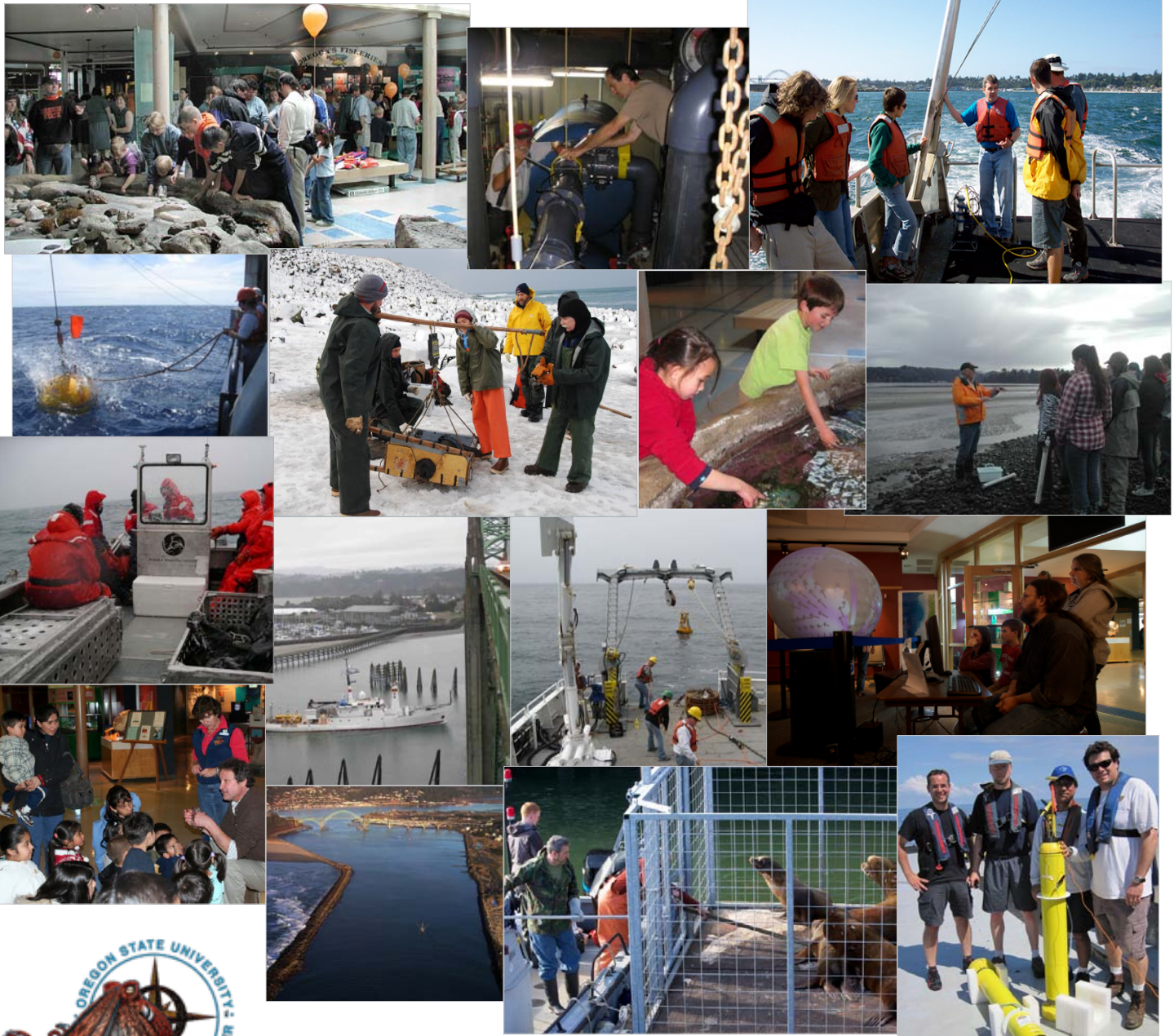


Oregon State University Hatfield Marine Science Center 2009 - 2010 Annual Report



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Director's Message

Dr. George W. Boehlert, Director

The past year has been a whirlwind for Newport and Lincoln County, and HMSC, as OSU's campus for research, education, and outreach in marine and coastal sciences, has been an important part of the developments. The announcement of the Port of Newport's winning bid to be the homeport of NOAA's Marine Operations Center of the Pacific has energized the area. Despite protests from Washington state, the development of the project has continued unabated. With this project, the expansion of OSU's Ocean Observing Initiative activities, and other growth at HMSC, Newport is cementing its role as a major center of marine science in the Pacific Northwest.

HMSC's research enterprise has continued to grow. In the area of ocean renewable energy, we have grown our ecological effects research through addition of Dr. Sarah Henkel, a research assistant professor with expertise in benthic ecology, to the Northwest National Marine Renewable Energy Center (NNMREC). We have also broadened our funding base in this research area to include the Minerals Management Service and are more broadly engaging other groups, including CIMRS and MMI. As NNMREC develops the "mobile ocean test berth" for wave energy devices off of Newport, we will see additional activities from the OSU College of Engineering at HSMC. The CROOS project has expanded beyond expectations to become a coast wide effort involving over 200 fisherman as active scientific collaborators along with multiple state, federal, university and tribal partners, thanks to the leadership of COMES and its partners at HMSC. Research at HMSC is attracting international attention with MMI tags all over the world, media coverage of cetacean genetic forensics, North Pacific linkages through PICES, and Bryan Black's innovative research on marine-terrestrial linkages through measurement of growth in long-lived organisms. We are also highlighted by serving as home to the editorial offices of two well known scientific publications, the *Journal of Heredity* and *Fishery Bulletin* (scientific editors Scott Baker and Richard Brodeur, respectively).

Our education programs have likewise grown this year. Our diverse internship programs have been strengthened by the renewal of the REU program, now in its 7th year, by the National Science Foundation. HMSC now hosts 20 or more interns each summer through multiple partnerships, pairing undergraduate students with diverse faculty and agency mentors. Development of experimental "hybrid" courses with combined on-line and on-site content delivery has been well received. Our four 1-credit experiential courses in marine habitats, seabirds, marine mammals, and coastal forestry are proving to be very popular with OSU undergraduates. Youth and public education programs offered by Oregon Sea Grant have forged new partnerships and received awards this year for the quality of the programs.



Hatfield Marine Science Center Director George Boehlert

HMSC's partnerships continue to grow. The USGS program resident in the EPA building at HMSC has grown to become designated as the eighth agency program on our campus. HMSC continues to partner with the community in education, with the fishing industry in cooperative research and issues like wave energy, and with the continued support of donors for the Friends of HMSC and other campus programs. Nowhere was the community and political support more evident than in the way this community pulled together to support the application for NOAA's MOC-P.

As always, at the core of HMSC's mission of research, education and outreach are the dedicated, creative and hardworking faculty and staff of OSU and its partners. On a sad note, we acknowledge Phil Rau, who served from November 2007 until this year as an important part of the HMSC Facilities crew. Phil passed away on 5/2/10, and as a valued member of the HMSC community, his friendship and his contributions are greatly missed.

HMSC continues to provide scientific leadership in the marine sciences. Our strong partnerships, both within and outside HMSC, along with the energy and capability of our diverse staff make HMSC a nexus for cutting edge marine and coastal research, learning and outreach.

I. RESEARCH

A. Oregon State University



Programs by Stations and Institutes

Coastal Oregon Marine Experiment Station

Gil Sylvia, Superintendent

No report submitted this year.

Cooperative Institute for Marine Resources Studies (CIMRS)

Michael A. Banks, Director

Now in its twenty-seventh 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.

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 31 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. A fantastic year for observation of undersea volcanic eruptions: See <http://nwrota2010.blogspot.com/>
2. CIMRS 'HOT ITEM' article <http://www.nrc.noaa.gov/ci/hotitems/index.html>
3. \$1,382,778 raised from external fund sources and

- \$11,290 from OSU's Research Equipment and Reserve Fund by CIMRS principal investigators
4. 14 peer review manuscripts dated 2009 & 2010

Besides the core NOAA funded research projects detailed below, CIMRS research faculty generated over \$2M in FY 09 alone for independent research projects funded from a variety of funding sources. Some examples of externally funded research include NSF funded studies of Strombolian volcanism, magma degassing, and hydrothermal discharge at an active submarine arc volcano; support from NOAA CAMEO for Building the Foundation in North California Current Shelf-Slope Oceanic Ecosystems; funding from the Office of Naval Research (ONR) for Datasets of Odontocete Sounds Annotated for Developing Automatic Detection Methods; and ONR funding for development of Next-Generation Bioacoustic Analysis Software. 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 - 2008-2010

Major Professor: Tim Cowles
NOAA Fisheries Rep: William Peterson

Marine Mammal Institute (MMI) **Bruce Mate, Director**

The mission of the Marine Mammal Institute research 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 build a multi-disciplinary group studying marine mammal ecology, incorporating the work of experts from several OSU colleges and international collaborators. 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 understanding how they interact with their environment and the human activities affecting them.

The MMI currently consists of 30 faculty, staff, and students. We are grouped into 4 areas since the addition of two labs in 2006. These include 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. As it grows to its projected size of 85 staff (including professors, research assistants, administrative staff and graduate students) over the next 5–7 years, the Institute will become an internationally recognized source of knowledge about marine mammals.

The faculty will not be traditional tenure-track positions. As budgets do not presently allow the expansion of faculty with state funds, the MMI depends almost entirely upon donor gifts and grants from federal agencies for everything from salaries and travel to tags. Therefore, a new model has been developed that provides each new faculty member with up to half of their salary based primarily upon endowment support (donor gifts), and the other half from grant-based research they generate themselves. This framework allows an opportunity to grow during a time of state government fiscal austerity. The Institute plans to add over one dozen living wage jobs per year to the local coastal economy for the next 5-7 years.

The Institute is committed to increasing conservation practices and understanding in developing countries, and will have 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.

With the expanded faculty efforts and awareness of the research being conducted at the Institute, funding opportunities continue to grow. The Institute's development plan was approved as part of the University's strategic plan, and is therefore part of its capital campaign. Because there is no empty space at Hatfield Marine Science Center, a component of the MMI growth plan is the creation of a new building to house the Institute and the expanding programs in marine genomics, of which Scott Baker is also a part. The 41,000-square-foot building will cost \$24 million and provide the space to support the dynamic growth envisioned for MMI in the near future. State matching funds were secured in February 2010 that will hopefully prove successful for the NIST proposal that was resubmitted by Dr. Boehlert in April.

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

- Bruce Mate (WTG) collaborated with John Parmigiani's group in the Department of Mechanical Engineering at OSU to foster a senior project program designing artificial skin, blubber, and muscle to simulate whales. The synthetic materials are being used to develop and test new tags without trail experiments on live whales. This senior team project was started in the fall of 2009.
- PhD graduate student, Andrew Szabo is now analyzing predator/prey distributions of humpback whales and distribution of krill in SE Alaska. He will defend his PhD thesis this year in Wildlife Science.
- Master's graduate student Robyn Matteson successfully defended her thesis in October 2009, entitled: "The Costa Rica Dome: A Study of Physics, Zooplankton and Blue Whales". She is now pursuing her PhD with Kelly Benoit-Bird in Oceanography.
- Two new tag types were developed in collaboration with Wildlife Computers (Redmond, WA), a leading manufacturer of marine telemetry devices, and funding by the Office of Naval Research. The tagging fieldwork was sponsored by two oil and gas companies to study the tags effectiveness on the abundant gray whale population off Oregon's coast before they are to be used on the endangered species of western gray whales off the coast of Russia (beginning later summer 2010). Resight efforts to observe the effects of the tags on the animal's health were also successful, providing the first detailed information on these effects over a long period of time. One whale's tag (831) has continued transmitting since it was tagged on September 2, 2009! This is a record holder for our gray whale tags – the previous record holder was 311 days.
- Preparation for tagging this summer off Sakhalin Island in Russia on Western Pacific gray whales (WGWs) has begun with funding secured from IUCN and oil industries. WGWs are the second most endangered group of whales worldwide with an estimated population of less than 150 individuals.
- A total of 17 MMI graduate students, faculty and research

staff presented original research at this biennial meeting, which is the most important forums in our field. MMI presented more research findings than any other academic institution in the world! Funds from the MMI Endowment provided support for two WTG graduate students and two junior faculty research staff who presented posters and/or talks at the 18th Biennial Conference for the Biology of Marine Mammals in Quebec City, Canada during October 2009: “Annual and Interannual Variability of Home Ranges and Core Areas for Blue Whales (*Balaenoptera musculus*) While on their Summer Foraging Grounds” (recent COAS graduate and now staff Ladd Irvine, talk); “Follow-up Observations of Satellite-tagged Sperm Whales in the Gulf of California for Evaluation of Potential Tag Effects,” (staff video/photo specialist Craig Hayslip, poster); “Blue Whale Habitat Preference at the Costa Rica Dome,” (COAS MS student Robyn Matteson, poster); and “Resource Selection by SE Alaskan Humpback Whales in Seasonally Variable Prey Environment,” (Wildlife PhD candidate Andy Szabo, poster).

- Markus Horning’s lab (PEARL) has received a three-year NSF award to study the development of a miniaturized implantable satellite transmitter to monitor survival predation and reproduction in pinnipeds. Dr. Horning will collaborate with Oregon State’s School of Mechanical, Industrial and Manufacturing Engineering and Wildlife Computers Inc. Undergraduate and graduate students in the Computational Mechanics and Applied Design Laboratory will participate 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.
- Scott Baker (CCGL), associate director of the MMI became part a group of over 50 scientists worldwide involved in the “Genome 10K” proposal to generate whole genome sequences for 10,000 vertebrate species using new genome sequencing technology. In preparation, they are identifying collaborators who can help assemble a collection of frozen or otherwise suitably preserved tissues or DNA samples from these species. “The idea behind the project is to prepare for this third generation of DNA sequencing technology that began with the Human Genome Project”, said Scott Baker. “Whereas that project took nearly 10 years at a cost of more than \$3 billion, the goal now is to sequence an entire genome in less than a week, for a cost of less than \$1,000.” Scott is coordinating efforts to assemble DNA samples for all known species of cetaceans – whales, dolphins and porpoises. Scott and his colleagues have been working for nearly 20 years on creating DNA barcodes for different cetacean species. The ability to create entire genome sequences would be of enormous benefits to conservation and basic scientific understanding of cetaceans.

- This year the Marine Mammal Institute garnered international recognition with the airing the film “The Cove”, which featured some of Dr. Scott Baker’s research, and received numerous film awards including a 2010 Academy Award, and with the news story of the California restaurant, “The Hump” which was caught serving whale meat in an undercover sting operation.
- The Oregon Marine Mammal Stranding Network, coordinated by MMI’s Jim Rice, also received national press with the disentanglement of a California sea lion on the Newport Bay front, using a newly placed capture cage. The footage was shown on NBC and CNN. The disentanglement cage had been in place for about a month when one particular sea lion, which was entangled in a “packing band” around its neck, appeared in the cage. A crew of veterinarians, aquarium staff and MMI staff assembled quickly and were successful in safely anesthetizing the animal, removing the band and returning it safely to the bay front. The custom-



built capture cage is a modified floating dock that the animals will basically use as a haul-out area. Collaborators in this project included the Animal Medical Care of Newport, the Port of Newport, Oregon Marine Mammal Standing Network, the Marine Mammal Institute, Oregon Coast Aquarium and the Oregon Department of Fish and Wildlife.

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.

Robert Paasch of the College of Engineering is principal investigator of the award and is the Center director. Co-principal investigators at OSU are Annette von Jouanne and George Boehlert.

Activities in NNMREC 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 the Minerals Management Service and the Oregon Wave Energy Trust. 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.

Oregon Sea Grant **Stephen Brandt, Director**

Sea Grant’s charge is to “increase the understanding, assessment, development, utilization and conservation of the nation’s ocean and coastal resources.”

—U.S. Congress, National Sea Grant
College and Program Act of 1966

First established at Oregon State University (OSU) in 1968, Oregon Sea Grant became one of the first four Sea Grant Colleges in the nation by 1971. With federal, state, local, and private funding totaling about \$7 million annually, it remains one of the largest and most productive of the 31 programs currently in the National Sea Grant network. Oregon Sea Grant has been a major component of OSU’s Hatfield Marine Science Center in research, outreach, and education since the creation of the National Sea Grant Program and the establishment of the science center in Newport over 40 years ago.

Headquartered on the OSU campus, Oregon Sea Grant is an integrated program of research, education, and outreach and is the conduit for National Oceanic and Atmospheric Administration research and outreach grants program. And, as a statewide program, it is open to all Oregon institutions of higher education.

Oregon Sea Grant provides competitive, peer-reviewed grants that allow top ocean and coastal researchers to apply their skills

to issues of critical importance to the state, the region, and the nation. Oregon Sea Grant’s Strategic Plan is the overarching guiding document for the program. This plan was shaped by the advice from our 2005 Program Assessment Team and lessons we have learned over the past four years about how best to conduct the business of Sea Grant. The Plan is shaped in part by the West Coast Regional Marine Research and Information Needs Report (2009), Oregon State needs, and by the NOAA National Sea Grant Strategic Plan. This plan can be viewed at: [http://seagrant.oregonstate.edu/inhouse/documents/OSG-StrategicPlan_2010_2013.pdf].

