progress.

In June 2011, Scott was a U.S. delegate to the scientific committee of the International Whaling Commission at the 63rd meeting in Tromso, Norway and to intersessional meeting intended to assess the current status of the western North Pacific minke whale, a population that is currently the target of scientific whaling under special permit by the Government of Japan.

National (and International) Panels or Committees:

- Invited members, Humpback Whales Biological Review Team, convened by the National Marine Fisheries Service, for listing review under the U.S. Endangered Species Act, Silver Springs, MD, May 2010.
- U.S. Delegate to the Scientific Committee of the International Whaling Commission, Tromso, Norway, June 2010.
- Chair, Executive Committee of the South Pacific Whale Research Consortium, representing independent researchers active in 10 nations or territories of the South Pacific or the Antarctic. April, 2010.
- Pre-implementation review meeting for the assessment of western North Pacific minke whales, International Whaling Commission, September 2010, Tokyo, Japan and December 2010, Busan, South Korea.

MMI - Pinniped Ecology Applied Research Laboratory (PEARL)

Markus Horning, Associate Professor; Kim Raum-Suryan, Faculty Research Assistant; Erin Kunisch, Graduate Student (M.S. Dept. Fisheries & Wildlife); Jamie Womble, Graduate Student (Ph. D., Dept. Fisheries & Wildlife); Stephen Meck, Graduate Student (M.S. Dept. Fisheries & Wildlife); Norma Vazquez, Graduate Student (M.S. Dept. Fisheries & Wildlife); Sheanna Steingass, Graduate Student (M.S. Dept. Fisheries & Wildlife); Julia Hager, Visiting Intern; Mee-ya Monnin, Undergraduate Intern - OSU; Darin Padula, Undergraduate Hollings Intern - Univ. Hawaii.

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.

Current research projects:

1) Title: *Thermoregulation in free-living Antarctic seals: the missing link in effective ecological modeling.*

Sponsor(s), award amount and duration: *National Science Foundation, \$303,000; 2011-2014.*

Science relies increasingly on computational models to infer impacts from environmental variance on individuals and populations. For individual based models this requires accurate parameterization of the major life history cost components. Despite being an essential physiological component of homeotherm life in polar regions, little is known about the energetic requirements for thermoregulation in either air or water for high-latitude seals. This study will fill a major knowledge gap by providing data essential to modeling all aspects of pinniped life history, in particular for ice seals. Utilizing a two-part study including a hypothesis-driven field experiment and an objective-driven model component, we will quantify thermoregulatory costs for the Weddell seal under both ambient air and water conditions. Such parameterization of energetic cost components will be essential for the accurate modeling of responses by pinnipeds to environmental variance, including direct and indirect effects driven by climate change.

OSU project participants include M. Horning and M. Monnin.

2) Title: *The impact of predation on juvenile survival and population recovery of Steller sea lions in the Gulf of Alaska.*

Sponsor(s), award amount and duration: (1) *North Pacific Research Board, \$343,000; 2010-2013;* (2) *Pollock Conservation Cooperative, \$15,000; 2009-2012.*

This long-term research project is led by the PEARL and conducted in collaboration with the Alaska Sea Life Center in Seward, AK. Activities continued in 2010 with the capture of five juvenile Steller sea lions in Prince William Sound. The surgical implantation of LHX tags at a quarantined facility at the collaborating Alaska Sea Life Center (Seward, AK) and their subsequent release brought the number of sea lions released with implanted satellite monitors to 32 since 2005. LHX devices allow remote monitoring of pinnipeds throughout their entire lives. LHX tag data recovered post-mortem via satellite allows the classification of detected mortalities into traumatic deaths likely the result of predation and non-traumatic from other causes (starvation, diseases, entanglement).

OSU project participants include M. Horning, S. Meck and N. Vazquez.

3) Title: *Development of a miniaturized implantable satellite transmitter to monitor survival, predation and reproduction in marine endotherms.*

Sponsor(s), award amount and duration: *National Science Foundation, \$485,000; 2010-2013.*

Building on the success of the first generation LHX devices, we are developing the next generation LHX life long satellite monitors for marine homeotherms. This effort will shrink the tags to approximately 50% of the volume of the current design, and will bring parturition detection for female homeotherms to the tags. The development is 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). Three undergraduate students in mechanical engineering (Tim Cross, Ty Kobashigawa, Michael Weller) built a programmable pressure cyclor for long-term testing of LHX tags. Graduate student in mechanical engineering Andrew Phan is developing the outer shell of the new device from composite materials. Dr. William Hanshumaker (HMSC) is coordinating education and outreach efforts under this grant. These efforts include the development of a project specific website and curriculum elements by contractors Seymour Creative Communications and MarEPOsa.

OSU project participants include M. Horning, J. Parmigiani, A. Phan, T. Kobashigawa, M. Weller, T. Cross and W. Hanshumaker.

Recently completed research projects:

1) Title: *Aging in Weddell Seals: Proximate mechanisms of age-related changes in adaptations to breath-hold hunting in an extreme environment.*

Sponsor(s), award amount and duration: *(1) National Science Foundation, \$537,000; 2005-2010; (2) National Science Foundation, \$34,000, 2008-2010.*

Pinnipeds appear to avoid senescence even though their habit of hunting and exercising while holding their breath suggests them as excellent candidates for aging, giving rise to two questions:

1) What specific physiological and morphological changes occur with advancing age in pinnipeds? and 2) What subtle adjustments are made by these animals to cope with such changes? This pilot study was the first to describe specific, small-scale physiological and behavioral changes relating to dive capability with advancing age in a model pinniped, the antarctic Weddell seal (*Leptonychotes weddellii*) [2]. Preliminary findings provided the first demonstration of organismal senescence in a wild marine mammal [6] and led to the preliminary rejection of a classic tenet in gerontology postulating the absence of pronounced organismal senescence in wild mammals since mortality is likely to occur first. This study was led by the PEARL in collaboration with the Alaska Sea Life Center and Texas A&M University.

2) Title: *Remote monitoring of Steller sea lions at Sea Lion Caves, Oregon.*

Sponsor(s), award amount and duration: *(1) Steller sea lion*

resights at Sea Lion Caves, Oregon, NOAA/CIMRS, \$25,000; 2010-2011; (2) Entanglement Incidence of Steller sea lions in Oregon, Oregon Sea Grant Program, \$10,000; 2010;

Remote monitoring of Steller sea lions at Sea Lion Caves in Oregon (previously funded by the National Science Foundation and the North Pacific Marine Science Foundation), continued in 2010 under NOAA funding. This project was coordinated by Kim Raum-Suryan, PEARL Faculty Research Assistant, and was conducted through cooperation with and support by Sea Lion Caves. Using a remote installation of multiple cameras that collect images inside the main cave, as well as at the external sea lion haul-out, individually marked animals were cataloged and observed. The incidence of entanglements and sources of debris were cataloged.

OSU project participants: K. Raum-Suryan, J. Hager, S. Meck.

Student activities:

PEARL graduate student Erin Kunisch (M.S., Dept. Fisheries & Wildlife) successfully defended her thesis entitled 'Northern Fur Seal Reproductive Rates and Early Maternal Care' on March 2, 2011. Erin has received support from the MMI Endowment, the HMSC Markham 1st year award, the HMSC Crebbin award, several awards from the Dept. of Fisheries & Wildlife, as well as logistics support from the NMFS.

Graduate student Jamie Womble (Ph.D., Dept. of Fisheries & Wildlife) is continuing her analyses of spatial movement data of harbor seals in Glacier Bay National Park, Alaska, in collaboration with Gayle Blundell (ADF&G) and Scott Gende (GBNP). Jamie has received support from the MMI Endowment, the HMSC Markham research award, the National Park Service and several awards through the Dept. of Fisheries & Wildlife.

Three new graduate students (M.S., Dept. of Fisheries & Wildlife) joined the PEARL in 2010, former HMSC Crebbin Intern Stephen Meck, Sheanna Steingass, and former HMSC REU intern Norma Vazquez. Norma will be supported through an NSF graduate research fellowship, Stephen is supported through a grant from the North Pacific Research Board, and Shea is supported in part through a Markham Research Award.

Graduate student Andrew Phan (Mechanical Engineering) is partially supported by our LHX tag development project under faculty advisor J. Parmigiani. Andrew is participating in the development of the 2nd generation LHX transmitter. He also supervised the senior project of three undergraduate students in mechanical engineering, Tim Cross, Michael Weller and Ty Kobashigawa in their design of a programmable pressure cyclor for tag testing.

Two undergraduate interns are joining the PEARL in the summer of 2011: NOAA Hollings Intern Darin Padula from the University of Hawaii will be testing different styles of water flow speed sensors to be used in future designs of animal-borne telemetry devices. OSU undergraduate Mee-ya Monnin will be traveling to McMurdo Sound, Antarctica with the PEARL and will conduct

calibrations of heat flux sensors during the summer.

Jamie Womble and Markus Horning participated in the 4th International Biologging Symposium in Hobart, Tasmania in March of 2011 through presentations and by hosting a workshop on the analysis of telemetered dive behavior data.

Shellfish and Fish Aquaculture and Conservation

Christopher Langdon, Professor; Kiril Chang-Gilhooly, MBP Hatchery/nursery manager; Marileen Reavis, MBP Algologist; Travis Oja, MBP Field Coordinator and broodstock manager; David Stick, PhD candidate; Matt Hawkyard, PhD candidate; Matt Gray, PhD candidate; Brian Arnold, MS candidate

A major focus of the OSU-COMES Aquaculture program at HMSC is the USDA-funded Molluscan Broodstock Program (MBP). This purpose of this program is to develop superior Pacific oyster (*Crassostrea gigas*) broodstock for the West Coast shellfish industry through selection. About 1300 families of Pacific oysters have been produced since the inception of MBP in 1995. These families have been planted at commercial test sites along the West Coast, from Prince William Sound, Alaska, to Tomales Bay, California. After three generations of selection, average yields of MBP families per cohort are up to 36% greater than those of oysters from unselected broodstock. Outstanding broodstock have been transferred to a private commercial repository in Netarts Bay, OR, and sold to hatcheries for commercial seed production.

MBP has introduced new strains of Pacific and Kumamoto (*Crassostrea sikamea*) oysters, collected from southern Japan, to improve the genetic diversity of existing West Coast populations. The new stocks were reared under strict quarantine conditions and subjected to numerous disease exams. Only disease-free, second generation oysters were released from quarantine and planted in coastal waters to avoid possible introductions of diseases and unwanted “hitch-hiker” species.

MBP has also been in the forefront of efforts to help commercial oyster hatcheries overcome major problems in producing larvae. The underlying cause of the problems seems to be related to strong upwelling of deep, acidic water that is rich in dissolved carbon dioxide. Acidic seawater conditions on the West coast during upwelling events are similar to predicted global seawater conditions at the end of the century. In fall 2010, a four-year NSF grant was obtained with COAS co-PI's George Waldbusser, Burke Hales and Brian Haley to study the effects of ocean acidification on bivalve larvae.

Recent efforts have been directed to studying the feeding physiology of native West Coast oysters (*Ostrea lurida*) in order to better understand their potential interactions with Pacific oysters and their role in providing ecosystem services by clearing water of suspended materials. These findings will assist in planning restoration projects on the West Coast for this oyster species.

The aquaculture program at HMSC also focuses on marine fish larval nutrition. On the West Coast, aquaculture of commercially important fish species, such as sablefish, lingcod, yellowtail, white bass and rockfish, will become increasingly important in meeting our food demands as natural fish stocks decline and fishing becomes more limited. The major bottleneck in rearing marine fish species is successful rearing of their larval stages. In response to this need, we continue to work on the development of microparticulate diets for marine fish larvae. In this effort, we are collaborating with Norwegian aquaculture nutritionists and scientists from the Alaska Fisheries Science Center in developing ways to enrich live feeds for rearing larval Pacific cod. In 2010, a USDA grant was obtained from the Western Regional Aquaculture Center to carry out nutritional studies with encapsulated micronutrients for West Coast fish larvae, in cooperation with researchers at Hubbs Sea World, NOAA and USDA.

Seabird Ecology

Robert Suryan (Ph.D.), Assistant Professor-Senior Research; Amanda Gladics (B.S.), M.S. Student, COAS Marine Resources Management; Cheryl Horton (B.S.), M.S. Student, Fisheries and Wildlife; Alexandra Gulick, Oregon State University, Summer Undergraduate Intern; Laura Filliger, National Science Foundation, Summer Undergraduate Intern

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 fifth year, SOL continued to expand the breadth of research projects and course offerings (BI 111/FW 111 Introduction to Marine Life in the Sea – Marine Birds [spring term, 1unit], FW499 Ecology of Marine and Estuarine Birds [summer term, 3 units]). Research conducted by SOL spanned the North Pacific, including projects in Japan, Alaska, Oregon, and Hawaii. During this report period, our lab was awarded over \$250,000 in funding, authored/co-authored one book review, two documents on climate change effects on marine birds, and gave or contributed to 25 presentations at scientific meetings, seminars, and public forums. Our local field study near Newport, Oregon, was featured in nine news stories (see list below) and our studies of albatrosses were featured in four national news stories and three television documentaries in Japan. We also contributed seabird expertise to marine reserve planning off the Oregon coast as a science representative to the Cape Perpetua Marine Reserve Community Team and participated in educational and public outreach activities, including International Baccalaureate programs and Careers in Science Investigation with Oregon Sea Grant at the Yaquina Head Outstanding Natural Area. Research projects during the past year included: 1) Foraging patterns and marine habitat use of short-tailed albatrosses (*Phoebastria albatrus*); 2) Experimental translocation of short-tailed albatross chicks for re-colonization of historical breeding sites in Japan; 3) Seabird tracking and prey patch dynamics near the Pribilof Islands, Alaska; 4) Seasonal patterns in the broad-scale distribution of seabirds and prey in the Bering Sea; 5) U.S. West coast fisheries

and seabird interactions; 6) Use of remote sensing data to identify biological hotspots with respect to seabird distribution and marine spatial planning; 7) Common murre (*Uria aalge*) reproductive biology and foraging ecology at Yaquina Head, Oregon; 8) Marine predator diets in the northern California current and responses to changing foraging conditions; 10) Seabird colony and at-sea distribution along the Oregon coast, 9) Breeding biology and at-sea distribution of seabirds on Lehua, Hawaii; 10) Modeling potential ecological effects of marine hydrokinetic energy development. To view maps and information about SOL's albatross satellite tacking studies visit <http://www.wfu.edu/albatross/> and follow the link to short-tailed albatross studies.

Short-tailed albatross, Japan: This is collaborative study between the Yamashina Institute for Ornithology, the Ministry of Environment, Japan, the U.S. Fish and Wildlife Service, and SOL 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 tenth 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 2010-2011 breeding season was particularly notable as the first year that translocated and hand-reared albatrosses began returning to the new colony site. It is still uncertain whether the birds will recruit to this site, but the early visits and courtship behaviors observed are very encouraging. Our primary focus is satellite-tracking chicks after fledging (leaving the colony) to ensure that translocated and hand-reared chicks are indeed surviving and migrating similarly to naturally-reared individuals. Additionally, these juvenile birds will be tracked into U.S. waters to evaluate critical habitats for this species and potential fishery interactions. This latter contribution is particularly important, because from a small sample during previous studies, this age class appears to have very different movement and distribution patterns than adults/sub-adults and therefore overlap a larger variety of fisheries.

The 4th year of translocation received media attention in Japan, where short-tailed albatrosses are a special national treasure (<http://www.asahi.com/national/update/0208/TKY201102080440.html>, <http://www.47news.jp/CN/201102/CN2011020801000749.html>).

Additionally, the return of 6 of 10 hand-reared albatrosses from 2008 (the first year of translocations) and one from 2009 to Mukojima was unexpected so early in the project and captured media attention from several news organizations in Japan (Asahi and Sankei). Finally, the The Ogasawara (Bonin) Islands were recently recognized as a world heritage site by UNESCO (<http://www.asahi.com/english/TKY201106250159.html>, <http://www.yomiuri.co.jp/dy/national/T110625002772.htm>). The short-tailed albatross reintroduction project was included in the nomination

document and contributed to this positive decision. These islands are being recognized, in part, for their endemic flora and fauna and efforts to control invasive species populations and introductions. For more information about this project go to <http://project.nprb.org/view.jsp?id=a077879a-11b2-4a9a-8b38-1a774dbff0ed>

Short-tailed albatross, Alaska: The Japan Broadcasting Corporation (NHK) has featured our collaborators', the Yamashina Institute for Ornithology, research and conservation efforts in Japan in numerous news broadcasts and documentaries. Last year, NHK, asked to feature some of our albatross studies in the Aleutian Islands, Alaska. Toward the end of two months filming the marine life and productive marine environment around the Aleutian Islands, we joined NHK to locate and film short-tailed albatrosses. This opportunity also allowed us to collect more data to test our hypothesis that albatrosses use specific molting areas in North Pacific when they undergo extensive flight feather molt. One of the highlights for us and the film crew was locating one of the translocated and hand-reared chicks from Mukojima. This was especially exciting for NHK because they had filmed this bird leaving the hand-rearing site on Mukojima in 2008 and the bird had not been seen since. NHK produced three programs, including one full-length documentary that aired in Japan in Spring 2011 (http://www.nhk.or.jp/wildlife/program/p060_e.html).

Seabird tracking and prey patch dynamics near the Pribilof Islands, Alaska: SOL joined the ongoing seabird tracking component of 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 how seabirds (thick-billed murres, *Uria lomvia*, and black-legged kittiwakes, *Rissa tridactyla*) respond to climate change in the Bering Sea. Field crews are using state of the art tracking devices 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 physical oceanographic forcing.

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. This project is also 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. Part of this work involves compiling current data from at-sea surveys and seabird tracking studies to integrate with what is known about the distribution of fishing effort and the approximate incidental bycatch of seabirds in west coast fisheries. This allows identification of fisheries and regions most in need of targeted mitigation. This effort will promote the conservation of seabirds through reduced bycatch and help prevent bait loss for fishers, thereby increasing targeted fish catch-per-unit-effort. Not surprisingly, this is a complex task, but we are optimistic that solutions developed by Washington Sea Grant and implemented for Alaska fisheries will also be effective and relatively easy to implement locally.

Use of remote sensing data to identify biological hotspots with respect to seabird distribution and marine spatial planning:

SOL is collaborating with the Farallon Institute for Advance Ecosystem Research to investigate new analytical approaches applied to satellite remote sensing data that will improve our ability to identify, over large spatial scales, persistent areas of high use (“hotspots”) for seabirds and enhance food web productivity, in general.

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 and most rapidly expanding 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 2011 breeding season, our fifth consecutive year of data collection. Between our studies and those conducted by Dr. Julia Parrish (University of Washington), we now have a 10 year time series at this site, and hopes of continuing this long-term coastal research and monitoring program. Seabird colonies at Yaquina Head are particularly relevant to study since they are quite dramatically affected by both “top-down” forces of eagle predation/disturbance and “bottom-up” forces of varying prey availability and changing ocean conditions. This colony is also 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 hundreds of thousands of visitors annually. The project received a bit of media coverage last summer. The following are links to these or related stories.

HMSC Chat

http://hmsc.oregonstate.edu/radio/HMSC_Radio/OSUs_Hatfield_Marine_Science_Center_-_Radio_Podcasts/OSUs_Hatfield_Marine_Science_Center_-_Radio_Podcasts.html

Register Guard

<http://www.registerguard.com/csp/cms/sites/web/updates/25146862-55/murres-murre-eagles-eggs-birds.csp>

OSU Press release

<http://oregonstate.edu/ua/ncs/archives/2010/jul/rapidly-growing-murre-colony-draws-interest-scientists-%E2%80%93-and-predators>

KPLU

<http://www.publicbroadcasting.net/kplu/news.newsmain/article/1/0/1682390/KPLU.Local.News/Bald.Eagle.Comeback.Pressures.Coastal.Seabirds>

KEZI, Eugene

<http://kezi.com/news/local/183218>

Newport News Times

http://www.newportnewstimes.com/v2_news_articles.php?heading=0&page=72&story_id=23548

High Country News (March 1, 2010, Isabelle Groc) (Lowe, Parrish, et al.)

<http://www.hcn.org/issues/42.4/new-world-order>

The Columbia Basin Fish and Wildlife News Bulletin (July 30 2010)

<http://www.cbulletin.com/393656.aspx>

The Columbian (October 7, 2010)

<http://www.columbian.com/front-page/>

Marine predator diets and changing foraging conditions: This is a new and particularly intriguing study 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*). This project integrates our on-going studies of common murres at Yaquina Head with collaborative fisheries research to help detect and understand food web wide adjustments resulting from sometimes biophysical changes in ocean dynamics off the Oregon coast.

Foraging ecology of two Hawaiian seabird guilds: A comparative study of tuna birds and solitary-feeders:

In collaboration with the University of Hawaii, San Jose State University, and Hawaii Pacific University, we completed a second year of studies of the breeding biology and at-sea distribution of four species of seabirds on Lehua, Hawaii. Lehua is an uninhabited island off of Kauai that is undergoing restoration of native flora and fauna following the removal of introduced land mammals. Our study involves the at-sea tracking of wedge-tailed shearwaters (*Puffinus pacificus*), red-footed boobies (*Sula sula*) - “tuna birds” where foraging is often associated with schools of tuna - and brown boobies (*Sula leucogaster*), red-tailed tropicbirds (*Phaethon rubricauda*) - which generally do not forage in association with tuna schools - using micro-electronic devices to help understand the population dynamics of these species and what potential conservation threats they face when away from Lehua.

Seabirds and wave energy development on the Oregon coast:

As with wind farms, electrical power lines, and mobile phone towers, proper placement of wave energy facilities is critical to minimize the impact to resident and migratory birds off the Oregon coast. One aspect of SOL’s involvement in these studies is working with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration to integrate datasets of breeding colony sizes and locations along the coast with vessel-based surveys of seabird distribution at sea. Results of this project will help to inform coastal marine spatial planning decisions and serve as an information gap analysis for planning future studies where data are deficient. A second aspect is working with the Northwest National Marine Renewable Energy Center and the Pacific Northwest National Laboratory to study ecological effects of marine hydrokinetic devices (buoys and

turbines). Part of this effort is developing impact models and conducting risk assessments specifically for marine birds.

Department of Agricultural and Resource Economics

Marine Resource Economics & Marketing

Gil Sylvia, Associate Professor

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, Oregon Department of Fish and Wildlife, the Cooperative Institute of Marine Resource Studies, 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 consumer surveys to determine perspectives and values for developing seafood traceability systems; 4) exploring ecosystem services associated with marine reserves; 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 and the World Bank.

We continued to work closely on numerous ventures with the Community Seafood Initiative. A key subproject is developing North American Fish Trax, an electronic fish information system using near real time information for supporting marketing, science, and fishery management (www.pacificfishtrax.com). A major marketing and traceability project was conducted with the Gulf of Mexico Reef Fish Alliance in support of the *Gulf Wild Brand*. A related project was organizing a West Coast Conference on Electronic Fish Information Systems held in May 2011 with more than 100 participants. We also worked with CSI and the Oregon Dungeness Crab Commission in developing information to support MSC certification of the Oregon Dungeness Crab Fishery. We are in the second year of a Sea Grant project evaluating ecosystem services that could be provided by marine reserves in the state of Oregon. The highly interdisciplinary CROOS project is funded from a variety of sources and involves COMES faculty, the Oregon Salmon Commission, National Marine Fisheries Service, Oregon Sea Grant, CSI, and ODF&W. The projects goals include using

genetic and oceanographic analysis to reduce harvests of weak salmon stocks while avoiding large area closures, develop new approaches for salmon management, and using digital technology for information tracking systems for management and marketing. The project is 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 cooperating with a consulting company (the Research Group, Corvallis) we are developing 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 in 2012.

These research projects have generated over \$2.5 million in extramural funding and are supporting four graduate students in the Departments of Agricultural and Resource Economics and Marine Resource Management.

College of Forestry

Department of Forest Ecosystems and Society

Marine and Terrestrial Linkages

Bryan Black, Associate Professor - Senior Research

Dr. Black's research addresses the long-term responses of marine, terrestrial and freshwater ecosystems to climate variability, natural disturbances, and human activities. Trained as a forest ecologist, Dr. Black's original research interests involved the ecology and development of forest ecosystems over the past three to four hundred years. Research in this area has included i) characterizing the composition, structure, and disturbance regimes of pre-European settlement forests ii) evaluating the effects of Native American populations on those forests, and iii) quantifying the forest changes that have followed European settlement in the context of land use history and altered disturbance regimes. Dendrochronology (tree-ring analysis) is an important tool for investigating stand dynamics and the effects of disturbance and climate on forest growth. Dr. Black is now applying tree ring techniques to the growth increments of long-lived marine and freshwater organisms. These multidecadal chronologies reflect the effects of climate, disturbance, and human activities on growth, and for particularly long-lived species, allow for the reconstruction of climate prior to the start of instrumental records. These growth increment chronologies can also be used to compare diverse taxa and ecosystems. Freshwater mussel, Pacific rockfish, Pacific geoduck, and tree-ring chronologies interrelate with one another, demonstrating how the same climatic variables simultaneously affect marine, terrestrial and freshwater environments.

Over the past year, Dr. Black's lab has led a number of research projects including:

- Reconstructions of stream temperature and flow from the growth increments of long-lived freshwater mussels. Collaborator: Jayne Brim-Box, Confederated Tribes of the Umatilla; Jason Dunham, USGS Corvallis.
- Evaluating the importance of wintertime ocean variability to ecosystem function in the central California Current. Collaborators: Isaac Schroeder and Steven Bograd, NOAA SW Fisheries Science Center; Bill Sydeman, Farallon Institute for Advanced Ecosystem Research, Vlada Gertseva and Pete Lawson, NOAA NW Fisheries Science Center.
- Relationships between somatic growth (fish size) and otolith growth increment chronologies for yellowfin sole in the eastern Bering Sea. Collaborators: Beth Matta, Tom Wilderbuer, and Tom Helser, NOAA AK Fisheries Science Center.
- A comparison between ¹⁴C ageing and crossdating in Pacific geoduck. Collaborators: Craig Kastle and Tom Helser, NOAA AK Fisheries Science Center, Shayne MacLellan, Darlene Gillespie, and Claudia Hand, Dept. of Fisheries and Oceans, Canada.
- Using tree-ring growth-increment analyses to develop chronologies from the growth increments in marine mammal teeth. Collaborator: Holger Klinck, OSU and Matthew Stuckey, UC Davis.
- Developing continuous growth-increment chronologies that extend over multiple centuries from the growth increments of live and dead-collected Pacific geoduck. Collaborators: Matthew Stuckey, UC Davis; Shayne MacLellan, Darlene Gillespie, and Claudia Hand, Dept. of Fisheries and Oceans, Canada.

Courses taught:

FS 115: Ecology of Coastal Oregon Forests

This 1-credit course is a combination of lecture and field exercises based at the Hatfield Marine Science Center and was designed to introduce students to the ecology and development of Oregon coastal forests. Vegetation patterns of Oregon coastal rain forests were introduced and interpreted with respect to climate, geology, natural disturbance, as well as pre- and post-European settlement land uses. Major vegetation types were introduced as were important tree species. Special emphasis was placed in the influence of ocean variability on coastal forests. The course was taught at HMSC by BA Black in Apr 2011.

Current grants:

BA Black and H. Klinck (OSU). A tree-ring approach to developing growth chronologies for marine mammal species. OSU General Research Fund. 3/2010-3/2011. \$8,972

BA Black, ME Matta (NOAA AK Fisheries Science Center), T Wilderbuer (NOAA AK Fisheries Science Center), T Helser (NOAA AK Fisheries Science Center). Impacts of climate on long-term growth patterns of yellowfin sole in the Bering Sea: empirical modeling and incorporation into stock assessment models. NOAA Fisheries and the Environment (FATE). 7/2010-9/2011. \$54,924

BA Black, I Schroeder, WJ Sydeman, SJ Bograd, V Gertseva, and P Lawson. Beyond the spring transition:

winter pre-conditioning and ecosystem dynamics and implications for sentinel species and fisheries. NOAA Fisheries and the Environment (FATE). 9/2009-9/2011. \$126,959

BA Black. Freshwater mussels as multidecadal indicators of discharge and ecology in the John Day River. Confederated Tribes of the Umatilla. 2/2011-2/2012. \$29,973

BA Black, WJ Sydeman and SJ Bograd. Importance of Winter Upwelling to California Current Ecosystem Dynamics. National Science Foundation Biological Oceanography. \$223,705. 9/09-9/11.