Oregon Sea Grant partners with others from the Pacific Northwest and beyond to explore questions of broader regional, national, or international scope. Sea Grant’s philosophy is that its research must be relevant to society, and a research project is not done until its results are shared with those who can use them. Thus Sea Grant Extension, education, and communications faculty are often involved with the funded research projects promoting student experiences, providing public outreach through extension and communication activities and products, and using the Visitor Center for public education to deliver quality education programs to youth and other audiences.

Oregon Sea Grant seeks to engage partners and build a broad funding base that ensures the program will continue addressing critical issues and helping people solve marine-related problems and participate knowledgeably in decisions and positioned to grasp opportunities. Over \$323,000 worth of competitive projects involving the Hatfield Marine Science Center were funded through Oregon Sea Grant during the 2009-2010 fiscal year covering topics on west coast shellfish; marine reserves; communicating ocean science in schools; informal science education with marine laboratories and community colleges.

Although the principal offices of the Sea Grant program are located on the main Corvallis campus, faculty are also housed in departments, at coastal county offices of OSU Extension, the Seafood Lab in Astoria, and in Charleston and Salem. The program has a large presence at the HMSC which is the major hub of Oregon Sea Grant’s marine education activities. For over 13 years Oregon Sea Grant has managed the HMSC Visitor Center moving it closer to a signature public science learning facility and free-choice learning laboratory. Sea Grant is also known for its work in national and international ornamental fish health. Both the Sea Grant Director and Extension Leader share a second office at the Hatfield Marine Science Center.

*Research Programs by Academic Unit***College of Agricultural Sciences****Department of Fisheries & Wildlife*****Ecological and Conservation Genetics of Fishes*****Kathleen O'Malley, Assistant Professor**

Our mission is to investigate 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, predominantly Pacific salmon distributed along the West coast. We employ cutting-edge techniques for high-throughput genomic analysis to enhance our efforts in developing conservation strategies and successfully retaining genetically healthy populations in threatened habitats.

During the first year, the Ecological and Conservation Genetics program hired a faculty research assistant, Brandon Jones, to work primarily on a three year collaborative project with Kathleen and Michael Banks investigating the genes that influence run timing of Chinook salmon in the Feather River, California. In the Fall, Kathleen and Michael will co-advise Amelia Whitcomb, a masters student, whose studies will focus on differences in mate choice between wild and hatchery coho salmon. Other ongoing research includes a collaborative project with NOAA/Southwest Fisheries Science Center and Jessica Miller to determine the reproductive success of juvenile salmon migrating to the ocean at varying sizes. Additionally, we are collecting population genetic data on the Umpqua chub that ODFW will use to develop an Umpqua chub Habitat Conservation Plan. Doug Markle, a professor in Fisheries and Wildlife is coordinating sampling and habitat assessments. Recent publications include two projects that identified genes influencing juvenile growth rate as well as spawning time in salmon; collaborations with the University of Washington and NOAA/Northwest Fisheries Science Center respectively.

Information from this research has been utilized by hatchery managers to alter breeding strategies with the aim of augmenting endangered spawning runs of Chinook salmon. In addition, our recent identification of genes contributing to faster growth and early migration of juvenile fish may prove valuable for hatchery production or re-stocking efforts. Ultimately, we hope our research efforts will increase our understanding of the adaptive capability of Pacific salmon to climate change

Fisheries Population Dynamics**David Sampson, Professor**

In 2009 David began a two-year leave of absence from OSU to take up a position as a Senior Fisheries Scientist for the European Commission at their Joint Research Center (JRC) in Ispra, in northern Italy near Milan. David works 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 that provide technical advice and policy support regarding various aspects of European fisheries science and management. David will return to Oregon in April 2011.

Since arriving at the JRC David has been involved in a number of diverse and interesting activities. During summer 2009, working with economists from Spain and Sweden and two fisheries surveillance technology experts from Spain David served as a contributing writer and the primary editor for a completion report to the Directorate General for Maritime Affairs and Fisheries (DG MARE) on an analysis of the costs and benefits of extending the use of modern surveillance technologies (e.g., vessel monitoring systems and electronic logbooks) to the small-boat portion of the European Union's fishing fleet. Later in the summer he worked with two economists from FISHREG and a consortium of researchers from the Netherlands, England, and Scotland in preparing a proposal to DG MARE for a one-year study to explore the performance of a set of "balance indicators" for a suite of European fishing fleets. In the late summer David began work constructing a general-purpose bioeconomic simulation model that is the primary focus of his JRC research activities. The model, which is multi-species, multi-fleet and spatially explicit, will be a tool for exploring various aspects of the European Union's Common Fisheries Policy. Other short-term activities conducted during the year included providing formal written comments to the Inter-service Steering Group on Impact Assessment for the Common Fisheries Policy Reform and participation in a workshop in Brussels on the development of regional fisheries databases. He also taught a two-day stock assessment training workshop for staff at the JRC. His other teaching activity was teaching the e-campus version of his OSU course "Dynamics of Marine Biological Resources".

Invasive Species**John Chapman, Research Associate**

In 2009-2010, John's volunteer presentations, lectures, labs and field trips on estuary ecology and aquatic biological invasions included:

- Presented at the 2nd Annual Oregon Parasitological Meeting, along with B. R. Dumbauld and T. H. DeWitt
- Gave lectures in two OSU courses; Coastal Ecology and Research Management (Fall quarter) and Marine Ecology - Zoology 451/551 (Spring quarter)
- Organized and taught the second ECampus course from HMSC (the 4 unit Aquatic Biological Invasions FW 421/521) which completed in November 2009 and is teaching the third iteration July-August 2010.
- Collaborated with Bill Hanshumaker of HMSC and volunteer Ralph Breitenstein on a revision of HMSC estuaries exhibit "*Undoing an Invasive Species – The Story of the Blue Mud Shrimp and its Parasite, Griffen's Isopod*"

John volunteered to organize the PICES rapid assessment survey (RAS) of west coast estuaries for introduced marine invertebrates

in August 2009 and as a result, participated in the October 2009, South Korean RAS, identifying introduced peracaridans of Korea. As part of this project, John collected samples along the west and south coasts of South Korea and the South Korean island of Jeju. John also travelled to Japan to recruit Japanese participants of the 2010 RAS on this trip. The North American RAS will occur in late October 2010 and will be based at HMSC.

John's research on the collapse of native mud shrimp populations following the introduction of the isopod parasite, *Orthonie griffenis*, has moved to the finer details of parasite/host population dynamics.

In collaboration with Brett Dumbauld, John collects weekly zooplankton samples from the Yaquina channel west of the Yaquina Bridge on flood tides. These samples are revealing the ocean survival and recruitment patterns of *Upogebia* and the cooccurring burrowing shrimp, *Neotrypaea* into Yaquina Bay.

In collaboration with Jack Chapman, John trained, and organized a Lincoln County/Oregon Youth Conservation Corps (OYCC) "Summer Natural Resources" (SNR) crew of "at risk youth" to sample burrowing shrimp populations of Yaquina Bay, Alsea Bay, Tillamook Bay and Coos Bay for his own research and for REU students Keya Jackson and Danielle Asson (see below) and Brett Dumbauld. The 2010 project (with Brett Dumbauld, USARS) is to examine juvenile mud shrimp recruitment and shrimp population structure. These data are needed to understand the interactions of the introduced parasitic isopod *Orthonie griffenis* and declines of its new, North American mud shrimp hosts.

John's fifth Murdock Charitable Trust, "Partners in Science" visiting high school teacher, Nathan Mauro of McKay High School, Salem, OR (2010 - 2011), is working on the mud shrimp burrow ecology which is necessary to understand the trophic interactions and shrimp host vulnerability to its new parasite. This work has produced the first methods for transplanting mature shrimp from the field and back, which is critical for conservation of collapsing *Upogebia* populations.

Along with Brett Dumbauld, John co-supervised 2010 REU student, Keya Jackson on field studies of the burrowing competence of *Upogebia pugettensis* with size and reproductive development and parasite vulnerability. John and Brett also co-supervised 2010 REU student Danielle Asson on *Upogebia* and *Orthonie* population structures within and among the Alsea Bay, Yaquina Bay and Tillamook Bay estuaries to reexamine conclusions and predictions about *Upogebia* life history and the dynamics of *Orthonie* proposed by Blaine Griffen. Their work will further the understanding of the population dynamics of the mud shrimp and the life histories of their parasites.

Honors:

Bill Barton, unsolicited 1 K donation to mud shrimp conservation project.

Ralph Breitenstein, unsolicited 0.25 K donation to mud shrimp conservation project.

Proposals submitted:

Oregon Sea Grant: Save the native mud shrimp *Upogebia pugettensis*, from its introduced bopyrid parasite *Orthonie griffenis*, 140 K (Full proposal rejected)

California Sea Grant: Emergency conservation of the native mud shrimp (*Upogebia*) in response to infection by the introduced parasite, *Orthonie griffenis* ~ \$58K (Full proposal rejected)

M. J. Murdock Charitable Trust, Culture the native estuary blue mud shrimp to save it from its unnatural parasite, 15K, (Funded)

Siletz Tribes Charitable Foundation: Mud shrimp conservation assistance, 5.333 K (Pending)

Other accomplishments:

John is continuing as president of the South Beach Community Center.

Marine Fish Ecology

Selina Heppell, Associate Professor

Scott Heppell, Assistant Professor

Research projects

This year the Heppell Lab had multiple projects running through our lab at HMSC. Alison Dauble (MS June 2010) finished her work that focused on recruitment of rockfishes into Oregon estuaries and Wade Smith continues his work on the incorporation and detection of isotopes to the vertebrae of young of the year sharks and rays. Because of interesting preliminary results, we have continued our laboratory work on Pacific ocean perch maternal effects, which had fieldwork based in the Gulf of Alaska, near Kodiak. These projects have been funded by ODFW (juvenile 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 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, and we have a group of undergraduate students (Marybeth Head, Katie Borgen, and Jacci Zappa) investigating dietary links to the green coloration observed in lingcod. The undergraduate work is funded by the Cooperative Institute for Marine Resource Studies (CIMRS). Sea Grant is funding a new project that started in April to study distribution and diet of Humboldt squid; our lab space will be utilized heavily for sample preparation and analysis for this project.

Results from the rockfish recruitment project indicate that YOY black rockfish utilize multiple estuaries on the Oregon coast from spring through late fall, and may be present in highly developed estuaries through their first winter before moving to deeper habitats, as shown by late season increases in catch-per-unit-effort (CPUEs) and the capture of multiple age-1 juveniles in the estuary. Catches were higher in the more developed estuaries on the coast, suggesting that the presence of structure is an extremely important component to the settlement process in this species and that the continued development of Oregon estuaries may not adversely affect YOY rockfish settlement. Two years of dive surveys on a standardized set of artificial reef

structures in Yaquina Bay showed that a settlement index of YOY rockfish within the estuary could reflect larger trends in the YOY population and suggest that habitat saturation is not a factor that affects the settlement process of YOY rockfish in estuaries. This study provides strong evidence of widespread use of estuarine habitat on the Oregon coast by black rockfish during their first year of life, and provides additional support that structure is an important component to the settlement process, and has set the groundwork for investigating inter-annual variation in the estuarine settlement of rockfish. This project will start back up in the Spring of 2011 under the guidance of a new graduate student.

For the skate work, field surveys to collect young-of-the-year scalloped hammerhead sharks, *Sphyrna lewini*, were conducted from October, 2008 through February, 2009. Artisanal fishery landings were surveyed from 18 sites along the Pacific coast of Mexico and Gulf of California, including locations in the northern-most state of Sonora and southern-most state of Chiapas. The remainder of the samples collected during the 2007 pilot study were received from collaborators in Mazatlan and transported to OSU for processing and analysis. Sampling efforts for the 2009-10 field season are scheduled to begin in August, 2009.

Between November, 2008 and January, 2009, nine 500 gallon closed-system tanks were set-up to examine the relationships between water and vertebral chemistry and temporal stability of elemental signatures within captive juvenile rays at Oregon State University's Hatfield Marine Science Center (HMSC). In early February, 2009, 113 round rays (*Urobatis halleri*) were collected from Long Beach, CA and successfully transported back to HMSC. Specimens were allowed to acclimate to their captive environment, and in April, 2009 all specimens were measured, weighed, photographed, injected with a dosage of oxytetracycline to indicate the start of the experimental period, and randomly distributed among the tanks at three temperature treatments (high, moderate, low). Salinity, temperature, and pH are currently being measured daily. Water and food samples were collected from each tank on a weekly basis and the specimens were maintained in captivity until April, 2010. At that time, animals were collected, vertebrae were removed, and elemental isotope analysis is ongoing. Two technicians were employed by this project and utilized lab space for food preparation, sample preparation, and data entry.

Dafne Eerkes-Medrano's project, through the Department of Zoology, is investigating the impacts of the Oregon coast ocean hypoxia on meroplankton by observing distributions of meroplankton in nearshore OR waters during the hypoxic season.

The juvenile lingcod research started in the fall of 2009. Fish were collected from the nearshore environment, held in two 6 foot diameter outdoor tanks with a flow through water system in the outdoor tank area located at Hatfield Marine Science Center, and were fed a variety of diets to determine whether different diets (with an emphasis on the hemocyanin content of cephalopods) could cause lingcod to develop a greenish tint to their skin and flesh. Based on preliminary results from last fall, the students expanded the project and obtained CIMRS funding

to continue the work through the summer. Lingcod research is currently in progress located in the "pizza hut", an indoor tank area, also connected with the flow through water system.

Summary of on-going student projects based in the Heppell lab at HMSC:

- Markham-award funded work on movement patterns of different demersal fish species in and around Oregon's new Redfish Rocks Marine Reserve. Project run by Tom Calvanese.
- Laboratory and fieldwork to determine if elemental and stable isotopic signatures incorporated into the vertebrae of young-of-the-year sharks and rays provide distinct, site-specific markers. Project run by Wade Smith.
- Laboratory work on intertidal invertebrate recruitment. Project run by Dafne Eerkes-Medrano.
- Diet analysis of Humboldt squid. Project run by Selina Heppell and Sarikka Attoe.
- Growth rates and color change in lingcod. Project run by K. Borgen, M. Head and J. Zappa, supervised by S. Heppell.

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 FW454/554 Fishery Biology and FW526 Ecology and Management of Marine Fishes and Scott taught eight days of BI450 Marine Biology during Spring term. They use their assigned laboratory space as a base of operations for teaching during the Fall and Spring terms.

Marine and Anadromous Fisheries Ecology

Jessica A. Miller, Assistant Professor

Program Objective: The Marine 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 includes 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: José Marin Jarrin, a Ph.D. student, is investigating the role of surf zones in the early life history of Chinook salmon. Londi Tomaro, a MS student, is quantifying the role of juvenile growth and migratory behavior in the survival of mid-upper Columbia River spring-run Chinook salmon. Ruth DiMaria, a MS student, is examining the spatial structure and source contributions of Pacific cod recruits in the southeastern Bering Sea, Alaska. Alexis Paul, a laboratory technician, provides research support for several projects. Hilary Browning,

a National Science Foundation intern (participant in the HMSC Research Experience for Undergraduates (REU) program), joined the laboratory during summer 2009 and Laurelyn Perry, an intern from the Centers for Ocean Sciences and Education Excellence (COSEE), has joined the laboratory for summer 2010. Ernestine Ahgeak, also a NSF REU intern, is working in the laboratory during summer 2010 on a collaborative project with Tom Hurst from NOAA's AFSC.

Current projects:

- Reconstructing juvenile migratory history of Columbia River spring-run Chinook salmon (Funded by NOAA NWFSC and the Bonneville Power Administration)
- Comparison of life history variation in pre- and post-development populations of Columbia River Chinook salmon based on ~500-yr-old archaeological otoliths (Funded by the Bonneville Power Administration)
- Elucidating stock-specific ocean migration in Chinook salmon (Funded by ProjectCROOS)
- Larval source contribution and dispersal histories of Pacific Cod in the Bering Sea (Funded by North Pacific Research Board)
- Nursery areas, natal origin and natural elemental signatures: implications for connectivity and conservation of shark and ray populations (Funded by the National Science Foundation)
- The role of the surf zone in the early life history of Chinook salmon
- Effects of temperature and salinity on the otolith incorporation of Sr/Ca and Ba/Ca in juvenile Chinook salmon
- The use of maternally-transmitted biochemical markers to quantify scales of connectivity among local populations of the tidepool scuplin (*Oligocottus maculosus*) (Funded by OSU General Research Fund)
- Source identification of non-native golden shiners collection in Diamond Lake, Oregon (Funded by the Oregon Wildlife Heritage Foundation)

Awards:

Oldfield/Jackman Team Award, J. Miller
Mamie L. Markham Endowment Award, J. Marin Jarrin
H. Richard Carlson Scholarship, J. Marin Jarrin
Henry E. Mastin Graduate Fund, L. Tomaro

Marine Fisheries Genetics

Michael Banks, Associate Professor

Our primary mission focuses on the application of genetic principles towards a better understanding of population processes among Pacific salmon and other West-Coast fishery species. We develop methods for resolving hybridized, admixed, or recently diverged populations, and statistical means of determining component estimates for fishery or other samples that are typically mixtures of various stocks or sub-populations. We also apply population genomic methods to better our understanding of the genetic associations of sub-population and life history diversity within species.