Organized sessions at national meetings:

Growth increments and the environment: multidecadal perspectives on climate and ecology in marine systems. American Geophysical Union Ocean Sciences Meeting, February 2010. Portland, OR.

Invited keynote address:

BA Black. Paleoclimate and paleoenvironmental reconstructions in sclerochronology. Second International Conference on Sclerochronology, July 2010. Mainz, Germany.

Invited Seminars:

BA Black. Growth increments, climate, and the interrelationships among diverse ecosystems of the Pacific Northwest, USA. Iowa State University, January 2011. Ames, Iowa

Other awards:

BA Black was appointed to the Scientific Steering Committee for the International Council for the Exploration of the Oceans / North Pacific Marine Science Organization Early Career Scientists Meeting, to be held in Spain. Summer 2012.

College of Oceanic and Atmospheric Sciences

Benthic Ecology and Biogeochemistry

George Waldbusser, Assistant Professor

Ongoing work in George Waldbusser's lab at Hatfield Marine Science Center is centered on the interactions between benthic organisms and biogeochemistry. Two main drives of this work have been to understand benthic species interaction effects on sediment biogeochemistry, and the mechanisms of larval bivalve responses to ocean acidification.

A series of microcosm experiments funded by a National Science Foundation award were completed in the winter of 2010 in which two common intertidal species of infauna were established in sediment microcosms in different densities. The broad objective of this work is to understand the underlying mechanisms responsible for biodiversity impacts on ecosystem functions, such

as elemental cycling in marine sediments. The two study species, *Abarenicola pacifica* (the lugworm), and *Macoma nasuta* (the bent-nose clam) are commonly found together in the tide flats adjacent to HMSC. Rates of oxygen and nutrient fluxes were measured within microcosms in a series of dates to quantify how individual species affected these processes when they were alone, with others of the same species, and with different species. In addition to biogeochemical fluxes, rates of particle mixing, individual locations of organisms, irrigation activity and several sediment properties were measured. Most excitingly however, are the computed tomography (CT scan) measurements to be made shortly in the OSU Veterinary Sciences Hospital that will permit the 3D quantification of burrow and activity locations with respect to the individuals within each microcosm.

In October of 2010, Dr. Waldbusser was awarded a \$2 million dollar grant from the National Science Foundation to investigate the mechanisms of bivalve responses to ocean acidification, with Co-PIs Drs. Burke Hales, Chris Langdon, and Brian Haley. This research grant is supporting the development of a state of the art experimental carbonate chemistry manipulation system being designed by Dr. Hales. The award follows on previous work by Waldbusser's lab investigating post-larval clam and oyster responses to acidification impacts. The current project is underway with significant efforts in method development for unique carbonate chemistry manipulations allowing the project team to explore what carbonate system variables bivalves are most susceptible to. Waldbusser hopes that this unique experimental approach will provide important information both to the broader scientific community regarding the basic physiological responses of shellfish to ocean acidification and to hatchery operators with respect to possible water treatment and mitigation strategies for acidified waters. Additionally, the team has been working closely with the Whiskey Creek Oyster Hatchery and currently collecting data on oyster larval biochemistry, including metals, isotopes, and lipids across this sensitive life stage with assistance from Drs. Fred Prah and Jennifer McKay in COAS.

In support of graduate student research being carried out at the Hatfield Marine Science Center, Dr. Waldbusser has assisted Chao Chen, a graduate student in Animal Sciences advised by Dr. Mark Camara of the USDA, in constructing a carbon dioxide manipulation system in which Chao is measuring genetic level responses of oyster larvae to acidification and disease. Additionally, Dr. Waldbusser had supported the research of Matthew Gray, a graduate student in Fisheries and Wildlife advised by Dr. Chris Langdon, by working with Matt to reassemble Dr. Waldbusser's hydrodynamic flume to study native oyster filter feeding under flow regimes. Finally Dr. Waldbusser is advising three new COAS graduate students who will be carrying out aspects of their graduate work at Hatfield Marine Science Center over the coming year. Elizabeth Brunner is a Master's student in Ocean Ecology and Biogeochemistry interested in the biochemistry and structure of larval bivalve shells, Rebecca Mabardy is a Marine Resource Management student interested in coastal acidification impacts on shellfish, and Iria Gimenez a Fulbright Scholar from Spain will be arriving this fall to begin a Ph.D. in Ocean Ecology and Biogeochemistry, and will be

exploring aspects of carbonate chemistry and shell cycling on oyster reefs and shell beds.

Marine Geochemistry

Clare Reimers, Professor

Research in Clare Reimers' Marine Chemistry 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 2010-2011, group activities were centered on two continuing projects. The first project entered a data synthesis phase to interpret time-series measurements of benthic oxygen exchange rates at stations on the Oregon shelf. Benthic oxygen exchange represents the rate that oxygen dissolved in seawater is consumed (or produced) by the biological community (mostly microorganisms) at the seafloor. Two complimentary methods for deriving benthic oxygen exchange are based on measuring fine-scale vertical profiles of oxygen concentrations across the sediment-water interface in situ, or alternatively, calculating the time average product of the fluctuating components of the oxygen concentration and the vertical velocity above the seabed. Essential to both these measurements are reliable, fast responding, low noise, and fully calibrated oxygen sensors (microelectrodes). These sensors are made in house and deployed with supporting equipment (e.g., a digital still camera) on benthic landers. Oceanography graduate student Kristina McCann-Grosvenor successfully defended her MS thesis in December 2010 which focused on measurements from a 30 m station located off Yaquina Head. Ms. McCann-Grosvenor also gave a presentation on her research at the 2010 Mamie Markham Research Symposium.

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, or BMFCs). The Reimers lab successfully demonstrated operation of a *Teledyne Benthos* sonar modem/optode sensor system powered by an unattended BMFC under shallow-water field conditions in Yaquina Bay for 50 days. This met an important milestone of the original proposal. These experimental results were published in 2011 in *Environmental Science and Technology* **45**, 5047-5053.

College of Science

Department of Science & Mathematics Education

Shawn Rowe, Marine Education Learning Specialist; Oregon Sea Grant Extension; Assistant Professor, Department of Science and Math Education, College of Science; Co-Director Center for Ocean Sciences Education Excellence, Pacific Partnerships

The College of Science's Department of Science and Mathematics Education continued in 2010 to be represented by Dr. Shawn Rowe at HMSC. Rowe continued to oversee research and evaluation work by students from the College of Science involving HMSC and Oregon Coast Aquarium visitors. The Visitor Center is a prime laboratory for this research. Between July 2010 and June 2011, Rowe and/or students presented research findings from their work at the HMSC to attendees at the 2010 Aquarium and Zoological Association meeting, the annual meeting of the Mathematics and Science Partnerships Program, the Oregon Academy of Sciences, and the American Educational Research Association. In addition, research results published earlier in 2010 were popularized in the journal *People & Science*.

Research efforts: The primary focus of Department of Science and Math Education efforts at HMSC is research on learning using the Visitors Center as a laboratory for both exploratory and experimental research. Research in the 2010-2011 academic year was funded by NOAA, National Science Foundation, the Oregon Department of Education, and student scholarships from the Holt Marine Education Award and the Oregon Sea Grant Malouf Scholarship. Holt award recipient Amy Vandehay completed a prototype exhibit on the conservation impacts of marine protected areas including evaluation work on visitors knowledge about marine protected areas prior to the development of the exhibit and after its installation. The exhibit will remain on display through summer 2011. Marine Resource Management student and Malouf scholarship recipient, Emily Lemagie developed an interactive game exhibit based on her numerical modeling of the currents in the Yaquina Bay estuary and carried out research on its effectiveness at teaching visitors about oyster restoration and mathematical modeling in Spring and Summer 2011. Faculty research continued with Dr. Rowe working with Katie Stofer, Céleste Barthel, and Michael Liu, graduate students in Science and Math Education, exploring visitor learning from interactions with live animals and complex scientific visualizations.

Oregon Coast Aquatic and Marine Science Partnership (OCAMP): The Department of Science and Math Education is a partner in a Department of Education Title IIB funded Math Science Partnership for which Dr. Rowe serves as Co-PI. OCAMP provides professional development for science teachers in Lincoln County partnering them with marine scientists from HMSC and other sites as well as informal science educators from partnering organizations. All of the 32 teachers involved with the OCAMP are encouraged to create and use field experiences at informal science education settings (ISEs) in Lincoln County as part of the project. Half of them get specific logistical and financial support to make these experiences happen. Many of the participating teachers had never taken their class to any field trip in Lincoln County before this project. As a result of this project, 32 teachers and approximately 1,000 LCSD students attended programs at the Oregon Hatchery Research Center, Oregon Coast Aquarium, Yaquina Head Outstanding Natural Area, and HMSC. They did this in the face of 1) decreasing numbers of days attending school in Lincoln County (12 fewer days), and 2) increasingly difficult legal demands on chaperones and teachers (including an online training for all potential chaperones). The

fact that the professional development program which delivers over 100 hours of ocean sciences focused education to teachers has not only maintained the number of Lincoln County students attending ISEs, but actually increased it is a true accomplishment. More than 30 scientists from HMSC and OSU worked with the teachers over the course of the 2010-2011 academic year.

Professional development for scientists and educators: Two projects funded by National Science Foundation, the Center for Ocean Science Education Excellence, Pacific Partnerships (COSEE PP) and the Communicating Ocean Sciences Informal Educators Network (COSIA) support Dr. Rowe in developing, carrying out, and evaluating professional development at HMSC for both ocean scientists and marine educators at HMSC and regionally. In 2010, workshops for HMSC educators and floor staff designed around video analysis of their teaching and public interactions were attended by 9 HMSC staff.

Additionally, Dr. Rowe developed and led a two-part webinar on research-based recommendations for creating and using scientific visualizations in informal science education for 46 participants from ISEIs, COSEE centers, and IHEs. Workshops were also carried out at the Vancouver (BC) Aquarium for K-12 teachers and aquarium staff. Laura Dover, a graduate student in Science and Math Education, Dr. Rowe, and the SMILE program's Alicia Christensen led day-long workshops with 18 SMILE afterschool leaders from around the state and at the NAME conference on July 7th for 15 educators from Alaska, British Columbia, Washington, and Oregon.

With the assistance faculty from COSEE Ocean Systems, Heidi Schmoock, Coral Gehrke and Shawn Rowe hosted a three-day workshop for ocean scientists from Cal Poly, San Luis Obispo, and informal educators from the central California coast. The workshop paired 5 ocean scientists with 15 informal educators to create concept maps of the scientists' work that could be used to develop programming at each ISE site. A second workshop for scientists from OSU and HMSC working with the Northwest National Marine Renewable Energy Consortium (NMREC) was held with 7 scientists and 28 teachers from Oregon. Lastly, Dr. Rowe gave a variety of workshops for scientists at HMSC on better powerpoints, better scientific posters, and using media to communicate.

SED 599: Communicating Ocean Sciences to Informal Audiences graduate class: The 2011 course enrolled 10 graduate students representing 5 departments from College of Science, College of Oceanic and Atmospheric Sciences, and Fisheries and Wildlife on campus. These 10 students ran informal science activities at 4 sites (HMSC, OSU, local schools, and an ocean day event in Corvallis) for an estimated 480 participants. For the second year in a row, some of the students continued to participate in outreach efforts. 6 former COSIA students were paired with ocean scientists to create activities for a SMILE high school ocean science day for 130 participants a month after the class, and three months after the class, 4 former COSIA students ran activities at the Lincoln County Science Fair for almost 400 participants, bringing our total COSIA outreach for winter and spring at OSU to 1,010 participants.

Department of Zoology

Benthic Ecology

Sarah K. Henkel, Assistant Professor - Senior Research

Program Objective: The Benthic Ecology Lab at HMSC characterizes substrate-associated algal, invertebrate, and fish communities in order to examine effects of human activities on these populations as well as organismal effects on human-engineered systems (e.g. biofouling). 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:

- Baseline Characterization and Monitoring of Mobile Ocean Test Berth Site: This project aims to describe the physical oceanographic and substrate characteristics of the proposed area for deployment of the NNMREC Test Berth as well as determine what organisms currently inhabit the area. To date, we have conducted 5 box core sampling trips from June 2010 to June 2011 and 6 trawl trips, and the trawl was outfitted with a video camera on three of those trips. Each sampling effort has conducted CTD casts to characterize the water properties. Sediment samples from each box core grab have been analyzed for grain size and TOC. This sampling is scheduled to conclude in October 2011. (Funded by the Oregon Wave Energy Trust)
- Benthic Characterization of the Reedsport OPT development site and reference site: Two sites at and near the OPT site were sampled using the same methods as the NNMREC Test Berth site. This was a one-time event, conducted in June-July 2011. (Funded by the Oregon Wave Energy Trust)
- Survey of Benthic Communities Offshore the Pacific Northwest: This project is focused on describing benthic invertebrates found in both soft and hard substrate habitats on the Outer Continental Shelf. The goal of this project is to establish species-habitat relationships to predict invertebrate communities that may be found in areas targeted for future development. In summer 2010, mapping was conducted by the Goldfinger lab of COAS and the Henkel lab followed to sample sedimentary habitats for organisms and sediment properties. (Funded by BOEMRE)
- Distribution, abundance, and caloric content of mysid shrimp: This project aims to characterize the distribution and abundances across space and time of different mysid shrimp species which may serve as food for gray whales in the NNMREC Test Berth project area.
- Seasonal patterns in condition and feeding ecology of juvenile flatfish: This project examines the growth condition and gut content of select juvenile flatfish across depths and seasons in the nearshore. Additionally, gut contents are being analyzed using the bomb calorimeter to determine the nutritional quality of commonly consumed prey species.
- Burial speed and duration of Dungeness and red rock crabs: Work on this project has been to gather preliminary data in support of a proposal submitted to Oregon Sea Grant.

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 13 projects conducted by 1-3 students each.

Mentees:

- Caitlyn Clark (Mentor, summer 2010): NSF REU. Project title: Seasonal patterns in condition and feeding ecology of juvenile flatfish
- Cynthia Sells (FW410 Mentor, summer 2010): Non-traditional student in F&W Intensive Internship. Project title: Does benthic infaunal biomass influence *Cancer magister* biomass on the nearshore of Oregon's central coast?
- Timothy Seung-chul Lee (Committee Chair, 2010-present): M.S. student in Environmental Science Program. Proposed thesis: Characterizing Asteroidea Echinoderm densities across continental shelf waters of Pacific Northwest
- Jeremy Henderson (Committee Member, 2011-present): M.S. student in Zoology. Proposed thesis: The effectiveness of clonal growth versus seedling recruitment for an invasive eelgrass across a gradient of disturbance
- Sarah Close (Committee Member, 2010-present): PhD student in Zoology, Project: Nutrient dynamics and the structure of macrophyte assemblages.
- Becca Givens (Mentor): 2010-2011 OSU University Honors Thesis, Project: Population structure and distribution of mysid shrimp in habitats targeted for wave energy development.

Marine Ecology

Bruce Menge, Distinguished Professor; and Sally Hacker, Professor

Mission and objectives: Two labs in the Zoology department maintain research activities at HMSC, those of Bruce Menge and Sally Hacker. The research focuses on the dynamics of coastal ecosystems, including marine inner shelf, rocky intertidal, estuarine and sand dune habitats. 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 NOAA Administrator Jane Lubchenco as a former co-PI) and Sally Hacker as a Senior Research Associate. Other funding for our collective work comes from grants from Sea Grant, EPA, NOAA and NSF.

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 have a new NSF-funded project investigating the influence of ocean acidification on coralline algae, specifically the common and abundant turf-forming species *Corallina vancouveriensis*. The goal is to determine the susceptibility of this alga to decreasing acidification resulting from increasing CO₂ in the atmosphere. The importance of this question is that we have learned that *C. vancouveriensis* is the facilitator of 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. Work includes field observations and experiments, and lab experiments carried out at HMSC in a newly fabricated ocean acidification mesocosm. This work is funded for three years.

Menge and Chan also have funding from a separate NSF grant to investigate the influence of ocean acidification on the ecology of mussels and sea urchins. This is part of a 13 PI, six institution consortium of research groups on the US west coast, ranging from Oregon to southern California. This research also involves field and laboratory studies, and will also use the HMSC ocean acidification mesocosm.

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. Leigh Tait, is overseeing the ocean acidification experiments at HMSC, which will also involve graduate students Jeremy Rose, Elizabeth Cerny-Chipman, and Chenchen Shen. Another graduate student, Allison Barner, will be carrying out separate laboratory experiments for her research on “no analogue” algal communities, or species combinations that may be driven by climate change that have no historical precedent. A graduate student, Jeremy Henderson, is doing his thesis research on the invasive eelgrass, *Zostera japonica*, within Yaquina Bay and using tanks at HMSC. Other personnel involved besides the PIs, postdocs, and students include Megan Poole, Lindsay Hunter, 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*. 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.

Graduate Students, Postdocs and Research Faculty:

Francis Chan (PISCO, Assistant 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>.

Leigh Tait (Valley Postdoctoral Fellow): Carries out studies of effects of ocean acidification and other environmental stresses on the eco-physiology, photosynthesis, and productivity of macrophytes.

Dafne Eerkes-Medrano (Menge Graduate Student, supported by NSERC (Canada) Predoctoral Fellowship and a Mamie Markham Graduate Fellowship): Dafne studies the influence of hypoxia on larval survival in the inner shelf waters of the central Oregon coast. Her activities at HMSC include sample processing, microscope work, maintenance of cultures of larvae and larval food, and lab experiments. She will defend her PhD in Autumn 2011.

Margot Hessian-Lewis (Hacker and Menge Graduate Student, supported by a NOAA National Estuarine Research Reserve Fellowship and a Mamie Markham Graduate Fellowship): Margot studies eelgrass communities, with a focus on interactions between eelgrass and macroalgae and how this is affected by nutrient inputs from terrestrial and oceanic sources (runoff and upwelling). Her activities at HMSC include mesocosm experiments studying how eelgrass growth and interactions with macroalgae respond to controlled variation in density, light and nutrients, sample processing, and staging for field experiments. She will defend her PhD in Autumn 2011.

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

Alison Iles (Menge Graduate Student, supported by an NSERC Predoctoral Fellowship and a Mamie Markham Graduate Fellowship): Alison is investigating the impact of temperature and other stresses on the impact of predators on their intertidal prey, and what the consequences are for the strength of interactions in food webs. She uses the HMSC as a base for field studies and for laboratory experiments.

Phoebe Zarnetske (Hacker and Eric Seabloom Graduate Student, supported by an IGERT Graduate Fellowship): Phoebe studies dunegrass systems, focusing on the interaction between invasive and native dune grasses and their impact on dune communities. Her activities at HMSC include mesocosm experiments studying the interaction between invasive and native species of *Ammophila*. She will defend her PhD in Autumn 2011.

Jeremy Henderson (Hacker Graduate Student, supported by teaching assistantship and a Mamie Markham Graduate Fellowship): Jeremy is working on the effects of disturbance on invasive eelgrass, *Zostera japonica*, within Yaquina Bay. His current work includes mesocosm and field research based out of HMSC. He is also supporting an undergraduate student, Paul Dixon, who is helping him with his research in the summer of July 2011.

Allison Barner (Menge and Hacker Graduate Student): Allie is interested in studying the interactions that might occur in “no-

analogue” assemblages of marine macrophytes on rocky shores, and how these might alter the structure and dynamics of rocky intertidal communities. She is also interested in investigating the influence of climate change on the diversity of these systems.

Chenchen Shen (Menge Graduate Student): Chenchen is investigating 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.

Elizabeth Cerny-Chipman (Menge Graduate Student): Elizabeth is interested in how climate change 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.

College of Veterinary Medicine

Department of Biomedical Sciences

Timothy Miller-Morgan, Extension Veterinarian/ Assistant Professor, Aquatic Species, Oregon Sea Grant Extension

Tim Miller-Morgan’s academic home is in the College of Veterinary Medicine, Department of Biomedical Sciences (BMS), and he is the first College of Veterinary Medicine faculty to be permanently based at the HMSC. Miller-Morgan continues to work with Jerry Heidel, Director, Veterinary Diagnostic Laboratory; Luiz Bermudez, Chair, BMS; and Michael Kent, Director, Laboratory for Fish Disease Research, to develop an aquatic medicine program within the veterinary college.

Dr. Miller-Morgan also serves as the Aquatic Section Head at 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 and facilitate development of diagnostic services to better serve the ornamental fish and aquaculture industries in Oregon and the aquatic animal research community.

Miller-Morgan, Heidel and Bermudez are also involved in a number of projects that assess the health of fish related to wild capture and post-capture handling and shipping. Through partnerships with a local ornamental fish importer, Washington State University – Vancouver and marine ornamental fish collectors in Hawaii they plan to use their results to develop recommendations for best management practices for marine and freshwater ornamental fish collectors, exporters and importers.

Miller-Morgan is also a Co-PI on a project with Dr. Ling Jin, a herpes virologist, at the CVM to study latency of koi herpes virus. This is a serious viral disease that has spread globally and impacts not only the koi industry and hobby but also the large food carp industry. Project KHV, a foundation associated with the Associated Koi Clubs of America, has funded this project. Our

work in this area has confirmed that this herpes virus does have latency, we have identified the site of latency and we have been able to develop a new diagnostic test that could be used by the industry to determine which fish are carriers of the virus.

Dr. Miller-Morgan has also been involved in two collaborative projects with a number of other aquatic veterinarians and aquaculture professionals to develop best health practice and biosecurity standards and educational programs for ornamental pond fish retailers and importers. Collaborating veterinarians and aquaculture professionals hail from multiple institutions including: Oregon State University, University of Florida, University of Tennessee, Hawaii Department of Agriculture – Aquaculture Development Program and private practice. A unique aspect of the best health practices program is that special trained veterinarians will train and certify retailers. These projects received initial funding from the Associated Koi Clubs of America. The training programs continue as fee-based seminars. We have completed beta testing of the best health practices program with 8 ornamental pond fish retailers and 4 certifying veterinarians. The guidelines and training program are currently under revision based upon feedback from the participants in the beta testing.

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 at international industry meetings about the implementation of such programs. He recently traveled to Australia to speak to members of the ornamental fish industry, and to Japan to survey fish health management techniques within the Japanese koi industry.

Dr. Miller-Morgan continues to teach VMB 727, Ornamental Fish Medicine for senior veterinary students each spring at the HMSC and lecture on various aspects of ornamental fish medicine, diseases and fish husbandry in VMB 738, Special Species Medicine; VMB 753, Veterinary Virology; and VMC 738, Introduction to Animal Care. Further, he continues to be a regular guest lecturer in ANS 280, Companion Animal Management and FW 499/599, Coastal Ecology and Resource Management and FW 499/599, Fish Diseases.

Miller-Morgan also co-coordinates the Aquatic Section of the American Veterinary Medical Associations’ annual conference. This year the session was 4 days with 32 hours of seminars. Miller-Morgan gave presentations addressing: the history of pet fish keeping, a current overview of the ornamental fish industry, an overview of essential biosecurity practices for the ornamental fish industry, the development of best health practices for the ornamental pond fish sector, an overview of continuing education opportunities in fish medicine for the veterinary practitioner and a series of case presentations with Dr. Tom Waltzek from UC – Davis, SVM.

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 is part of the Western Ecology Division, located in Corvallis, Oregon. The mission of the Pacific Coastal Ecology Branch (PCEB) is to provide research support to the Program Offices such as the Office of Water, and to the Regional Offices of EPA. The research mission of PCEB is to develop procedures to assess the cumulative and interactive effects 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. During 2010-2011, PCEB has conducted research under the Estuarine Ecosystem Services Research Project, the goal of which 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. It may be argued that the 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, as well as 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 PNW estuaries at scales from single system to the entire Pacific coast.

An increased area of emphasis for PCEB research has been on the effects of climate change on estuarine ecosystems. In 2007 the Oregon legislature created a new Oregon Climate Change Research Institute (OCCRI), which is based at Oregon State University (OSU) with a mandate to produce a biennial report for the state legislature synthesizing climate change impacts and research within Oregon. PCEB scientists were invited to contribute to Chapter 6, "Impacts of Climate Change on Oregon's Coasts and Estuaries". Dr. Cheryl Brown synthesized data on climate effects on estuarine water quality, including temperature, salinity, dissolved oxygen (DO), nutrients, and changes in pH (ocean acidification). An important conclusion is that climate effects on estuarine water quality will depend strongly upon changes in ocean processes, such as the timing and intensity of upwelling, advection of low DO ocean water into estuaries, and increases in storm surges. Dr. Henry Lee II and Dr. Brown and their USGS partners also provided a synthesis of the current state of the science in predicting changes in tidal wetland habitats in response to sea-level rise using "Sea Level Affecting Marshes Model" (SLAMM). They concluded that SLAMM is a useful management tool, but should be modified to better capture the dynamics of Pacific Northwest estuaries. The document chapter will help the Oregon Legislature to identify the key uncertainties in predicting the effects of climate drivers on estuarine water quality and estuarine habitats. These uncertainties will also help direct estuarine climate change research at WED.

As part of the emphasis on climate change, a workshop on Modeling for Estuaries, Climate Change, and Restoration and Conservation Planning was held at HMSC in early 2011. The meeting was cosponsored by the U.S. Fish and Wildlife Service, Oregon Climate Change Program, USGS, and U.S. EPA. The workshop's purposes were to develop better conservation designs and planning approaches for Sea Level Rise (SLR) on the Oregon and Washington coasts, and to assess modeling utility and reliability in predicting changes to estuarine wetlands in response to SLR. PCEB scientists attending included Henry, Chris Janousek, along with USGS Debbie Reusser and Justin Saarinen.

EPA research staff at HMSC consists of 16 federal employees, including 2 EPA postdoctoral fellows, and 8 technical 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 Service

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 world class experimental seawater laboratories on the campus of the Hatfield Marine Science Center. The 10 members of FBEP staff, and their university collaborators, conduct laboratory research in Newport and field studies in Alaska aimed at understanding the role that behavior, physiology and ecology plays 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, 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, Aquaculture, 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. These species represent a diverse set of life histories and have allowed FBEP scientists to conduct a series of experiments examining how temperature, food availability, prey quality 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 collaborating with oceanographers at Oregon State University to provide the vital rate data for models examining the effects of seasonal and annual environmental variability on recruitment potential in Pacific cod. 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 low juvenile mortality rates. Many species of fishes and crabs in the Gulf of Alaska utilize shallow water nursery grounds, which lend themselves to the study of basic ecological, behavioral and trophic interactions between juveniles and their predators. Laboratory experiments in Newport are being conducted to distinguish the mechanisms by which structural components of habitat (e.g. seagrasses, algal beds and worm beds) mediate the interaction between predator and prey. Complimentary field manipulations and experiments are then conducted in Alaska waters to test hypotheses developed in the lab. 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 the Gulf of Alaska. Habitat studies are partnered with researchers from Oregon State University, the University of Alaska and NOAA laboratories in Kodiak and Juneau.

The behavior and ecology of Tanner crab is a relatively new focal area of research for the program. The Tanner crab fishery is closed throughout much of the Bering Sea and Gulf of Alaska because of declining populations. The ecology of this species is largely unknown. During studies of juvenile flatfish nursery habitats around Kodiak Island in 2009, FBEP researchers documented large numbers of recently settled juvenile Tanner crabs associated with polychaete worm tube beds in depths of 15 – 40 m. More extensive field and laboratory research during 2010 has contributed greatly to our basic knowledge of the nursery requirements, growth and ecology of this important commercial species. Of particular interest was documentation of more rapid juvenile growth in some nursery embayments compared to others. More rapid juvenile growth should lead to higher survival as juveniles begin their migration to deep water. In addition, growing 1 or 2 molt stages larger during their critical first summer will mean crabs reach reproductive age 1 or 2 years earlier. Current research is focused on differences between nurseries that may explain these difference in juvenile growth.

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 is focusing upon egg, larval and juvenile stages of commercially important Alaskan species. Current experiments are examining growth rates of larval walleye pollock and juvenile Pacific cod to explore the interactive effect of pH, temperature, and prey availability.

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 and Tanner crabs. During 2011,

experiments began to examine bycatch mortality in spot prawns, a small but lucrative fishery in the north Pacific. Results from those experiments are currently under analysis.