Dr Mattias Johansson marks the finishing of the seventh graduate student from our program (4th PhD). Mattias's research advanced our learning in population structure, olfactory reception and mate choice in rockfish. He has elected to take up a post doc opportunity with the CIMRS and Bill Peterson of the NOAA Fish Ecology Division here where he will research genetic and life history diversity of krill. This bravely leads the lab into crustacean studies - an exciting first. A new student, Amelia Whitcomb, has begun her masters training looking at genetic aspects of mate choice in coho salmon (co-advised by Dr Kathleen O'Malley). Two summer interns have also initiated new projects in the lab. The first in association with David Noakes of the Oregon Hatchery Research Center examines population structure of Alsea basin steelhead (William Hemstrow). The second (Miles Naughton) uses molecular pedigree analysis to evaluate the relative success of various out-planting strategies for Mackenzie River spring Chinook supplementation. This latter project begins a long term study associated with Marc Johnson & Mike Hogeson of ODFW and supported by the US Army Corps of Engineers. Ongoing work in genetic aspects of run timing with the California Department of Water Resources continues with hiring of a new faculty research assistant Brandon Jones (supervised by Dr O'Malley) where recent work has yielded encouraging results. Estimates for jack returns for Chinook, principally in California, were also sufficiently promising for us to resume ocean sampling for ProjectCROOS (Collaborative Research for Oregon Ocean Salmon) this year. Indeed synergy has flourished so extensively in this fisherman-scientist-agency project that it now involves over 200 parties working in WA, OR & CA and is re-named 'West Coast Salmon Genetics Stock Identification Collaboration'.

Selection of our 'Acquisition of a Next Generation Sequencer for Marine Genomics' proposal by OSU's Agricultural Experiment Station Strategic Investment Fund presents another exciting moment to announce (co-PIs Scott Baker (MMI) & Kathleen O'Malley). This has enabled our recent installment of a Junior 454 Genome Sequencer into the HMSC Marine Genomics lab bringing the first instrument of this caliber to Oregon. We are thrilled with research and potentials for cross disciplinary collaboration that will likely result from the broad spectrum of interest in this instrumentation. We also trust that this investment will provide fitting precedent for the forthcoming decision we await on the 'Marine Mammal and Marine Genomics Building' proposed to the National Institute of Science and Technology.

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; Claudia Hollatz (PhD), visiting graduate student from Federal University of Minas Gerais, Brazil (PhD); Ursula Gonzalez (PhD), visiting graduate student from 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 understanding of the impact of hunting on the abundance of whales and the ecological role of whales before human exploitation, the CCGL is working to improve population dynamic models by including genetic information on long-term effective population sizes before exploitation and minimum population size during exploitation. Postdoctoral Fellow Dr. Jennifer Jackson has been working on the ‘History of whale populations before whaling’, with funding from the Lenfest Ocean Program of the Pew Foundation. Jennifer is working on new analytical methods to improve population dynamic models used previously by the International Whaling Commission by including genetic information on long-term effective population sizes before exploitation, minimum population size during exploitation and estimate of abundance based on genotype capture-recapture (Jackson et al. 2008). Results of this work were presented to the annual meeting of the Scientific Committee of the International Whaling Commission in Funshal, Madeira (June 2009) and Agadir, Morocco (June 2010).

As part of our efforts to reconstruct the history of whale populations, Angie Sremba has been extracting ‘ancient DNA’ from whale bones collected on the shores of South Georgia Island in the South Atlantic. These bones are the remnant of one 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. With DNA sequences from these bones, Angie will be able 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, the *Structure of Populations, Levels of Abundance and Status of Humpbacks* (SPLASH) project has collected more than 6,000 samples from all known feeding and breeding grounds in the North Pacific. To date, we have completed sequencing of the mtDNA control region and microsatellite genotypes for more than 2,000 individuals representing nine feeding grounds and eight breeding grounds. A manuscript is now in preparation describing population structure and maternal fidelity to both feeding and breeding grounds.

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 10th annual meeting at the University of Auckland, New Zealand in February 2010.

Alana Alexander, International Fulbright Fellow, is now using molecular markers to analyze the nearly 1,000 genetic samples of sperm whales collected during the five-year voyage of the RV *Odyssey*. In collaboration with Dr. Roger Payne, Iain Kerr and Dr. John Wise of the *Ocean Alliance*, Alana will use the information for her PhD research on worldwide study of genetic diversity and population structure of sperm whales.

Conserving the future of whales and dolphins: Ongoing surveys of ‘whale-meat’ markets in Japan and the Republic of (South) Korea play an active role in conserving the future of whales and dolphins. Debbie and Scott traveled to Seoul, South Korea in September 2009, to conduct genetic identification of whale and dolphin products sold in commercial markets. The results of the survey provided further evidence of the growing threat of Illegal, Unreported or Unregulated (IUU) exploitation of minke whales. This level of exploitation represents a serious threat to the survival of the genetically distinct J stock of minke whales found along the coast of Korea and Japan.

With funding from the Marine Mammal Commission, Becca Hamner has been continuing research her PhD research on the endangered Hector’s dolphin 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 region’s 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 April 2010, she returned to New Zealand to complete DNA profiling of a new collection of biopsy samples from Maui’s dolphins. These will be matched to previous samples collected from 2001 to 2006 to estimate the abundance and trends of this critically endangered subspecies.

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.

In June 2010, Scott was a U.S. delegate and Jennifer was an invited participant to the scientific committee of the International Whaling Commission at the 62nd meeting in Agadir, Morocco. Scott presented further work on whalemeat market surveys, as well as progress with research on migration and abundance of humpback whales in the South Pacific. Jennifer was nominated to act as rapporteur for the subcommittee on Southern Hemisphere stocks.

Scott and Jennifer have been active members of the ‘Genetic Monitoring Working Group’, chaired by Fred Allendorf and Michale Schwartz, with funding from NSF through the National Evolutionary Synthesis Center (NESCENT) and the National Center for Ecological Analysis and Synthesis (NCEAS). The Working Group has recently published a number of articles related to the policy on genetic diversity and species conservation (e.g., Laikre et al. 2010).

'*The Cove*' a feature length documentary on the hunting of dolphins in the small Japanese whaling town of Taiji, won an Oscar for the 'Best Documentary' at the 2010 Academy Awards. Directed by world-renown photographer Louie Psihoyos, the documentary features Scott's collaborative research with Japanese scientists on the high level of mercury contamination found in dolphin meat sold in Taiji and elsewhere in Japan. Scott also worked with the filmmaker of '*The Cove*' to identify illegal whalemeat for sale in a sushi restaurant in Santa Monica, California. The results, published later in a peer-reviewed journal (Baker et al. 2010), received wide media interest and resulted in a criminal complaint against the restaurant by NOAA Enforcement Officers.

MMI - Pinniped Ecology Applied Research Laboratory (PEARL)

Markus Horning, Assistant 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

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.

The PEARL is completing the investigations of the physiological ecology of aging in pinnipeds ("Aging in Weddell Seals: Proximate mechanisms of age-related changes in adaptations to breath-hold hunting in an extreme environment") using Weddell seals in Antarctica as a model species. Funding for this study through the National Science Foundation (\$468,000) is expiring in August 2010. While data analysis is continuing, the study has led to the following publications to date: Hindle & Horning, J. Theoretical Biology 2010; Mellish et al. J. Wildlife Diseases 2010; Mellish et al. Antarctic Science 2010; Mellish et al. Vet. Anesthesia & Analgesia 2010; Hindle et al. J. Experimental Biology 2009; as well as the comparative paper from a related study - Hindle et al. J. Experimental Zoology A 2009.

The long term research project monitoring juvenile Steller sea lions in the Gulf of Alaska ("Satellite-linked Life-History Transmitters in Steller Sea Lions: Assessing the effects of health status, foraging ability, and environmental variability on juvenile survival and population trends") led by the PEARL continued in 2009 with the capture of six 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 release brought the number of sea lions released with implanted satellite monitors to 27 since 2005.

LHX devices allow remote monitoring of pinnipeds throughout their entire lives, a first for any marine mammal (see Random Samples, SCIENCE Vol. 326, p505). While primary funding through the NOAA Steller Sea Lion Research Initiative has been exhausted, bridge funding for the continuation of this long-term monitoring project was secured through the University of Alaska Fairbanks' PCCRC program, followed by a newly awarded grant from the North Pacific Research Board (\$343,000). Under the NPRB award, an additional 12 animals will receive implanted, life-long satellite monitors in 2010 and 2011. This project has led to the following publications since its inception: Horning & Mellish Endangered Species Research 2009; Walker et al. Applied Animal Behaviour Science 2009; Horning et al. BMC Veterinary Research 2008; Petrauskas et al. J. Experimental Zoology A 2008; Thomson et al. Endangered Species Research 2008; Mellish et al. J. Experimental Marine Biology & Ecology 2007; Mellish et al. Aquatic Mammals 2006; Horning & Hill, J. Oceanic Engineering 2005.

Building on the success of the first generation LHX devices, in 2010 the PEARL was awarded a grant by the National Science Foundation to develop the next generation LHX life long satellite monitors for marine homeotherms (\$485,000). This 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), and Mr. William Hanshumaker (HMSC) to coordinate education and outreach efforts.

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), is continuing in 2010 under NOAA funding. This project is coordinated by Kim Raum-Suryan, PEARL Faculty Research Assistant, and is 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, attendance patterns in Steller sea lion mother-pup pairs are evaluated. These will be compared to similar patterns collected by other researchers in Alaskan regions, and used to draw inferences on comparative levels in prey availability. The remote imaging system is being enhanced with infrared imaging capabilities. In 2009, international intern Julia Hager from Germany joined this project to assist with image and data analysis.

PEARL graduate student Erin Kunisch (M.S., Dept. Fisheries & Wildlife) has completed her field research on reproductive rates in Northern fur seals on St. Paul Island in the Bering Sea, in collaboration with Ward Testa and Tom Gelatt (NMML, NMFS). Erin is busy analyzing and writing. 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. 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, and the National Park Service.

Three new graduate students (M.S., Dept. Fisheries & Wildlife) are joining 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.

PEARL students and researchers delivered ten spoken and poster presentations at multiple conferences including the 2009 Biennial Conference on the Biology of Marine Mammals (Quebec City, Canada), the 2010 Alaska Marine Science Symposium (Anchorage, AK), and the 2010 National Stranding Network Conference (Shepherdstown, VA).

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; Bryan Gillooly, M. Ag. 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 1200 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, with a realized heritability of 0.61. 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 oysters, collected from southern Japan, to improve the genetic diversity of existing West Coast populations. The original broodstock, first generation and juveniles of the second generation of each species had to be maintained under quarantine conditions and subjected to intensive disease testing. 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.

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.

Seabird Ecology

Robert Suryan (Ph.D), Assistant Professor-Senior Research; Amanda Gladics (B.S.), M.S. Student, Marine Resources Management; Cheryl Horton (B.S.), Summer Intern; Adrian Lohr, Oregon State University, Summer Undergraduate Intern; Leah Segui, National Science Foundation Summer Undergraduate Intern

The Seabird Oceanography Lab (SOL) at 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 in its fourth 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, 1 unit], 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 \$268,000 in funding, authored/co-authored one peer-reviewed paper, one textbook chapter, a briefing report to the Oregon State Legislature on climate change effects on marine birds, and gave fifteen presentations at scientific meetings, seminars, and public forums. One of our local studies was also featured on Oregon Public Broadcasting’s Oregon Field Guide series (<http://www.opb.org/programs/ofg/segments/view/1735>). Research projects during the past year included: 1) Foraging patterns and marine habitat use of short-tailed albatrosses (*Phoebastria albatrus*) nesting on Torishima, Japan; 2) Experimental translocation of short-tailed albatross chicks for re-colonization of historical breeding sites in Japan; 3) Seabird tracking and prey patch dynamics in the Bering Sea; 4) U.S. West coast fisheries and

seabird interactions; 5) Climate change and phenology in the seasonal cycle of California's marine flora and fauna; 6) Common murre (*Uria aalge*) reproductive biology and foraging ecology at Yaquina Head, Oregon; 7) Breeding biology and at-sea distribution of seabirds on Lehua, Hawaii; 8) Over-winter distribution of Laysan albatrosses (*P. immutabilis*) breeding at Kaena Point, Hawaii; 9) 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, 11) 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 ~2,800 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 ninth 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. 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 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.

Seabird tracking and prey patch dynamics in the Bering Sea: 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.

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.

Tackling Ecological Complexity: Climate Change and Mismatches and Mismatches in the Seasonal Cycle of California's Marine Flora and Fauna: SOL is collaborating with the Farallon Institute for Advance Ecosystem Research, NOAA Fisheries Pacific Fisheries Environmental Lab, (Pacific Grove, CA), UC Davis Bodega Marine Lab, and UC Berkeley ocean modeling group to study climate change effect on the timing (phenology) of season production cycles and their effect on food web dynamics. Additionally, we are investigating 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 2010 breeding season. Between our studies and those conducted by Dr. Julia Parrish (University of Washington), we now have a 9 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.

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, although there was a setback this year in that rats were not fully eradicated in the first removal attempt and are beginning to repopulate. 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.

Over-winter Distribution of Laysan Albatrosses breeding on Oahu, Hawaii: In collaboration with the University of Hawaii and San Jose State University, SOL is using micro-electronic archival tags to track Laysan albatrosses year-round. Relatively few studies of albatrosses have occurred in the main Hawaiian Islands and SOL is helping to continue a multi-year study started by University of Hawaii investigators. This study will be particularly valuable in determining how inter-annual variation in over-winter foraging conditions may affect reproductive success and survival.

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 murre at Yaquina Head with collaborative fisheries research to help detect and understand food web wide adjustments resulting from sometimes subtle biophysical changes in ocean dynamics.

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 Fisheries Management and Policy

Susan Hanna, Professor

Susan Hanna is involved in a number of issues related to trends in fishery management and ocean policy, incentive-based fishery

management tools, fishing communities and ecosystems.

Trends in Fishery Management and Ocean Policy

- Oregon Ocean Policy: Service on the Scientific and Technical Advisory Committee (STAC), Oregon Ocean Policy Advisory Council (OPAC). The primary advisory role concerns the economic dimensions of marine reserves and process aspects of marine reserve development.
- Oregon Ocean Policy: Invited presentation “Understanding the Economic Impacts of Marine Reserves” at the Heceta Head Coastal Conference, Florence Oregon, 24 October 2009.
- Integrating Fishery Management and Markets: Service on the Board of Directors of the Oregon State University Seafood Consumer Center.
- National Fishery Policy: Invited presentation: “East and West: The Path Ahead for Social Science Data,” presented at the Northeast Regional Social Science Symposium, University of New Hampshire, Durham, New Hampshire, 12 April 2010.
- National Ocean Policy: Service on the Science Advisory Panel of the Joint Ocean Commission Initiative (JOICI), the combined implementation effort of the US Commission on Ocean Policy and the Pew Ocean Commission.
- National and International Fishery Policy: Recipient of the 2010 Distinguished Service Award, International Institute for Fisheries Economics and Trade.
- National and International Fishery Policy: Invited plenary presentation: “Economics in the Service of Fisheries Policy and Practice” to be presented at the IIFET 2010 Conference, Montpellier France, 12- 17 July 2010.
- International Fishery Policy: Service on the Board of Directors of the Institute of Innovative Fishery Management, Aalborg University, Aalborg, Denmark.
- International Evaluation: Service as an External Examiner, Quach Thi Khanh Ngoc, Ph.D. Candidate, University of Tromsø, Tromsø, Norway. Presentation of the Evaluation Committee Report of her Ph.D. thesis “Essays on the Economics of Marine Protected Areas and Fisheries Management.”
- International Scientific Service: Scientific Committee of the 2010 Conference of the International Institute for Fisheries Economics and Trade (IIFET). Montpellier, France.

Incentive-Based Tools

- Regional Fishery Policy: Session Chair, “Human Responses to Hatcheries: Understanding the Social, Cultural, Legal, and Economic Dimensions” at the 2010 State of the Salmon Conference Ecological Interactions between Wild and Hatchery Salmon, Portland, Oregon.
- Regional Fishery Policy: Invited introduction to session: “Co-evolution of Hatcheries, Economics, Property Rights and Management” at the 2010 State of the Salmon Conference Ecological Interactions between Wild and Hatchery Salmon, Portland, Oregon, 5-7 May 2010.
- Regional fishery policy: Service on the Independent Economic Analysis Board, Northwest Power and Conservation Council.

Fishing Communities

- Oregon Working Waterfronts: Collaborated on a Consumer Seafood Initiative research project to develop information on tools to protect working waterfronts.