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; C. Barry Semple, IT Specialist, System and Network Administrator; Jim H. Miller, 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. NWFSC / OMI continued to manage the operations and maintenance contract through Oregon State University for maintenance of the 3 NOAA buildings to benefit all occupants and users of these buildings. This year to better support the NOAA Office of Law enforcement and make space available for the expanding Catch Shares Observer Program, the former computer server and IT support space BFB211 was converted to a smaller IT staging space and two new offices for Office of Law Enforcement personnel located here in Newport. The previous space occupied by OLE is now used for Observer program trainers and debriefers to support the Catch Shares Observer Program. New climate controlled space with new racks was created for the computer servers.

The OMI IT department continued to provide onsite IT Administration, Helpdesk and Network Administrator support to the NWFSC during the past year. Recent improvements to NWFSC IT Security include the installation of Adaptive Security Appliances (ASAs) to enhance data security. A project due to be finished this summer is the physical relocation of mission critical devices into a single, secured and climate-controlled room. Licensing has been secured to begin Enterprise level deployment of operating systems and productivity suites to further staff productivity and collaboration.

The OMI Safety and Environmental Compliance Office in Seattle continued to provide lab safety training for staff and students, respirator fitting, waste removal, inspections and consultations supporting environmental compliance and safety for the NOAA buildings on the HMSC campus.

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.

This year Patty George was recognized as the National Marine Fisheries Service, Northwest Fisheries Science Center Administrative Employee of the Year. She attended a ceremony in Washington D.C. where senior NOAA Fisheries leadership recognized her contributions and support of the NOAA programs here in Newport.

Conservation Biology Division (CB):

Dr. Peter Lawson; Dr. Laurie Weitkamp; Heather Stout

Dr. Peter Lawson, Dr. Laurie Weitkamp and Heather Stout 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. Dr. Weitkamp's primary research interests include the marine and estuarine ecology of Pacific salmon, life history variation, and conservation. Heather Stout's interests focus on the role of estuarine and other wetland habitats in threatened Oregon Coast coho salmon recovery.

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.

Coho salmon populations in freshwater are structured by the spatial stream network and are dependent on adequate quantity and quality of habitat. In cooperation with Dr. Kelly Burnett and Dr. Steve Wondzell (U.S. Forest Service), Dan Miller (Earth Systems Institute), Dr. Ashley Steele (U.S. Forest Service), and post-doc Dr. Mark Meleason (U.S. Forest Service), Dr. Lawson is embedding a habitat-based coho salmon life-cycle into a dynamic landscape model. This work will enable investigations of the effects of upslope and in-stream habitat change on coho salmon populations with applications to salmon recovery planning, habitat protection and restoration strategies. Integration with climate models will further enhance understanding of coho salmon population dynamics. The work is funded in part by a grant from the Oregon Watershed Enhancement Board.

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 habits, parasite 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). 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 could be 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 collaborative project 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 data base 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 Service, 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.

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/tr/oregonnccal.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. With the completion of its biological recovery criteria report the TRT completed the initial phase of its work, which was utilized in the Biological Review Team Analysis.

Biological Review Teams: Dr. Lawson is chair of a Biological Review Team (BRT) which has reassessed the status of the Oregon Coast Coho Salmon Evolutionarily Significant Unit. Dr. Weitkamp and Dr. Wainwright also participated, and Heather Stout staffed this BRT. Based on the BRT’s findings NMFS recently announced that the Oregon Coast Coho Salmon ESU will continue to be listed as Threatened under the Endangered Species Act (ESA). Dr. Lawson is also a member of the Recovery Implementation Science Team, which provides technical advice and oversight for recovery planning and activities throughout the Pacific Northwest. Dr. Weitkamp was involved in two additional biological reviews of Pacific salmon under the ESA. She served on the Central California coho (CCC) salmon BRT, which dealt with a court-ordered determination of ESU boundaries for the southern-most coho salmon ESU. She also worked on the five year update for listed ESUs in the Pacific Northwest (Washington, Oregon, and Idaho), which included the first review of Washington Coast and Puget Sound coho salmon for purposes of ESA listings since 1995. While the results of the CCC status review have been published, the five year update is still in preparation.

**Environmental Conservation Division (EC):
Dr. Mary Arkoosh, Supervisor, Immunology and Disease**

Drs. Mary Arkoosh and Joe Dietrich represent the Environmental Conservation Division (EC) in Newport and are part of the Ecotoxicology Program. Their research continues to focus on the influence of environmental stressors (e.g. pollution, infectious diseases and the hydropower system) on fish health. Previous research, by EC scientists and collaborators, has shown that exposure to environmental stressors can lead to a suppressed immune system and to an increase in disease susceptibility in juvenile fish. However, little is currently known regarding the

extent and relative significance of altered immune function or delayed-disease induced mortalities associated with stressors on the structure and fitness of host populations and communities. In an attempt to examine the relationships between environmental stressors, individual health and population risk, their studies have followed the framework proposed by the U.S Environmental Protection Agency for ecological risk assessment. Once a hazard is identified, the ecological risk assessment framework follows a three step process: (1) exposure assessment or field studies to determine how much of the stressor the fish is exposed to during out-migration, (2) dose-response assessment or laboratory studies to determine if altered health is observed in salmon after exposure to the stressor and ultimately (3) risk characterization, or determining what the extra risk is to salmon populations exposed to the stressor.

Staff and collaborators from many disciplines are involved with these studies and they include the following: Dr. Frank Loge, Dr. Claudia Bravo, Kai Eder, and Don Thompson from University California Davis, Stacy Stickland, Ahna VanGaest, Alex Krupkin, and Greg Hutchinson from Frank Orth, Dr. Ed Little from USGS Columbia Environmental Research Center, Dr. Larry Curtis from Oregon State University and Lyndal Johnson, Mark Myers, Dr. Nat Scholz, Sandy O'Neil and Gina Ylitalo from the EC Division in Seattle. Agencies and individuals who funded the projects are Shirley Zystra and Tory Henderson from the US Forest Service, Scott Hecht and Tony Hawkes from NOAA's Office of Protected Resources, and Michael Cox from US Environmental Protection Agency.

LABORATORY STUDIES

Sublethal and lethal effects of long-term fire-retardants: EC scientists are currently investigating products that have been approved by the Forest Service for fire fighting; Phos-Chek 259F and Phos-Chek 95A. In the previous 2009 study, they examined the sub-lethal and lethal (acute toxicity) effects of the fire retardants on stream-type Chinook salmon that were exposed as yearlings during the physiologically stressful time of smoltification, i.e. immediately prior to saltwater entry. The results indicate that sub-lethal exposure adversely affected saltwater survival for stream-type Chinook. This adverse effect was observed immediately after exposure to the Phos-Chek formulations; hence, the permanence or time-to-recovery from sub-lethal effects are currently unknown. In these 2010-2012 studies, they are determining the acute toxicity of the fire retardants Phos-Chek 259F and Phos-Chek 95A as well as two additional fire retardants (Phos-Cheks P100 and D75) on both ocean-type and stream-type Chinook at different stages of their development. In addition, they are investigating the impact of fire retardant exposure on seawater survival and time to recovery in ocean- and stream-type Chinook following sub-lethal exposures to the fire retardants. A principal element of the sub-lethal exposures is the determination of no-effect concentrations of the fire retardants.

The EC scientists are also investigating the toxic effects of four wildland firefighting foams on *Myxobolus cerebralis*, the

causative agent of Whirling Disease. *M. cerebralis* is considered an important Aquatic Invasive Species (AIS) in North America responsible for significant declines in wild and hatchery stocks of trout and salmon. The goal of the proposed experiment is to determine if firefighting foams are effective in inactivating *M. cerebralis* to prevent the spread of Whirling Disease throughout the western US. This research is part of a larger research effort that is coordinated through the USGS Columbia Environmental Research Center to examine the effects of fire retardants.

Disease challenge after dietary exposure to contaminants: EC scientists conducted a number of studies to characterize how contaminated diets may influence the ability of salmonids to respond to an infectious disease. They found that disease challenged fish (rainbow trout exposed to *Aeromonas salmonicida*) treated with an environmentally relevant contaminant mixture of polycyclic aromatic hydrocarbons (PAHs) suffered about 40% cumulative mortality compared to 29% for controls. These results have been published in *Environmental Chemistry and Toxicology* (Bravo et al 2011). This study also assessed the role of aryl hydrocarbon receptor affinity, and cytochrome P4501A protein and activity in PAH-induced oxidative stress. These results have been published in *Toxicology and Applied Pharmacology* (Curtis et al. in press).

EC scientists have also conducted a study examining the toxicity of the flame retardant polybrominated diphenyl ether (PBDEs) in juvenile sub-yearling Chinook salmon. The fish were fed an environmentally relevant diet of PBDE congeners (BDE-47, BDE-99, BDE-100, BDE-153 and BDE-154) found in the stomach contents of sub-yearling Chinook salmon outmigrating through the highly urbanized and industrialized lower Willamette River. The fish were then exposed to the marine bacterial pathogen *Listonella anguillarum* and found to be more susceptible to the pathogen than salmon fed the control diet. These results have been published in *Aquatic Toxicology* (Arkoosh et al. 2010).

Recently, the EC scientists were awarded a grant from EPA region 10 through EPA's Puget Sound Science and Technical Studies Assistance Program to expand their PBDE research into Puget Sound. They are exposing juvenile Chinook salmon to a range of individual PBDE congener (BDE-47, BDE-99) concentrations that reflect current levels found in Puget Sound Chinook salmon as well as uncertainties associated with modeled toxic loadings. In 2012, they will expose juvenile Chinook salmon to a range of congener mixture concentrations in order to identify primary toxicity and synergism. They will then determine the impacts of PBDE exposure on Chinook salmon disease susceptibility and endocrine and immune function. The collective results will provide dose-response relationships that can be used to develop tissue residue and related guidelines for PBDE exposure, which can subsequently be employed in biological monitoring at remediated and contaminated sites.

Anadromous Fish Evaluation Passage (AFEP): Characterize the impact of transport operations on disease transmission: EC scientists recently expanded research into host-environment interactions to address the impact of in-river stressors (e.g., dams,

barges) on host susceptibility due to the Federal Columbia River Power System (FCRPS). Transport operations, such as raceway and barge loading densities and water volume exchange rates, may contribute to secondary disease transmission. EC scientists examined various fish densities and water volume exchange rates in the laboratory to determine the effect of these parameters on disease transmission and ultimately their contribution to direct mortality. Snake River spring/summer Chinook salmon were raised from the egg stage and exposed to the freshwater pathogen (*Renibacterium salmoninarum*) through infected fish to determine the effect of various fish densities and water flow rates on disease transmission. Disease transmission was evaluated by the detection of the pathogen DNA in the fish kidneys and gills by conventional and real-time polymerase chain reaction (PCR). Both techniques indicated a high level of transmission from infected fish to susceptible fish gills during a 60-hour exposure period, representative of raceway holding periods and barge transport times through the FCRPS. The initial transmission resulted in detectable levels of the pathogen in the kidneys of susceptible fish by both assays over a 100-day monitoring period. Over the monitoring period, a trend of increasing pathogen detection occurred among fish held at the highest densities and flow rates, conditions that mimic the barge transport during the height of the outmigration season.

The combined effect of temperature stress and pesticide exposure (malathion) on the disease susceptibility of sub-yearling Chinook salmon: The EC scientists examined the effect of acute and sub-lethal exposure of the pesticide, malathion, on sub-yearling Chinook salmon that have experienced a temperature stress. Although temperature stress has been shown to increase the acute toxicity of malathion in Bluegills, the effect of temperature stress on either acute or sub-lethal toxicity of malathion to juvenile Chinook salmon was currently unknown. They found that malathion was significantly more acutely toxic to sub-yearling Chinook salmon when exposure occurred at a higher temperature. Since pesticides are generally applied in the summer months, the likelihood of both stressors (malathion and temperature) occurring concurrently is realistic. Sub-yearling Chinook salmon exposed to a sub-lethal concentration of malathion at a higher temperature had greater than a 10% increase in disease susceptibility than fish exposed to malathion at a lower temperature. However at 11°C, disease susceptibility was independent of malathion exposure. This research is part of a larger research effort that is coordinated through NOAA's Office of Protected Resources to examine the effects of pesticides.

FIELD STUDIES

AFEP: Characterize the impact of transport operations on disease transmission: EC scientists challenged both Rapid River Hatchery PIT (Passive Integrated Transponder)-tagged in-river and barged fish that were collected at Bonneville Dam with *L. anguillarum* to provide an aggregate measure of immune status. They found that fish that traveled in-river had a substantially higher incidence of disease-induced mortality relative to barged fish. This study was performed in 2002 in conjunction with the Army Corps of Engineers and other NWFSC scientists and has been published in the *Journal of Aquatic Animal Health*. This

study was repeated during the 2006 outmigration and expanded to include PIT-tagged salmon from the Dworshak National Fish Hatchery. The observation of increased disease susceptibility among in-river outmigrants was also observed among fish from the Rapid River Hatchery. However, EC scientists determined that the condition of the fish prior to barging (including the hatchery of origin) impacted the survival of fish during the disease challenge. This work has recently been published in the *Journal of Aquatic Animal Health* (Dietrich et al. 2011).

Little is known about the occurrence and transmission of infectious agents in barged juvenile salmon relative to juvenile salmon that remain in-river to navigate the Columbia River as they migrate to the ocean. EC scientists have conducted a pathogen prevalence survey on hatchery spring/summer Chinook salmon at various points along their outmigration path as they leave their natal hatcheries and either migrate in-river or are barged to Bonneville Dam. Ten salmonid pathogens, encompassing viral, fungal-like, and bacterial microorganisms, were surveyed in juvenile salmon kidneys and river water samples by the detection of their genetic material with polymerase chain reaction (PCR). The presence of nine pathogens was detected collectively among all samples analyzed; *Renibacterium salmoninarum*, Saprolegniaceae, and Infectious Hematopoietic Necrosis Virus (IHNV) were the most prevalent. Pathogen prevalence increased in juvenile salmon as they outmigrated in-river, although the increase was less than that observed in juvenile salmon over the course of barging. In addition, a decrease in *R. salmoninarum* prevalence in fish over the course of the outmigration season was observed. Results suggest that pathogen prevalence is greater in Chinook salmon that are barged through the FCRPS than fish left to outmigrate in-river. These results suggest that the transmission of infectious agents to susceptible juvenile salmon may occur during the barging process. Therefore management activities to reduce pathogen exposure during barging could increase post-release survival. This work has recently been submitted to the *Journal of Aquatic Animal Health* (Van Gaest et al. 2011).

Since contaminants can influence salmon survival and disease susceptibility, EC scientists have collected fish whole bodies and bile from barged and in-river fish during each sampling event from 2006-2008 to estimate the concentrations of PBDE, PCB congeners, PAHs, DDTs and biliary fluorescent aromatic hydrocarbons. Spatial and temporal trends of organic pollutants were examined in outmigrating juvenile spring/summer Chinook salmon from the Lower Snake and Middle Columbia River Basins. Specifically, hatchery-reared juvenile salmon were monitored as they navigated the Federal Columbia River Power System (FCRPS) by either transport barge or remaining in the river from Lower Granite to a terminal collection dam, either John Day Dam or Bonneville Dam. Levels of polychlorinated biphenyls (PCBs), polybrominated diphenylethers (PBDEs), and organochlorine pesticides were detected in the bodies of both in-river and barged salmon during the 2006, 2007 and 2008 outmigrating season. Of the persistent organic pollutants (POPs), DDTs were found at the greatest concentrations in the salmon bodies. At the terminal dam, in-river fish had greater body burdens of POPs than barged salmon due to lipid depletion and, depending upon the year, as a result of increased exposure to POPs as indicated by wet weight

contaminant concentrations. Barged and in-river salmon were also exposed to PAHs as indicated by the phenanthrene (PHN) signal for biliary fluorescent aromatic compounds (FACs). The PHN FACs levels remained constant as both groups outmigrated from the hatcheries to the terminal dam in some years. In other years, the PHN FACs levels were reduced in in-river fish upon arrival to the terminal dam compared to barged fish. The potential exists for adverse affects to occur in threatened/endangered juvenile salmon from the Lower Snake and Middle Columbia River Basins due to exposure to the levels of organic pollutants observed in this study. These results have recently been submitted to the *Science of the Total Environment*.

Fish Ecology Division (FE)

Dan Bottom, Team Leader, Estuarine Ecology

Richard Brodeur, Team Leader, Ocean Ecology

William Peterson, Team Leader, Climate Change and Ocean Productivity

Dan Bottom, Richard Brodeur, Robert Emmett, Kym Jacobson, William Peterson, Tom Wainwright, and Julie Scheurer represent the Fish Ecology Division in Newport and are all members of the NWFSC's Estuarine and Ocean Ecology Program. Laurie Weitkamp is part of the NWFSC's Conservation Biology (CB) Division in Newport and is also an active member of Estuarine and Ocean Ecology Program. Research programs involve extensive collaboration with scientists from other NWFSC laboratories as well as the NOAA Alaska and Southwest Fisheries Science Centers, Oregon State University, Oregon Graduate Institute, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, University of Washington, Canadian Department of Fisheries and Oceans, University of California at Santa Cruz, Virginia Institute of Marine Science, University of Maryland, Georgia Institute of Technology, and Centro Interdisciplinario de Ciencias Marinas.

Affiliated scientists:

Cooperative Institute for Marine Resources Studies (CIMRS):

Senior Research Assistants: Leah Feinberg, Cheryl Morgan, and Tracy Shaw

Research Assistants: Toby Auth, Tristan Britt, Andrew Claxton, Elizabeth Daly, Jennifer Fisher, Alyssa Hopkins, Jesse Lamb, Marisa Litz, Anita McCulloch, Jennifer Menkel, Jason Phillips, and Mary Beth Rew

Research Associates: Mattias Johansson, Jay Peterson, David Rupp, and Jim Ruzicka

Oregon State University Graduate Students: Rebecca Baldwin, Xiuning Du, Amanda Kaltenberg, and James Losee

Pacific States Marine Fisheries Commission: Andrew Claiborne and Greg Hutchinson

Visiting Scholar: Dr. Ryan Rykaczewski, NOAA – Geophysical Fluid Dynamics Laboratory, Princeton University

Columbia River Plume Study: Ocean conditions and juvenile salmonids: FE scientists study the interactions and ecological linkages within and between the California Current, the Columbia River plume, and coastal upwelling to investigate the effects of the plume and ocean conditions on the distribution, abundance, stock composition, growth, and survival of juvenile salmonids. This project includes study of salmon feeding and relationships between feeding preferences and prey, and of the potential impact of salmonid predators on salmon survival. FE scientists also study interrelationships between zooplankton and salmon, sardines, anchovy, and herring. In conducting these studies, scientists use an ecosystem-based approach to investigate the biotic and abiotic factors that control growth, distribution, health, and survival of important fish species and on the processes driving population fluctuations. Ultimately, this ecosystem-based research (described in more detail below) will be applied to management of fish stocks off the Oregon coast.

Predator and Prey Field Studies: FE scientists study predator-prey relationships among hake, mackerel, forage fishes, and juvenile salmon off the Oregon and Washington coasts as part of a project funded by the Bonneville Power Administration. This project is led by R. Emmett with field assistance from Paul Bentley (NMFS Hammond Laboratory), M. Litz, and A. Claiborne. Cruises were conducted twice a month off Willapa Bay and the Columbia River from 1998–2009, but beginning in 2010 FE scientists focused efforts monthly off Willapa Bay. Predators and prey are sampled with a pelagic trawl during both day and night to determine if hake and mackerel are significant predators on juvenile salmonids. Information is also gathered on the abundance and distribution of forage fishes and the available juvenile salmonid prey field, both of which may act as alternative prey for these predators. This study is testing the hypothesis that recent fluctuations in abundances of predators and forage fishes may explain the recent fluctuations in juvenile salmonid abundances. In addition, CIMRS researchers M. Litz and E. Daly have been measuring the seasonal profiles of lipid and fatty acid concentrations in juvenile salmon and their associated prey field to test the hypothesis that bottom-up processes influence the condition and ultimate survival of salmon smolts.

Juvenile Salmon Ocean Survival Studies: Another major FE investigation involves examining the correlation between salmon growth and survival and the unique physical and biological characteristics of the continental shelf waters off Washington and Oregon. This work is also funded by the Bonneville Power Administration and is being performed in collaboration with scientists from Oregon State University and the Oregon Graduate Institute. As part of this study, scientists are collecting information on the distribution and abundance of salmon and other species in the upper water column, both in the Columbia River plume and in coastal waters. These data will be related to ocean conditions and compared to data collected in the 1980s. Scientists are measuring salmonid growth, condition, pathogen load, food habits, parasites, and prey fields and relating them to ocean conditions. There are many scientists involved with these studies including W. Peterson, R. Brodeur, J. Ruzicka, K. Jacobson, C. Morgan, J. Lamb, M. Litz, M. B. Rew, J. Losee,

E. Daly, and J. Scheurer. Drs. Wainwright and Ruzicka are developing a suite of integrated simulation models that link ocean physics with plankton dynamics, salmon bioenergetics, and overall food web dynamics. The ultimate goal of these studies is to determine whether the plume represents a favorable feeding location for juvenile salmon. Ongoing studies are looking beyond actual prey availability to examine prey quality using lipid and fatty acid composition and caloric content. Results show that the fatty acid profiles of salmon change quickly in the transition to the ocean as they adapt to a marine diet of more fish and that both salmon and forage profiles are affected by ocean conditions.

In another project funded by the Bonneville Power Administration, W. Peterson, Hongsheng Bi (University of Maryland), C. Morgan, and Joe Fisher (OSU) are studying habitat requirements of juvenile salmon in the Washington and Oregon upwelling zones. They have established that coho and Chinook salmon juveniles are restricted entirely to coastal waters, and are found chiefly off the coast of Washington State. Chinook were found at stations with shallower water depths than coho. In fact, through analysis of their data, along with historical data collected by Dr. William Percy (OSU), they found that the two species maintain a constant depth separation. To further study the habitat requirements of juvenile salmon, GIS is used to map salmon distributions along with oceanographic variables. Dr. Bi has been using logistic regression and quantile regression to determine which oceanographic variables best describe salmon habitats. At this point, the best predictors of habitat size are water depth, chlorophyll, and copepod biomass. Chlorophyll, as measured by NASA satellites, is a good predictor of the size of available habitat for juvenile salmon in continental shelf waters. Analyses of habitat requirements is continuing with support from NASA whereby we are trying to relate transport, as measured by the TOPEX program to food chain structure, and salmon survival are being investigated.

Long Term Coastal Monitoring: This research program involves euphausiid, copepod, and ichthyoplankton studies, as well as ecological indices.

Euphausiid Studies: A research program under the leadership of Dr. Peterson involves at-sea sampling 2–3 times per month at stations from 1 to 25 miles west of Newport (a.k.a. the Newport Line). 2011 marks the 16th year of these efforts. At each station, J. Peterson, T. Shaw, J. Menkel, and J. Fisher measure temperature and salinity profiles and collect samples for later analysis of nutrients, phytoplankton, zooplankton, and ichthyoplankton. T. Shaw and L. Feinberg are analyzing data from the 15-year time series to determine factors that control euphausiid recruitment in the Oregon upwelling zone. Dr. W. Peterson continues to measure egg production rates of the copepod *Calanus marshallae* collected during these cruises to test the hypothesis that cold ocean conditions are more productive than warm ocean conditions, using copepod egg production as an index of coastal productivity. Live zooplankton collected off Newport are often sent to Dr. Jeanette Yen (Georgia Institute of Technology), who uses high-speed high-resolution cinematography to film swimming and feeding behavior of

copepods, krill, and pteropods.

Over the years, this coastal monitoring research program has provided valuable information. Through this program, FE scientists found that from 1996–1998 zooplankton biomass was low and there was a high incidence of subtropical species in coastal waters. Euphausiids, a key forage item for rockfish, salmon, Pacific whiting, seabirds, and whales, were low in numbers and spawned only once per year, in late summer. Beginning in 1999, commensurate with cool ocean conditions, zooplankton biomass began to increase and the euphausiid spawning season expanded to April through September. From late 2002 through 2007, the ocean warmed, productivity declined and copepod biodiversity increased to levels near those observed during the 1983 and 1997/1998 El Niño events. The summer of 2005 was particularly unusual in the northern California Current, being characterized by a “warm water event” which resulted in a collapse of the food chain and high death rates of many fishes (including salmon) and seabirds. A perturbation of the normal climate forcing resulted in a delayed start of the coastal upwelling season, from the usual April to late July. Papers discussing the physical forcing and biological response were published in November 2006 in a Special Issue of Geophysical Research Letters. A similar set of events (delayed upwelling) occurred in 2006, however upwelling was initiated by late May, so it was delayed but not enough to cause a problem for seabirds. In 2007 cold ocean conditions returned, a situation which continued through mid-2009, after which a small but significant El Niño resulted in another round of warm ocean conditions. Cold conditions have now returned to the California Current.

Laboratory studies of living zooplankton continue to be a key focus of the euphausiid research program, including measurements of euphausiid brood size, molting rates, and feeding rates using live animals that are collected during each cruise. This work is carried out by T. Shaw, J. Menkel and L. Feinberg. This year we added experiments on the effect of ocean acidification on egg hatching and naupliar development of euphausiids and copepods. Some of this work was completed by an undergraduate intern, Melissa Precht. L. Feinberg will be continuing these experiments this year, in collaboration with Dr. Tom Hurst (NOAA Alaska Fisheries Science Center/Newport). J. Menkel is enumerating euphausiids in plankton net samples to produce some of the first estimates of euphausiid biomass in the northern California Current. She is finding that there is often a maximum in euphausiid biomass on Heceta Bank and off southern Oregon. Xiuning Du, a graduate student from Qingdao, China, finished her Ph.D. research which focused on the feeding rates of adult *Euphausia pacifica* incubated in natural seawater. One key finding is that *E. pacifica* show a strong preference for ciliates as prey, and select against small flagellate phytoplankton. X. Du was honored with the award “Best Paper by a Graduate Student” at the PICES meeting in Portland, in October 2010. She returned to China in April 2011.

In a new project, Dr. Mattias Johansson has joined the Peterson lab for one year to study genomics of krill with a focus on *Euphausia pacifica*. He was ably assisted during the summer of 2010 by Angie Sremba. He is determining the unique

characteristics of the life history and genetic diversity of this cosmopolitan euphausiid species that allow it not only to populate such a wide variety of ecosystems, but to become a dominant species among the plankton. The goal of M. Johansson's work is to develop microsatellite markers for *E. pacifica* and *Thysanoessa* spp. using next-generation sequencing. In addition, the plan is to sequence mitochondrial genomes from five species of euphausiids, including *E. pacifica*, *T. raschii*, *T. inermis*, *T. spinifera*, and *T. longipes*, also utilizing a next-generation sequencing-based approach. Once microsatellite markers have been developed, they will be used in conjunction with appropriate mitochondrial markers to assess the population structure of *E. pacifica* across the North Pacific.

Copepod Studies: W. Peterson, C. Morgan, and J. Fisher continued analysis of historic data sets collected off Newport to describe long-term changes in hydrographic conditions and zooplankton abundance off the Oregon Coast. Recent analysis of these zooplankton data show high correlation between coho salmon survival and zooplankton species and copepod community composition: when waters off Newport are dominated by species with subarctic Pacific (cold water) affinities, salmon growth and survival is high, but when the zooplankton community has anomalously high concentrations of warm water species, salmon do poorly. Changes in the sign of the Pacific Decadal Oscillation clearly manifest themselves in Oregon waters, but with varying time lags: water temperatures lag the PDO by several months, changes in copepod biodiversity lag the PDO by 4–6 months, but changes in copepod biomass lag the PDO by two years. Similarly, the response of forage fish abundances and juvenile salmon abundance lag a change in PDO by 1–2 years.