Ecosystems:

- Climate Change and Fishery Governance: Invited presentation: "Climate Change Effects on Capture Fisheries: Economic and Policy Issues," presented at the OECD Workshop on the Economics of Adapting Fisheries to Climate Change, Busan, South Korea, 10-11 June 2010. Chapter in Workshop Proceedings, in press.
- Oregon Marine Reserves: Chaired a review of the Socioeconomic Research and Monitoring Plan for Oregon Marine Reserves prepared by the Oregon Department of Fish and Wildlife Marine Resources Program.

Marine Resource Economics & Marketing

Gil Sylvia, Associate Professor
No report submitted this year.

College of Forestry

Department of Forest Ecosystems and Society

Marine and Terrestrial Linkages

Bryan Black, Assistant 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:

- A dendrochronological reconstruction of Swiss needle cast disease impacts on Douglas-fir of the western Oregon Coast Range. Collaborators: Jeff Stone, Dept. of Botany and Plant Pathology, Oregon State University and Dave Shaw, Dept of Forest Science, Oregon State University.
- Growth increment analysis of Pacific geoduck as a tool for reconstructing sea surface temperatures in the northern Pacific. Collaborators: Emily Whitney, Whitworth University; Rose Kormanyos, Whitman College; Claudia Hand and Darlene Gillespie, Dept. of Fisheries and Oceans, Canada.
- Reconstructions of stream temperature and flow from the growth increments of long-lived freshwater mussels. Collaborator: Jason Dunham, USGS Corvallis
- Quantifying the severity and frequency of coral bleaching events in the Mesoamerican Reef. Collaborator: Jessica Carilli and Richard Norris, Scripps Institution of Oceanography.
- 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.
- Climate-growth relationships of three flatfish species in the Bering Sea. Collaborators: Beth Matta and Tom Helser, NOAA AK Fisheries Science Center.
- A comparison between ¹⁴C ageing and crossdating in Pacific geoduck. Collaborators: Craig Kastle, NOAA AK Fisheries Science Center; Shayne MacLellan, Darlene Gillespie, and Claudia Hand, Dept. of Fisheries and Oceans, Canada.
- Dating of "peel bark" ponderosa pine trees in eastern Oregon. Native American populations used the underside of ponderosa pine bark as a food source. Scars from harvesting tree cambium remain, and dating these scars provides clues as to Native American activities and land use. Collaborators: Matthew Stuckey, UC Davis and Carolyn McAleer, OR Dept. of Transportation.
- 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.

Ongoing funded projects include:

- Tree-ring techniques for age validation and establishing long-term effects of climate variability on the growth of Gulf of Mexico red snapper. NOAA Fisheries and the Environment (FATE) program.
- Improving geoduck age estimation through the tree-ring technique of crossdating. Department of Fisheries and Oceans, Canada.
- Reconstructing water temperatures in Oregon streams through analysis of growth increments in long-lived pearlshell mussels. Oregon Watershed Enhancement Board
- A dendrochronological approach for reconstructing Swiss Needle Cast disease in the Oregon Coast Range.

- Investigating the importance of wintertime ocean conditions to biological productivity in the California Current Ecosystem.
- Reconstructing bottom temperatures in the Bering Sea from growth-increments of long-lived flatfish species.

The lab hosted a summer intern, Emily Whitney, an undergraduate at Whitworth University, in the lab during the summer of 2009 as participant in HMSC's National Science Foundation Research Experience for Undergraduates. Her project was titled: Pacific geoduck (*Panopea abrupta*) growth patterns reflect nearshore climate heterogeneity along the British Columbia coast.

Courses taught:

- FS 199: Ecology of Coastal Oregon Forests: This 1-credit course is a combination of lecture and field exercises based at the Hatfield Marine Science Center 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 Dr. Black in Jan 2010.
- Instructor: Growth Increments and the Environment. University of Western Australia, Perth (March 1-5, 2010) and the University of Adelaide, Adelaide Australia (March 8-12, 2010). This course was taught twice: once at the University of Western Australia (15 participants) and again at the University of Adelaide (8 participants). Participants included state, federal, and university scientists as well as some graduate students. At both locations we surveyed fish species for their suitability to growth-increment analysis. A fishery growth-increment chronology was developed at each workshop (rock flathead in Perth and parore in Adelaide). As of May 2010, a post-doctoral position has been created at the Australian Institute of Marine Science to address this research, and a grant has been submitted to fund a second. The goal is to establish long-term research projects with Australian colleagues.

Invited Keynote Address:

- BA Black. Tree rings, otoliths, and the development of annually resolved growth-increment chronologies. The Fourth International Otolith Symposium, August 2009. Monterey, CA.

Grants awarded

- **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 Helsler (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**. A dendrochronological evaluation of culturally modified trees. OR Dept. of Transportation. 7/2009-7/2010. \$15,000
- **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**, Jeffrey Stone, David Shaw. Refining techniques for detecting Swiss needle cast outbreaks in tree-ring records from the western Oregon Coast Range Swiss Needle Cast Cooperative. 3/2008 – 9/2009 \$24,000

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.
- BA Black was selected for an Outstanding Presentation Award at the North Pacific Marine Science Organization Eighteenth Annual Meeting in Oct. 2009, Jeju, Korea

Research in the press

- *Swiss needle cast Epidemic in coastal Douglas-fir*, April 27, 2010. KVAL News, Eugene, OR (televised)
- *Forests at Risk: Swiss Needle Cast Epidemic in Douglas-fir Unprecedented*, April 8, 2010, eBio News, Sciencedaily.com, Physorg.com, other online outlets, The Oregonian, various Oregon newspapers
- *Researchers Pry Climate Change Record from Giant Clams*. Aug. 11, 2009, Scientific American online
- *OSU Researchers Look to Marine Life for Climate Clues*. Jul. 30, 2009, KEZI 9 News, Eugene, OR (televised)
- *Natural Clues to Northwest Climate History*. Jul. 31, 2009, Oregon and Washington Public Broadcasting / NPR (radio broadcast)
- *Douglas-fir, Geoducks Make Strange Bedfellows in Studying Climate Change*. Aug. 1, 2009, ScienceDaily.com, Physorg.com, NSF.gov, various online outlets, The Oregonian, Portland, OR. Newport News Times, Newport, OR
- *Ocean Researchers Get It Together*. May 2009, Oregon Stater Magazine.
- *Ancient trees win the tortoise vs. hare race*. Feb. 12, 2009, The Oregonian

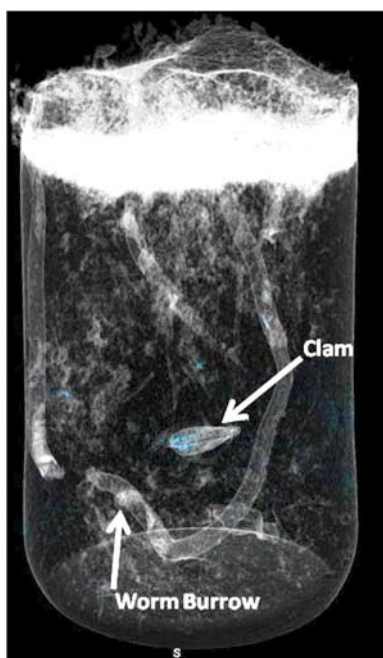
College of Oceanic and Atmospheric Sciences

Benthic Ecology and Biogeochemistry

George Waldbusser, Assistant Professor

Ongoing work in George Waldbusser's lab at Hatfield Marine Science Center has been focused on the interactions among different types of benthic macro-organisms and the consequences to sediment biogeochemistry.

Since arriving at Oregon State University in October of 2009, efforts have been underway to establish experimental microcosms and develop new sediment imaging methodologies as part of a National Science Foundation funded project. The drive of this work is to understand the mechanisms that create macrofauna biodiversity effects on sediment biogeochemical processes. Benthic infauna create a mosaic of interfaces for energy and material transformation beneath the sediment surface, and these interfaces significantly alter biogeochemical cycling in sediments. However, these 3-D structures are destroyed by most benthic sampling methods. George Waldbusser and his technician Heather Bergschneider have been working closely with the OSU College of Veterinary Sciences to utilize medical computed tomography (CT) methods to image and quantify three-dimensional sediment structures and particle mixing due to benthic infauna. Significant



methodological development has been undertaken to identify limitations of CT technology for studies of benthic infauna. Recently a small pilot study was completed to measure changes in particle mixing rates by deposit-feeding infauna in relation to food availability. Particle tracers of a density different than that of bulk sediment were used to measure the rates of sediment mixing and quantify 3-D tracer distribution. Experiments are underway to examine the effects

inter- and intra-species interactions on irrigation rates and burrow geometries of infaunal deposit-feeders and the resulting consequences to biogeochemical cycling.

In addition to research activities, George Waldbusser led a reading and conference course on ocean acidification and impacts on shellfish for two OSU Fish and Wildlife Ph.D. students (Chao Chen and Matthew Gray) based out of HMSC, and is serving on the graduate committees for three HMSC students (Chao,

Matthew, and Katelyn Cassidy).

Marine Geochemistry

Clare Reimers, Professor

Research in Clare Reimers' Marine Chemistry laboratory is focused on the role of seafloor processes in ocean chemical cycles and developing new electrochemical tools for ocean observations of biogeochemical properties.

During 2009-2010, group activities were centered on two continuing projects. A highlight of the newest project, funded by the National Science Foundation, was a set of *Wecoma* and *Elakha* cruises to collect a time-series 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 is focusing on measurements from a 30 m station located off Yaquina Head. She and Dr. Reimers presented a subset of their results at the 2010 Ocean Sciences Meeting in Portland. Ms. McCann-Grosvenor was also a recipient of a 2008 Mamie Markham Research Award.

The second major Reimers lab project, funded by the Office of Naval Research, has been to develop and evaluate prototypes for revolutionary microbial fuel cells designed as self-refueling power sources for fixed seafloor sensors (the benthic microbial fuel cell). Field experiments with chambered benthic microbial fuel cells were conducted in Yaquina Bay and parallel laboratory experiments are ongoing in a refrigerated laboratory at HMSC. The next stage in the field experiments will be to demonstrate powering an acoustic modem/oxygen sensor on a small mooring in Yaquina Bay. This work is being accomplished by post-doctorate researcher, Yanming Gong, with collaborative support from staff at the marine instrument company *Teledyne Benthos*.

College of Science

Department of Botany and Plant Pathology

Gayle Hansen, Courtesy Associate Professor - Senior Research

Mission and Objectives:

During the 2009-2010 academic year, Gayle Hansen, our marine

botanist, continued her research on the distribution and taxonomy of west coast seaweeds. In addition to updating her Oregon checklist, her ultimate goal has been to provide comprehensive floristic accounts of the seaweeds and seagrasses inhabiting specific areas along the west coast from Alaska to Oregon. Her Oregon studies are particularly timely since biodiversity information is a key factor in determining those areas in Oregon that will be set aside as marine reserves during the coming years.

Research:

- **Oregon's Historical Baseline Data for Seaweeds:** As a herbarium botanist, Gayle relies heavily on the distribution information provided by specimens of pressed marine algae held by herbaria around the world. By studying these specimens, checking the identifications, and recording the label information from these as well as on her own collections, she has developed a database of the information derived from nearly 12,000 specimens. The records start with the Lewis and Clark Expedition and extend to the present day, and they provide an important historical baseline for seaweed distributions in Oregon. Information from this study was presented at the 2009 CERF meeting in Portland and is being prepared as a report to ODFW for their Marine Reserve Study and as a chapter in a special publication on Oregon's Historical Baseline Data.
- **Oregon's Seaweed and Seagrass Biodiversity:** As a part of preparing the distribution database, Gayle has collected and vouchered (as herbarium specimens) seaweeds and seagrasses from many areas along the Oregon coast. This past year, she has concentrated on 3 rocky intertidal beaches located near the Hatfield Marine Science Center in Newport: Boiler Bay, Otter Crest, and Seal Rock. Comprehensive checklists from these beaches are needed to facilitate the extensive teaching and research that occurs at these sites. Moreover, vouchering the species will make it possible to update the taxonomy of these seaweeds as more is discovered about their molecular biology. Previous Oregon biodiversity surveys have published relatively low counts per site of identified seaweed and seagrass species (up to 40 for PISCO and 36 for ODFW). Gayle's counts are much higher. She has found between 190 and 220 species of seaweeds and seagrasses at each of her 3 sites, making central Oregon locally rich and possibly a hot-spot for west coast seaweed biodiversity.
- **Oregon's Rarely Collected Seaweeds and Seagrasses:** Gayle's database of collections is extensive enough for her to begin to assess seaweed rarity in Oregon. Although most species are fairly common along the Oregon coast, there are some that have been collected at only 1-3 sites, making them eligible for rare species status. Last year, she nominated 40 seaweed species for inclusion in the Rare and Endangered Species Target Lists maintained by the Oregon Natural Heritage Information Center and by the Nature Conservancy. This year, she updated the list for their new publication. Rare species target lists are critical to our future since they are used to fortify conservation efforts both in Oregon and around the world.
- **Molecular Biological Studies of Oregon's Seaweeds:** As

a taxonomist, Gayle has provided Oregon seaweeds to molecular biologists in many parts of the world to be certain that Oregon's seaweeds are included in the new phylogenetic studies. A number of the species she has collected are new records to Oregon, and several are new species. One estuarine species, sequenced in the Netherlands, turned out to be a new record and a new combination. *Cladophora amphibia* had not been collected in over 100 years, and her study along with her Netherlands collaborator will clarify its taxonomy. Papers on a new kelp and a new green alga are currently in progress.

Outreach: Although Gayle concentrated on research this year, she continues to sell her poster for outreach. "Oregon Seaweeds, A Sampler" includes pristine illustrations of 40 of our local seaweeds. It is available for purchase at the HMSC, Yaquina Head, and South Slough bookstores as well as various gift shops along the coast.

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

Shawn Rowe, Ph.D., represents the College of Science's Department of Science and Mathematics Education at the HMSC as well as the Environmental Sciences Program and the College of Oceanic and Atmospheric Science's Marine Resource Management Program. In addition to his own research, which focuses on developing accessible learning environments and tools for people to learn marine sciences in informal settings like the HMSC's Visitor Center, Rowe oversees or coordinates 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 2009 and June 2010, Rowe and/or students presented research findings from their work at the HMSC to attendees at the 2010 AGU Ocean Sciences Meeting, the American Educational Research Association and the National Association of Research in Science Teaching Annual Meetings, the Visitors Studies Association Meeting, the Western Museums Association Meeting, the Sea Grant Climate Workshop, the Science on a Sphere Network meeting, and the Aquarium and Zoological Association annual meeting. In addition, research findings were published in the journals *Public Understanding of Science*, *Visitor Studies*, and *Tourism in Marine Environments*.

Faculty and Student Research at HMSC: Studies this year at the HMSC's Visitor Center shifted focus slightly from studies aimed mostly at the development and evaluation of exhibits to studies of the efficacy of various types of professional development for scientists, educators, volunteer communicators, and K-12 teachers. External funding from the Holt Marine Education Award, the Oregon Department of Education, NOAA, and the National Science Foundation supported the work of 5

students from Science and Math Education and 1 student from Environmental Sciences as well as Dr. Rowe and Nancee Hunter (Oregon Sea Grant). In particular, Céleste Barthel, Kathryn Stofer, Nancee Hunter, Mark Farley, and Shawn Rowe continued their work on how individuals and groups learn science from complex scientific visualizations of data using the Magic Planet Spherical Display System as a research platform. Research on how learning can be facilitated through interactions with live animals also continued this year with funding from Sea Grant to Shawn Rowe and Jim Kisiel, Department of Science Education, California State University, Long Beach. Holt Marine Education funding supported the work of Michelle Mileham to better understand professional development of volunteers. In addition to this work, the HMSC Volunteer Coordinator, Becca Schiewe enrolled this year in the department's master's degree in Free-Choice Science Learning. Becca brings her experiences and activities from the classes she is attending in the College of Science to her work on the floor, benefiting volunteers and visitors.

Communicating Ocean Sciences to Informal Audiences: Every winter, the Department of Science and Mathematics Education offers the Communicating Ocean Sciences to Informal Audiences Class. While the class is taught on campus, all of the students travel to HMSC, Oregon Coast Aquarium and other sites to deliver hands-on ocean sciences activities. The purpose of this National Science Foundation funded class is to introduce future scientists to communication techniques by giving them the opportunity to use hands-on materials to teach basic science concepts to schoolchildren, adults, and public audiences. Students from Oceanography, Marine Resource Management, Biology, Zoology, Atmospheric Sciences, Engineering, and Science and Math Education took the class in winter 2010 and delivered hands-on activities on marine biology and physical oceanography to audiences at the HMSC and the Oregon Coast Aquarium, high-school students at OSU's Salmon Bowl, middle-school students at SMILE's Middle School Challenge, and families at SMILE and HHMI funded family science nights. As a spin-off of this class, Heidi Schmoock – M.S. 2007 (OSG) and Shawn Rowe prepared a new five-week class for informal educators from HMSC that uses reflective practice techniques and activities to promote on-going, long term professional development. This is the third professional development program for informal educators piloted at HMSC. Rowe and Schmoock also worked with other staff from the COSEE, Pacific Partnerships and COSEE Ocean Systems to offer a three-day workshop on communicating ocean sciences via concept mapping to scientists and informal educators at California Polytechnic University, San Luis Obispo.