Ecological Indicators: W. Peterson recently updated a report, "Ocean conditions and salmon survival in the northern California Current off the coasts of Oregon and Washington: taking an ecosystem approach to salmon management" that is published on the web. This report includes 15 indicators of ocean conditions in the northern California Current and shows how they are used to predict returns of coho and Chinook salmon one year in advance. A web-page is now maintained by the Northwest Fisheries Science Center, providing forecasts of salmon survival and salmon returns, using large-scale indices (PDO and El Niño Southern Oscillation), local physical measurements (water temperature and salinity; date of spring transition, upwelling strength) and local biological indicators (biomass of cold-water and warm-water copepods, copepod biodiversity, copepod community composition, date of biological spring transition, and catches of juvenile Chinook (in June) and coho (in September) salmon during the BPA surveys discussed above). See <http://www.nwfsc.noaa.gov> and click on "Ocean Conditions and Salmon Forecasting."

Salmon Management Strategy Evaluations: Drs. Rupp, Wainwright, Lawson, and Peterson have initiated a study of the utility of climate and ecological indicators for improving Northwest salmon harvest management and conservation. By using the formal techniques of Management Strategy Evaluations (MSEs), they are looking at how much environmentally driven

variation in salmon production influences achievement of harvest and conservation goals, and whether incorporating environmental indicators into salmon run size forecasts would improve management. They are also working with Oregon Department of Fish and Wildlife to examine alternatives to current harvest management rules for coastal coho salmon.

Ichthyoplankton Studies: R. Brodeur, B. Peterson, R. Emmett, and T. Auth examined ichthyoplankton samples collected by the Peterson lab along the Newport Line to investigate seasonal and interannual variability in fish recruitment. The data from the last decade of sampling have been added to a historical database to examine long-term trends in ichthyoplankton abundance. From the 1970s to present, they have found major changes in the ichthyoplankton composition related to shifts in ocean conditions. In recent years, sardines, anchovies, Pacific whiting, and jack mackerel have been spawning regularly off the Oregon Coast in contrast to some earlier periods, whereas some cold-water species such as smelts are in relatively low abundance. Long-term changes have been established in ichthyoplankton densities, diversities, and dominant species in relation to regional and local environmental forcing factors using Generalized Additive Modeling. Another project funded by the Fisheries and the Environment Program examined the relationship between winter larval fish biomass and salmon survival the following summer to provide an early indicator of salmon recruitment. Results show that the larval fish biomass in winter is strongly correlated with juvenile salmon survival in the early summer and may be a useful early predictor of salmon survival.

Drs. Emmett and Brodeur lead a study initiated in 2004 to examine seasonal variation in abundances of juvenile fishes, including rockfish. This project has been funded by NOAA's Stock Assessment Improvement Program and examines fishery independent catch rates as an indication of relative success or failure of commercially important fish species off the Oregon Coast. Cruises are conducted monthly off Newport, Heceta Head, the Columbia River, and Willapa Bay. T. Auth, T. Britt, and A. Claiborne conduct the sampling and process the biological and physical data. Surveys since 2004 (five each year) have found high numbers of juvenile rockfishes, but also found many juvenile hake and jack mackerel, species not known to spawn off Oregon. In collaboration with OSU scientists, T. Britt and M. Litz are using DNA markers to determine the identity of larval and juvenile rockfishes that are not distinguishable morphologically, thus providing important new information on this poorly-studied life stage. Dr. Brodeur and collaborators are using genetically-specified juvenile rockfishes to examine their diets both visually and by the use of stable carbon and nitrogen isotope ratios. Several surveys and the diets of piscivorous predators suggest that the 2010 year class of rockfish should be stronger than any other year the past decade. In 2009, these and other surveys collected large numbers of a large, voracious predator, the Humboldt squid, that is usually found in more southern waters but these squid were completely absent from our surveys in 2010. We are presently examining their potential effect on the ecosystem using stable isotope analysis and modeling. Starting in May 2011, a coastwide prerecruit survey was reinstated together with the FRAM Division to examine large-scale (Northern

Washington to Central California) indices of fish recruitment. This project is led by R. Brodeur, J. Phillips, and K. Bosley.

GLOBEC Investigations: The US GLOBEC Program began its multiyear Synthesis Phase in 2005 and ongoing activities include 1) synthesis of salmonid studies, including distribution and abundance, trophodynamics and diseases and parasite studies, along with determination of habitat requirements of juvenile salmon, 2) population dynamics of euphausiids, and 3) synthesis of relationships between the Oregon upwelling and other upwelling systems and comparisons between zooplankton dynamics in the Kuroshio and California Currents. Dr. Hongsheng Bi has developed statistical models of habitat requirements of juvenile salmonids and, with W. Peterson and C. Morgan, is developing statistical models that predict coho survival based on measurements of water temperature, chlorophyll, and zooplankton biomass and species composition. The third study involves scientists from Georgia Institute of Technology, University of Maine, Oregon State University, NOAA's Pacific Fisheries Environmental Laboratory in Monterey and NOAA's Geophysical Fluid Dynamics Laboratory at Princeton University. A germane aspect of that study is the demonstration that zooplankton species composition in the northern California Current (NCC) is controlled to a large degree by the types of source waters that feed the NCC. When the PDO is in positive phase, about 40% of the source waters come in from offshore, whereas when the PDO is negative, nearly all of the water enters from the north. The former case brings subtropical (warm-water) species to Oregon, the latter, sub-arctic (cold water) species. Dr. Rykaczewski, a visiting scholar with W. Peterson from mid-June 2011 through mid-October 2011, is working on the "bifurcation problem" to identify the mechanisms that control the source waters which feed the Northern California Current. Drs. Rykaczewski and Peterson are also working on climate change scenarios for the NCC.

Dr. Jacobson and T. Sandell evaluated the ecology of disease and the importance of disease processes that affect salmon populations in the estuary and ocean environments. The potential contribution of salmon pathogens (viruses, bacteria, and macroparasites) to growth and survival of salmon is being examined in ocean juveniles along the coast. The results will be related to results of growth, condition, and bioenergetics being conducted by Joe Fisher (OSU) and FE scientists at the NWFSC in Seattle. Pathogen prevalences will also be compared to the results of studies conducted in Oregon and Washington estuaries by scientists within the Environmental Conservation Division. These later studies are aimed at gaining a better understanding of the contribution of infectious agents to salmonid mortality.

Dr. Ruzicka is developing an end-to-end model for the Northern California Current. End-to-end models describe the flow of production through the entire food web, from the input of nutrients to the production of top predators. They must incorporate nutrient cycling pathways and the basic physics of the system that drive nutrient input and transport of nutrients and plankton production in and out of the system domain. This model is part of the GLOBEC pan-regional synthesis program and is being used in the comparison of large-scale

ecosystem structure and dynamics of the coastal Gulf of Alaska, the Northern California Current, the Southern Ocean, and Georges Bank. The primary efforts of this project are 1) the development and validation of a data-based end-to-end trophic model; 2) quantification of the propagation of uncertainty through the model; 3) analysis of the model to derive a suite of ecosystem state and process rate metrics for inter-regional and inter-annual comparisons; and 4) use of the model to predict system response to alternate perturbation and physical forcing scenarios. This work complements food web development funded by the Bonneville Power Administration to examine inter-annual variability in bottom-up and top-down trophic pressures upon juvenile salmon in the ocean. To date, five independent mass-balanced models for years 2003 through 2007 have been completed, critically evaluated, and finalized. Additional models based on ocean observations for years 2000–2002, and 2008–2010 are currently in preparation.

Harmful Algal Blooms: Dr. Peterson was funded by the NOAA Ocean and Human Health Initiative program to begin work on Harmful Algal Blooms (HAB) in Oregon's coastal waters. Anita McCulloch assumed this project from a previous post-doc, Linda O'Higgins in August 2010 and she is funded on a NOAA project grant. This research has found a high incidence of *Pseudonitzschia* in samples collected year-round. Bill works closely with members of the HAB groups at the University of Washington and the NWFSC in Seattle, and with HAB scientists from Oregon State University (Angel White) and NOAA's Miami Laboratory (Michelle Woods). As part of this project, Xiuning Du published a paper describing an unusual bloom of a red-tide algae, *Akashiwo sanguinea*, that occurred during autumn 2009. This bloom caused widespread deaths of seabirds, through a process of saponification. That is, the bloom was whipped up into a foam by the winds and the foam saponified the oils in the birds' feathers (essentially washing them off) leaving the birds without protection from the cold. Bird deaths were due to hypothermia.

Coastal Pelagic Species: Drs. Jacobson and Emmett began a program in 2005 to investigate the migration and stock distribution of small coastal pelagic fishes, initially focusing on Pacific sardines off of Oregon and Washington. This program includes the use of parasites as potential biological markers for sardine migration. This work was conducted by Rebecca Baldwin, who recently completed her Ph.D. project on this topic. In 2007 we began a collaboration with personnel from NOAA's Southwest Fisheries Science Center (SWFSC) to conduct a coastwide survey of sardines using acoustics, trawling, and egg sampling to estimate spawning stock biomass.

Drs. Brodeur and Doug Reese (OSU) are collaborating on a project using LIDAR (laser) technology to survey pelagic schools from airplanes and compare abundance estimates to shipboard and moored acoustic arrays. A survey off the Washington Coast in the summer of 2006 indicated very patchy distribution of schools related to oceanographic features such as fronts and the Columbia River plume. Geostatistical techniques are being used to examine the proximity of fish schools and individual fish targets to the location of temperature and chlorophyll fronts

determined by satellites. Results indicate that fish schools are found closer to fronts than would be expected by chance.

Time of Ocean Entry Studies: Since 2002, R. Emmett and more recently with A. Claiborne and A. Kaltenberg have been investigating how size and the time when juvenile salmon enter the ocean can influence their marine survival. From 2002–2006, hatchery Chinook salmon were released into the Columbia River estuary every two weeks. All adult returns from these releases have been collected. Scales from these adult salmon have been analyzed by A. Claiborne to identify how size and time of ocean entry affects survival. His research indicates that proportionally more larger smolts at ocean entry survived to adulthood versus smaller smolts. Currently A. Claiborne is working on a project that tests whether size-dependent mortality occurred between the time of freshwater emigration and a later period during the first summer at sea for Columbia River sub-yearling Chinook salmon collected in 2010 and 2011 in the Columbia River estuary and later off the coasts of Oregon and Washington. Additionally, A. Claiborne is developing a baseline to differentiate hatchery- and naturally-reared individuals from this project that, if accurate, will be useful for comparing many metrics between hatchery- and naturally-reared juveniles and could provide a basis for examining other populations from the Columbia River basin.

A. Kaltenberg has been working on acoustic data captured from bottom-mounted profilers located off the Columbia River from April–June. Her study has been looking at the environmental conditions that influence the arrival and abundance of forage fish to the mouth of the Columbia River. We hypothesize that when forage fish are abundant, marine survival of salmonids should increase because of increased alternative prey for predators. This study showed that if forage fish populations play a role in determining marine juvenile salmon survival, then the timing of ocean entry by juvenile salmon is critical due to the abrupt appearance of forage fishes.

Columbia River Estuary Studies: FE and Conservation Biology Division scientists have been regularly sampling the pelagic environment in the lower Columbia River estuary for forage fishes and juvenile salmon. This program is led by Drs. Weitkamp and Jacobson, with assistance from M. Litz, A. Claiborne, P. Bentley (NOAA-Hammond Facility), and others. Information generated from this research includes the timing of various stocks of juvenile salmon through the estuary and into the ocean, the size and health of juvenile salmon in the lower estuary, the relative abundance of different forage fish species, length-age frequency distributions, and comparisons to offshore catches of forage fishes. Ultimately this study should identify if estuaries provide a “critical” habitat for a resource (forage fish), which strongly influences salmonid marine survival and the role the lower estuary plays in juvenile salmon life histories.

In collaboration with NWFSC scientists at other laboratories, Dr. Emmett has been conducting a Salmon Time of Release Study funded by the Army Corps of Engineers. This study examines the relationship among time of juvenile salmon ocean entry, physical and biological characteristics of the estuary and nearshore ocean plume environment, and smolt-to-adult return rates (SARs)

for spring Chinook salmon reared by the Clatsop Economic Development Committee Fisheries Project in the lower Columbia River. By enhancing our understanding of the linkages between ocean entry and the physical and biological estuarine and ocean conditions that smolts encounter, we can optimize SARs by manipulating transportation tactics and hatchery release dates.

A team of researchers led by D. Bottom and supported by funds from the U.S. Army Corps of Engineers has been evaluating the effects of flow management and historic habitat change on juvenile salmon in the Columbia River estuary since 2002. A primary goal of the research is to examine the estuary’s importance as a rearing area for juvenile salmon and to support ongoing estuary restoration activities that are intended to benefit the recovery of 13 at-risk salmon stocks in the Columbia River basin. The study evaluates fish and prey assemblages within selected tidal wetlands; analyzes historical changes in flow, sediment input, and salmon rearing opportunities throughout the tidal river; and evaluates the effects of habitat change and flow regulation on estuarine food chains supporting juvenile salmon. K. Jacobson and A. Claxton examine parasite communities of juvenile salmon to provide independent indices of juvenile salmon diet, habitat use, and habitat health within the Columbia River estuary. Scientists also use models to compare the relative effects of river modifications and flow regulation on salmon habitat availability and to evaluate the effectiveness of alternative scenarios for restoring estuarine habitat.

In 2010 the NOAA research team secured funding from the U.S. Army Corps of Engineers to expand their research activities into the upper tidal fluvial portion of the estuary, which extends ~233 km from the river mouth to Bonneville Dam. During the first two years of study, a continuous series of bimonthly salmon surveys will be completed to determine the genetic stock composition and distribution of juvenile Chinook salmon migrating through the estuary. These results will define key habitat complexes in the tidal fluvial reaches of the estuary that are utilized by a diversity of Columbia River salmon stocks. The research team will design a series of intensive studies within these habitats to identify factors that affect salmon habitat opportunities, abundance, life history, and performance (i.e., foraging success, bioenergetics, growth) in the upper estuary. These results will aid development of estuary restoration strategies to support salmon recovery efforts throughout the Columbia River basin.

Fishery Bulletin Scientific Editorial Office: The *Fishery Bulletin* is an international marine fisheries journal published by the National Marine Fisheries Service. The *Fishery Bulletin* publishes original research reports and technical notes on investigations in fishery science, engineering, and economics. The editorial office rotates among the regions of the National Marine Fisheries Service every three years. In September 2008, Dr. Brodeur was selected to serve as Scientific Editor and the Editorial Office moved to the NWFSC Newport Laboratory from the Alaska Region. Julie Scheurer serves as the Associate Editor. The Editorial Office is responsible for reviewing manuscript submissions, coordinating peer-reviews, editing, and publishing four issues of the journal each year. Additionally, the *Fishery Bulletin* Editorial Office facilitates the reviews and editing of

the NOAA Professional Papers series. Issues of *Fishery Bulletin* are available online at <http://fisherybulletin.nmfs.noaa.gov> and paper copies are available at the HMSC Guin Library. NOAA Professional Papers are available at <http://spo.nwr.noaa.gov/profpapers.htm>.

Fishery Resource Analysis and Monitoring Division (FRAM):

Dr. Patricia Burke, Groundfish Monitoring Program Manager

West Coast Groundfish Observer Program: The West Coast Groundfish Observer Program is in its tenth year deploying observers aboard commercial fishing vessels along the west coast with expanded coverage of the trawl fishery Catch Share Program in 2011. The new program, which began in January 2011, established individual fishing quotas for shore-based trawl fleets as well as fishing cooperatives for the at-sea mothership and catcher/processor sectors (<http://www.nwr.noaa.gov/Groundfish-Halibut/Groundfish-Fishery-Management/Trawl-Program/index.cfm>). The regulations require 100% observer coverage for this fishery.

Fisheries observers sail as biologists aboard commercial fishing vessels and are responsible for collecting catch and discard



estimates, species composition data, and biological specimens in west coast groundfish fisheries. Through a cooperative agreement between NOAA Fisheries and the Pacific States Marine Fisheries Commission, observer program staff are stationed at ports along the west coast from San Diego, California to Bellingham, Washington. The program has several staff members stationed at HMSC, including coastal coordinator B. Alex Perry; training coordinator Jennifer Cramer; and data debriefers Jason Eibner, Christa Colway, Bo Whiteside, and Toby Mitchell. Providing logistic support is Eric Brasseur. We report with deep regret the passing of Allen Cramer in July 2011, a long time member of the Observer team, after a hard fought battle with cancer. The program conducted its three-week training course for new observers seven times over the past year to ensure an ample number of trained observers for the catch shares program, which requires 100% observer coverage of all of the trips by participating fishing vessels. Safety is always a priority, and the observer program has held multiple annual refresher safety

training classes for returning observers and has aided with training FRAM's at-sea survey staff here at the HMSC. The observers have collected fish specimens for several different labs, research projects, and the Oregon Department of Fish and Wildlife for education and outreach program.

Resource Surveys

Groundfish Bottom Trawl Survey: The FRAM West Coast Groundfish Bottom Trawl Survey (WCGBTS) members stationed at the HMSC are biologists Keith Bosley, John Buchanan, Dan Kamikawa, and Doug Draper. They are responsible for conducting the annual coast-wide groundfish trawl survey. The survey runs from Washington to California using a stratified random site selection design (from 55 m to 1,280 m in depth). These surveys are designed to provide information needed to determine the relative abundance and distribution of groundfish species along the continental shelf and slope off the Washington, Oregon, and California coasts.

The 2011 groundfish survey began with the annual At-Sea Safety Training and Survey Orientation sessions held at the HMSC during the first week of May. The contracted fishing vessels *F/V Noah's Ark* and *F/V Ms. Julie* embarked upon the first pass of the survey in May and will return in late July. The second pass, using contract vessels *F/V Excalibur* and *F/V Raven* departs in August and is expected to conclude in late October. In addition to FRAM survey members and scientists, participants in the annual bottom trawl surveys have included graduate students from Oregon State University, the University of Washington, and Moss Landing Marine Laboratories, as well as biologists from the Oregon Department of Fish and Wildlife.

As part of the WCGBTS, scientists also examined the abundance of benthic organisms in a known hypoxic area off the Oregon coast. Since 2002, seasonal hypoxia has been observed extending over an area greater than 700 km² offshore of Newport, Oregon. FRAM dedicated 2-days of the groundfish survey in August to examining the abundance of demersal fish and invertebrates within the hypoxic zone in greater detail, as was initially done in 2007. During the 2-day survey, bottom oxygen concentrations at all stations ranged from 0.85 to 1.11 ml l⁻¹ and was hypoxic along 14 tow tracks. Preliminary results indicate that total catch (kg) and bottom dissolved oxygen (DO, ml l⁻¹) levels for 2010 were significantly related and that the relationship was similar to that observed in 2009.

In a second hypoxia-related study, individuals from the FRAM Groundfish Survey and Habitat and Conservation Engineering group (Aimee Keller, Victor Simon, and Waldo Wakefield) have continued an ongoing collaboration with OSU's College of Oceanic and Atmospheric Sciences (Jack Barth and Stephen Pierce) and Zoology Department (Francis Chan) studying demersal fish species composition and biomass in relation to the oxygen minimum zone along the U.S. West Coast. The goal of this research is to provide information to fisheries managers to aid in the assessment of fish populations in the face of future climate changes. This work will be continued as part of the 2011 WCGBTS.

Integrated Hake Acoustics Survey: Scientists from the FRAM Acoustics group conduct fisheries acoustic surveys and carry out post-cruise analysis of the collected survey data. Pacific hake is a primary target of this survey. The acoustics group also works on fisheries related research projects that include examining the environmental factors driving the distribution of groundfish species and the application of acoustic and other advanced technologies to fisheries problems.

In 2011, the group conducted the 2011 Pacific Hake integrated acoustic and trawl survey. This survey began on June 23 and is scheduled to run until August 30, 2011 aboard the NOAA ship *Bell M. Shimada*. The survey effort covers the area from Morro Bay, California (35°N), to the northern extension of the hake, which varies from year to year. The scientific team from Newport includes FRAM scientists Lisa Bonacci, acting Acoustics team lead; Julia Clemons, Acoustics team; and Omar Rodriguez, Aging Laboratory. Oceanographer Steve Pierce and OSU graduate students Tanya Chesney and Matthew Sroufe conducted oceanographic sampling during the survey including CTD casts and collection of ADCP data. Additionally, a new collaboration with Bill Peterson's lab allowed collection of plankton sampling. This collaboration is a step towards the goal of an ecosystem-based survey. Among the participants from the Peterson lab were Jennifer Menkel, Anita McCulloch, Jennifer Fisher, and Tracy Shaw. Additional scientific cooperators conducted research on specific legs of the survey as well.

Groundfish Stock Assessment Team: The FRAM stock assessment team (STAT) leads assessment activities for Pacific coast groundfish. Analysts conduct fishery stock assessments to estimate the current status and future trends in abundance and productivity of Pacific coast groundfish resources. The team also conducts rebuilding analyses which involve projecting the status of overfished resources into the future under a variety of alternative harvest strategies to determine the probability of recovery to a target level within a pre-specified time-frame. The peer-reviewed assessment and rebuilding results provide the scientific basis for the management of the groundfish fisheries off the West Coast of the U.S., including the setting of Overfishing Limits (OFLs) and Allowable Biological Catch (ABCs) as mandated by the Magnuson-Stevens Act.

During 2011, nine Pacific coast groundfish stocks, including Pacific hake, Pacific ocean perch, petrale sole, widow rockfish, spiny dogfish, sablefish, Dover sole, greenspotted rockfish and blackgill rockfish, will be assessed using benchmark or full assessments. Benchmark assessments are peer-reviewed within the Pacific Fishery Management Council's Stock Assessment Review (STAR) process. The STAR process is an in-depth, multi-day peer review panel meeting. Participation varies with each panel but includes member(s) of the Council's Scientific and Statistical Committee (SSC) as well as independent reviewers. The peer review panel meeting for the 2011 sablefish and Dover sole stock assessments will be held on the HMSC campus at the NWFSC.

In addition to the benchmark assessments, stock assessment

analysts will conduct updated assessments for rockfishes including bocaccio, canary, darkblotched and yelloweye stocks and rebuilding analyses for all overfished stocks. Updated assessments and rebuilding analyses are reviewed by the Council's SSC.

Three members of the stock assessment team are stationed at the HMSC: Dr. Andi Stephens, stock assessment analyst; Ms. Stacey Miller, stock assessment coordinator; and Mr. Curt Whitmire, information technology specialist. Because this is an assessment year, a large share of their time has been focused on activities such as coordinating the 2011 stock assessment review (STAR) process, preparing new assessments, in particular, the updated assessment for darkblotched rockfish, and supporting assessment development through computer programming and mapping of data.

Ongoing activities in which the HMSC assessment team are involved include developing individually-based models to examine genetic drift as a response to fishing pressure; creating improved techniques for portraying fishery-related data, particularly confidential data, in spatial-explicit ways; contributing to national coral reports; and supporting 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.

Cooperative Fish Ageing Project (CAP): The Cooperative Ageing Project (CAP) provides direct support for U.S. West Coast groundfish stock assessments by providing ages derived primarily from otoliths. Otoliths are fish ear bones which accumulate annual layers that can be read in much the same way as tree rings. The program is funded by FRAM through a grant to the Pacific States Marine Fisheries Commission, and is housed at the Hatfield Marine Science Center. CAP routinely provides 20,000 to 30,000 ages annually, and throughout much of this year was ageing otoliths for stocks that are being assessed during the 2011 cycle. Those species include sablefish, canary rockfish, darkblotched rockfish, Pacific Ocean perch, Petrale sole, Dover sole, and Pacific hake. Ageing specialists located at the HMSC include Patrick McDonald, Nikki Atkins, Betty Kamikawa, Omar Rodriguez, and Meredith Cavanagh.

These age determinations are of fundamental importance for understanding rates of fish growth, year-class strength, and the vulnerability of segments of each stock to fisheries and survey monitoring.

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. This year our Pacific hake age reader participated in the Pacific hake Acoustic Survey. The lab has been asked to participate in a bocaccio rockfish ageing workshop that would involve scientists and age readers from the SWFSC and state agencies. The CAP will continue to work with NWFSC assessment scientists to investigate rapid age determination methods using otolith

morphometrics. Possible benefits of this method should include faster and more precise ageing with no reduction in accuracy, thus decreasing subjective analysis.

Additionally, CAP is providing ages for vermillion and sunset rockfish caught during 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. CAP personnel were also asked to collaborate with the principle investigators in the writing of a manuscript for publication.

Habitat and Conservation Engineering: The FRAM Habitat and Conservation Engineering (HCE) group, Dr. Waldo Wakefield and Mr. Mark Lomeli (collaborator from the Pacific States Marine Fisheries Commission) are located at HMSC. The HCE group is responsible for conducting fish habitat studies off the U.S. West Coast. The team also works with agency scientists, academic scientists, and the fishing industry to develop and evaluate modifications to fishing gear to reduce the impacts of fishing on bycatch species and marine habitats.

The HCE group continues to maintain its ongoing collaborations with Dr. Chris Goldfinger's Active Tectonics and Seafloor Mapping Laboratory (ATSMML) at Oregon State University, developing and maintaining a marine habitat database for the U.S. west coast. Information from this project feeds directly into the "PaCOOS, West Coast Habitat Data Portal". The data portal can be accessed via the Internet at: <http://pacoos.coas.oregonstate.edu/>.

In September 2010, an interdisciplinary expedition team completed an exploration of the Northern San Andreas Fault (NSAF) fault offshore of northern California (<http://oceanexplorer.noaa.gov/explorations/10sanandreas/welcome.html>). Along with the HCE group, the team included scientists from Oregon State University and the U.S. Geological Survey. The NSAF has been largely unexplored and stretches from the Mendocino Triple Junction, an area in northern California where three tectonic plates meet, south through the San Francisco Bay area. The expedition utilized the Sailing Research Vessel *Derek M. Baylis* and the Oregon State University Research Vessel *Pacific Storm*, as well as the NMFS SeaBED AUV *Lucille*. Multibeam mapping operations and seismic profiling were conducted onboard the *Baylis*, while AUV and fisheries sonar operations were conducted onboard the *Pacific Storm*. A multi-frequency Simrad EK60 sonar system was used to image animals living in the water column.

During this exploration, the exploration team completed the first comprehensive high-resolution multibeam sonar and seismic reflection survey of the NSAF. When combined, data from these two complementary geophysical surveys will provide an unprecedented high-resolution 3D visualization of the fault system. Digital photographs and photomosaics obtained with a hovering AUV will provide the collaborative team of geologists and biologists with direct observation of the seafloor and associated biological communities. Mapping and imaging the

NSAF at georeferenced spatial scales from kilometers to meters will support ongoing studies and discoveries on the nature of the NSAF and contribute to the assessment of marine habitats in the California Current Ecosystem. The exploration also provided a case study and outreach opportunity for conducting a "green" oceanographic research project aboard a sailing research vessel.

Beginning in 2009, the NOAA Fisheries Northwest Fisheries Science Center (NWFSC) and Pacific States Marine Fisheries Commission developed and began field-testing a bycatch reduction device (BRD) to reduce bycatch of Chinook salmon (*Oncorhynchus tshawytscha*) and rockfishes (*Sebastes* spp.) in the U.S. Pacific coast hake fishery (*Merluccius productus*). The basic design of this BRD consists of two mesh panels that direct actively swimming fish towards open escape windows on each side of the net. This project has examined two versions of the open escape window BRD to date. Tests were conducted off central Oregon during 2009 and 2010. During this study, bycatch of Chinook salmon, widow rockfish (*S. entomelas*), and canary rockfish (*S. pinniger*) was reduced by as much as 81.8%, 26.7%, and 14.7%, respectively. In addition to these encouraging results, interactions with the fishing industry has resulted in a technology transfer where variations of this BRD design are being evaluated in the Bering Sea walleye pollock trawl fishery. In 2011, the NWFSC has planned to build and test a recapture net to accurately measure the escapement rates of salmon and rockfishes under tows conducted with and without artificial light.

In August 2010, NOAA Fisheries adopted a catch share program for the U.S. Pacific coast groundfish trawl fisheries. NOAA Fisheries anticipated that these fishery management measures would create increased demand for bycatch solutions across all sectors of the fishing industry. Reducing this bycatch would result in more fish becoming available to fishermen and potentially higher annual catch limits. The HCE group put together two loaner video camera imaging systems and is currently making those systems available to commercial fishers and other sectors of the industry for their use in evaluating industry-designed bycatch reduction devices. During 2011 and 2012 the NWFSC plans to further develop this program and expand the availability of video systems. Information on the loaner video camera systems can be found at: <http://www.nwfsc.noaa.gov/research/divisions/fram/habitat.cfm>.