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, the spring sampling has been conducted using a 'flying' video sled, box cores, trawls and CTD casts. These surveys will be repeated seasonally. (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. (Funded by Minerals Management Service)
- **Interaction of Wave Energy Devices and the Environment: Biofouling Concerns on Device and Mooring Systems:** This project is being conducted with a NOAA Hollings Scholar summer intern in collaboration with NNMREC chemical engineers to test anti-biofouling coatings on device surfaces and with the Wood Science Engineering laboratory to conduct stress-strain tests on fouled mooring lines.

Teaching:

- **BI/FW 111-Introduction to Marine Life in the Sea:** Sarah served as a second instructor in addition to Itchung Cheung in order to learn more about the level of instruction and pace of such courses in preparation for potentially developing her own course.
- **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.

Mentorees:

- Elizabeth (Liz) Lopez is an NSF REU from California State University Monterey Bay. Liz has been sorting and identifying invertebrates collected from box cores taken at the Mobile Ocean Test Berth site and participated in the trawl cruise on the R/V *Elakha*.
- Maha Haji is a NOAA Hollings Scholar from University of California, Berkeley. Maha designed the mooring experiment to test the effects of biofouling on the strength of Spectra line. She has been assisting Matt Delaney (chemical engineering graduate student) with his biofouling prevention experiments and assisted on both the box-coring and trawling cruises to the Mobile Ocean Test Berth site.

Marine Ecology

Bruce Menge, Distinguished Professor; Sally Hacker, Associate Professor; Francis Chan, Assistant Professor, Senior Research; Sarah Henkel, Assistant Professor, Senior Researcher

Mission and objectives: Several labs in the Zoology department maintain research activities at HMSC, those of Bruce Menge, Sally Hacker, Eric Seabloom (now moved to the University of Minnesota), Francis Chan, and Sarah Henkel. The research focuses on the dynamics of coastal ecosystems, including marine inner shelf, rocky intertidal, estuarine and sand dune habitats, and on environmental impacts of ocean energy activities. 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 and Jack Barth 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.

Activities: PISCO uses HMSC laboratory sea water space to stage field work, using space in April-June each year. Personnel involved besides the PIs include Camryn Pennington, Megan Poole, Lindsay Hunter, Ryan Craig, Ruth Milston-Clements and Kim Page. 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 mud shrimp species interactions on mudflats adjacent to HMSC, Hacker and Seabloom's studies of dune ecosystems, and Henkel's studies of the impact of wave energy generation activities are based out of the Science Center. Francis Chan's research is primarily ship-based and focuses on coastal biogeochemistry, ocean acidification and hypoxia. This work is based on cruises on the R/V *Elakha*, including ROV surveys conducted in close collaboration with HMSC-based ODFW biologists, and moorings along the coast deployed from the R/V *Elakha*. See <http://www.piscoweb.org/outreach/topics/hypoxia>. A new direction for the research of Chan, Menge and Hacker is a focus on effects of ocean acidification. Plans are to build a mesocosm at HMSC for use in experiments testing organismal responses to ocean acidification. Sarah Henkel is a full-time resident at HMSC, with laboratory and office space in the Fisheries wing (see separate report from Dr. Henkel). Chan, Kristen Milligan (Zoology) and Michael

Donnellan (ODFW) are also working collaboratively with Bill Hanshumaker to update and develop displays of hypoxia research and findings for the HMSC Visitor Center in order to enhance public understanding of ocean science.

Graduate Students and Postdocs:

- Joe Tyburezy (Menge Graduate Student, supported by EPA STAR Predoctoral Fellowship): Joe studied larval (mussels and barnacles) ecology in pelagic systems of the inner shelf, trying to understand how larval behavior and interaction with oceanographic features such as upwelling fronts influences the patterns of recruitment along the shore. His activities at HMSC were limited to sample processing and staging of cruises on the R/V *Kalipi*, a 29' research vessel operated by PISCO. Joe is currently a Knauss Fellow in Washington DC, and will defend his thesis in fall 2010.
- 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 is based in Newport and her research is based almost entirely at HMSC.
- Margot Helsing-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.
- 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 Zarnetsky (Hacker and Eric Seabloom Graduate Student, supported by a research assistantship from Sea Grant funds and 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*.
- Orissa Moulton (Hacker Graduate Student): Orissa is investigating the interaction between surfgrass and a polychaete symbiont, focusing on the role that metabolic

products of the symbiont (e.g., ammonium as a waste product) play in affecting surfgrass growth. She uses the HMSC as a base for field operations and for laboratory experiments.

practices for marine ornamental importers. They have developed a one-hour seminar for aquatic animal health practitioners outlining their key findings and industry recommendations. This seminar was presented for the first time at the AVMA Annual Conference in Seattle, Washington

College of Veterinary Medicine

Department of Biomedical Sciences

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

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

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

Miller-Morgan teaches and lectures in a number of courses within the College of Veterinary Medicine, including a lecture in VMB 753, *Veterinary Virology – Introduction to viral diseases of ornamental fish*, a section of VMB 728, *Special Species Medicine*, a course offered to junior veterinary students in which he introduces students to the practice of pet fish medicine as a component of a traditional veterinary practice. He is a co-instructor for VMC 738, *Animal Care- Introduction to Fish Husbandry and Handling* and teaches VMB 727, *Ornamental Fish Medicine*, a 40-hour course that teaches senior veterinary students the basic skills they need to begin practicing fish medicine.

Dr. Miller-Morgan continues to serve with Dr. Helen Roberts, a private ornamental fish practitioner in New York, as the Aquatic Animal Medicine Session Coordinators for the American Veterinary Medical Association (AVMA) Annual Conference. This year we offered 4 days (28 hours) of training in aquatic animal medicine with a focus on ornamental fish and shellfish health management for the conference in Seattle, WA.

Miller-Morgan and Heidel are also involved in an Oregon Sea Grant-funded project to characterize the health status of recently imported wild-caught marine ornamental fish and model shipping stress in these fish in order to decrease shipment and post-shipment morbidity and mortality. Through a partnership with a marine ornamental importer in Los Angeles, they plan to use the results to develop recommendations for best management

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

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 will 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 is 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 to 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 Australian ornamental fish industry, Japan to survey fish health management techniques within the Japanese koi industry, and India to address members of the nascent but rapidly expanding Indian ornamental fish industry. This last visit resulted in a request from the Indian Government for the Ornamental Fish Health Program and the OSU College of Veterinary Medicine to develop collaboration to improve the Indian ornamental fish industry's fish health management infrastructure. A previous visit to Israel has resulted in collaboration with a large Koi and goldfish producer that has resulted in the development of a paid internship opportunity for OSU undergraduate students with an interest in fish culture and biosecurity. We are currently exploring opportunities collaborate on developing industry training opportunities for fish health management and biosecurity.

A new book, *Fundamentals of Ornamental Fish Health Management*, Wiley, 2010, contains two chapters authored by Dr. Miller-Morgan: *Overview of the Ornamental fish Industry and Hobby and Biosecurity and Ornamental Fish*, co-authored by Dr. Heidel.

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 2009-2010, PCEB has completed its transition to a new 5-year research effort in the area of Estuarine Ecosystem Services. The Estuarine Ecosystem Services Research Project will 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 will focus 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 will 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.

Dr. Henry Lee II provided a briefing to a National Research Council Committee on Assessing Numeric Limits for Living Organisms in Ballast Water. Dr. Lee is the lead author of a recent report to US EPA Office of Water entitled "Density Matters: Review of Approaches to Setting Organism-Based Ballast Water Discharge Standards" which evaluated existing approaches to generating organism-based discharge standards for ballast water. EPA and the U.S. Coast Guard have requested that the NRC conduct a study that will significantly inform their joint efforts to derive environmentally protective numeric ballast water discharge limits in the next Vessel General Permit.

At the request of the Southern California Coastal Water Research Project, Dr. Jim Kaldy provided technical support to the California State Water Resources Control Board on the development of nutrient criteria for the State's estuaries. Dr. Kaldy's expertise was used to evaluate how submerged aquatic vegetation such as eelgrass can be used as an indicator of eutrophication for a diverse set of California estuaries. The technical issues on SAV as indicators of numeric nutrient endpoints are complex, and the state of the science is such that expert opinion will be required to provide guidance to the California Regional Water Boards.

PCEB scientists Pat Clinton, T Chris Mochon-Collura, Melanie Frazier, and Ted DeWitt volunteered to support US EPA response to the Deep Water Horizon oil spill disaster in the Gulf of Mexico. The volunteers served as EPA representatives providing oversight to environmental monitoring activities on a research vessel at the well head site of the oil spill.



View of gas flare off and relief well drill rig at the site of the Deep Water Horizon oil spill in the Gulf of Mexico as seen from the environmental monitoring vessel. *photo credit: Chris Mochon-Collura*

EPA research staff at HMSC consists of 17 federal employees, including 2 EPA postdoctoral fellows, and 15 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. 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

Allan W. Stoner, 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 12 members of FBEP staff conduct laboratory research in Newport and field studies in Alaska aimed at understanding the role that behavior 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.

Red king crab ecology: The red king crab (RKC) fishery in the Gulf of Alaska is now closed completely because of declining populations. In response, the Alaska King Crab Research Rehabilitation and Biology Program (AKCRRAB) was established as a consortium of scientists from the University of Alaska and the Alaska Fisheries Science Center to begin research into the feasibility of releasing hatchery-reared crabs with the ultimate goal of stock enhancement. The Program has many facets including hatchery, laboratory and field research. FBEP biologists are now focused on determining the best practices for culture of RKC from newly settled juveniles to a size suitable for release into the field, and understanding recruitment processes including growth and mortality under different environmental conditions. During the last year, FBEP scientists completed experiments at the Newport Laboratory designed to evaluate the role of seawater temperature on the growth, energy allocation, and survival of newly settled RKC juveniles, and to determine some of the factors that determine cannibalism in the species and predation by Pacific cod. The temperature experiments are relevant to both climate changes in Alaska as well as aquaculture practices for RKC.

Responses of fishes to ocean acidification: FBEP has begun to investigate the impacts of ocean acidification on Alaskan commercial fishery species. During the last year, in collaboration with researchers at the University of Alaska, a seawater system designed to rear larval and juvenile fishes under predicted levels of oceanic pH. Juvenile walleye pollock were reared in this system for 6 weeks to determine the effect of environmental pH on growth rate, condition factor, stress hormones, and

blood chemistry. This experiment showed that fish responded to the change in environmental pH by increasing levels of bicarbonate in the blood and there was a trend toward elevated stress hormones at lower pH. However, there was no effect of environmental pH on growth rate when fish had access to unrestricted rations. Future experiments will examine 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. Mortality predictors were used to evaluate the effects of different forms of handling in the Bering Sea snow crab harvest during the winter 2009/2010. Results from those observations are currently under analysis.

Northwest Fisheries Science Center

NOAA Fisheries' Northwest Fisheries Science Center (NWFS) is headquartered in Seattle and has three research stations in Washington and two in Oregon. The NWFS's Newport Research Station, the Center's only ocean-port facility, is located on the Oregon State University Hatfield Marine Science Center campus. Newport Research Station scientists conduct critical research on west coast groundfish, salmon biology, ocean conditions of the California Current Large Marine Ecosystem (CCLME) and support the pilot Integrated Ecosystem assessment of the CCLME.

Operations, Management, and Information Division (OMI):

Captain Rick Brown, NOAA (ret.), Resource Management Specialist; Hollis Lundeen, Facilities Manager; C. Barry Semple, IT Specialist, System and Network Administrator; Patty George, Administrative Support Specialist; Deborah Boylen, Safety and Environmental Compliance

NWFS'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.

A significant facility contribution for this reporting period was the upgrade of the monitoring and recording software of the quarantine water treatment facility serving the Newport Aquaculture Lab and Research Support Facility systems, and the upgrade of the injection system loop controllers for the treatment system. This has improved the dosing, neutralizing and monitoring of water that is exposed to quarantine species used in research programs by NWFS, AFSC, and OSU in the NAL

and RSF buildings. These enhancements ensure that this facility remains in compliance with ODEQ requirements for the HMSC campus treatment facility permits. OMI supported a NOAA funded energy review of the NOAA buildings on the HMSC campus and participated in a strategic facilities review of all Northwest Fisheries Science Center. NWFS/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.

The OMI IT department continued to provide onsite IT Administration, helpdesk and Network Administrator support to the NWFS during the past year. Recent improvements to NWFS IT Security include the installation of Adaptive Security Appliances (ASAs) to enhance data security. A project due to be finished this summer is for 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.

Ms. Debra Boylen continued to provide outstanding onsite Safety and Environmental Compliance (SECO) support for the NOAA facilities on the HMSC campus during this reporting period. This included ensuring compliance with Oregon Department of Environmental Quality Toxics Use and Hazardous Waste Reduction Plan (TUHW), onsite monitoring of waste generation and hazardous waste disposal under the facilities small quantity generator status. In October Ms. Boylen consolidated comments of the draft ODEQ permit from the multiple agency users of the NAL treatment facility. She also researched the proposed provisions within the draft permit and provided consultation on the wording to the user group for final comments. The OMI SECO group in Seattle continued to provide safety, CPR and AED 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.

NWFS 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.

NOAA Fisheries Service Office for Law Enforcement (OLE):

NOAA NMFS OLE agents assigned to the Newport Field Office are responsible for the enforcement of more than 100 legislative acts and 35 statutes related to the conservation and protection of marine resources, essential habitat, and other matters of concern to NOAA. These duties are completed through four pillars: Investigations and Patrols, Community Oriented Policing and Problem Solving, Vessel Monitoring Systems and future technologies, and Partnerships with various federal, state,

local, tribal agencies, as well as Fishery Councils and non-governmental and other organizations.

The office also conducts liaison programs with the West Coast Groundfish Observer Program (WCGOP) and Shoreside Catch Monitor Program. Agents conduct formal training, provide guidance, and work closely with the Fisheries Resource Analysis and Monitoring (FRAM) Division and Sustainable Fisheries Division to ensure a safe and hostile free work environment for scientific and monitoring personnel. This partnership between science and regulatory compliance helps to ensure the collection of quality and unbiased data and encourages voluntary compliance by industry members with fishery management plans. This program also helps the science components better understand the importance of the compliance role and its link to obtaining high quality data, personnel safety, and achievement of the goals and objectives of fishery management plans.

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, salmon bioenergetics, 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 (EC Division), 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, 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 habitats, 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-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). He and Dr. Weitkamp 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, Oregon State University, 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 be used to improve harvest management, initially, 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. 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. A major effort for 2010 is development and testing of an at-sea data entry system that will allow fishermen to enter their catch into the system with minimal disruption to the commercial fishing operation. This system is based on the

Canadian E-Log program. The major innovation is development of touch-screen data entry for use at sea.

Salmon Recovery Planning: Recovery planning for salmon populations listed under the Endangered Species Act is a complex process involving both scientists and policymakers. NOAA Fisheries recovery teams are creating recovery plans for all listed salmon in several broad geographic areas (for more information about the process, see <http://www.nwfsc.noaa.gov/trt/oregonnal.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 has completed the initial phase of its work which was utilized in the Biological Review Team Analysis.

Oregon Coast Coho Salmon Biological Review Team: Dr. Lawson is chair of a Biological Review Team (BRT) which is reassessing the status of the Oregon Coast Coho Salmon Evolutionarily Significant Unit. Dr. Weitkamp and Dr. Wainwright also participated, and Heather Stout staffed this BRT. 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.

Alaskan Salmon Marine Ecology: Dr. Weitkamp continues to work with scientists at the NOAA Fisheries Auke Bay Lab in Juneau to document the early ocean ecology of juvenile Chinook and coho salmon in southeast Alaska. This research is part of the Southeast Coastal Monitoring Program, which focuses on the marine ecology of juvenile pink and chum salmon, the dominant salmon species. The study provides a unique opportunity to compare the ecology of Chinook and coho salmon from southeast Alaska with those captured off the Washington and Oregon coasts as part of an FE Division study to understand how salmon respond to diverse marine environments.

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

Dr. Mary Arkoosh, Dr. Joe Dietrich and Deborah Boylen represent the Environmental Conservation Division (EC) in Newport. 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, i.e. field studies to determine how much of the stressor the fish is exposed to during outmigration; (2) dose-response assessment, i.e. laboratory studies to determine if altered health is observed in salmon after exposure to the stressor; and, ultimately (3) risk characterization, i.e. 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, Dr. Joe Groff, Erik Loboschefskey, Kai Eder, and Don Thompson from University California Davis, Stacy Stickland, and Ahna VanGaest, from Earth Resource Technology, Dr. Ed Little from USGS Columbia Environmental Research Center, and Lyndal Johnson, Dr. Nat Scholz, and Gina Ylitalo from the EC Division in Seattle. Agencies and individuals who funded the projects are the US Army Corps of Engineers, Shirley Zylstra and Tory Henderson from the US Forest Service, and Scott Hecht and Tony Hawkes from NOAA’s Office of Protected Resources.