Oceanic and Atmospheric Research Division

Pacific Marine Environmental Laboratory (PMEL)

Vents Program

Steve Hammond, Director

The NOAA Vents program is currently engaged in its 27th year of oceanographic exploration and research at the HMSC. The program's principal focus is on discovering and understanding ocean environmental effects of submarine volcanic and hydrothermal activity. Submarine volcanic activity is the primary means by which heat and mass are transported from the hot interior of the Earth to its surface and more than 80% of the Earth's volcanism occurs in the deep ocean.

Until recently, submarine volcanism remained undetected, unstudied, and virtually completely unknown in terms of how it affects ocean ecosystems, how it impacts the budgets and cycles of important chemicals, gases, and nutrients in the ocean, and what its roles are in the complex ocean and atmosphere processes that influence the movement of ocean currents and the Earth's climate.

During the past three decades, Vents scientists have pioneered the interdisciplinary science that is essential to understanding the fundamental planetary-scale processes associated with submarine volcanism and its accompanying hydrothermal activity. In doing so, they have published hundreds of peer-review publications in prestigious journals, devised new sensors and systems to accomplish new scientific objectives, often in extreme *in situ* conditions, and used established technologies in new and innovative ways to discover new insights into how geologic and oceanographic process interact in large-scale ocean processes. Notable examples of Vents' continuing path finding exploration and research include:

- Monitoring at the NeMO Axial Volcano seafloor volcanic observatory which is slated to be a principal study site for the NSF/OOI cabled observatory. Based on ongoing measurements in the caldera of the volcano, Vents scientists are forecasting another eruption in the next 10-12 years.
- The submarine seismic and volcanic state of the entire NE Pacific continues to be monitored by means of Vents unique access to the US Navy's real-time SOSUS hydrophone arrays. Vents scientists have also developed and are using their own independently designed hydrophones for the purpose of extending acoustic surveillance of natural phenomena (including marine mammals) throughout the global ocean.
- Vents is now pioneering development and use of autonomous ocean gliders which they are equipping with sensors for a variety of missions including eruption event response at Axial Volcano.
- Expeditions will be continuing to West Mata submarine volcano. This volcano was discovered by Vents in 2009 and the eruptions taking place there are the most explosive and spectacular ever the witnessed in the deep sea.
- Vents scientists are continuing to participate in expeditions aboard the NOAA Office of Ocean Exploration and Research's ship, the Okeanos Explorer. Scientists' participation in Okeanos Explorer expeditions is through satellite-based "telepresence". Vents scientists utilize telepresence PMEL Exploration Command Centers in both Seattle and Newport.

The exciting results from our 2009 Jason dive program at West Mata, the world's deepest erupting volcano in the NE Lau basin (SW of Samoa), has been accepted as an article in *Nature Geoscience*. A December 2010 follow up expedition to our exciting May 2009 and May 2010 expeditions to the area collected a large selection of lava samples that will be worked on in collaboration with scientists at the University of Hawaii and the Australian National University. Plans are also moving forward to mount a more intensive multidisciplinary dive

expedition back to the NE Lau basin in 2012.

In collaboration with scientists at Australian National University, the Vents Program has also been studying the Northwest Lau Spreading Center, another volcanic rift zone in the northern Lau Basin. The NOAA/PMEL Helium Isotope Laboratory here in Newport has recently analyzed gases in volcanic rock and water-column seawater samples collected from this spreading center. The region is unusual in that it appears to have been "contaminated" with material from the Samoan hotspot or mantle plume, which is similar to the Hawaiian hotspot. This Samoan signature is marked by excess of helium-3, which is the rare isotope of helium. This Samoan hotspot material has apparently made it past the downgoing Pacific Plate and has leaked into the northern Lau Basin. All of the rocks and hot spring fluids from the NWLSC are marked with excess amounts of helium-3.



This spreading zone is host to several sites of active hydrothermal activity, and because of the unusual hotspot-type character of the region, one might expect to find unusual fluid chemistry and biota at these hydrothermal vents.

Vents Ocean Acoustics Project 2010-2011

Accomplishments: In FY 10-11, the major focus of the Vents Ocean

Acoustics project was the analysis of US Navy hydrophone recorded earthquakes detected throughout the Northeast Pacific Ocean which lead to the identification of major volcanic and tectonic events off the Washington, California, and Oregon coasts. As before, the hydrophone derived earthquake locations lead to several collaborative efforts with oceanographers and geologists within NOAA, as well as the Institute for Ocean Sciences (Canada), Oregon State University, University of Washington, and University of Hawaii. A major goal of this year's research effort was submission of a paper synthesizing the 20-year Northeast Pacific earthquake database we have compiled using the US Navy hydrophone arrays. We have been in discussions with the editors of the journal *Oceanography*, and our paper will be the featured article, as well as the cover image, for one of their monthly journals.

A portable hydrophone was deployed near the explosively erupting West Mata submarine volcano near Western Samoa for all of 2010-2011. Data analysis also continues of recently recovered 16-element hydrophone array in the Lau Basin volcanic zone. New research funding has been acquired to place eight autonomous hydrophones in the equatorial Atlantic ocean around the Mid-Atlantic Ridge and Romanche Transform

Fault. The Romanche Fault routinely produces large (magnitude >5) earthquakes and the goal of our project is to test models of earthquake predictability (retrospectively) using foreshock-mainshock sequences we record from the Romanche. We will also continue to analyze last year's hydrophone data recorded from the Bransfield Strait, Antarctica, and will continue developing our plan to move the Bransfield array to the Ross Sea, west Antarctica, to study submarine volcanoes and iceberg processes in this region.

NOAA/OAR funded the purchase of an acoustic ocean glider, and we flew its first scientific mission at West Mata volcano. The glider successfully surveyed the 2-D sound field of the erupting volcano. The radiation pattern of the volcano closely resembled the predicted ocean acoustic propagation model, and the result was published in the Journal of Acoustic Society of America. The *QUEphone* was deployed three times in FY10-11 off Kona, HI, the Bahamas, and San Clemente Island. It has detected and recorded wide-band underwater sounds made by beaked whales, an endangered species, and reported the presence of the whales in near real-time. We will continue developing new technologies to help us quantify and understand the ambient ocean sound field.

Bioacoustics Group Report: The Bioacoustics group in OSU's Cooperative Institute for Marine Resources Studies, associated with the NOAA/PMEL Vents Program and led by David K. Mellinger, had four principal experiments/projects this past year, focusing on the detection, classification, and localization of marine mammal vocalizations:

- We continued to develop and test autonomous passive-acoustic platforms for conducting expansive scans over remote and extensive territory for marine mammals, especially beaked whales. This work is conducted in collaboration with the Applied Physics Laboratory, University of Washington (the acoustically equipped *Seaglider*TM) and with the Vents Program's Marine Geophysics group (the *QUEphone*). In the last year, both systems were successfully tested off Hawaii and at U.S. Navy ranges in the Bahamas and Southern California.
- In collaboration with the Vents Program's Marine Geophysics group, we deployed moored hydrophones in the Fram Strait between Greenland and Spitsbergen to monitor ambient noise levels and marine mammals in the Arctic environment. This will provide baseline data as global warming begins to impact the high-latitude ecosystem.
- In a collaborative project with the College of Oceanic and Atmospheric Sciences at OSU, we deployed moored hydrophones off the Oregon coast to quantify the frequency and duration of near-shore residence of Gray whales. We will also use these data to examine acoustic and foraging behavior of the whales and explore the links between ocean conditions, mysid swarms, and gray whales.
- We deployed moored hydrophones in Yaquina bay to monitor the sound levels of pile-driving activities associated with the construction of NOAA's new home port dock facilities, and to study potential impacts on the local population of marine mammals, especially California sea lions and harbor seals. This work is conducted in collaboration with OSU's Marine

Mammal Institute.

In addition to these projects, we continued to make improvements on *Ishmael*, a user-friendly, open-access bioacoustics analysis software package, which has become one of the most widely-used analysis tools used by bioacousticians. We also continued to update *MobySound*, an open-access sound database for research in automatic call recognition (ACR) which provides training data for ACR methods and contains recordings of baleen whales, toothed cetaceans, and pinnipeds. This research is supported by a diverse team of CIMRS research staff, including (in alphabetical order) Jon Dodge, Sara Heimlich, Holger Klinck, Karolin Klinck, Sharon Nieukirk and Lu Yang. Postdoctoral research associate Elizabeth T. Küsel was also with the group for most of this year.

U.S. Department of Agriculture (USDA)

Agricultural Research Service (ARS)

Mark Camara, 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 methods for producing genetically improved stocks of commercially important shellfish, and to seek alternatives to chemical methods to control pests in shellfish farms. The USDA supports two research programs at HMSC. Mark Camara's laboratory studies shellfish genetics. Brett Dumbauld's laboratory addresses ecological aspects of shellfish farming 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 works in collaboration with the Molluscan Broodstock Program, a USDA-funded oyster breeding program working to improve economically important traits such as growth rate/efficiency, reproduction, survival, disease resistance, and product quality.

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

Identifying genes that control reproductive effort in Pacific oysters: Mass mortalities of oysters are in no small part caused by self-induced stress associated with producing millions of eggs and billions of sperm every summer. One strategy to increase survival, therefore, could be to reduce the amount of energy and resources farmed oysters allocate to reproduction through selection. We used a technique called quantitative trait locus

(QTL) mapping to identify three regions of the Pacific oyster genome that have strong effects on gonad development and could be useful as biomarkers in a program of marker assisted selection.

Demonstrating that larval resistance to *Vibrio tubiashii* is genetically variable: *Vibrio tubiashii* (Vt) is a highly virulent pathogen that has been implicated in recent failures of commercial-scale cultures of Pacific oyster larvae. We subjected a large group of Pacific oyster families to controlled Vt challenges and found large differences in survival among families. This demonstrates that larval resistance to Vt is under a high degree of genetic control and that selective breeding could be used to create oyster strains that can survive Vt exposure.

Releasing new Kumamoto oyster broodstock to industry in partnership with the NIFA- supported Molluscan Broodstock Program: Inbreeding and hybridization with Pacific oysters has created problems with commercial production of Kumamoto oysters. ARS previously collaborated with the shellfish industry and the University of Southern California to collect fresh breeding stock from the Ariake Sea in Japan. The Molluscan Broodstock Program spawned these animals, reared an entire generation under quarantined conditions, and tested all the progeny for diseases to prevent the importation of parasites and pathogens. After several years and passing all these tests, we were finally able to release this new broodstock resource to commercial producers.

This past year the Shellfish Ecology Program accomplishments include :

Examining the population dynamics and ecology of two species of burrowing shrimp (*Neotrypaea californiensis* and *Upogebia pugettensis*) that cause substantial damage to oyster crops in Oregon and Washington: The intent of this project is to develop integrated pest management strategies that combine physical, chemical, and augmentative biological control mechanisms for these shrimp in shellfish aquaculture and target these efforts to the most appropriate life history stage when shrimp populations are high. Shrimp population monitoring efforts were established and data continue to be collected in four coastal estuaries. The average density of both species of shrimp has declined over time and mapping efforts in Yaquina Bay, OR and Willapa Bay, WA suggest that populations have also declined in size or extent. A collaborative project with Dr. John Chapman at HMSC indicates that increased prevalence of an introduced parasitic bopyrid isopod coincided with the large historical decline in abundance of mud shrimp. These isopods effectively eliminate egg production in infected female shrimp and 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 shrimp recruitment to these populations and its contribution to subsequent year class strength to discern what other factors influence these population trends. Recruitment of both shrimp species to Washington estuaries has been low since the mid 1990's, tracking population declines there, but a substantial ghost shrimp settlement and recruitment event occurred to Oregon estuaries in 2010. Mud shrimp also recruited

extensively to Yaquina Bay and Tillamook Bay, OR in 2006 and 2011 with low to moderate recruitment from 2007-2010. A method using the ageing pigment lipofuscin in shrimp neural tissue was modified and is successfully being used to examine the age of larger individuals of both species of shrimp. Ghost shrimp were shown to reach at least 8 years of age and have similar age classes present in the above estuaries, but distinct differences in growth rate of shrimp were found and shrimp size clearly does not reflect age. These results are important because they imply that in addition to finding alternative control measures for controlling adult shrimp on a bed, a basic understanding of recruitment and the ecology of burrowing shrimp as pests is essential to meeting the goal of integrated pest management on aquaculture beds. Low shrimp recruitment and declining populations should be reducing the need to control them in Washington estuaries. Nonetheless, shrimp are relatively abundant outside the growing areas and growers still report need for control, so experiments to examine movement of larger shrimp were implemented in 2009 and surveys to document this movement into oyster beds initiated in 2010. Only restricted movement of adult shrimp near the edges of plots has been documented to date, so we continue to emphasize and experiment with control measures for small newly recruited juveniles.

Studying the effects of shellfish aquaculture on estuarine habitats utilized by juvenile *English sole* and other important fish and invertebrates: This project is designed to document the 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 industry in developing farming practices and farm plans that are compatible with the habitat requirements of these species. Willapa Bay, Washington is being targeted in this effort due to the extensive aquaculture operations there and 2005 aerial photography was used to create an intertidal aquatic vegetation layer for this estuary. Extensive groundtruthing and mapping was conducted to produce burrowing shrimp and sediment layers and improve an existing intertidal bathymetry layer. Finally, interviews with shellfish growers were used to produce a current aquaculture use layer and a 2005 base map and GIS system was completed in 2009. Two subsequent aerial photographic datasets (2006 and 2009) were acquired and are being processed to enable temporal change analyses of habitat at the estuarine landscape scale. An underwater video system and small traps were developed and are being used to track use of these intertidal habitats by fish and invertebrates including juvenile *English sole* which have been shown to utilize intertidal areas and inhabit West Coast estuaries as nurseries during their first year of life. We have found that these fish utilize structured habitat like eelgrass and oysters more frequently than open unstructured mudflat and we are currently conducting tethering and growth experiments to further determine the functional role of these habitats. Landscape scale processes like the function of edge habitats will also be examined.

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) 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 2010-11, the Oregon Coast National Wildlife Refuge Complex had nine permanent employees, one temporary Biological Technician, one temporary Office Clerk, and one Environmental Education Intern located at the HMSC. The Refuge Complex's South Coast Office in Bandon had two permanent employees, one Term Restoration Biologist, two interns (one Environmental Education and one Biology), one temporary Office Clerk, 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. In January 2011, the USFWS acquired the former Hagerty tract, an 87.4 acre parcel of pasture and wetland located adjacent to the Little Nestucca River. This parcel contains primarily open pasture and is an important addition to the Refuge's land base for providing high quality forage and sanctuary for wintering geese.

Detailed planning and design for the 418-acre Ni-les'tun Tidal Marsh Restoration Project on Bandon Marsh NWR occurred from 2008 and into 2010. In June 2009, after more than 10 years of land acquisition, planning, design and preparation, major construction began on the restoration project which is scheduled for completion in late summer 2011. During Phase I (summer of 2009) construction activities involved the obliteration of over 11 miles of small agricultural drainage ditches. Some of the new tidal channels that will deliver tidal flows to the upper marsh were also dug during this phase. As part of Phase II construction (summer of 2010), the majority of the 5 miles of pilot tidal channels were dug and 4 miles of larger drainage ditches filled. Currently, in Phase III (summer of 2011) the dike along the river will be lowered, and tide gates will be removed. The tidal marsh restoration project has been constructed by the Knife River Corporation of Coos Bay, Oregon who is under contract with our partner Ducks Unlimited to complete this work in 2011. The removal of the tide-restricting dikes and gates will allow the unimpeded return of the daily tides to this historic salt marsh for the first time in more than a century.

The restoration project also involves two other major wildlife refuge construction projects. In 2010, North Bank Lane, a

county road, was raised approximately 7 feet along two extended locations within the refuge to reduce flooding due to tidal inundation and to improve safety. During this road work in 2010, two large fish friendly road culverts were installed. Tidewater Contractors Inc. of Brookings, Oregon is under contract with the Federal Highway Administration to finish the road improvements, which includes final paving in 2011. The third related wildlife project involves undergrounding a large electrical transmission line that crosses the Refuge and Coquille River. The U.S. Fish and Wildlife Service has contracted with Doyon Project Services to underground the transmission line and this project is funded by Federal Stimulus (ARRA) Funds. The lines were undergrounded in 2010 and the remaining overhead poles and lines will be removed in the summer of 2011 prior to the tides flooding the project area.

U.S. Fish and Wildlife Service personnel conducted annual aerial surveys of nesting seabirds (e.g. common murre, Brandt's cormorant and pelagic cormorant) at colonies and estimated breeding populations of each species by counting the birds on digital photographs. An annual aerial survey of California brown pelicans was conducted to estimate the summer population before fall migration. Six sub-species of white-cheeked geese including delisted Aleutian Canada geese and dusky Canada geese, a species of special concern, were monitored and counted in the Nestucca Valley. Also, a special monitoring effort to document the presence of previously marked Semidi Islands Aleutian cackling geese was conducted at Nestucca Bay. Other wildlife surveys included the monitoring of peregrine falcons, bald eagles, black brant, and wintering waterfowl along the Oregon coast. Research, monitoring, and branding of Steller sea lions, led by NOAA-Fisheries and the Oregon Department of Fish and Wildlife's Marine Mammal Program, continues at Rogue Reef. In June, Refuge staff embarked on a study to document the effects that Independence Day fireworks displays have on seabird colonies at Depoe Bay and Coquille Point during the breeding season. Monitoring was focused on populations of breeding seabirds, particularly the Brandt's cormorant, pelagic cormorant, western gull, and black oystercatcher, to examine potential responses and effects on reproductive success from fireworks displays. The Refuge Complex continued (second year of study) to conduct tufted puffin research at Haystack Rock in Cannon Beach, and hired a biological science technician and 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 USFWS Oregon Islands National Wildlife Refuge; 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 will be important to Oregon Department of Fish and Wildlife (ODFW) and the USFWS if the tufted puffin becomes a candidate for state threatened or endangered species status.

The Environmental Education program continues to reach out to new schools and more students. Oregon's Annual Junior Duck Stamp Competition received nearly 400 artwork entries from public, private, and home schools across the state. The 2011 Oregon "Best of Show" winner was Belinda Li, a 12 year old

art student at the Jiao Ying Chinese Culture and Art School in Portland. She submitted a colored pencil rendition of a Long-tailed Duck, entitled "Swimming in Solitude". The Shorebird Sister Schools Program completed its ninth year using the talents of two wildlife education interns through the refuge's friends group. The program reached over 700 4th and 5th grade students in the communities of Newport, Waldport, Lincoln City, Coos Bay and Bandon. The students learned about the importance of estuaries, shorebird behavior, adaptations, migration, and conservation and ended the program with a field trip to their local estuary. 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. Currently we have over 75 volunteers that have given more than 7,000 hours of their time in 2011. The dedicated volunteers' time is worth over \$150,500.

Newport Field Office

Laura Todd, Field Supervisor

The Newport Field Office (NFO) Ecological Services office is co-located with the Oregon Coast National Wildlife Refuge Complex at HMSC. The NFO administers the Ecological Services program of the Service on the Oregon coast with a staff of five permanent employees and various volunteers throughout the year. The responsibilities of the NFO include administration of Endangered Species Act requirements such as listing, recovery, private and state lands conservation for listed species, candidate conservation, consultation with Federal agencies, and technical assistance. The Oregon Coastal Program is also administered out of this office with staff also co-located at the Bandon Marsh National Wildlife Refuge. The purpose of the program is to provide funding and technical assistance to support habitat restoration assessment, habitat restoration projects, and public education. In addition to these two 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 2010-2011, the Newport Field Office celebrated a number of accomplishments:

- We welcomed Mike Szumski, a contaminants specialist, who relocated from Portland to the coast last fall. Mike will continue to work on issues related to the New Carissa oil spill that occurred in 1999, response to oil or other spills as necessary, and other concerns related to spills and contaminants.
- Completed 16 restoration or habitat assessment projects under the Coastal Program which enhanced or restored: 6 miles of stream and riparian habitats; 146 acres of wetlands; and 35 acres of upland. We anticipate a total of over 14 active projects in FY11 and are continuing to implement our Coastal Program strategic plan to focus our restoration, education, and assessment opportunities on the most sensitive coastal habitat types. This strategic plan will be

reviewed and updated in FY11.

- To improve the population numbers and distribution of the threatened Oregon silverspot butterfly, we released over 3,000 pupae and caterpillars at three locations on the central Oregon coast, with the assistance of approximately 50 volunteers. Over 1,000 butterflies emerged from the augmented pupae and caterpillars. To improve habitat, volunteers and Service staff also planted 10,000 early blue violets, the host plant for Oregon silverspot larvae, and nectar plants including a new site on the Nestucca Bay National Wildlife Refuge. Seeds were also collected from a number of nectar plants to be propagated by NRCS for future habitat restoration efforts.
- Contributed to Western snowy plover recovery efforts throughout the state including predator control, nest protection and monitoring, habitat restoration, law enforcement, and public education.
- Completed the Habitat Conservation Plan for Western Snowy Plovers (HCP) developed by Oregon Parks and Recreation Department to manage plover on Oregon's beaches. The plan will define recreation and beach management in areas currently inhabited by plovers as well as areas to be managed for plovers in the future. In conjunction with the HCP, the Service and five State and Federal agencies signed a Memorandum of Understanding to consistently manage and protect plovers across management boundaries to ensure the success of the measures included in the HCP.
- Arranged for the Coast Guard to transport female Pacific green and olive Ridley sea turtles to Sea World, San Diego, California. The two turtles were severely cold-stunned and received life-saving treatment at the Oregon Coast Aquarium. The Pacific green sea turtle was released at sea in June 2011 and is being radio-tracked by NOAA to determine its movements.
- Supported a number of recovery projects and habitat restoration for sensitive species on the Oregon Coast under the Endangered Species Recovery Implementation Fund, including projects for western lilies, pink sand-verbena, sea turtles, plovers, and butterflies.

U. S. Geological Survey

Biological Resources Discipline, Western Fisheries Research Center - Newport Duty Station
Deborah Reusser, Duty Station Leader

The Newport Duty Station, established in 2010, is part of the Western Fisheries Research Center (WFRC), located in Seattle, Washington, and is co-located in the US EPA Pacific Coast Ecology Branch building at the Hatfield Marine Science Center. The mission of WFRC is to provide research and technical assistance to support the best possible stewardship of the Nation's natural resources, emphasizing fish populations and aquatic ecosystems of the West.

USGS scientists, working in collaboration with the Oregon

Climate Change Research Institute, U. S. EPA, U. S. Fish and Wildlife, U. S. Dept. of Agriculture, U. S. Forest Service, The Nature Conservancy, University of Oregon and Oregon State University, focus their research on defining, developing and evaluating models to predict climate change effects in Pacific Coast estuaries at a range of spatial and temporal scales. In 2011 the USFWS, USGS and EPA sponsored the second two day workshop at the Hatfield Marine Science Center highlighting on-going sea level rise modeling efforts on our coast bringing together federal, state, and NGO land stewards, modelers, and GIS specialists. A third workshop is scheduled to be held here at the Hatfield Marine Science Center in February 2012. Also in 2011, USGS released an Open File report providing information and summarized sea surface temperature (SST) data for the North Pacific at an ecoregional scale (<http://pubs.usgs.gov/of/2010/1251/>) and contributed to the Oregon Climate Assessment Report (<http://ocri.net/ocar>). Climate change is affecting the distribution and availability of suitable habitat for many estuarine species on the Oregon Coast at varying degrees. The goal is to provide insights and tools toward a better understanding of what these effects will be.

The Newport Duty Station also provides software development and computer programming expertise to several national and international programs. Two of these programs are The National Atlas of the United States (www.nationalatlas.gov) and the North Pacific Nonindigenous Species Information System (PICES-NISIS). The National Atlas is a comprehensive, interactive, web-based tool for exploring facts about America and its people. Using maps as the medium, the National Atlas strives to provide a fun and engaging learning experience for students and learners of every age. The goal is that these efforts add clarity to what is often a difficult to conceptualize world of numbers and data, and by so doing help to further the scientific missions of the organizations from whom the data for these maps originates. In 2011, the upgrade and migration of all the National Atlas servers from Reston, VA to Rolla, MO was completed. Enhancements and new data have also been added and are now available to the public at nationalatlas.gov.

PICES-NISIS is currently a stand-alone Microsoft Access database being developed jointly by USGS, U.S. EPA and Working Group 21 of the North Pacific Marine Science Organization containing information about nonindigenous species in the North Pacific. Biological information of use to the scientific community regarding the nature and distribution of species tends to primarily reside scattered within the pages of various scientific journals. The goal in the design and structure of the database is to gather together these scattered bits of information into a searchable database, adding much-needed usability to a wealth of biological information. The next stage in the evolution of the database is to convert it from a desktop application to a web-based application for native and nonindigenous marine and estuarine species. Limited access to the web based version of the database for testing will be available soon. Also, an atlas of nonindigenous species in the North Pacific will be made available on the web in the near future.

USGS staff at HMSC currently consists of 7 federal employees and one student contractor. USGS interacts with the HMSC and

wider university community both in research and educational programs.

Oregon Department of Fish and Wildlife

Marine Resources Program Caren Braby, Program Manager

As part of the Oregon Department of Fish and Wildlife (ODFW) Fish Division, the Marine Resources Program (MRP) assesses and manages Oregon's marine habitat, biological resources and fisheries (primarily groundfish, shellfish, ocean salmon, coastal pelagic species, such as sardines, and highly migratory species such as albacore tuna). In addition to direct responsibilities in state waters (from shore to three miles seaward), the MRP provides technical support and policy recommendations to state, federal, regional, and international decision-makers who develop management strategies from shore to 200 miles offshore that affect Oregon fish and shellfish stocks, fisheries, and coastal communities. ODFW is the lead agency in Oregon's efforts to establish marine reserves in ocean waters. The program's work focuses on three major categories:

- marine resource policy, management, and regulation
- fisheries monitoring, sampling, and data collection
- research on marine fisheries, estuaries, ocean species, and habitats.

Staffing and Budget: MRP headquarters is in Newport at the Hatfield Marine Science Center on Yaquina Bay. MRP has port offices along the coast in Astoria, Charleston, Brookings, and a marine mammal program located in Corvallis.

Staffing consists of about 60 permanent and more than 60 seasonal or temporary positions. The annual program budget is approximately \$8 million: about 70 percent comes from state funds including license fees, commercial fish fund, a small amount of general fund, and the remainder comes from federal grants.

Policy, Management and Regulation: The Marine Resources Program is authorized by the State Legislature in statute and the Oregon Fish and Wildlife Commission through administrative rule, to administer the regulation, harvest, and management of commercial and recreational fisheries and management of other marine species, such as marine mammals, in Oregon. Generally the MRP is involved in natural resource management from the innermost margin of estuaries to 200 miles out in the ocean.

U.S. ocean fisheries are managed at the federal level through the Magnuson-Stevens Fishery Conservation and Management Act (MSA). This federal law forms the framework around which the west coast states regulate fisheries in state and federal waters. The law established an area from shore to three miles that generally falls under state jurisdiction for fishery management. From three miles to the 200-nautical-mile distance, federal authority establishes fishery regulations for many species. In some cases

(such as commercial Dungeness crab and pink shrimp fisheries), the act delegates full authority (in state and federal waters) to state management. States may set overriding fishery regulations as long as they are more conservative than those set in the federal process.



MRP shellfish biologist examines the bycatch from a shrimp trawl.

Development of Marine Reserves in Oregon: This year, ODFW forwarded marine reserve site recommendations, based on consultation with the Oregon Ocean Policy Advisory Council (OPAC) and results of an extensive public process. The extensive 11-month public process centered around community team efforts to develop boundaries and associated marine protected areas for three evaluation sites: Cape Perpetua, Cascade Head, and Cape Falcon. Each community team represented diverse and balanced stakeholder interests. Based on the success of the community teams, the Oregon legislature funded the marine reserves program through the 2011-2013 biennium. Implementation of the three evaluation sites will be consistent with state policy established by House Bill 3013, and any additional statutes that provide policy guidance.

Marine Reserves Program work during the past year also included implementation activities at the two marine reserve pilot sites: Redfish Rocks and Otter Rock. Harvest and fishing prohibitions are scheduled to take effect in 2012, after completion of baseline data collection.

Ongoing work at the pilot sites includes work with community teams to develop and implement monitoring programs and management plans (both ecological and human dimensions). This work consists of:

- Conducting ecological baseline studies and establishing monitoring protocols, including contracting with local fishing vessels to assist in the field, and
- Conducting human dimensions monitoring and outreach efforts, including contracting with local liaisons to assist with these efforts.

More information can be found at www.oregonocean.info/marinereserves.

Coastal and Marine Spatial Planning: MRP staff developed

proposals and work plans in support of Coastal and Marine Spatial Planning (CMSP) initiatives that will assist the state in determining sites for renewable energy developments, among other proposed uses. This work is in conjunction with the state's Territorial Sea Plan (TSP) process, lead by the Oregon Department of Land Conservation and Development and OPAC. This process will result in a publically available collection of spatial information (human dimensions and ecological), viewable through an on-line GIS portal called Oregon Marine Map (<http://oregon.marinemap.org/>). While the TSP process is scheduled to be completed in 2012, the information collection and incorporation into Marine Map will continue to be used by and for management. CMSP has become a focus regionally and nationwide. MRP staff have participated in discussions about CMSP at the Pacific Fishery Management Council meetings, the Science Advisory Team for the Regional Sediment Management Plan for the Mouth of the Columbia River, the Bureau of Ocean Energy Management Regulation and Enforcement (BOEMRE) task force, and a number of local and national workshops on the topic. MRP will continue to provide comments to other state and federal agencies related to CMSP plans and impacts on fish, wildlife, and habitat of proposed coastal developments (e.g., wave energy, shoreline armoring, dredge disposal sites).

Fisheries Monitoring and Assessment: The MRP continued ongoing programs to monitor catch and effort in commercial and recreational ocean fisheries. Data and biological samples collected in these programs are used for in-season management (e.g., tracking progress toward catch limits), evaluating the success of management measures, and informing fish stock assessments.

Marine Mammals: ODFW's Marine Mammal Program is involved in research, monitoring and management of Oregon's seal and sea lion populations. The program continues efforts to address California and Steller sea lion predation on threatened and endangered salmonids at Bonneville Dam on the Columbia River. Related work includes marking California sea lions in Astoria and a Steller sea lion acoustic and satellite telemetry study at Bonneville Dam.

Other program activities include: participation in the Northwest Marine Mammal Stranding Network; a multi-year, mark-resight survival study on Steller sea lions; and analysis of pinniped fecal samples (including publishing of "Food habits of Steller sea lions (*Eumetopias jubatus*) in Oregon and Northern California, 1986–2007" in *The Fishery Bulletin*). Federal, state, and tribal collaborators in program activities include: National Marine Fisheries Service, National Marine Mammal Laboratory, US Army Corps of Engineers, US Fish and Wildlife Service, Oregon State University, Portland State University, Washington Department of Fish and Wildlife, and Columbia River Inter Tribal Fish Commission.

Shellfish Program: The shellfish program has been rebuilt over the past seven years due to the institution of a new recreational shellfish harvesting permit (2004). Expanded staff resources has allowed MRP to initiate fishing effort surveys and stock assessments on recreationally important shellfish

species in estuaries and on the coast. Catch and effort surveys for recreational crab continued this year (started in 2006) in Yaquina and Alsea Bays. In addition to these efforts, Newport shellfish staff continued a bay crab sampling project in Yaquina Bay (started in 2007) to collect more specific biological and harvest information about the bay crab resource. With the newly expanded shellfish staff, recreational sampling was expanded to include catch and effort surveys for bay clams in Yaquina and Alsea bays and both crabs and clams in Tillamook, Netarts, and Coos bays. The goal of this expanded research is to further our understanding of the harvesting activity of recreational crab and clam resources and factors affecting the sustainability of this resource.

MRP's Astoria office shellfish staff continued annual razor clam stock assessment research (started in 2004) on 18 miles of the Clatsop Beaches extending from the mouth of the Columbia to Seaside. Ninety-five percent of the state's razor clamming effort is in this area. This is the first program of its kind in Oregon. Accurate assessments of razor clam populations will help ODFW understand and manage razor clams in the future.

Shellfish and Estuarine Habitat Assessment: In 2010-2011 MRP biologists assessed clam populations in Tillamook Bay. The goal of the project was to document where gapers, butters, cockles, and native littleneck clams are found, their abundance and to describe the habitat to determine estuarine habitat associations for these species for each species. MRP shellfish biologists conducted a similar study in Coos Bay in 2008-2009. An agency report is on the shellfish and estuarine habitat assessment web site at: <http://www.dfw.state.or.us/MRP/shellfish/Seacor/index.asp>.

Commercial Dungeness Crab Fishery Management: In 2010, the MRP added a new commercial crab fishery manager position to assist with the assessment and management of the commercial Dungeness crab fishery. This new program was created with funds from increases to commercial licenses and landing fees. The program increased the capacity of ODFW to be proactive in management of the fishery. The crab manager is working collaboratively with the fishing industry on fishery management issues, derelict gear management, and meeting the conditions of the recent Marine Stewardship Council's sustainability certification of the Oregon Dungeness crab fishery.

The agency completed a two-year project to recover derelict crab gear off Oregon, funded by a \$735,000 federal economic stimulus grant. The project successfully demonstrated methods to combat the growing problem of derelict gear. Recovery efforts will be turned over to the commercial crab industry.

2010-11 Research

Reducing commercial fishery bycatch: ODFW continued to work with the pink shrimp fishing fleet to enhance the progress made with bycatch reduction devices (BRDs) in shrimp trawl nets. Recent and planned studies focus on reduction of residual eulachon bycatch and on modifying trawl footropes to reduce the bycatch of small demersal fishes along with seafloor impacts.

Studying rockfish discard survival: Studies continued to use special cages for holding individual fish to study short-term discard survival of a wide variety of nearshore species as a function of capture depth, fish condition, and sea temperature.

Black rockfish research: MRP researchers are in the 10th year of a black rockfish mark-and-recapture project off Newport (started in 2001). The project was initiated to determine the recreational fishery exploitation rate of this species, which is an important species in Oregon's recreational bottomfish fishery. Passive Integrated Transponder (PIT) tags are injected into the pectoral muscle tissue to assure tags are not lost. ODFW staff count and scan fish at charter and private docks to estimate recaptures.

Developing survey methods for rocky reefs: Four separate research studies using a simple video lander as a survey tool are underway. The aim is to measure distribution and abundance of several demersal rockfishes on Oregon's nearshore rocky reefs.

Marine Habitat Research: ODFW's Marine Resources Program staff on the Marine Habitat Project conducted data compilation, review, and analysis of 1) a state-wide aerial and biomass survey of canopy-forming kelps (which are indicative of shallow rocky seafloor habitat) using multi-spectral imagery and on-the-water plant collections; and 2) a Remotely Operated Vehicle (ROV) survey of the newly-established Redfish Rocks Marine Reserve and Marine Protected Area and associated reference sites near Port Orford.

The ROV survey focused on the deep (more than 20 meters) nearshore rocky reefs and complemented the work of ODFW's Marine Reserves Program, which focused on the associated shallow areas and sandy offshore areas. The survey was designed to collect baseline data at the reserve site and two reference sites as part of a Before-After-Control-Impact study design to assess the effects of reserve status on fish communities. MRP staff worked on upgrades and retrofits the ODFW's ROV, specifically outfitting the vehicle with high definition video and still camera systems.

The Marine Habitat Project continued to collaborate with Oregon State University's Partnership for the Interdisciplinary Study of Coastal Oceans (PISCO) group to monitor hypoxia conditions offshore of the central Oregon coast. Fieldwork on this project is ongoing and a survey was conducted in May 2011. A Sea Grant Fellow has been reviewing and working up data for benthic invertebrates collected over the past 11 years, and will be publishing the work in a peer-reviewed journal during 2011-12.

C. HMSC Visiting Scientists

HMSC Visiting Scientists

Maryann Bozza, HMSC Program Manager

Through the Visiting Scientist program, HMSC encourages and supports collaborative visits from researchers from across the nation and the world. During their stay, which can vary in length

from days to months, visitors share knowledge through seminars and formal and informal interactions while advancing their own investigations, leaving both visitor and host richer for the exchange.

An important source of support for long-term visits is the Lavern Weber Visiting Scientist Fellowship endowment, named in honor of Lavern Weber, who directed the HMSC between 1977 and 2002. In 2011, HMSC hosted Weber Visiting Fellow Fred Allendorf of the University of Montana. Professor Allendorf collaborated with HMSC genetic researchers, including Michael Banks, Scott Baker, and Kathleen O'Malley during his three-month tenure at HMSC. He gave four research seminars and a public talk, co-taught a topics course, and mentored and taught a number of graduate students. His collaboration with HMSC's Kathleen O'Malley ultimately resulted in a submitted proposal, and his well-attended public talk entitled "Evolution Today: Return of the Bed Bugs" focused on genetic approaches to the study of evolution.

HMSC hosts frequent visits from OSU faculty and graduate student researchers from the main campus in Corvallis, faculty from other universities as well as agency scientists and natural resource managers from the region, with occasional visits of personnel from federal agency headquarters. These interactions serve to facilitate collaboration and information exchange and advance regional initiatives including ocean renewable energy and ocean observing infrastructure.

II. EDUCATION

Student Enrollment Statistics

Itchung Cheung, Academic Program Coordinator

Summer 2010	Credit	Course Title	2010-2011 Enrollment
BI 150	4	Introduction to Marine Biology (Cheung)	8
BI 302	4	Biology and Conservation of Marine Mammals (Sumich)	3
BI 421	4	Aquatic Biological Invasions (Chapman)	1
FW 302	4	Biology and Conservation of Marine Mammals (Sumich)	7
FW 421	4	Aquatic Biological Invasions (Chapman)	1
FW 521	4	Aquatic Biological Invasions (Chapman)	0
FW 499	3	Ecology of Coastal and Estuarine Birds (Suryan)	5

Fall 2010	Credit	Course Title	2010-2011 Enrollment
BI 111	1	Introduction to Marine Life in the Sea: Marine Mammals (Sumich)	6
FW 111	1	Introduction to Marine Life in the Sea: Marine Mammals (Sumich)	4
FW 323	3	Management Principles of Pacific Salmon in the Northwest (Archer)	8
FW 407	1	HMSC Research Seminar (Boehlert)	4
FW 507	1	HMSC Research Seminar (Boehlert)	3
FW 426/526	5	Coastal Ecology and Resource Management (Langdon)	10
FW 454/554	5	Fishery Biology (Heppell)	19
FW 464/564	3	Marine Conservation Biology (Se Heppell)	8
FW 474	4	Early Life History of Fishes (Miller/Cianelli)	9
FW/OC 574	4	Early Life History of Fishes (Miller/Cianelli)	14
FW 499/599	1	Ecology of Coastal Fishes (Emmett/Weikamp)	6
FW 499/599	3	Natural History of Whales and Whaling (Baker)	11
FW 520	3	Ecology and Management of Marine Fishes (Heppell)	8
OC 599	3	Math on the Beach (Smyth)	8

Winter 2011	Credit	Course Title	2010-2011 Enrollment
BI 111	1	Introduction to Marine Life in the Sea (Cheung)	11
FW 111	1	Introduction to Marine Life in the Sea (Cheung)	8
FS 599	2	Special Topics in Fisheries and Wildlife: Genetics & Management of Exploited Populations (O'Malley)	7

Spring 2011	Credit	Course Title	2010-2011 Enrollment
BI 111	1	Intro to Marine Life in the Sea: Marine Birds (Suryan)	11
FS 115	1	Ecology of Coastal Forests (Black)	12
BI 450	8	Marine Biology Lecture (Hacker)	20
BI 451	8	Marine Biology Lab (Hacker)	20
FW 111	1	Intro to Marine Life in the Sea: Marine Birds (Suryan)	4
VMB 727	2	Ornamental Fish Medicine (Miller-Morgan)	6

Internships at HMSC

Itchung Cheung, Academic Program Coordinator

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, the 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 2010-11, twenty-five 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 HMSC Visitor Center Education internship, NSF-funded Center for Ocean Science Education Excellence Pacific Partnerships (COSEE PP) Promoting Research Investigations in the Marine Environment (PRIME) program, and NSF-funded "Research Experience for Undergraduates" (REU) program. Twenty students were selected (through a competitive application process which attracted 257 applicants) 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 2010. An additional student was added to the REU program through NOAA Education funds from the Living Marine Resources Cooperative Science Center (LMRCSC). In addition, three undergraduate students participated in the HMSC Visitor Center Internship in marine science education. Three community colleges students participated in the COSEE PP PRIME internship with one transferring to OSU in the fall. One OSU undergraduate student participated in the state sponsored Professional and Managerial Internships in State Employment (PROMISE) program with the HMSC Academic Programs. Three undergraduate students participated in the NOAA Hollings Scholar program. Three undergraduate students participated in a new Oregon Sea Grant Undergraduate Scholars Program. There was one visiting summer undergraduate researcher with EPA. One teacher intern participated in the Communicating Ocean Sciences to Informal Audiences (COSIA) Teacher internship Program.



2010 REU students at the SACNAS Conferenc in California

Five of the REU student interns from the Summer 2010 program presented research posters at the February 2011 American Society of Limnology and Oceanography, Aquatic Sciences Meeting in San Juan, Puerto Rico. Seven of the REU student interns presented at the 2010 Society for the Advancement of Chicanos and Native Americans in Science Conference, Anaheim, California.

The HMSC REU students who presented are listed below. Seven COAS REU students (not listed) also presented:

Ahgeak, Ernestine*; Hurst, T.: Juvenile Pacific Cod Growth Rates in Response to Ocean Acidification

Asson, Danielle*; Chapman, J and Dumbauld, B: Sex and Location, or Size and Time? *Upogebia pugettensis* Can Wait But Can't Hide from It's Introduced Isopod Parasite, *Orthione Griffenis*

Chavez, Keith*; Reimers, C.: Eddy Correlation Accuracy in the Presence of a Seafloor Lander Framework

Jackson, Keya*; Chapman, J and Dumbauld, B: Size Dependent Burrowing Competence of the North American Blue Mud Shrimp, *Upogebia pugettensis*

Lopez, Elizabeth*; Henkel, S: Baseline Survey of Macroinfaunal Invertebrate Community at Potential Wave Energy Site Off the Oregon Coast

Prechtl, Melissa*; Peterson, B.: Impacts of Ocean Acidification on Hatching and Early Larval Development of *Calanus pacificus* and *Calanus marshallae*, and *Euphausia pacifica*

Segui, Leah*; Brodeur, R. and Suryan, R.: Species Composition and Energy Density of Black Rockfish (*Sebastes melanops*) Diets Off Newport, Oregon

During the summer at HMSC several students gained research experience at sea. For example, Leah Segui (working on black rock fish) participated in one of the NOAA cruises. Megan Cahill accompanied her mentor, Kym Jacobson, on a trip to sample the Columbia River. After the end of the REU program, Danielle Asson and Melissa Prechtl remained in the program continuing their research into the school year as OSU students. Several students who conducted laboratory-based REU projects also gained field experience on the 54-ft coastal research vessel *Elakha*.

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 a NOAA Brown Bag Workshop series on resume writing and interviewing skills and attended a weekly research seminar series.

REU Interns	Undergraduate Institution	Faculty Mentor	Project Title
Ahgeak, Ernestine	University of Alaska Fairbanks	Hurst, Tom	Juvenile Pacific Cod Growth Rates in Response to Ocean Acidification
Asson, Danielle	Oregon State University	Chapman, John & Dumbauld, Brett	Population Structures of the Mud Shrimp (<i>Upogebia pugettensis</i>) and its Introduced Parasitic Isopod (<i>Orthione griffensis</i>) Within and Among Oregon Estuaries
Cahill, Megan	Georgetown University	Jacobson, Kym	Prevalence of <i>Renibacterium salmoninarum</i> Within Yearling Chinook Salmon (<i>Oncorhynchus tshawytscha</i>) Found in the Columbia River Estuary
Chada, Revanth	St. Olaf College	Ryer, Cliff	Size-dependent Modification of Density-dependent Habitat Selection in Juvenile Flatfish
Chavez, Keith	University of Oregon	Reimers, Clare	Eddy Correlation Accuracy in the Presence of a Seafloor Lander Framework
Hankin, Shannon	North Central College	DeWitt, Ted	Diatom and Vascular Plant Responses to Nutrient Addition in Oregon Estuarine Marshes
Jackson, Keya*	Hampton University	Chapman, John & Dumbauld, Brett	Size Dependent Burrowing Competence of North American Blue Mud Shrimp, <i>Upogebia pugettensis</i>
Lopez, Elizabeth	California State University Monterey Bay	Henkel, Sarah	Baseline Survey of Macrofaunal Invertebrate Community at Potential Wave Energy Site Off the Oregon Coast
Prechtl, Melissa	Oregon State University	Peterson, Bill	Impacts of Ocean Acidification on Hatching and Development of Marine Copepod Species, <i>Calanus pacificus</i> and <i>Calanus marshallae</i> , and Euphausiid Species, <i>Euphausia pacifica</i>
Segui, Leah	San Diego State University	Brodeur, Ric & Suryan, Rob	Species Composition and Energy Density of Black Rockfish (<i>Sebastes melanops</i>) Diets Off Newport, Oregon
HMSC VC Education Intern	Undergraduate Institution	Faculty Mentor	Project Title
Biederbeck, Karl	Oregon State University	Hanshumaker, Bill	Ocean Quest: Current Research in the Deep Sea
Hirota, Alex	Oregon State University	Hanshumaker, Bill	Wave energy display for the HMSC Visitor Center
Rodgers, Lauren	Oregon State University	Hanshumaker, Bill	Exhibit Design of the Hypoxia/Dead Zone off the coast of Oregon and Washington
Promise Intern	Undergraduate Institution	Faculty Mentor	Project Title
Jauron, Amy	Oregon State University	Cheung, Itchung	Hatfield Marine Science Center Sea Water System Narrative and Timeline
NOAA-Hollings Scholars	Undergraduate Institution	Faculty mentor	Project Title
Haji, Maha	University of California, Berkeley	Emmett, Bob & Henkel, Sarah	Interaction of Wave Energy Devices and the Environment: Biofouling Concerns on Mooring Systems
Sasnett, Peri	Columbia University	Chadwick, Bill	Mapping recent lava flows at Axial Seamount
Wilcox, Troy	University of New England	Weitkamp, Laurie	Seasonal Changes in Sub-Yearling Chinook Salmon Diet in the Columbia River Estuary

HMSC COSEE PP PRIME Interns	Undergraduate Institution	Faculty mentor	Project Title
Hubert, David	Linn-Benton Community College	Langdon, Chris	Determining the viability of the green macro algae <i>Ulva</i> as a dissolved CO2 reducing biofilter.
Moore, Samuel	Portland Community College	Parr, Leslee	Gaper Clam Reburial Study
Perry, Laurelyn	Portland Community College	Miller, Jessica	Determining the role of sandy beach surf-zones as a habitat for juvenile Chinook salmon
COSIA Intern	Undergraduate Institution	Faculty mentor	Project Title
Marshall, Paula	Wilson College	Rowe, Shawn	Communicating Ocean Sciences to Informal Audiences

Not listed: Oregon Sea Grant Undergraduate Scholars (3) and EPA undergraduate intern (1). * Funded by NOAA LMRCS



HMSC interns and mentors, summer 2010

Student Awards and Scholarships

Itchung Cheung, Academic Program Coordinator

Scholarships and awards given by HMSC through the generosity of various donors represent an important source of financial support for undergraduate and graduate student education and research in marine science. The 2011 Markham Research Symposium (named for the Mamie L. Markham Endowment, which annually awards two years of financial support for nine students pursuing research at HMSC) was held on June 15, 2011. Students who had made significant progress towards completion of their research gave brief presentations. Those students being awarded new monies for 2011-12 year displayed posters explaining their proposed research. Their awards are listed below:

<u>Award</u>	<u>Recipient</u>
HMSC Housing Scholarship - <i>To provide free or reduced-rate housing on-site for the duration of the term in which they are enrolled.</i>	No applicants for 2010-2011 (\$250)
Mamie L. Markham First Year Student Award - <i>to provide financial assistance to an incoming, first year graduate student who plans to be resident at the HMSC after completing first academic year in Corvallis.</i>	Stephanie Labou, Marine Resource Management (\$10,000) Advisor: Sarah Henkel
Fred and Joan Crebbin Memorial Fellowship - <i>To foster education in the marine sciences by providing financial support to undergraduate or graduate students pursuing marine science related fields at OSU.</i>	Rebecca Hamner, Wildlife Science (\$3,000) Advisor: Scott Baker
Lillian Brucefield Reynolds Scholarship Fund - <i>for graduate students engaged in study of marine science at Hatfield Marine Science Center.</i>	Amanda Gladics, Marine Resource Management (\$1,000) Advisor: Rob Suryan
Curtis and Isabella Holt Education Fund - <i>intended to foster education in the marine sciences by providing financial support to undergraduate or graduate students pursuing marine science studies.</i>	Rebecca Schiewe, Free Choice Learning (\$2,161) Advisor: Shawn Rowe Jedediah Smith, Science & Math Ed (\$3,800) Advisor: Shawn Rowe
Walter G. Jones Fisheries Development Award - <i>intended to support an academically qualified graduate student pursuing research which contributes to fisheries development.</i>	Amelia Whitcomb, Fisheries Science (\$1,300) Advisor: Kathleen O'Malley
William Q. Wick Marine Fisheries Award - <i>intended to encourage graduate student research in the area of marine fisheries ecology with special area of interest in Pacific whiting or intended to fund graduate research in marine fisheries and ocean related research</i>	Amanda Gladics, Marine Resource Management (\$4,000) Advisor: Rob Suryan
HMSC Student Teaching Award - <i>intended to recognize undergraduate or graduate student teaching excellence and promise in marine science education at the Hatfield Marine Science Center.</i>	Caleb Price (2011 Winter), Marine Resource Management (\$250) Cheryl Horton (2011 Spring), Fisheries & Wildlife (\$250) Diana Raper (2011 Spring), Forest Ecosystem Science (\$250)
Mamie L. Markham Endowment Award - <i>intended to assist graduate or student research utilizing OSU's Hatfield Marine Science Center.</i>	
Andrew Claiborne, Fisheries Science (\$10,000) Advisor: Jessica Miller	Sarah Close, Zoology (\$6,561) Advisor: Bruce Menge
Laura Dover, Free Choice Learning (\$9,000) Advisor: Shawn Rowe	Ryan Easton, Marine Resource Management (\$9,721) Advisor: Selina Heppell
Cheryl Horton, Wildlife Science (\$10,000) Advisor: Rob Suryan	Timothy Lee, Environmental Sciences (\$1,633) Advisor: Sarah Henkel
Marisa Litz, Oceanography (\$9,425) Advisor: Lorenzo Ciannelli	James Losee, Fisheries and Wildlife (\$6,750) Advisor: Jessica Miller
Chenchen Shen, Zoology (\$7,423) Advisor: Lorenzo Ciannelli	Sheanna Steingass, Fisheries and Wildlife (\$6,823) Advisor: Markus Horning

Course Descriptions

Itchung Cheung, Academic Program Coordinator

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, Veterinary Medicine and Zoology. The courses are open to undergraduate students, graduate students and professionals, and generally attract 20-35 students per term.

Note: * = use of Interactive Television (ITV) or online course.

Summer 2010 Courses

BI 150. INTRODUCTION TO MARINE BIOLOGY (Cheung) (4)

An introduction and overview of marine life in the sea.

FW/BI 302. BIOLOGY AND CONSERVATION OF MARINE MAMMALS (Sumich) (4)

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.

BI/FW 421/FW 521. AQUATIC BIOLOGICAL INVASIONS (Chapman) (4)

An overview of the background, theory, evolution, ecology, politics and conservation of invasions by introduced species in aquatic environments.

FW 499. SPECIAL TOPICS IN FISHERIES AND WILDLIFE: Ecology of Marine and Estuarine Birds (Suryan) (3)

An overview of the evolution and ecology of marine and estuarine birds on the Oregon coast.

Fall 2010 Courses

ALS 199 – U-ENGAGE: MARINE SCIENCE – LUNAR FORCES, EDIBLE SEA VAMPIRES AND OTHER CURIOSITIES OF THE SEA. ccc(Cheung) (2)

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

A field-focused learning experience, this inquiry-based course is a basic overview of the marine mammals on the Oregon coast.

FW 323. MANAGEMENT PRINCIPLES OF PACIFIC SALMON IN THE NORTHWEST (Archer) (3)

Course explores the nature of the salmon problem in the Northwest. Experts from diverse disciplines describe principles of salmon biology, habitat ecology and management, socioeconomics of direct and indirect users, and government policies.

*FW 407/507. MARINE SCIENCE SEMINAR (Boehlert) (1)

See list of seminar series speakers.

*FW 426/526. COASTAL ECOLOGY AND RESOURCE MANAGEMENT (Langdon) (5)

This course is an intensive, team-taught class designed to lay the foundation for students' understanding of coastal and marine ecosystems and resources. Topics range from the coastal forests to the open ocean and emphasize the linkages between basic science and management. Lectures, laboratories, field experiences, and seminar discussions in CERM will expose students in a variety of venues to the ecology and issues surrounding use of natural resources on the Oregon coast.

*FW 454/554. FISHERY BIOLOGY(Se Heppell) (4)

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 464/564. MARINE CONSERVATION BIOLOGY (Se Heppell) (3)

Lectures, group library research, and class debates on current issues regarding the conservation of biodiversity in the sea. Topics include overfishing, invasive species, eutrophication, marine pollution, and global warming, as well as means of addressing these threats.

*FW 474/574. EARLY LIFE HISTORY OF FISHES (Miller/Cianelli) (4)

Lectures and labs introducing the unique considerations of eggs, larvae, and juvenile fishes as well as conceptual and quantitative models associated with the role of early life history in ecology, evolution, and fisheries science.

FW 499/599.SPECIAL TOPICS IN FISHERIES AND WILDLIFE: Natural History of Whales and Whaling (Baker) (3)

Various topics in fisheries science and wildlife science.

FW 499/599.SPECIAL TOPICS IN FISHERIES AND WILDLIFE: Ecology of Coastal Fishes (Emmett/Weitkamp) (1)

Various topics in fisheries science and wildlife science.

FW 520. ECOLOGY AND MANAGEMENT OF MARINE FISHES (Se Heppell) (3)

A lecture and lab course that covers the ecology of marine fishes and important ecological principles that guide conservation and management. Life history, behavior, habitat, community dynamics and ecosystem processes are emphasized, along with alternative management strategies.

OC 599. SPECIAL TOPICS IN OCEANOGRAPHY: Math on the Beach (Smyth) (3)

Subjects of current interest in oceanography, not covered in depth in other courses.

Winter 2011 Courses

BI/FW 111. INTRODUCTION TO MARINE LIFE IN THE SEA (Cheung) (1)

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.

*FW 599. SPECIAL TOPICS IN FISHERIES AND WILDLIFE: Genetics & Management of Exploited Populations (O'MALLEY/ ALLENDORF) (2)

Current topics in marine science research: Potential effects of harvest on the genetics and sustainability of wild populations.

Spring 2011 Courses

BI/FW 111. INTRODUCTION TO MARINE LIFE IN THE SEA: Marine Birds (Suryan) (1)

A field-focused learning experience, this inquiry-based course is a basic overview of the marine birds on the Oregon coast.

FS 115. ECOLOGY OF OREGON COASTAL FORESTS (Black) (1)

A field-focused learning experience, this inquiry-based course is a basic overview of the ecology of Oregon coastal forests.

BI 450. MARINE BIOLOGY (Hacker) (8)

A comprehensive introduction to the flora and fauna of the marine environment approached from the level of the cell to the whole organism. Ecological patterns and processes characteristic of marine communities will be emphasized.

BI 451. MARINE BIOLOGY LABORATORY (Hacker) (8)

Laboratories and field experience with flora and fauna of marine environment, microbes, physiological and biochemical characteristics and adaptations of marine organisms, ecological patterns and processes of marine populations, communities, and ecosystems.

VMB 727. ORNAMENTAL FISH MEDICINE (Miller-Morgan) (2)

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.