EC LABORATORY STUDIES

Sub-lethal and lethal effects of long-term fire-retardants: EC scientists are currently investigating two products that have been approved by the Forest Service for fire fighting in 2010 and thereafter; PHOS-CHEK 259F and PHOS-CHEK LC-95A. In a 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 their 2010 studies, they are determining the acute toxicity of the fire retardants PHOS-CHEK 259F and PHOS-CHEK LC-95A 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 PHOS-CHEK LC-95A and 259F. A principal element of the sub-lethal exposures is the determination of no-effect concentrations of the fire retardants. 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 submitted to Environmental Chemistry and Toxicology. EC scientists have also exposed juvenile fall Chinook salmon to an environmentally relevant concentration (0.1861 ng/g) of a flame-retardant mixture, polybrominated diphenyl ethers (PBDE mixture: PBDE-47, PBDE-99, PBDE-100, PBDE-153 and PBDE-154), introduced through diet over a 40-day period. The specific chemical composition was designed to reflect the stomach contents of juvenile Chinook salmon previously collected at contaminated sites in the Willamette River. The fish were then challenged by water bath exposure for a 1-hour period to *Listonella anguillarum*, a marine pathogen and causal agent of vibriosis. Mortalities were monitored post-challenge for 21 days. Fish exposed to PBDEs were more susceptible to *L. anguillarum* infection than fish fed a control diet. These results have recently been published in Aquatic Toxicology.

Anadromous Fish Evaluation Passage (AFEP), Characterize the impact of transport operations on disease transmission:

EC scientists 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 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 nested 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 are currently examining the effect of acute and sub-lethal exposure of the pesticide,

malathion, on sub-yearling Chinook salmon that are concurrently experiencing a temperature stress. Although temperature stress has been shown to increase the acute toxicity of malathion in Bluegills, the effect of temperature on either acute or sub-lethal toxicity of malathion to juvenile Chinook salmon is currently unknown. Sub-yearling Chinook salmon will be exposed to malathion at a favorable environmental temperature (12°C) as well as to a temperature that they would normally attempt to avoid (18°C). The EC scientists will examine the acute toxicity of malathion with the generation of lethal concentration (LC) curves after 96-hour exposure to the pesticide. Sub-lethal toxicity will be examined with a disease susceptibility assay. The pathogen, infectious hematopoietic necrosis virus (IHNV), will be used to determine if sub-lethal exposure to malathion impacts salmonid disease susceptibility.

EC FIELD STUDIES

AFEP: Characterize the impact of outmigration history on fish health, pathogen prevalence, and chemical body burdens:

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 submitted to the Journal of Aquatic Animal Health.

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*.

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 assessed 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 Dam 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 seasons. 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 concentrations of POPs than Barged salmon. Elevated levels were due to lipid depletion in all years as well as increased exposure to POPs, as indicated by increased wet weight contaminant concentrations, in some years. 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 effects 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. A synopsis of these results is currently in progress.

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

Drs. Dan Bottom, Ric Brodeur, Robert Emmett, Kym Jacobson, William Peterson, Tom Wainwright, and Julie Scheurer represent the Fish Ecology Division (FE) in Newport and are all members of the NWFSC's Estuarine and Ocean Ecology Program (EOEP). Dr. Laurie Weitkamp is part of the NWFSC's Conservation Biology Division (CB) in Newport and is also an active member

of EOEP. Research programs involve extensive collaboration with scientists from other NWFSC laboratories, Oregon State University, Oregon Graduate Institute, Canadian Department of Fisheries and Oceans, NOAA Alaska Fisheries Science Center, and NOAA Southwest Fisheries Science Center, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, the University of Washington, Ehime University, Virginia Institute of Marine Science, Troy State University, 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, Elizabeth Daly, Jennifer Fisher, Jesse Lamb, Marisa Litz, Jen Menkel, Jason Phillips, and Mary Beth Rew

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

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

Pacific States Marine Fisheries Commission: Greg Hutchinson, James Losee, and Andrew Claiborne

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.

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 Robert Emmett with field assistance from Paul Bentley (NMFS Hammond Laboratory), Marisa Litz, and Andrew Claiborne. Cruises are conducted twice a month off Willapa Bay and the Columbia River. Predators and prey are sampled with a pelagic trawl at 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, 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.

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, and prey fields and relating them to ocean conditions. There are many scientists involved with these studies including Bill Peterson, Ric Brodeur, Jim Ruzicka, Kym Jacobson, Cheryl Morgan, Jesse Lamb, Todd Sandell, Mary Beth Rew, James Losee, Elizabeth Daly, and Julie 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. New promising avenues of research are looking beyond actual prey availability to compare prey quality using lipid and fatty acid composition. Preliminary results show that the fatty acid profiles of salmon change quickly in the transition to the ocean and that they are affected by ocean conditions.

In another project funded by the Bonneville Power Administration, Drs. Peterson and Bi, Cheryl Morgan, and Joe Fisher 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. Bill Pearcy (OSU), they found that the two species maintain a constant depth separation. To further study the habitat requirements of juvenile salmon, we use GIS to map salmon distributions along with oceanographic variables. Hongsheng 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.

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, continued this past year and involves at-sea sampling 2–3 times per month at stations from 1 to 25 miles

west of Newport. The year 2010 marks the beginning of the 15th year of these efforts. At each station, Jay Peterson, Tracy Shaw, Jen Menkel, and Jennifer Fisher measure temperature and salinity profiles and collect samples for later analysis of nutrients, phytoplankton, zooplankton, and ichthyoplankton. Tracy Shaw and Leah Feinberg are analyzing data from the 15-year time series to determine factors that control euphausiid recruitment in the Oregon upwelling zone. Bill 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.

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 in low 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 was expanded to include 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. A similar set of events (delayed upwelling) occurred in 2006, however upwelling was initiated by late May, late, but not so late as to cause a problem for seabirds. Observations of ocean conditions early in 2007 have found a return to cold ocean conditions, a situation which continued through mid-2009, after which a small but significant El Niño resulted in another round of “warm ocean conditions.”

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 Tracy Shaw, Jen Menkel, and Leah Feinberg. Jen 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 joined the lab last fall and is measuring feeding rates of adult *Euphausia pacifica* incubated in natural seawater. She is finding that krill prefer to feed upon ciliates and select against small flagellate phytoplankton.

Copepod Studies: Bill Peterson, Cheryl Morgan, and Jennifer 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. They also have shown that 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 baitfish abundances and juvenile salmon abundance lags a change in PDO by 1–2 years.

Ecological Indicators: Bill Peterson recently completed 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 has been published on the web. This report includes 15 ecological 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 which provides forecasts of salmon survival and salmon returns, using large-scale indices (PDO and ENSO), 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)). 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: Drs. Brodeur, Peterson, and Emmett, and Toby 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 hake, 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. They have also examined interdecadal changes 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 FATE (Fisheries and the Environment) Program has been examining the relationship between winter larval fish and crab abundances and salmon survival the following summer to provide an early indicator of salmon recruitment.

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. Toby Auth, Tristan Britt, and Andrew 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, Tristan Britt and Marisa 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 is using genetically-specified juvenile rockfishes to examine their diets both visually and by the use of stable C and N isotope ratios. In 2009, these surveys collected large numbers of a large, voracious predator, the Humboldt squid, that is usually found in more southern waters and we are examining their potential effect on the ecosystem.

GLOBEC Investigations: Zooplankton studies transitioned from the data acquisition to data synthesis phase. Synthesis activities began in 2005 and 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, and 2) population dynamics of euphausiids. Dr. Hongsheng Bi has developed statistical models of habitat requirements of juvenile salmonids and, with Dr. Bill Peterson and Cheryl Morgan, is developing statistical models that predict coho survival based on measurements of water temperature, chlorophyll, and zooplankton biomass and species composition. Suzan Pool and Drs. Brodeur and Reese are using a different suite of statistical tools (Generalized Additive Models, GIS and Classification and Regression Trees) to examine habitat preferences of juvenile coho and Chinook salmon based on the 2000 and 2002 GLOBEC sampling program.

Dr. Jacobson and Todd 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.

As part of the GLOBEC pan-regional synthesis program, Dr. Ruzicka is developing a coastal food-web model driven by bottom-up (primary production) processes for comparing large-scale ecosystem structure and dynamics between the coastal Gulf of Alaska, the Northern California Current, the Southern Ocean, and Georges Bank. The primary effort of this project to date, and continuing, is the development of trophic models for the Northern California Current off Oregon and Washington. To date, three independent mass-balanced models for years 2003, 2005, and 2007 have been completed, critically evaluated, and finalized. Additional models based on ocean observations for years 2004, 2006, and 2008 are currently in preparation.

Harmful Algal Blooms: Dr. Bill Peterson was recently funded by the NOAA/OHHI program to begin work on Harmful Algal Blooms in Oregon's coastal waters. A post-doc, Dr. Linda O'Higgins, worked on this program from September 2006 through December 2009, but has since moved to Scotland. She will be replaced by Anita McCullough, a recent graduate of North Carolina University and who will join the group in August 2010. This research has found a high incidence of *Pseudonitzschia* in samples collected year-around. Bill works closely with members of the ECOHAB and ORHAB groups at the University of Washington and the NOAA Fisheries Northwest Fisheries Science Center in Seattle, and with HAB scientists from Oregon State University (P. Strutton) and University of Oregon (M. Woods). Strutton, Woods, O'Higgins and Peterson recently received a five-year award from the NOAA MERHAB program to continue work on ecology of HABS and to develop forecasting capability for HABS in Oregon's coastal waters.

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 and is being conducted by Rebecca Baldwin. In 2007 and 2008, we collaborated 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. Richard Brodeur and Doug Reese are collaboration on a project to use LIDAR (laser) technology to survey pelagic schools from airplanes and comparing abundance estimates to shipboard and moored acoustic arrays. A second 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. Researchers

from NOAA's Environmental Technology Lab and University of Alaska, University of Washington, and Oregon State University are also involved in the project.

Time of Ocean Entry Studies: Since 2002 Robert Emmett and recently with Andrew Claiborne and Amanda Kaltenberg have been investigating how 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 survive ocean entry versus smaller smolts (Claiborne et al., *In Review*).

Amanda Kaltenberg (Ph.D., OSU Oceanography) 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 (Kaltenberg 2010). We hypothesize that when forage fish are abundant, marine survival of salmonids should increase because of increased alternative prey for predators. Raw data from 2010 has just arrived back to the lab. Eventually these data will be compared with weekly salmon marine survival data to identify if this hypothesis is valid.

Columbia River Estuary Studies: FE and CB 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 Todd Sandell, Carrie Johnson, Paul Peterson, 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 (CEDC) 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.

Since 2002, a team of researchers led by Dan Bottom and supported by funds from the U.S. Army Corps of Engineers (USACE) and the Bonneville Power Administration (BPA) has been evaluating the effects of flow management and historical habitat change on juvenile salmon in the lower 100 km of the Columbia River estuary. This research supports salmon recovery efforts by providing new information about the estuary's role in salmon life history diversity and population resilience. We have investigated fish and prey assemblages within selected emergent, forested, and scrub-shrub wetlands; historical changes in flow, sediment input, and salmon rearing opportunities; and the effects of habitat change and flow regulation on the estuarine food webs of juvenile salmon. Dr. Jacobson and Andrew Claxton also have examined parasite communities of juvenile salmon to provide independent indices of juvenile salmon diet, habitat use, and habitat health within the Columbia River estuary. Laboratory and field studies have been staged at the NOAA Fisheries Pt. Adams Research Laboratory at Hammond, Oregon by FE scientists Susan Hinton, Regan McNatt, Dr. Curtis Roegner, and Dr. Jen Zamon. Other key members of the estuary research team include researchers from Oregon Health and Sciences University, Portland State University, University of Washington, and the Washington Department of Fish and Wildlife. In 2007, BPA provided support for complementary studies in lower Grays River, a lower Columbia River tributary, where several dike and tidegate removal projects have restored tidal wetland habitats. The Grays River study has examined salmon use of natural and restored wetland habitats, wetland prey production, and salmon life history diversity, comparing these results with the salmon and prey resource data collected in the main-stem Columbia River estuary. The analysis and publication of all the lower-estuary results (since 2002) is continuing.

The estuary research program began a new phase of activity in 2010. Funded by the USACE, this research is identifying the genetic-stock distribution, life histories, and habitat associations of juvenile salmon, with emphasis on the poorly-studied tidal freshwater reaches of the estuary between Rkm 100 and Bonneville Dam (Rkm 231). During the first several years, the study is conducting a series of bimonthly genetic surveys to determine whether patterns of Chinook salmon distribution and habitat use vary among different genetic stock groups. Dr. David Teel has lead responsibility for all genetic analyses. In future years, the estuary research team will use the genetic-survey results to identify key sites and habitat complexes for conducting higher-resolution studies of habitat use by at-risk salmon stocks. In addition to the ongoing field surveys, Dr. Antonio Baptista and staff at the Oregon Health and Sciences University are using a hydrodynamic model to assess the effectiveness of alternative restoration scenarios in the upper reaches of the Columbia River estuary. The results of both field and modeling studies will be used to identify restoration strategies that are most likely to benefit a diversity of Columbia River salmon stocks.

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 entered its ninth successful year deploying observers aboard commercial fishing vessels along the West Coast. Through a cooperative agreement between NOAA Fisheries and the Pacific States Marine Fisheries Commission (PSMFC), observer program staff are stationed along the entire West Coast. The program has several staff members stationed at the Hatfield Marine Science Center (HMSC): Jason Eibner, data debriefer; Jennifer Cramer, data debriefer/data quality controller and training coordinator; and Allen Cramer, Oregon and Washington observer coordinator. Observers are responsible for collecting catch and discard estimates, species composition data, and biological specimens in West Coast groundfish fisheries. The program conducted a thirteen-day training course for new observers in March 2010, and held multiple refresher safety training classes for returning observers and FRAM's at-sea survey staff at HMSC. HMSC's facilities and proximity to the docks make it a great place to train. Observer staff assisted local educators by giving fish identification and physiology classes to grade school children through HMSC's education program, as well as providing fish specimens for the students to dissect. Program staff also worked with the West Coast Groundfish Bottom Trawl Survey to update and improve an extensive species identification guide, and also assisted survey staff with the Southern California Hook and Line Survey. A significant new focus for the observer program in 2010-2011 is observer training and monitoring coordination related to the new West Coast trawl fishery catch share program.

Resource Surveys: The FRAM West Coast Groundfish Bottom Trawl Survey (WCGBTS) program members stationed at HMSC are biologists Keith Bosley, John Buchanan, Erica Fruh, Dan Kamikawa, and biological technician Katie McGourty. They are responsible for conducting annual coast-wide groundfish trawl surveys. The surveys run from Washington to California using a stratified random site selection design from 55m 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 2010 groundfish survey began with the annual At-Sea Safety Training and Survey Orientation sessions held at HMSC 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 contracted fishing 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, the University of Hawaii, and Moss Landing Marine Laboratories, as well as biologists from the Oregon Department of Fish and Wildlife.

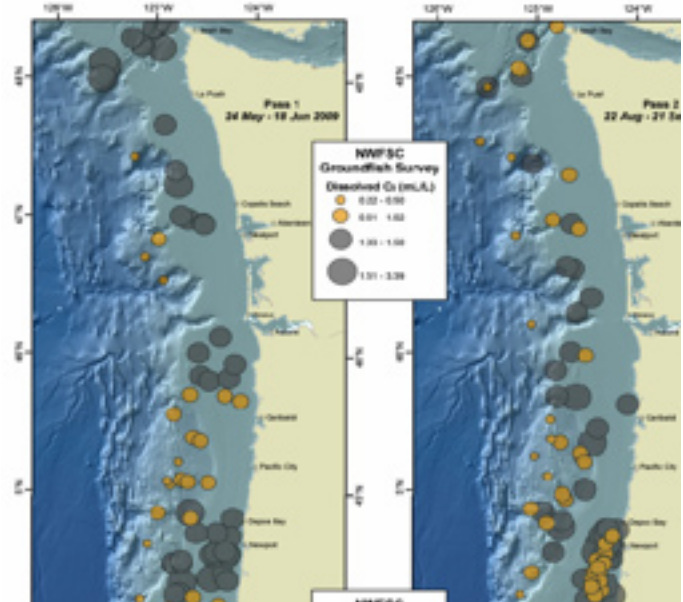
In August 2009, as part of the WCGBTS, scientists examined the abundance of benthic organisms in a known hypoxic area off the Oregon coast. Since 2002, seasonal hypoxia has been observed extending over an area greater than 700 km² offshore of Newport, Oregon. FRAM dedicated 3 days of the groundfish survey to examining the abundance of demersal fish and invertebrates within the hypoxic zone in greater detail, as was initially done in 2007. During the 3-day survey, bottom oxygen concentrations at all stations ranged from 0.55 to 1.48 ml l⁻¹ and was hypoxic along 12 tow tracks. Preliminary results indicate that total catch (kg) and bottom dissolved oxygen (DO, ml l⁻¹) levels for 2009 were significantly related.

In a second hypoxia-related study, individuals from the FRAM Groundfish Survey and Habitat and Conservation Engineering groups (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 2010 WCGBTS.