HATFIELD STUDENT ORGANIZATION (HsO) ACTIVITIES Itchung Cheung, Academic Program Coordinator

President: Alana Alexander

Vice President: Jose Marin Jarrin

Secretary: Ruth DiMaria

Treasurer: Rebecca Hamner

Communications Officer: Matthew Gray

Activities: HMSC Community Building, HsO Holiday Raffle, HsO Student Symposia, OIMB/HMSC Scholar Exchange, HMSC Donut Hour, HsO Reading Group, HMSC Cook-offs, HsO Travel Awards, HMSC Olympiad.

Aquatic Animal Health Program

Tim Miller-Morgan, Extension Veterinarian, Aquatic Pets, Oregon Sea Grant

The Aquatic Animal Health Program (AAHP), supported by Oregon Sea Grant and the College of Veterinary Medicine, has completed a busy seventh year solidifying existing programs and expanding into new areas. Tim Miller-Morgan is the extension veterinarian overseeing this program and Dennis Glaze is the Aquatic Health and Husbandry Specialist that manages the teaching and research laboratory at HMSC and assists Dr. Miller-Morgan with outreach and education.

The Ornamental Fish Health Program is the major outreach initiative within the AAHP. The purpose of the Ornamental Fish Health Program (OFHP) is to provide educational programming and service to the ornamental fish industry in Oregon and it's 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 web site, <http://seagrant.oregonstate.edu/extension/fishhealth/index.html>. 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 Israel, India, Australia, Japan, Malaysia and Singapore and the Netherlands continue to give an international flavor to the program. Miller-Morgan was invited to speak at the Australasia Aquaculture Conference in Hobart, Tasmania and the recent Asia Pacific Aquaculture Conference, in Kerala, India. At both meetings he was asked to discuss the development of professional training programs and extension outreach for the aquaculture industry and more specifically the ornamental fish industry. Further, he was requested to give presentations related to biosecurity and how the principles of biosecurity could be applied within the ornamental fish industry. Miller-Morgan continues to work with local koi, goldfish, and aquarium clubs.

Dr. Miller-Morgan is currently working with trade organizations in India, the Netherlands and Malaysia to develop on-line training and certification programs for aquaculture professionals throughout Southeast Asia.

Dr. Miller-Morgan has coordinated, co-coordinated and instructed in multiple industry and veterinary professional seminars and workshops throughout the year, including: Wildlife and Aquatic Animal Medicine Symposium, UC Davis, School of Veterinary Medicine; Emerging Health Issues in the Ornamental Pond Fish Industry, HMSC, Newport, OR; Advanced Koi Health Management for Hobbyist and the Pond Professional, Point Defiance Zoo and Aquarium, Tacoma, WA; Aquatic Veterinary Medicine Sessions (27 hours), American Veterinary Medical Association Annual Conference, Atlanta, GA; International

Zoo, Exotic and Wildlife Medicine Workshop – Fish Medicine Session, HMSC, Newport, OR; Overview of the United States Ornamental Fish Industry and Biosecurity Risks, Melbourne, Australia.

The Ornamental Fish Health Program 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, Israel 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: Volunteer Aquarist Aides (20 hour minimum), Practicum Experiences (50 hours minimum), or Internships (400 hour minimum). In the past year we have provided these learning experiences for 5 Volunteer Aquarist Aides (average of 148 hours), 2 practicum students and 1 intern. We have also hosted 2 summer interns, one from the Department of Animal Science and a summer research scholar from the College of Veterinary Medicine.

We also offer regular back-wing tours of our teaching and research facility and we have seen significantly increased demand for such tours. These interactive tours follow an outline and script developed by OFHP staff and students. During the past year we led or facilitated at least 40 such tours.

The AAHP also provides veterinary care, consultation, and training to the research community at the HMSC. Dr. Miller-Morgan serves as the clinical veterinarian for the HMSC. We offer training seminars for new faculty, graduate students, educators and volunteers that address recognition of disease and distress in aquatic animals, occupational health and safety and the requirements associated with institutional animal care and use.

Sea Grant Youth and Family Marine Education **Nancee Hunter, Director of Education, Oregon Sea Grant**

During the 2010/11 year, 9,826 K-12 students and other youth participated in marine education programs hosted by Oregon Sea Grant at the Hatfield Marine Science Center. The majority of the youth served come with organized school groups from as far away as Idaho and Montana. Trips range from a single class to multiple days worth of programming.

One new class program was added this year to meet newly adopted state science inquiry standards. Speedy Science: A Race to Inquiry is designed to allow 3rd-12th grade students to work in teams to design and run an experiment on shore crabs aimed at identifying variables that affect the speed of these organisms. During this program, students learn how to make good observations, develop a research question and hypothesis, develop and implement a research protocol, collect and analyze

data, and report findings to their peers, all critical components of real world research. This program has proven to be very popular, with 775 students participating in the class this school year. Feedback from both the teachers and students participating in this new program has been very positive.

This year, two more Career Day programs at HMSC opened the eyes of 159 high school students from across the state. Attendees participated in activities such as tours of the OSU Research Vessel the *Wecoma*, a salmon shark necropsy which was also webcast live, mud shrimp research in Yaquina Bay with John Chapman, and construction of mini-ROVs. Oregon Sea Grant Communications staff was on hand at the Spring 2011 Career Day to photograph and video the activities. A short promo video has been produced to publicize upcoming career day events. During this school year, demand for Career Day was so high we once again had to turn large numbers of students away. As a result, additional Career Days (3 instead of 2) will be offered in the 2011/2012 school year to accommodate the demand for such a program. A \$2000 award has also been received to create and run a similar career program for local middle school students. Planning for this event, which will take place at the beginning of the new school year, has already begun. Plans for an Oregon Sea Grant 40th Anniversary Career Day to be held October 21st are also underway. This event will highlight research that is currently being funded by Oregon Sea Grant or research that has been funded by OSG in the past. Members of the Legislature will also be invited to the event.

Homeschool Days continued to be a popular program, serving 168 students. In addition to the hands-on classes offered for K-12 homeschool students, a professional development workshop focusing on science lessons was run for 10 homeschool parents. Attendees of the workshop took home numerous curricular materials and the confidence to use them.

Additional professional development opportunities were provided at Hatfield Marine Science Center for Middle and High School teachers from Oregon and Washington through the NOAA Ocean Explorer program. These daylong programs provide curriculum, materials, and instruction on the deep-sea environment. Twenty-one educators participated in the Fall workshop and sixteen in the follow-up workshop in the Spring.

During 2010, Sea Grant sponsored six Summer Day Camps at HMSC, providing field experiences and hands-on programming for 92 campers ages 7-17. Oregon Sea Grant staff continue to partner with other precollege programs at OSU (4-H, Saturday Academy, CAMP) and at other organizations (OMSI, Grande Ronde, YMCA) to provide additional field experiences for middle and high school aged youth during the summer.

A series of 5 two-hour, interactive Family Programs for ages 4 and up were also run at HMSC last summer by OSG staff. There were 90 participants of these programs that covered topics ranging from plankton to whales.

A total of ten Boy and Girl Scouts programs were also held at HMSC with 150 participants. In addition to earning merit

badges, participants learn about a wide variety of marine issues and current research being conducted at OSU and HMSC. Changes in the Oregon Sea Grant youth and family programs at HMSC included the creation of a new position of Marine Education Program Assistant. This is a fulltime position that is responsible for the scheduling of marine education programs as well as leading some of those programs. Former Museum Assistant, Kathryn Hawes, accepted the position and began her new duties at the end of May.

In addition to educational activities at HMSC, Oregon Sea Grant staff from HMSC also provided outreach at several events including DaVinci Days in Corvallis. Staff also provided a strong presence through displays and presentations at the Oregon Science Teachers Association (OSTA) and the Northwest Aquatic and Marine Educators (NAME) Annual Conferences.

Oregon Coast Quests: Oregon Coast Quests is a place-based education program at OSG that uses clue-directed hunts to encourage people of all ages to get outside and explore the natural, cultural, and historical ‘treasures’ of Oregon’s coastal communities. Cait Goodwin initiated and now coordinates Oregon Coast Quests activities, and Nancee Hunter oversees the program. Oregon Coast Quests started in 2007 and been responsible for the creation of more than 30 Quests in Lincoln, Coos and Benton Counties. Nearly 4000 logs have been made in hidden Quest Boxes by people who gone on Quests (1000+ in the past year), and more than 1500 Quest Books of directions have been distributed. Over 45 different community groups have been involved in building, hosting and marketing Quests. Quests are located in city, state, and federal parkland, on OSU and Lincoln County School District campuses, and in public urban districts. This free-choice, self-guided learning activity continues to be low-cost and low-tech so as to reach young, underserved, and general populations.

The Oregon Coast Quests program connects people to community, which is the first step to promoting healthy lifestyles, a healthy planet, and a healthy economy. Questers get out from behind the computer monitor and are active and engage in hands-on learning in local outdoor environments. Explorers of all backgrounds learn about invasive species, coastal habitats, local history, renewable resources, land management issues, and much more when they go on Quests. They gain direct experience with places and topics about which they may have to make decisions in the near or distant future. Most Quests are undertaken by small multi-age family groups, youth/school groups, or adult pairs.

Oregon Coast Quests is an outreach education program. The activity is an appropriate tool for communicating research results to the public. Students may create Quests to extend field-based experiences and share new knowledge with others. Quests necessarily bring together many different community groups in collaboration (site hosts, topic experts, Quest-builders, explorers), and can be used by many different groups of people (tourists,

residents, families, school groups, team-builders, etc).

Questing has been made available to the public through the sale of Oregon Coast Quest Books in 21 retail locations in Lincoln County and Corvallis. Select Quests may be downloaded from the Oregon Coast Quests website or those of our partners. Quests are promoted to teachers as a field trip activity through the website, by OSG K-12 programs at HMSC, by Yaquina Head Outstanding Natural Area, by the OCAMP Math Sciences Partnership and by the B-WET funded Oregon Coastal Education Program.

The focus of the 2010/2011 year has been to expand the Oregon Coast Quests program’s reach to Quest-building activities and partnerships in new areas. As a result, Oregon Coast Quests are now present outside Lincoln County for the first time. In addition to three new Quests in Lincoln County, the newest edition of *The Oregon Coast Quests Book* also includes two Coos County and two Quests in Benton County.

New Quest Partnerships:

- As a result of the April 2010 workshop held in Corvallis, OSU Precollege Program leaders have now become actively involved in creating Quests. Two Quests located on the main OSU campus have been finished and are included in the new Quest Book, and both the Saturday Academy and Talented and Gifted Precollege programs have included Quest-building in their curricula.
- As a result of the May 2010 workshop held in Charlestown, two new Quests in Coos County have been finished and are included in the new Quest Book. OSG extension agent Jamie Doyle helped coordinate the effort and work with partners such as South Slough National Estuarine Research Reserve, the Port of Coos Bay, Americorps, and the Coos Bay Tourism Board.
- As a result of the February 2010 workshop held at HMSC, a participant volunteered to put the new Bayfront Quest into rhyming verse. The Bayfront Quest is now in the new Quest Book, and the Port of Newport has volunteered to care for the hidden box.
- In April and May 2011, Oregon Coast Quests partnered with the Taft Cemetery Association to help youth at Taft Elementary’s afterschool program create the “Taft Pioneer Cemetery Quest” on the historic site located within walking distance of the school.

Outreach:

- Goodwin, C., ed. 2011. *The Oregon Coast Quests Book, 2022-2012 Edition*. Corvallis, OR: Oregon Sea Grant. 214 pp. This book contains 25 Quests in three Oregon counties, including: seven brand new Quests, updates to existing Quests, and one Quest in Spanish.
- Beginning with the launch of the new Quest Book, a new embroidered Quest patch will be awarded to those who complete 10 or more Quests.
- A Quest-Building Workshop was held for the general public at Hatfield Marine Science Center, Newport, OR, January 22, 2011.
- The “Quest-News” listserv was launched in October 2010,

and 234 subscribers receive monthly updates from Oregon Coast Quests. E-newsletters contain links back to the Quests webpage for further information.

- Goodwin, C. , “*Exploring communities through Questing.*” Northwest Aquatic and Marine Educators Conference, July 9-10, 2010, Florence, OR

Support and Awards:

- \$1250 – ODFW’s Salmon and Trout Advisory Council to print *The Oregon Coast Quests Book, 2011/2012 Ed.*, March 2011
- \$153 – The Greater Newport Chamber of Commerce financed the production of 100 embroidered patches which will be awarded to those who have successfully completed 10 or more Quests.
- Cait Goodwin was awarded a conference scholarship to attend and present at the 2010 Northwest Aquatic and Marine Educators (NAME) conference.
- Sales of the remaining 2009/2010 Quest Books have continued to help fund the OCQ program.

Upcoming Projects:

- The Chintimini Fund of The Oregon Community Foundation has awarded funds to the Lincoln County School District to contract Oregon Coast Quests to help students create an urban Quest in the OceanLake district of Lincoln City (accepted)
- 6th grade teachers in the Lincoln County School District have applied to the Confederated Tribes of Siletz Indians to create a Quest at Eureka Cemetery in Newport (pending)

III. RESEARCH AND EDUCATION SUPPORT

HMSC Director's Office

Maryann Bozza, HMSC Program Manager

In September 2010, OSU's Research Office convened a panel of OSU and external reviewers to conduct an External Review of HMSC, focused on progress toward and barriers to achievement of HMSC's mission and strategic plan. The panel reviewed documents made available by the HMSC Director's Office, followed by two days on site interviewing faculty, staff, agency employees, students and community leaders. The review committee's report identifies many recommendations to improve HMSC's role in the University and its ability to advance OSU's strategic mission. In response to the report, the OSU Provost convened an implementation task team to explore the key questions raised by reviewers toward implementation of the report's recommendations, with the intent of strengthening HMSC's role in the overall strategic direction of the University. The task team's conclusions are expected in spring of 2012.

As a marine lab on the Oregon Coast, HMSC is sited at sea level within the tsunami inundation zone. In May 2011, HMSC disseminated an updated version of the HMSC campus-wide emergency evacuation plan, which dictates evacuation to high ground in the event of an earthquake. In support of this plan, the Director's Office has offered a series of informational events to assist staff in preparedness for an emergency evacuation. The first event was a forum with state and local experts, who presented the plan and answered questions and concerns. Several other events are planned for summer 2011, and the annual evacuation drill will follow in the fall.

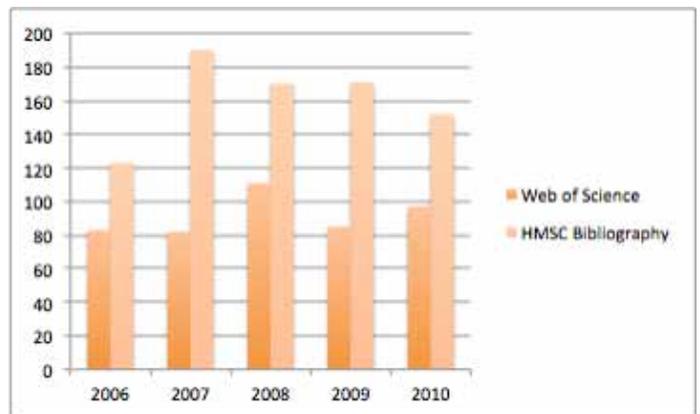
Other functions of the Director's Office include strategic planning and annual reports, administration of the numerous interagency committees that contribute to campus-wide policy and strategic decisions, and maintenance of HMSC's infrastructure including IT, building maintenance and seawater system infrastructure.

Guin Library

Janet Webster, Librarian

The Marilyn Potts Guin Library continues to be one of best marine and estuarine libraries in North America. Its strengths are information on the marine and estuarine sciences of the Northeast Pacific region with particular attention on Oregon. As part of the OSU Libraries, this branch serves the OSU faculty, staff and students located at HMSC as well as the other agency researchers working in Newport. While funding is flat, we continue to shape our services and collections to meet our users' expectations. These include increasing access to electronic scientific information in the form of journals and ebooks. The OSU Libraries completed the second year of a planned reduction to the collection budget resulting in reduced access, but done in a strategic manner to lessen the impact on our researchers and students. The most visible result at the Guin Library is

fewer print journals. Our excellent resource sharing allows us to continue to provide our users with rapid access to what they need.



Tracking HMSC Publications: The Library staff tracks HMSC publications as a means to document the research and teaching effort of all at the center. In addition to articles published in the main stream scientific journals, researchers publish in other outlets and present in many forums. The annual compilation of the HMSC Bibliography allows us to maintain a deeper understanding of who is doing what at HMSC from the OSU faculty to graduate students to our federal and state partners. Below is a comparison between what is indexed in Web of Science, a major index to the peer-reviewed literature, and what we find for the HMSC Bibliography.

As part of work tracking publications, the Guin Library staff wants to help our faculty and students make their research accessible. We plan to make the HMSC Bibliography more useful on the Web this coming year with links to the full text when available. We are working with authors to deposit their work in OSU's ScholarsArchive. The HMSC Administration uses this digital repository to store and provide access to our planning and administrative documents.

Creating Digital Collections: We provide access to electronic journals and books that we purchase. We also are growing our own digital collections. Our focus is on the information about Oregon's estuaries. To date, we have over 500 documents available digitally. We use our estuary bibliographies as finding tools. These will be available on the Web this coming year.

Maintaining the Library as Place: While much emphasis is put on virtual access, we also want to provide a comfortable physical space for students to collaborate and study, for faculty to get away from their office for a little quiet, and for all at HMSC to gather for seminars and meetings. This spring, we surveyed how people were using the library by zone and activity. Spring term students work collaboratively.

- More students bring their own laptops rather than using OSU computers.
- Our public computers are in demand.
- Traffic flow starts in the late morning and continues through the late afternoon.
- Wednesday is the slowest day.

With this information, we will plan for changes in layout,

equipment and maybe even hours!

Library Displays:

“Census of Marine Life”

“Banned Books: Titles you wouldn’t think would be challenged”

“Art and Science of Anemones”

“Diatoms: Small but powerful”

Staff activities: Janet Webster, the librarian, chairs the Oregon Library Association’s Legislation Committee. She chairs the Standing Committee of International Federation of Library Association’s Science and Technology Libraries Section. She is part of the OSU team affiliated with the Northwest National Marine Renewable Energy Center.

Susan Gilmont leads the work on the Oregon Estuary Bibliographies, making accessible the historic and current information on the natural resources of these important environments.

Judy Mullen serves on the HMSC Sustainability Committee. Besides being the main person for user services, she compiles the HMSC Station Bibliography.

HMSC Facilities

Randy Walker, Facilities Manager

The past year has been one of change for HMSC Facilities as some staff have moved on or retired. The department has enjoyed the energy brought in by new staff. Work requests are up and completion time is reduced. Both mechanically and esthetically, the campus and infrastructure are in great shape. Many of the buildings have received, or are in the process of receiving, a fresh coat of paint by our crew. The campus landscaping is immaculate.

During this period several labs have been added or remodeled, for example the Veterinary Medicine Laboratory in the West Wing of the Main Building. State-of-the-art low flow fume hoods are welcomed additions to this same area. Facilities completed the final phase of 1.6 million dollars worth of remodel and replacement work to the building and grounds. These projects include: the seawater disinfection facility, a complete remodel of the plumbing and fixtures in OSU spaces, a complete remodel of the teaching labs in the Education Wing, and installation of fiber from the Main Building to the pump house that will enhance research capabilities for HMSC scientists.

In addition, Facilities has been busy with all the changes brought to the South Beach area with the addition of the NOAA MOC-P construction across the street. During the construction period Facilities kept a close eye on the environmental health of the seawater taken in by the pumps that supply the life blood to seawater research at HMSC. During this period, HMSC experienced no degradation of the quality of seawater. Many adjustments to the road in front of HMSC have allowed Facilities opportunities to improve the “public face” that folks see as they come onto the property. Paving and improvements to access have

been greatly improved and are being well received by those that come to HMSC.

Planning for future projects has been a focus for this department. The complete re-keying of the interior doors of the OSU buildings has been planned and will come to culmination in September of 2011. The planning and bidding of the complete replacement of the library roof has been accomplished. The roof replacement will begin in August 2011.

It has been a positive and successful year for HMSC Facilities and the groundwork has been laid for even more success in 2011-2012.

Ship Operations

Demian Bailey, Marine Superintendent

Oregon State University’s (OSU) College of Oceanic and Atmospheric Sciences (COAS) operates the 185-foot Research Vessel (R/V) *Wecoma* and the 54-foot R/V *Elakha*. OSU is one of 15 vessel-operating institutions in the University-National Oceanographic Laboratory System (UNOLS). The Ship Operations office and pier facility are located at the Hatfield Marine Science Center in Newport, Oregon.

The R/V *Wecoma* is owned by the National Science Foundation (NSF) and operated by OSU under a cooperative agreement. She carries a crew of 12 and a science complement of up to 18. The National Science Foundation, NOAA, and the Office of Naval Research combined to fund 166 operational days in 2010. With tightening budgets, 122 days are scheduled in 2011. Science missions are led by researchers from Oregon State University, Oregon Health & Science University, University of Washington, University of Maryland, John Hopkins University, the Navy, and NOAA.

The vessel spent the winter in Alameda, CA in dry dock undergoing a variety of repairs and renovations. Several important projects were conducted on *Wecoma* in 2010 and 2011 including work on the Cascadia Subduction Zone, proof of concept for moorings to be used in the Ocean Observation Initiative (OOI), and work studying the physical, acoustical, or biological properties of the Eastern Pacific Ocean.

R/V *Elakha* is owned by OSU and is funded by user charges. The vessel supports research and education in coastal waters, bays and estuaries from Southern Washington to Northern California. This year the *Elakha* has conducted a variety of research programs including those for COAS, Zoology, Microbiology, and the OSU/NOAA Cooperative Institute for Marine Resource Studies (CIMRS). The vessel also supports educational activities for various OSU colleges and departments and Linfield College.

OSU Ship Operations also manages the West Coast NSF/UNOLS scientific van pool. There are currently five science vans in the pool including an isotope van, a general-purpose van, a “cold laboratory” van and two vans for use by the Office of Polar Programs. The vans are based in Newport at the Ship Operations

facility but may be shipped anywhere in the Pacific region to support NSF-funded research.

The COAS Ship Operations pier in Newport serves a variety of visiting oceanographic research ships in the UNOLS fleet and also U.S. government vessels. OSU Ship Ops welcomes NOAA MOC-P to the Yaquina Bay waterfront. We look forward to future collaboration.

Additional information on OSU's Research Vessels can be found at the following website www.shipops.oregonstate.edu/ops/wecoma/



The Multi-Function Node is deployed off of Yaquina Head in support of the Ocean Observation Initiative

IV. PUBLIC OUTREACH & EXTENSION

OREGON SEA GRANT EDUCATION

Sea Grant, Visitor Center

Nancee Hunter, Director of Education, Oregon Sea Grant

Exhibits: The Visitor Center underwent continual renovation efforts this year. With the assistance of 14 Linn-Benton Community College graphic art students, all of the in-house produced exhibit signage was reproduced to a uniform design with a standardized format, type and style. Some signage was redesigned to include inquiry questions. We continued with a layered interpretation approach to exhibit design by constructing adjunct exhibits that engage children while adults are exposed to complex, higher-level concepts.

Every spring, we install twelve temporary hands-on exhibits titled "Puzzle Patterns". These are extremely popular, and serve the additional benefit of reducing handling stress on the touch pool animals by visiting school groups. On a more irregular basis, temporary hands-on displays are set up to support seasonal themes. This year, incorporating inquiry questions, marine mammals, deep-sea geology and marine debris were featured.

New or updated this year:

Burning Ridges: The Burning Ridges display features the impressive geology and seismic activity of mid-ocean ridges. The display accompanies the Global aquarium and includes information about mid-ocean ridges, and associated undersea seismic activity accompanies this relief map of the Juan de Fuca Ridge. The map is color-coded to show water depth.

OSU Engineering Wave Energy: Visitors pull a lever to see this working model wave energy buoy array in action. Below the model, interpretive text and illustrations explain the principles of wave energy. A new panel details the operation of a wave energy buoy.

Are Jellies Taking Over the Coast?: This display accompanies the small moon jelly kreisel and addresses rising jelly populations. The display also addresses reasons for the increasing jelly numbers.

Bird's Eye: The Bird's Eye tank approximates an Oregon kelp forest habitat. This tank contains the larger rockfish species on display, including a Canary rockfish and a bocaccio.

Freshwater Fishes: The Freshwater Fish tank contains several species of small freshwater fish commonly used in research. The interpretive panel above lists the types of research for which each species is used. The Tropical Reef Tank serves as an example of a typical home hobbyist saltwater tank. Interpretive materials for this and the nearby Freshwater Fish tank include home fish-keeping necessities and advice on keeping domestic fish healthy.

High Sea Stowaways: This exhibit explains how species can travel the globe inside the ballast tanks of ships, and how mid-ocean ballast exchange can reduce the risk of harmful introductions. Visitors can use a microscope to examine specimens on a rotating platter beneath. Each platter, when positioned under the microscope, prompts a monitor above to

display species information.

Intertidal Warfare: This interactive display explores the complex and sometimes brutal interspecies interactions within intertidal zones, as interpreted by animated characters. Still images and lively descriptions capture the drama.

Life of the Jelly: This display outlines the unusual life cycle of the jelly using descriptive text and colorful illustrations. Discussion questions flank a small diorama below.

LOBO: This interactive touch screen display provides an overview of the data collected at the Land-Ocean Based Observatory (LOBO) at Yaquina Bay. This water quality information is used to study natural rhythms and human impacts in the bay.

Microbial Fuel Cell: This working model fuel cell demonstrates how the natural breakdown of organic matter can generate energy. Interpretive text describes the process and practical applications.

Ocean Today: The Ocean Today kiosk highlights current research and discoveries. Visitors can access videos and other content, all updated daily, via the touch screen.

OSG Welcomes: This interpretive panel introduces visitors to Sea Grant and HMSC as a whole. It explains HMSC's purpose and describes the people responsible for the Visitor Center's daily operations.

Refraction in Degrees: This super-sized refractometer demonstrates how light refraction can be used to measure salinity. The laser pointer will show a dot at a different point, depending on the salinity of the vial of water through which its beam is directed. Scientists and aquarists use refractometers to monitor salinity on a daily basis.

Sink or Swim: This interactive game puts the player in the role of a larval walleye pollock. The player can advance through the pollock's life stages to maturity, but only by carefully avoiding predators and finding food.

Sustainable Fisheries: This exhibit contains locally-made scale models of local fishing vessels, each representing a specific fishery from fish (tuna and salmon) to pink shrimp and Dungeness crab. A description of each fishery accompanies each model, along with actual fishing gear. A video demonstrates working excluder devices. A trawl net with an excluder device (and model halibut) hangs overhead.

Talk Science: This interactive exhibit allows users to access regularly-updated content from the Talk Science Network. The exhibit comes courtesy of the Science Museum of Minnesota.

VENTS Program: This exhibit discusses the work of NOAA's VENTS Program in studying undersea vents using remotely-operated vehicles. The display includes models of ships and the Alvin and ROPOS submersibles.

Hypoxia: The Hypoxia exhibit explains the formation of dead zones off the Pacific Northwest coast. This installation features a video and an interactive model of offshore wind and water movement patterns. An informational poster explains the mechanics of hypoxia.

All About Albatrosses: This exhibit and diorama details the life cycle of the albatross. The display also includes a list of albatross species native to the region.

Predicting Salmon Runs: This interactive exhibit examines some of the many factors involved in predicting salmon runs. A chart above the interactive computer component depicts the life cycle

of the Chinook salmon.



Sustainable Fisheries exhibit

Free-Choice Learning: In its 7th year, Oregon Sea Grant Extension's Free-Choice Learning Program continues to develop innovative research and education on lifelong free-choice learning. The program at HMSC has grown tremendously from 1 faculty member and 1 graduate student in 2005 to 1 faculty member, 2 research associates, and 9 graduate students doing work at HMSC for 2010-2011. Through its ongoing partnerships with the graduate program in Free-Choice Learning in the College of Science's Department of Science and Mathematics Education, Oregon Sea Grant is using the Hatfield Marine Science Visitor Center and Marine Education programming to carry out research, evaluation, and education in free-choice learning.

For the last year, Dr. Rowe, colleagues and graduate students carried out professional development programs on site and regionally, took on several external evaluation projects to support partnering organizations, and continued basic and applied research on learning using the Visitor Center as a Laboratory Museum. New partnerships this year with the Evergreen Aviation Museum, the Science and Math Investigative Learning Experiences (SMILE) program at OSU, the OSU College of Engineering, Humboldt State University, NOAA Pacific Northwest Fisheries, and the NOAA Hawaii Pacific Services supported free-choice learning research and programming work in the Visitors Center and regionally.

Professional Development: Programs for Oregon Sea Grant Education and Visitor Center floor staff continued this year with NSF funding for 20 hours of education centered on video analysis of educators' practice. Dr. Rowe delivered similar workshops for informal educators at Oregon Coast Aquarium, the Vancouver Aquarium, and at the annual Northwest Aquatic and Marine Educators conference in Florence, OR. The same funding supported Dr. Rowe, Alicia Christensen, Heidi Schmoock, and Céleste Barthel to deliver professional development in communicating ocean sciences to educators and scientists at HMSC, on campus in Corvallis, at California Polytechnic Institute, San Luis Obispo, at Humboldt State University, and in Washington DC. Finally, with funding from the Center for Ocean

Sciences Education Excellence (COSEE) – Pacific Partnerships, free-choice learning faculty and students continued to partner in the development of a Coastal Master Naturalist Program this year, with the piloting of curriculum modules.

Dr. Rowe is also co-PI on an ODE funded Title IIB Math Science Partnership. The Oregon Coastal and Aquatic Marine Science Project (OCAMP) partners 32 Lincoln County k-12 teachers with informal educators and scientists from HMSC, Oregon Coast Aquarium, Yaquina Head Outstanding Natural Area, and the Oregon Hatchery Research Center for professional development and the creation of high-quality, on going marine science field experiences for Lincoln County students. Over 70 hours of professional development were offered for the teachers this year involving more than 20 scientists from HMSC.

Faculty Research: Dr. Shawn Rowe and Dr. Jim Kisiel, California State University, Long Beach, completed their Sea Grant funded research on learning from interactions with live animals in touch tanks at HMSC, Oregon Coast Aquarium, and both the Aquarium of the Pacific and Cabrillo Marine Aquarium in Southern California. Results will be available in publications in the coming year. Other research carried out by Dr. Rowe looked at barriers and supports to professional development for informal and formal educators, the impacts of communicating science experiences for graduate students and scientists, and the nature of the development of professional learning communities.

Student Research:

- Céleste Frazier Barthel (Science and Math Education) continued her work this year on the efficacy of professional development for informal educators and completed her master's degree in Geosciences at OSU with research done on Magic Planet and the Science on a Sphere.
- Kathryn Stofer (Science and Math Education) worked closely with Dr. Rowe and Mark Farley on the evaluation and research surrounding the Magic Planet as well as exhibits on NOAA fisheries this year with funding from NOAA.
- Michael Liu (Science and Math Education) worked with Chinese speaking families to understand in what ways their experiences at touch tanks are similar to and different from those documented by Rowe and Kisiel in their on-going work.
- Michelle Mileham (Environmental Sciences) collected data on teacher and student experiences as part of the OCAMP project as well as defending her master's project working to help volunteers communicate about marine protected areas.
- Laura Dover (Science and Math Education) and Michelle Mileham (Environmental Sciences) both carried out research with volunteers at both HMSC and Oregon Coast Aquarium to understand best practices in the professional development of volunteers both in communications and content delivery.
- Amy Vandehey (MRM) developed and tested an exhibit on marine reserves and defended her master's project on that topic. Amy was awarded a Holt Marine Education fund award to support this project.
- Jed Smith (Science and Math Education) worked on a variety of exhibit and evaluation projects as part of his

course work. These included exhibits on data collection by buoy, wave energy, and the Magic Planet.

- Emily Lemagie (MRM) carried out front-end and formative evaluation of her exhibit on numerical modeling of estuary currents in the Visitors Center. Emily was awarded a Malouf Fellowship from Oregon Sea Grant to support both her modeling work and the resultant exhibit.
- Joy Irby (MRM) completed her research on the knowledge and attitudes about climate change of visitors to the Oregon Coast Aquarium, HMSC Visitors Center, and the Oregon Zoo. She defended her project in February.

Public Programming Highlights: Special public programs are offered each month and can be viewed on-line at: <http://hmsc.oregonstate.edu/visitor/exhibits-and-events> Some titles of this year's events included:

- "Octopus Day" comprised of public necropsies on both a giant Pacific octopus and a Humboldt squid. Over 100 people observed this either in person or from a live video pickup sent into the Hennings Auditorium. The video of the necropsy can be viewed at: <http://oregonstate.edu/media/rdkdd>
- "Fossil Fest": Over 900 people attended this annual event, bringing in many fossils for identification. Auditorium presentations by Dr. Orr and the North America Research Group were well received.
- "Whale Watch Week" programming was offered during both March and December. Temporary exhibits focusing on marine mammal skeletal parts were displayed. Auditorium presentations on marine mammal research were delivered daily during these two weeks reaching more than 200 people.
- "Tsunami Preparedness" as a topic was delivered in the Hennings Auditorium by Oregon Sea Grant's Pat Corcoran. More than forty people from HMSC and the local community attended his presentation.
- "Biological Effects of Wave Energy": More than 65 people attended this public lecture by Dr. Sarah Henkel.
- "Brown Pelicans" delivered by Deborah Jacques. Over 60 people attended this event.
- "Shark Day": Performed a necropsy on 6 foot salmon shark and collected tissue, vertebrae and parasite samples for researchers.
- "Rocky Shores Training" In conjunction with BLM at Yaquina Head, and Oregon Parks and Recreation, conducted intertidal interpretive for over 30 temporary staff being trained as public interpreters.

Daily public programming events from June 26 through Labor Day included Octopus and Eye-Level Aquarium Feedings, Estuary Walks, and OceanQuest. Approximately 650 people participated in the guided estuary tours, and over 1000 people attended the auditorium program on deep-sea research.

We also conducted the following public presentations:

- Delivered Antarctica presentation to 45 Upward Bound students from Roseburg
- OceanQuest for Family Friday participants, 90 students and parents during Career Day and to ~30 HMSC volunteers
- Spoke on hypoxia and wave energy to 43 members of the

Urban Tour Group and 24 member of the 1952-53 tri-delta alumni group

- Delivered Whale Research presentation to 20 adults from Lane Community College
- Dissected giant Pacific octopus and Humboldt squid for "Family Friday"
- Conducted "Dock Walk" for 40 students from Cove High School
- Developed and delivered educational program on Invertebrate Taxonomy for 24 high school students
- Delivered octopus demonstration that was translated into Spanish by AnaMaria Esparza-Smith for participants in the Las Olas program
- Created hands-on activities for the general public on specific gravity, hardness and streak testing of different minerals. Installed additional activities on tectonic forces resulting in folding, subduction and underwater volcanics
- Delivered programs on intertidal animals for ~25 people at the South Beach State Park
- Created and delivered daylong program for 26 teachers from the Oregon Summer Institute that included Seal Rock tide pools, Yaquina Bay mudflats, octopus feeding and auditorium presentation
- Assisted with squid dissection for 30 OCAMP science educators

In addition, the annual Newport Schools Science Fair represents a unique partnership between HMSC, the science community, and local elementary schools. This year, 15 teachers at Sam Case Primary School and 17 science mentors worked together for weeks to bring special science activities into K-3 classrooms. Students studied topics such as crab behavior, boat and car design, plankton, life cycles, decomposition, recycling, and plant growth. Then they presented their findings at a culminating Science Fair event on May 26th. The 2011 Science Fair had a new twist this year... it was held in the HMSC Visitor Center! An estimated 375 people attended the event at HMSC, where 15 classroom projects and 12 independent projects from grades K-5 were on display. It was a treat for all to see the kids' science projects intermingled with exhibits featuring the work of adult scientists. Watch video coverage of the event: <http://news.lincolncounty.com/?p=25318>. Co-coordinators Cait Goodwin (Oregon Sea Grant) and Ted DeWitt (EPA) recruited the volunteer science mentors, most of whom were based at HMSC. Mentors hailed from a variety of institutions, including OSU, EPA, USGS, NOAA, DOGAMI. Oregon Sea Grant sponsored the use of the Visitor Center, arranged for Free-Choice Learning graduate students to provide additional hands-on activities, and additional HMSC volunteers jumped in to help with event set up and clean up. It was a true community effort!

HMSC Visitor Center Bookstore **Lynne Wright, Bookstore Manager**

Oregon Sea Grant's Bookstore, located in the Visitor Center of Hatfield Marine Science Center, provides the visiting public, students and staff with quality books, clothing and other educational resources. The goal of the bookstore is to support

the educational mission of the Visitor Center and provide an enhanced learning opportunity for visitors about the natural world. The bookstore is managed by Oregon Sea Grant and is presently staffed by the full-time bookstore manager and two part-time staff. During the high season months of June through September, the store also employs an additional temporary seasonal staff. Volunteers assist throughout the year as needed, such as spring break assistance, annual inventory help and special events.

The bookstore promotes the HMSC through author presentations, book signings, and other special promotions and events, including the annual Lincoln County Glass Float Drawing and promotion, held from November to January each year. Hundreds of visitors and local residents follow an area map from location to location to enter a drawing for a free glass float from each location. We see many new faces each year because of this promotion, and many residents who have never been to HMSC enjoy their first visit while taking part in this promotion.

The secure online website continues to thrive. HMSC logo merchandise are the most popular items and orders are regularly mailed all over the United States. Visitors coming to the area order many beach and animal identification guides for their trip to the coast, and educators and parents purchase many of the Sea Grant "Oregon Coast Quest" guide books, which have become the bestseller for the website.

The Bookstore Manager is responsible for visitor center marketing, print media ads, and publications stocked in the visitor center. There has been a focus on purchasing local ads this year, since local publications seem to generate more interest from visitors. One of the new ads created this year included HMSC in a locally produced Newport map. In order to promote OSU and HHSC locally, the Bookstore Manager also regularly attends Chamber after-hours events and Chamber lunch meetings to connect with local businesses and community members. She also represents Oregon Sea Grant on the HMSC Sustainability Committee.

HMSC Visitor Center Volunteers **Rebecca Schiewe, Volunteer Coordinator**

During FY10/11, the HMSC had 83 volunteers who contributed 6,611 hours of service to Visitor Center operations. New volunteers were recruited throughout the year, mostly through word of mouth. This recruitment method enabled us to add 27 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 and exhibits in addition to general marine science. Furthermore, volunteers contribute to the visitor center by feeding animals each week, creating and updating display signage, assisting in exhibit maintenance and development, organizing our volunteer library, and some are involved in the training of our summer interns. Their enthusiasm for learning

and desire to share information creates memorable experiences for visitors of all ages.

Monthly meetings and training sessions were held throughout the year to enhance communication between individual volunteers and between volunteers and staff members. Training topics included (among others): albatross research, pinniped research, ROV design, estuary currents and modeling research, and the biology of Yaquina Bay. Eight volunteers attended the 2010 Pacific Northwest Docent and Volunteer Association Conference during September 30 - October 2, held at Wildlife Safari in Winston, OR.

In the fall of 2010, volunteer Ralph Breitenstein received the Epsilon Sigma Phi (ESP) Friend of Extension Award. The Friend of Extension Award is the highest recognition presented by an ESP chapter to a non-Extension person, company, or organization and is designed to recognize truly outstanding support and personal involvement in Extension efforts. Ralph received his award from Vice Provost Scott Reed and President Ed Ray at a ceremony in Corvallis on November 17.

Volunteers' efforts were recognized on a daily basis and were also celebrated at a summer picnic at Big Creek Park, a holiday potluck in December, and again at a banquet in April during National Volunteer Appreciation Week.

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, and through partnerships with Lincoln County School District and a number of local organizations. The "Friends of HMSC" group serves to communicate our activities to a broader audience. 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 2010-2011, including the Lincoln County Farmers Market, Oregon Coast Council for the Arts, Newport Symphony, Partnerships in Education, City of Newport, Toledo City Council, 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 2010-11 included many HMSC scientists who served as mentors for teachers and students and organized a science fair hosted by the HMSC Visitor Center. Other community activities included a beach clean-up in partnership with the Mid-Coast Watershed Council, fundraising for the local food bank and American Cancer Society Relay for Life 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. Public hearings on ocean renewable energy, ocean observing systems, statewide budget and fisheries issues were hosted by HMSC in the past year. Visitors included elected officials or their staff for briefings on marine topics of interest to their constituents and leadership of federal and state agency partners. HMSC is a partner for planning of the August 2012 dedication ceremony for the new NOAA's Marine Operations Center – Pacific, which serves as home port for four ships of NOAA's research fleet. HMSC has also taken the lead on tsunami preparedness among the South Beach Peninsula organizations.

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 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 served a critical role in supporting members (including HMSC volunteers) and the public with information about the new NOAA Marine Operations Center – Pacific, which serves as home port for four ships of NOAA's research fleet. The facility was under construction for the 12 months prior to the June 2011 completion date, and due to intense public interest in the project, HMSC's volunteers served an outreach role in helping visitors and the coastal community better understand the MOC-P organization and its connections to HMSC. The Friends hosted a series of public talks, "Seagoing Partnerships: Current Ship-based Research in the Pacific Ocean" as well as briefings for HMSC staff and volunteers.

The Friends hosted a Member-Only Event in October entitled "DNA Demystified: The Use of Genetics in Salmon Research". A short presentation on DNA basics was followed by a lab tour of genomics instrumentation, a hands-on lab exercise and a reception with scientists. Other Friends events included public talks by Lavern Weber Visiting Scientist Fred Allendorf, and by marine debris artist Angela Pozzi.

The Friends of HMSC remain a key source of support for graduate student research at HMSC. In total, over \$100,000 was awarded this year to students in 4 departments in 3 different 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.

Donor Honor Roll

Annual Support of the Hatfield Marine Science Center:

The Honor Roll recognizes HMSC's annual supporters who have made outright gifts or pledge payments totaling \$100 or more between July 1, 2010, and June 30, 2011.

Contributors of \$10,000 or more

Pat Lewis & Lavern J. Weber
Janet Gray Webster '95 & Stephen A. Webster

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HATFIELD MARINE SCIENCE CENTER ANNUAL REPORT 2010-2011
Seminars presented at HMSC from July 2010 to June 2011

DATE	NAME	AFFILIATION	TITLE
July 8, 2010	Ali Dauble	Near-shore Fisheries Assistant Project Leader, ODFW	<i>Young-of-the-year Rockfish (Sebastes spp.) Settlement Dynamics in Oregon Estuaries</i>
July 13, 2010	Howard Ross	Bioinformatics Institute & School of Biological Sciences, University of Auckland	<i>DNA Barcoding: the Reliability of Molecular Genetic Methods for Species Identification</i>
July 22, 2010	Jack Barth	College of Oceanic & Atmospheric Sciences, Oregon State University	<i>Oregon's Dynamic Coastal Ocean: Upwelling, Low Oxygen, and Ocean Observing</i>
July 29, 2010	Maha Haji	NOAA Hollings Scholar, UC Berkeley	<i>Interaction of Wave Energy Devices and the Environment: Biofouling Concerns on Mooring Systems</i>
August 5, 2010	Dan Avery	Estuarine and Freshwater Habitat Biologist, Oregon Dept. of Fish and Wildlife at HMSC	<i>An Overview of the Development of the NOAA Home Fleet Docks in Yaquina Bay</i>
September 2, 2010	Veronique Theriault	Faculty Research Assistant, OSU/CIMRS at HMSC	<i>Survival, life-history characteristics and reproductive success in coho salmon: how do hatchery unfed fry and smolt releases differ from wild fish?</i>
September 30, 2010	Scott Heppell	Department of Fisheries & Wildlife, Oregon State University	<i>Nassau grouper conservation and recovery in the Cayman Islands: Evaluating the efficacy of marine reserves and the "Importance of Place"</i>
October 7, 2010	Ric Brodeur	NorthWest Fisheries Science Center, NOAA-NMFS, Newport	<i>Interactions between jellyfish and marine fish and fisheries</i>
October 15, 2010	Nancy Prouty & Viktor Zykov	Schmidt Vessel Research Institute	<i>Collaborative Opportunities with Schmidt Research Vessel Institute</i>
October 21, 2010	Pete Lawson	NorthWest Fisheries Science Center, NOAA, Newport	<i>Project CROOS: Developing information systems for fishery science, management, and marketing</i>
October 28, 2010	Rebecca Baldwin	HMSC, Department of Fisheries and Wildlife	<i>Assessing Pacific Sardine (<i>Sardinops sagax</i>) Population Structure Along the West Coast of North America</i>
November 1, 2010	Tom Cross	University of Dublin	<i>The Irish National Atlantic Salmon Genetic Stock Identification Project: Genetic Screening and Mixed Stock Fishery Analysis</i>
November 2, 2010	Steve Parker	National Institute of Water and Atmospheric Research, Nelson, New Zealand	<i>Protect the coral in Antarctica! Huh? Why?</i>
November 4, 2010	Jim Ruzicka	Research Associate, OSU-CIMRS, Newport	<i>Food web models for the Northern California Current: Top-to-Bottom and End-to-End</i>
November 11, 2010	John Chapman	Department of Fisheries & Wildlife, OSU	<i>The unnatural history of the introduced isopod parasite, <i>Orthonoe griffenis</i>, in North America</i>
November 18, 2010	Tony D'Andrea	Oregon Department of Fish & Wildlife	<i>Dig or Suck? A field comparison of methods used to quantifying intertidal bivalve populations in Oregon estuaries</i>
December 2, 2010	Rob Witter	Regional Coastal Geologist, Oregon Dept. of Geology and Mineral Industries	<i>Impacts of the Mw 8.8, February 27, 2010 Chile Earthquake and Implications for Oregon</i>
January 6, 2011	Tamara McGuire	Wildlife Biologist, LGL Associates, Anchorage, Alaska	<i>Cook Inlet Beluga Whales: research for recovery of an endangered urban whale</i>
January 12, 2011	Fred Allendorf	University of Montana	<i>The use of genomics to detect and understand the spread of introgression from introduced rainbow trout into native westslope cutthroat trout</i>
January 13, 2011	Don Lyons	Department of Fisheries and Wildlife, OSU	<i>Ocean/Climate Effects on Estuarine Piscivorous Birds</i>
January 20, 2011	Mark Needham	Assistant Professor, Dept. of Forest Ecosystems & Society, OSU; Adjunct Professor, University of Hawaii	<i>Living the life aquatic: Human dimensions research in marine environments</i>
January 27, 2011	Yumei Wang	Oregon Department of Geology & Mineral Industries (DOGAMI)	<i>Cascadia earthquake deaths, dollars and downtime: a need for risk management of critical infrastructure</i>
February 3, 2011	Bruce Mate	Director, Marine Mammal Institute, Oregon State University	<i>How Whale Telemetry Studies Can Help Assess Effects Of Anthropogenic Activities</i>
February 10, 2011	Carmel Finley	Department of History, Oregon State University	<i>Fishing the American Fisheries Frontier: Salmon, Tuna, and the Evolution of the U.S. High Seas Fisheries Policy, 1949</i>

HATFIELD MARINE SCIENCE CENTER ANNUAL REPORT 2010-2011
PUBLIC OUTREACH AND EXTENSION

DATE	NAME	AFFILIATION	TITLE
February 16, 2011	Tung-Yung Fan	Department of Planning and Research, National Museum of Marine Biology and Aquarium, Taiwan	<i>High resistance and resilience of Houbihu coral reef in Kenting National Park, Taiwan to environmental change</i>
February 16, 2011	Fred Allendorf	Division of Biological Sciences at the University of Montana & Lavern Weber Visiting Scientist at HMSC	<i>Evolution Today: Return of the Bed Bugs</i>
February 17, 2011	Kim Gould	Aquatic Biologist, SWCA Environmental Consultants	<i>Flexible Methods for Rapid Mapping of Marine Habitats and Fish Presence Using Towed Underwater Video</i>
March 3, 2011	Shawn Rowe	Oregon State University Hatfield Marine Science Center	<i>Examining family interactions and the potential for science learning at touch tanks</i>
March 10, 2011	Tara Maginnis	Biology Department, The University of Portland	<i>Polarized Camouflage in Marine Fish</i>
March 17, 2011	Tom Hurst	Alaska Fisheries Science Center, NOAA-NMFS	<i>Understanding the influence of climate on growth of Alaskan flatfishes</i>
March 31, 2011	Anita McCulloch	CIMRS	<i>ENSO-related Variability of Phytoplankton Distributions in the Galapagos Marine Reserve</i>
April 7, 2011	Burke Hales	Associate Professor, COAS, OSU	<i>Biogeochemistry of the Cascadian Margin: Implications for pacific oysters?</i>
April 14, 2011	Bill Chadwich	CIMRS, Oregon State University	<i>Preliminary science from the March 2011 Japan earthquake and tsunami</i>
April 21, 2011	David Hansen	OSU Sea Grant Extension	<i>From the Chesapeake Bay to the Oregon Coast; a Land Grant/Sea Grant Story</i>
April 28, 2011	Mark A. Albins	Ph.D. candidate, OSU Department of Zoology	<i>Effects of the invasive Pacific red lionfish on Atlantic coral-reef fish communities</i>
May 5, 2011	Bill Hanshumaker	HMSC, Oregon Sea Grant	<i>Making an Aquarium Environment Interactive: A Design Research Analysis of Exhibit Design Processes</i>
May 12, 2011	Dr. Ana Sirovic	Scripps Institution of Oceanography	<i>Using sound to estimate rockfish abundance in the Southern California Bight</i>
May 16, 2011	Laura Brophy	Director, Estuary Technical Group, Institute for Applied Ecology, Corvallis OR	<i>Estuarine wetland responses to sea level rise and climate change</i>
May 19, 2011	Christina Dewitt	Director, OSU Astoria Seafood Laboratory	<i>A transition from seafood to meat and then back again to seafood</i>
May 20, 2011	Bob Pressey	Professor, James Cook University, Townsville, Queensland, Australia	<i>Integrated land-sea planning for conservation: from theory to implementation</i>
May 26, 2011	Emily Lemagie	Graduate Student, Oregon State University	<i>Developing an Interactive Exhibit about Estuary Currents and Modeling</i>
June 2, 2011	Jennifer Bachman-Kise	Graduate Student, Oregon State University	<i>Science and math learning practices of home-educating families</i>
June 9, 2011	Elizabeth Wheat	University of Washington	<i>Gradients in Intertidal Productivity Established by Bivalve Filtration in Water of Varying Residence Time</i>
June 16, 2011	David Sampson	OSU F&W Professor, COMES	<i>Exploring fishery selection curves: an Italian adventure tale</i>
June 23, 2011	Murray Bauer	Special Agent, NOAA Fisheries Office of Law Enforcement	<i>The Evolving Role of Science in Combating Illegal, Unreported and Unregulated (IUU) Pirate Fishing and the Effects of IUU Activities on the Marine Environment</i>
June 30, 2011	Ellen Garland	PhD student, University of Queensland	<i>Cultural transmission of humpback whale song across the South Pacific</i>

V. PUBLICATIONS

KEY: * = Student, ** = Student at OSU Seafoods Research Lab, **Bold** = at HMSC ¹ = OSU, ² = NMFS, ³ = PMEL, ⁴ = EPA, ⁵ = ODFW ⁶ = USDA ⁷ = HMSC Intern ⁸ = USGS ⁹ = USFWS

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VI. BUDGETS

State and Federal Agency Budgets at Hatfield Marine Science Center

	<u>\$ Amount</u>	<u>% of Total</u>
Environmental Protection Agency	2,500,000	10%
Oregon Department of Fish & Wildlife	5,967,000	24%
Vents Program - Federal	1,120,000	4%
Nat'l Marine Fisheries Service - NWFSC	10,005,800	40%
Nat'l Marine Fisheries Service - AFSC	1,478,500	6%
US Department of Agriculture - ARS	691,008	3%
US Fish & Wildlife Service	2,601,061	10%
US Geological Survey	750,000	3%
Total State & Federal Agency Budgets	\$25,113,369	100%

FUNDING SOURCES

Direct State Funding

HMSC	1,448,435	
COMES	1,610,058	
MMI	50,461	
CIMRS	388,805	
Guin Library	256,464	
Extension Sea Grant	425,387	
Total Direct State Funding	\$4,179,612	9.2%

Other State Funding

Matching Funds (Endowments)	242,773	
Student Fees (TRF)	15,000	
Total Other State Funding	\$257,773	0.6%

Sponsored Research and Education Programs

Nat'l Oceanic & Atmospheric Admin. (NOAA)	5,301,521	
Nat'l Science Foundation (NSF)	3,907,578	
U.S. Dept. of Agriculture (USDA)	514,158	
Office of Naval Research (ONR)	1,058,141	
Department of Defense	100,969	
Department of Energy (DOE)	809,051	
Department of Interior (DI)	351,512	
Other Federal Agencies	312,477	
Oregon Dept. of Fish & Wildlife (ODFW)	11,810	
Other Oregon Agencies	184,131	
California Dept of Water Resources	208,300	
Foundations & Other Organizations	2,032,279	
Sub-Contracts from other Universities	130,212	
Total Sponsored Research	\$14,922,138	32.7%

Other Funding

Self-Funding Units	779,247	
OSU Foundation	393,431	
State & Federal Agency Budgets	25,113,369	
Total Other Funding	\$26,286,047	57.6%

<u>TOTAL FUNDING:</u>	\$45,645,569	100%
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BUDGETS

OSU at Hatfield Marine Science Center

	<u>\$ Amount</u>	<u>Unit</u> <u>Sub-Total</u>	<u>% of</u> <u>Total</u>		<u>\$ Amount</u>	<u>Unit</u> <u>Sub-Total</u>	<u>% of</u> <u>Total</u>
<u>Research Administration</u>				<u>College of Oceanic & Atmospheric Sciences</u>			
Administration	471,402			Ship Support/Operations	2,232,449		
Visitor Center Support	76,299			Ship Support/Maintenance	699,347		
Non-Sponsored Research	0			Ship Special Projects	228,912		
Non-Sponsored Education	141,302			Ship Scientific Equipment	240,789		
Sponsored Education	0			Total Ship Operations:	\$3,410,496		
Sponsored Research	722,190			Sponsored Research-Reimers	335,476		
Total Research Administration:	\$1,411,192		6.9%	Total COAS:	\$3,736,972		18.2%
<u>Physical Plant</u>				<u>Education Programs</u>			
State Support	787,273			Extension	310,530		
Federal Support	596,595			Sea Grant	314,335		
Other Sponsored Activity	15,000			Visitors Center	149,746		
Total Physical Plant:	\$1,398,868		6.8%	Sponsored Programs	230,263		
<u>Coastal Oregon Marine Experiment Station (COMES)</u>				<u>Self-Funded Programs</u>			
Administration	307,081			Total Education Programs:	\$1,027,729		5.0%
Non-Sponsored Research	1,269,641			<u>Housing</u>			
Cost Shared to Sponsored Research	33,336			Self-Funded Operations	85,976		
Self-Funded Programs	189,979			Total Housing:	\$85,976		.419%
Physical Plant-State	0			<u>Bookstore</u>			
Extension	0			Self-Funded Operations	144,629		
Endowment	0			Total Bookstore:	\$144,629		0.7%
Sponsored Research	1,676,774			<u>Other</u>			
Total COMES:	\$3,476,811		16.9%	Guin Library	256,464		
<u>Cooperative Institute for Marine Resource Studies (CIMRS)</u>				OSU Foundation & Gifts	82,465		
Administration	269,995			Network Service/Computer Support	161,019		
Non-Sponsored Research	118,810			State Agencies (through OSU)	1,314		
Physical Plant-State	0			Federal Agencies (through OSU)	19,777		
Sponsored Research	6,055,558			Total Other:	\$521,039		2.5%
Total CIMRS:	\$6,444,363		31.4%	<u>Marine Mammal Institute</u>			
<u>Marine Mammal Institute</u>				State End Match - Admin.	164,945		
State End Match - Admin.	164,945			State Support Director's Salary-Admin	0		
State Support Director's Salary-Admin	0			Self-Funded Fee Programs	392,380		
Self-Funded Fee Programs	392,380			OSUF Funds	310,966		
OSUF Funds	310,966			ARF Funds	0		
ARF Funds	0			Sponsored Research	1,416,329		
Sponsored Research	1,416,329			Total MMI:	\$2,284,620		11.1%
Total MMI:	\$2,284,620		11.1%	TOTAL HATFIELD MARINE SCIENCE CENTER:			
				\$20,532,200 100%			