Acoustics Survey/Research: In addition to coast-wide bottom trawl surveys for groundfish, FRAM scientists from the 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. These include examining the environmental factors driving the distribution of groundfish species, and the application of acoustic and other advanced technologies to fisheries problems.

In 2009, the acoustics group conducted the 2009 Integrated Acoustic and Trawl Survey of Pacific Hake. This survey was conducted from June 27 - August 29, aboard the NOAA Ship *Miller Freeman*. The survey covered the area from Monterey, California (36°N), to the northern extension of the hake that varies from year to year. The scientific team from Newport included Lisa Bonacci, acoustician; Julia Clemons,

oceanographer for both the acoustics and habitat groups; and Waldo Wakefield, project leader for the habitat group. They were joined by Steve Pierce, an oceanographer from OSU. Additional scientific cooperators conducted research on specific legs of the survey as well. Large amounts of Humboldt squid were



2009 sampling station by survey pass: North of Crescent City. The size of the circles are proportional to the concentration of bottom DO (ml l⁻¹) and clearly show low oxygen in deep water within the DO minimum zone as well as low oxygen at shallower depths offshore of Newport Oregon. Low DO appeared to move shoreward as the summer progressed.

encountered during this survey and initiated recommendations by the stock assessment scientists to conduct further research on target strength and sampling designs during the 2010 research season.

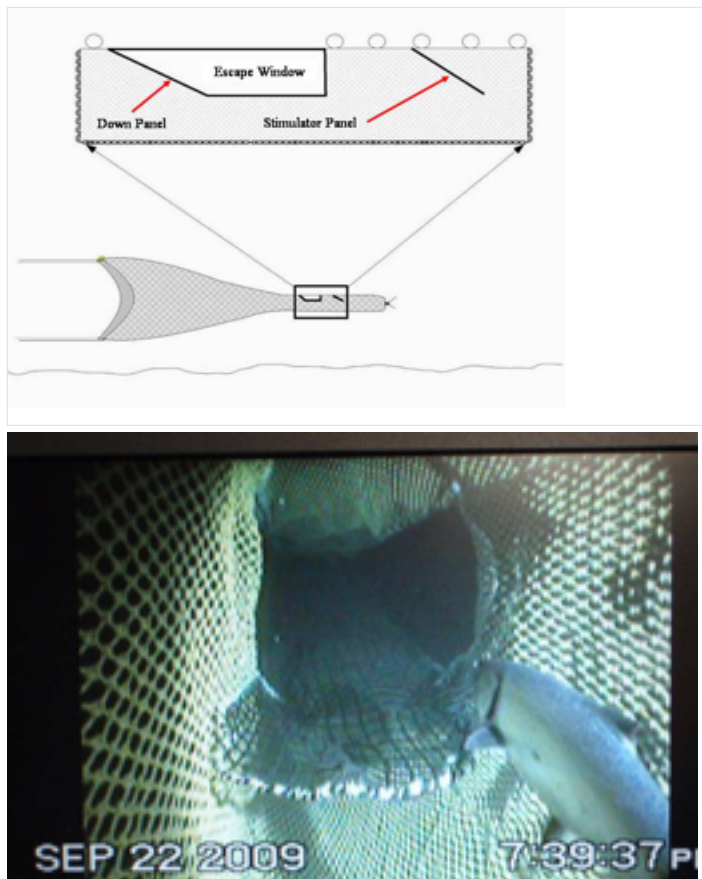
In June-July 2010, two NOAA vessels, the *Miller Freeman* and the *Bell M. Shimada* were staffed by the acoustics team, along with staff and volunteers from other NOAA and university programs. A primary charge for this year's research is to inter-calibrate the fisheries acoustics systems on the two vessels because the NOAA Ship *Bell M. Shimada* is in its first year of deployment. The team is also testing a trawl-net mounted video system that will allow for non-extractive counting and measuring of fish as they pass through an open-ended trawl net. A DIDSON ultra-sonic camera was deployed on the *Shimada*'s CTD rosette as a technology to assist with the target strength measurements. Thus far, the Humboldt squid have not been sighted. Additional work to test out the trawling and fishing systems on the new NOAA vessel is taking place. The team is also studying the accuracy of the groundtruthing trawl net hauls compared to the fishery acoustics signals.

Habitat and Conservation Engineering: The FRAM Habitat and Conservation Engineering (HCE) group is located at HMSC. The HCE group consists of Waldo Wakefield; Julia Clemons; and Mark Lomeli, a collaborator from the Pacific States Marine Fisheries Commission (PSMFC). 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 has an ongoing collaboration with Chris Goldfinger's Active Tectonics and Seafloor Mapping Laboratory (ATSML) at Oregon State University to develop and maintain a marine habitat database for the U.S. west coast. Initiated in 2001, the goal of this program was to create and use a multi-layered GIS database for groundfish habitat assessment with a focus on the Pacific Northwest. 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 2009, the HCE group, working jointly with the PSMFC and the Oregon Department of Fish and Wildlife (ODFW), developed and began field testing an open escape window bycatch reduction device (BRD) to reduce ESA-listed Chinook salmon and rockfish (genus *Sebastes*) bycatch (e.g., darkblotched, canary, and widow) in the Pacific whiting fishery. The development of this BRD benefited from extensive interactions with scientists, especially those from the NMFS Alaska Fisheries Science Center, commercial fishermen, and gear manufacturers working in the Pacific Northwest and Alaska.



Schematic view of midwater trawl and open escape window bycatch reduction device (BRD) (top). Chinook salmon (ca. 80 cm) approaching BRD's escape window (bottom).

In addition to the above work on flexible sorting grids, the HCE group has continued work on two additional bycatch reduction research projects. The first project is a collaboration with the gear research group at ODFW (Bob Hannah and Keith

Matteson) and PSMFC (Mark Lomeli). This project focuses on observations of fish behavior in the vicinity of the footrope of the bycatch-reducing selective flatfish trawl, using a dual-frequency identification sonar (DIDSON) ultrasonic camera. A second bycatch reduction related collaboration involving ODFW (Bob Hannah and Steve Jones) and PSMFC (Mark Lomeli) focuses on developing more efficient shrimp trawls with footrope designs that reduce both impacts on megafaunal invertebrates and the bycatch of small demersal fishes.

In 2010, a team of NMFS scientists, including Waldo Wakefield from the NWFSC Newport Lab, completed a national Habitat Assessment Improvement Plan (HAIP) for the U.S. This is the first nationally coordinated plan to focus on the marine fisheries aspects of habitat science.

Groundfish Stock Assessment Team: The FRAM stock assessment team (STAT) leads assessment activities for west coast groundfish. Analysts conduct fishery stock assessments to estimate the current status and future trends in abundance and productivity of west 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.

Most groundfish stock assessments and stock assessment review (STAR) panels are conducted on a biennial schedule (in odd-numbered years) to accommodate the Pacific Fishery Management Council's (PFMC) management process. The exception to this is Pacific hake (also known as Pacific whiting) which is assessed and reviewed annually and will be the only stock assessment conducted in 2010. Benchmark assessments are reviewed within the Council's STAR process, which includes a multi-day review by a panel which includes independent reviewers and a member of the Council's Scientific and Statistical Committee (SSC). For some species, previously reviewed assessments are updated, with science review provided only by the SSC, prior to use by the Council. Typically, in an odd-numbered year, the FRAM Assessment Team develops 5-7 benchmark assessments and 2-4 assessment updates.

During "off-assessment" years, analysts conduct research on a wide variety of topics relating to improving the understanding of and ability to model West Coast groundfish populations. This research includes the exploration of stock characteristics, as well as ways to improve stock assessment methods, to capture and report scientific uncertainty more completely, and to improve extraction, processing, and synthesis of data included in assessments. Research promoting the evolution of stock assessment methods includes developing approaches which are appropriate for circumstances where data are very limited, and incorporating ecosystem considerations into assessment models. Additionally, the Assessment Team works with FRAM's

Observer and Survey Teams, as well as with state fishery agencies, to help ensure that efficient and effective objectives are established for the collection of biological data to support assessment activities.

Four members of the stock assessment team are stationed at HMSC: Vladlena Gertseva and Andi Stephens, stock assessment analysts; Stacey Miller, stock assessment coordinator; and, Curt Whitmire, information technology specialist.

Ongoing research projects by the assessment team at HMSC include: development of individually-based models to examine genetic drift as a response to fishing pressure, developing methods to quantify and incorporate spatial and temporal variability in life history characteristics and climate-growth relationships into groundfish stock assessment models, investigating geographic variation in growth and maturity of skates over large marine ecosystems, and utilizing an autonomous underwater vehicle to measure habitat-specific densities of various demersal fishes.

Additionally, Vladlena Gertseva and Andi Stephens, in collaboration with ODFW, have recently completed a reconstruction of historical landings in Oregon for rockfish and flatfish dating back to 1927. The historical reconstruction will improve the reliability of species-specific time-series of landings for use in stock assessments. Planning for the 2011 assessment cycle is currently underway.

The Cooperative 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 that accumulate layers annually 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 is currently ageing otoliths for stocks to be assessed during the upcoming 2011 assessment cycle. Ageing specialists located at HMSC are Patrick McDonald, Nikki Atkins, Betty Kamikawa, Omar Rodriguez, and Meredith Cavanaugh.

The ages 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. Ageing specialists also collaborate with stock assessment scientists and staff from other ageing labs to improve current ageing methods, evaluate alternate ageing approaches, and better understand the uncertainty associated with age determination. Currently, CAP personnel are collaborating with NWFSC assessment scientists to investigate rapid age determination methods using otolith morphometrics for four groundfish species with very different otolith morphologies (Pacific hake, petrale sole, sablefish, and splitnose rockfish). A possible benefit of this method is faster and more precise ageing with no reduction in accuracy, which decreases subjective analysis. The preliminary results demonstrate that otolith weight is a strong predictor of age in Pacific hake and petrale sole using a piecewise predictive model with the breakpoint occurring around the age

of maturation. Predictive performance was poorer in the two long-lived species: sablefish and splitnose rockfish. The lack of fit affected the growth coefficient estimates the most, with the poorest fit occurring at transition ages of maturity. Otoliths can be notoriously hard to read at these ages, and the poor model fits may not be due to a weak underlying otolith weight-to-age relationship, but rather inaccurate ages.

Additionally, CAP provides ages for vermillion and sunset rockfish caught during FRAM's Hook and Line survey in Southern California. 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.

Oceanic and Atmospheric Research Division

Pacific Marine Environmental Laboratory (PMEL)

Vents Program

Steve Hammond, Director

The Vents Program, which is part of NOAA's Pacific Marine Environmental Laboratory, is an interdisciplinary research effort focused on discovering and quantifying the effects of submarine volcanic and hydrothermal activity on the world's oceans. The program's team of Principal Investigators includes federal employees (Steve Hammond, Bob Embley, and John Lupton) and also PIs affiliated with OSU's Cooperative Institute for Marine Resources Studies (Bob Dziak, Bill Chadwick, and Dave Mellinger). The Vents Program efforts in Newport can roughly be divided into three research areas: an ocean acoustics group (headed by Bob Dziak), a geology and geophysics group (headed by Bob Embley and Bill Chadwick), and the helium isotope laboratory (headed by John Lupton). This research is supported by a diverse team of CIMRS research staff, including (in alphabetical order) Andra Bobbitt, Leigh Evans, Matt Fowler, Ron Greene, Joe Haxel, Andy Lau, Haru Matsumoto, and Susan Merle. We also receive valuable assistance from Jessica Black and Jonathan Klay, both federal employees.

The 2010 expedition to NW Rota-1 submarine volcano was a great success, despite the challenges faced at sea. We found that the volcano was still actively erupting even though it had experienced a major landslide since our previous visit a year ago. The landslide was a mixed blessing, because on the one hand it gave us a unprecedented view of how arc volcanoes grow by the cyclic process of eruption, collapse, and regrowth, how the volcano's magmatic and hydrothermal systems responded to such a large perturbation, and how the resident chemosynthetic biological community was impacted. On the other hand, the landslide destroyed some of the instrument moorings that we left last year to monitor the volcano's activity, and that is a major disappointment. We had hoped to capture just this kind of event, but this one turned out to be much larger than we thought possible. Still, we were able to recover one hydrophone mooring and will be examining the sound recordings it made shortly. It is safe to say that these processes have never been documented in such detail and we are sure to learn new things about submarine

eruptions as well as large mass-wasting events and their impacts. <http://nwrota2010.blogspot.com/>

The Acoustic Monitoring Project of the PMEL Vents Program provides wide-area, continuous seismic monitoring of global ridge systems using low-frequency acoustics. There are five main experiments/projects that were our research focus this past year: 1) in March 2010, we deployed a trawl protected, passive acoustic (hydrophone) mooring at the wave energy test bed site off Yaquina Head, Newport Oregon. The goal of the project is collect several months of ambient sound levels to provide a site characterization of background noise prior to any wave energy device installation. The background levels will provide a baseline of acoustic observations to assess potential sound impacts on marine ecosystems in the area. 2) During April 2010, NSF funded a cruise aboard the R/V Kilo Moana to recover of 12 hydrophones in the Lau basin back-arc spreading centers. Study will look at volcanic activity in region and address seismo-acoustic propagation. Hydrophones were deployed contemporaneously as a 60-instrument OBS array. 3) During December 2009, we deployed a 4-element hydrophone array at the continually erupting West Mata volcano in the northeast Lau Basin to identify the unique volcano explosion sounds and potential new eruption vents. West Mata volcano is the deepest erupting volcano ever observed. These four hydrophones were recovered during the April 2010 cruise. 4) Performed 3-day test deployment of an ocean glider in the Lau basin, western Pacific. Glider was equipped with a hydrophone to record sounds of volcanic activity in the region. 5) Recovered and re-deployed 5 hydrophones in the Bransfield strait, off the west Antarctic Peninsula to continue monitoring efforts in advance of ROV expedition in January 2011. This will add to the two-year earthquake dataset time-series of Bransfield, where we have identified 8 active volcanic centers. Sponsored by KOPRI and OE.

We have also developed two new acoustic platforms and tested in open ocean. One is a glider-based system, which is built from the slocum glider from the Teledyne Webb Research (MA). It is capable of “flying” and navigating around the survey area for up to 40 days. By controlling the buoyancy and going up and down the water column up to 1000-m, it can navigate up to 40cm/s of horizontal speed. Besides the acoustic system designed by OSU/PMEL, it is equipped with a standard CTD, chlorophyll and turbidity sensors. The acoustic glider was tested off Kona in this March and surveyed near the active underwater volcano of West Mata in the Northern Lau Basin.

The other platform developed and operated successfully was the QUEphone. It is a vertical profiler float system which can go up and down the water column by the same buoyancy engine principle as the glider. We have developed a high-sampling-rate (125kHz) acoustic system and an interface to control the float. A new DSP-based system can detect and identify the whale calls including beaked whale. It can repeat vertical profiles up to 50 times for a few months. Both the acoustic glider and QUEphone are near real-time systems, which can send short messages related to the acoustic events of the field where they are moving through or receive commands related to the mission control.

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 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 close 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:

- ***Demonstrating that the expression levels of stress-related genes in juvenile Pacific oysters are predictive of subsequent growth and survival in field trials.*** Currently, oyster breeding relies on lengthy and labor-intensive field trials for selective breeding, and this research indicates that molecular testing may provide a rapid, low-cost alternative. We tested sub-samples from families produced as part of a USDA/NIFA- funded oyster breeding program under laboratory conditions and tested for correlations between the test results and field data. We conclude that assays measuring gene expression in whole bodies of juveniles hold promise for predicting performance of Pacific oyster families and thus accelerating and streamlining genetic improvement efforts.
- ***Showing that the effective population size in brooding European flat oysters is less affected by sweepstakes recruitment than in previously studied species of broadcast spawning oysters.*** Low effective population size makes populations more sensitive to human-mediated genetic impacts from transplantation or hatchery-based restoration. We analysed recruitment in European flat oyster populations in France using molecular markers to determine how many

parents successfully reproduce and found little evidence that different bouts of reproduction are genetically differentiated. This has important implications for the management and restoration of brooding oyster populations because they are less susceptible to genetic impacts than previously studied species.

- ***Developing a partnership with NIFA- supported Pacific oyster breeding program to improve selective breeding protocols and address emerging challenges and opportunities.*** The NIFA-funded Molluscan Broodstock Program (MBP) has, since 1995, selectively bred Pacific oysters for enhanced yield using unconventional methods that are inadequate to address emerging problems with oyster seed production in commercial hatcheries related to ocean acidification. Scientists from the USDA-ARS Shellfish Genetics Program in Newport, Oregon worked closely with MBP to develop a collaborative plan of work to elucidate the potential for genetic improvement for larval survival and trade-offs with other characters. This will facilitate the transition from a single-trait breeding program to a genetically rigorous, multi-trait strategy that can address current problems and opportunities for the cultured oyster industry in the Pacific Northwest.

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 and target these efforts to the most appropriate life history stage when shrimp populations are high. Shrimp population monitoring efforts were continued in four coastal estuaries and results suggest that ghost shrimp recruitment continues to be very low in all estuaries (though an early recruitment event to Oregon estuaries occurred in June 2010), while mud shrimp recruited extensively to Yaquina Bay and Tillamook Bay in Oregon in 2006 and 2007 with low to moderate recruitment from 2008-2010. Mud shrimp populations have collapsed in Washington estuaries and these shrimp did not recruit to our monitoring sites in Willapa Bay and Grays Harbor (except to Willapa Bay in 2010). A collaborative project with Dr. John Chapman at HMSC indicates that an introduced parasitic bopyrid isopod greatly influences reproduction in mud shrimp and likely contributed to their decline. A method using the ageing pigment lipofuscin in shrimp neural tissue was modified and successfully used to examine the age 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. Along with mapping efforts which have shown that shrimp populations are also declining in size in both Yaquina Bay, Oregon and Willapa Bay, Washington, they should enable us to quantitatively examine population dynamics of shrimp in these estuaries. Low shrimp recruitment should be reducing the need to control them in Washington estuaries. Nonetheless, shrimp are still 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. Experiments designed to investigate control of newly settled juvenile shrimp are also underway using both hatchery reared post-larvae and the 2010 year class of ghost shrimp sampled from the wild.

- ***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 investigating landscape scale processes like the function of edge habitats.

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 2009-10, the Oregon Coast National Wildlife Refuge Complex had eight permanent employees, one temporary Biological Technician, one temporary Office Clerk, and one AmeriCorps member located at the HMSC. The Refuge Complex's South Coast Office in Bandon had two permanent employees, one Term Restoration Biologist, one temporary Biological Technician, one temporary Office Clerk, one AmeriCorps member, 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 May 2010, the USFWS acquired a 5.17 parcel of tidal salt marsh located within the Brooten Marsh Unit of Nestucca Bay NWR. This parcel was the last privately owned tidal salt marsh in this area, and its acquisition completed the USFWS ownership of this relatively pristine tidal marsh at the confluence of the Nestucca and Little Nestucca rivers.

Planning for the 418-acre Ni-les'tun Tidal Marsh Restoration Project on Bandon Marsh NWR continued through 2009 and into 2010. In June 2010, after more than 10 years of land acquisition, planning, design and preparation, major construction began on the restoration project and is scheduled for completion in late summer 2010. Phase I preliminary restoration work began during the summer of 2009 and included obliteration of over 12 miles of the smaller agricultural drainage ditches. Some of the new tidal channels that will deliver tidal flows to the upper marsh were dug. As part of Phase II construction in 2010, the majority of the 5 miles of tidal channels will be dug, larger drainage ditches will be filled, the dike along the river will be lowered, and tide gates will be removed. This will allow the unimpeded return of the daily tides on this area for the first time in more than a century, and plants and wildlife will start adjusting to the newly restored conditions.

The tidal marsh restoration project will be constructed by the Knife River Corporation of Coos Bay, Oregon who is under contract with our partner Ducks Unlimited to complete this work. The restoration project also involves two other major construction projects. North Bank Lane, a county road, will be raised approximately 7 feet along two extended locations within the refuge to prevent this area from flooding due to tidal inundation and improve safety on north Bank Lane. Tidewater Contractors Inc. of Brookings, Oregon is under contract with the Federal Highway Administration to perform the road improvements, which are scheduled for construction in 2010 and paving in 2011. The third related 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 of Federal Way, Washington to

underground the transmission line and this project is funded by Federal Stimulus (ARRA) Funds.

Annual wildlife surveys included the monitoring of nesting seabirds (e.g. common murre, Brandt's cormorant and pelagic cormorant), peregrine falcons, bald eagles, Aleutian cackling and dusky Canada geese, black brant, wintering waterfowl, and brown pelicans. Research and monitoring of Steller sea lions continues at Rogue Reef, in cooperation with NOAA-Fisheries and the Oregon Department of Fish and Wildlife's Marine Mammal Program. The Refuge Complex is conducting tufted puffin research at Haystack Rock in Cannon Beach and provided funding to hire an independent biologist, a biological science technician, and volunteer to assist with the project. This project will be 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. A citizen science effort, where volunteers monitor tufted puffins through a pilot "Adopt-a-Burrow" program, will be an important component of the project, conducted in partnership with the Haystack Rock Awareness Program (HRAP). In addition, HRAP will incorporate a public outreach program into the puffin project to build greater appreciation and awareness of the species, its relationships to changes in marine ecosystems, and the need for marine conservation. The study is expected to receive strong public interest due to the charismatic nature and local rarity of the tufted puffin. 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. This year, Oregon's Annual Junior Duck Stamp Competition received 329 artwork entries from public, private, and home schools across the state. The 2010 Oregon "Best of Show" winner was Christine Swanson, an 18 year old art student at Renaissance School of Fine Art in Tigard. She submitted an acrylic and airbrush rendition of a Ringnecked Duck. For the seventh year in a row environmental educators hired through the AmeriCorps National Service Program brought the Shorebird Sister Schools Program to almost 700 4th and 5th grade students from Newport to Bandon. The students learned about estuaries, bird behavior, adaptations, migration, and conservation and ended the program with a field trip to their local estuary. Volunteers were again critical to Refuge Complex operations this year. Dave and Diane Bilderback, volunteers at Bandon Marsh NWR, are working on their third year as volunteers with the USFWS and together have donated over 1,400 hours of their time this year.

Newport Field Office **Laura Todd, Field Supervisor**

The Newport Field Office (NFO) of Ecological Services 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 one volunteer. 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 the purpose of providing funding 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 2009-2010, the Newport Field Office celebrated a number of accomplishments:

- Completed several restoration or habitat assessment projects under the Coastal Program, including the initial phases of a large tidal wetland restoration on the Miami River in the Tillamook Bay area, which was funded through the American Reinvestment and Recovery Act.
- To improve the population numbers and distribution of the threatened Oregon silverspot butterfly, we released thousands of pupae and caterpillars on the north and central Oregon coast, with the assistance of dozens of student, community, and visiting volunteers. To improve habitat, volunteers and Service staff also planted early blue violets, the host plant for Oregon silverspot larvae, and/or native nectar plants at several locations, including a new site on the Nestucca Bay National Wildlife Refuge.
- Contributed to Western snowy plover recovery efforts throughout the state including predator control, nest protection and monitoring, habitat restoration, law enforcement, and public education.
- Worked with Oregon Parks and Recreation Department to finalize a state-wide Habitat Conservation Plan (HCP) for Western snowy plovers along 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. The final HCP was approved by the Oregon Parks and Recreation Commission in May 2010, and the HCP and final Environmental Impact Statement are expected to be released for final public comment in late summer to Fall 2010.
- Coordinated volunteers and biologists for the annual Black oystercatcher and winter and spring Western snowy plover surveys along the Oregon Coast.
- Supported a number of recovery projects and habitat restoration for sensitive species on the Oregon Coast, including Oregon Coast Aquarium rescue and treatment of two severely hypothermic sea turtles. With the support of the U.S. Coast Guard, the Olive Ridley and Pacific green turtles, both female, were returned to SeaWorld San Diego, and both are expected to be released this summer.

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 2009 the USGS and EPA sponsored a one day workshop to identify sea level rise modeling needs/efforts beginning or on-going on the Oregon Coast which brought together federal, state, and NGO land stewards, modelers, and GIS specialists. A second workshop is scheduled to be held here at the Hatfield Science Center in February 2011. Sea level rise will effect the distribution and availability of suitable habitat for many estuarine species on the Oregon Coast. 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.

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. Data collection has begun and much of the programming groundwork necessary to do so was completed this year.

USGS staff at HMSC consists of 6 federal employees, 2 OSU doctoral students 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 that affect Oregon fish and shellfish stocks, fisheries, and coastal communities. In March 2008 the governor designated ODFW as the lead agency in his efforts to establish marine reserves in Oregon's ocean waters. The program's work focuses on three major categories:

- marine resource policy, management and regulation
- fisheries monitoring and data collection
- research on marine fisheries, 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 at Astoria, Tillamook, Charleston, Central Point, 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 \$6.5 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 manages marine waters from the innermost margin of estuaries to 200 miles out in the ocean. Watershed management, from the upstream estuary environment to inland freshwater

outflows, is handled by a pair of separate ODFW programs, the Northwest Region and Southwest Region, which coordinate with the MRP.

U.S. ocean fisheries are managed at the federal level through the Magnuson-Stevens Fishery Conservation and Management (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 would generally fall under state jurisdiction for fishery management. From three miles to the 200-nautical-mile distance, federal authority establishes fishery regulations. 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.

Development of Marine Reserves in Oregon: In 2009, the Oregon legislature passed marine reserves legislation (HB 3013) that directs state agencies to implement marine reserve recommendations made by the Oregon Ocean Policy Advisory Council (OPAC), provides for funding of marine reserves work, and requires ODFW to develop a marine reserves work plan. The specific call of the legislation is to implement the OPAC recommendations by adopting rules to establish two marine reserve pilot sites; studying and evaluating potential marine reserves at three additional areas; and supporting the development of a new marine reserve proposal at one final area. ODFW has hired five marine reserves staff to work on implementation of HB 3013, and a marine reserves work plan was finalized in November 2009, for work to be conducted during the 2009-2010 biennium. A summary of completed and planned work follows.

Pilot sites:

- The two pilot sites have been established through state agency rule making. Harvest prohibitions will take effect on June 30, 2011.
- ODFW staff are working with scientific experts and pilot site community teams to develop biological and socioeconomic baseline studies and plans for long term monitoring at each site.
- ODFW staff are working with pilot site community teams and other state agency staff to develop management plans for each site. Management plans will: incorporate biological and socioeconomic monitoring plans, include strategies for education and outreach, and include strategies for compliance and enforcement.
- Biological and socioeconomic baseline studies and year zero data for long term monitoring will be conducted starting in summer 2010 and completed by June 2011.
- ODFW will present a progress report to an interim legislative committee in November 2010.
- Reports on baseline studies and year zero of monitoring will be completed by June 2011.

Evaluation sites:

- Community teams representing diverse and balanced stakeholder interests, as prescribed in HB 3013, have been

formed for each of the three evaluation sites and have been meeting since January 2010.

- Each team is to evaluate the original marine reserve site proposal recommended by OPAC. Specifically, each site must meet the 2 sideboards established by Governor's Executive Order 08-07: the site is large enough to allow scientific evaluation of ecological benefits, but small enough to avoid significant economic or social impacts.
- State agency staff will compile and provide existing data and information to assist the community teams in their evaluation. New data may be collected depending on information needs, securing additional funds, and time.
- Community teams are to determine whether adjustments to the original proposed site must be made to meet sideboards.
- Community teams are to forward a final site recommendation to ODFW by October 2010.
- ODFW is to present a progress report to an interim legislative committee in November 2010.

Proposal site:

- The International Port of Coos Bay is leading a community effort to potentially propose a marine reserve site for further evaluation.

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 primary focus of our work in 2009-2010 was implementation of Marine Mammal Protection Act Section 120 authority to manage California sea lions predated threatened and endangered salmonids at Bonneville Dam on the Columbia River. Related work included completion of the 14th season of marking California sea lions in Astoria and initiation of a Steller sea lion acoustic and satellite telemetry study at Bonneville Dam. Other program activities included: participation in the Northwest Marine Mammal Stranding Network; completion of the 9th year of a mark-resight survival study on Steller sea lions; and analysis of pinniped fecal samples (including preparation of a manuscript on Steller sea lion food habits in Oregon). Federal, state, and tribal cooperators for 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.

Expanded Shellfish Program: In 2004, the Oregon Legislature enacted a new sport shellfish license requirement with all resulting revenues dedicated to enhance enforcement of shellfish regulations (Oregon State Police), public health (Oregon Department of Agriculture) and management, monitoring,

research and public education (Oregon Department of Fish and Wildlife (ODFW)). MRP's shellfish program expanded in 2007 with the addition of four new permanent positions and seven limited duration positions and again in 2009 with the addition of five new permanent positions all dedicated to research and assessment of shellfish species and estuarine habitat.

In 2006, ODFW's Marine Resources Program in Newport began catch and effort surveys for the recreational crab fisheries in Yaquina and Alsea Bays. In addition to these efforts, Newport shellfish staff began a sampling project in Yaquina Bay in May, 2007 to collect more specific information about the bay crab resource. With the new permanent positions, 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 research is to further our understanding of the recreational crab resource and factors affecting the sustainability of this resource.

Oregon's Harmful Algal Bloom monitoring project was initiated in June of 2005, after a coast wide shellfish harvesting closure due to Domoic Acid. Through NOAA's MERHAB-CSCOR (Monitoring and Event Response Harmful Algal Blooms-Center for Sponsored Coastal Ocean Research) emergency response funding, Oregon was able to develop a monitoring program similar to Washington State's ORHAB (Olympic Region Harmful Algal Bloom) project. In 2006, ODFW in collaboration with Oregon State University, University of Oregon and the NOAA Northwest Fisheries Science Center were awarded a five-year, nearly \$2,300,000 grant to develop an integrated harmful algal bloom (HAB) monitoring and event response program. This new program, Monitoring Oregon's Coastal Harmful Algae (MOCHA) has been collecting data since 2007. Currently ODFW staff, in conjunction with Oregon Department of Agriculture, is working to monitor 10 sites along the coast of Oregon for any potential signs of the phytoplankton that cause Domoic Acid (*Pseudo-nitzschia* sp.) and Paralytic Shellfish Poisoning (*Alexandrium* sp.).

MRP Astoria office shellfish staff began annual razor clam stock assessment research 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 2008-2009 MRP biologists assessed clam populations in Coos 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 for each species. Maps and other select results can be found at <http://www.dfw.state.or.us/MRP/shellfish/Seacor/index.asp>. Data from the project is available from the ODFW data clearinghouse: <https://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?p=202&XMLname=884.xml>. A formal agency report will be released by winter 2011 and posted on the shellfish and estuarine habitat assessment web site.

Starting April 2010 and continuing into 2011 the focus of the

assessment team will be on Tillamook Bay. Similar to the survey in Coos Bay, MRP biologists will focus on the four recreational and commercially important species of bay clams and determine estuarine habitat associations for these species. Additionally, the group will evaluate different sampling methods to determine the most efficient and statistically robust approach to track bay clam populations in Oregon estuaries. Preliminary results will be presented to the HMSC community in the fall 2010 seminar series.

Commercial Dungeness Crab Fishery Management: In May 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 will increase the capacity of ODFW to be proactive in management of the fishery.

The agency completed the first year of a two-year project to recover derelict crab gear off Oregon, funded by a \$735,000 federal economic stimulus grant. During 2009, the program recovered more than 67 metric tons of marine debris, including 1,359 crab pots. Recovery activities will be repeated during the fall of 2010.

2009-10 Research:

- Reducing commercial fishery bycatch: ODFW is continuing to work with the pink shrimp fishing fleet to enhance the progress made with pink shrimp bycatch reduction devices (BRDs) in 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 are continuing 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.
- Studying movement of nearshore rocky reef fishes: Studies currently underway include acoustic tagging of several rockfish species at reefs off Cape Perpetua to study movements generally and also movements in response to hypoxia.
- Black rockfish research: MRP researchers are in the eighth year of a black rockfish mark-and-recapture project off Newport. The project began in the summer of 2001 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: Ongoing research is evaluating the use of a simple video lander to measure distribution and abundance of several demersal rockfishes on Oregon's nearshore rocky reefs.
- Female fish maturity: Work continues on maturity studies to develop improved female length/age at maturity for fish species for which little information exists, such as quillback, china, vermillion, tiger, and copper rockfish.
- Ageing studies: Recent research in collaboration with NMFS Apex Predators lab is examining ways to use histology techniques to enhance the banding of thin sections of longnose skate vertebral centra.
- Hypoxia effects on seafloor communities: MRP partnered with OSU's Partnership for Interdisciplinary Study of Coastal Oceans (PISCO) program to document and describe the ecological effects of hypoxia events on fish and seafloor communities conducting Remotely Operated Vehicle (ROV) survey work off Cape Perpetua during October 2009. ODFW obtained Sea Grant funding to continue and expand this work during 2010-11. The MRP will conduct pre-, during-, and post-hypoxia ROV surveys during each of the next two years at three locations along the central Oregon coast (Cape Perpetua, Yaquina Head, and Siletz Reef). In concert with PISCO's oceanographic data collection efforts (e.g., temperature, salinity, dissolved oxygen content), MRP researchers collected video footage of seafloor organisms along a previously-established transect line that has been surveyed regularly since 2000.
- ROV survey of habitat and fish communities at Otter Rock: MRP personnel completed a survey of benthic habitat and fish communities at a reef complex offshore of Otter Rock on Oregon's central coast (Lincoln County). We teamed up with the United States Geological Service and OSU's Active Tectonics Laboratory to provide visual ground-truthing data for this newly-mapped area using the MRP ROV. This ongoing research quantifies species-habitat associations and characterizes the biota and habitat on Oregon's nearshore rocky reefs.
- ROV survey of fish species-habitat associations at Siletz Reef: The MRP completed a survey of benthic fish communities at a reef complex offshore of Lincoln City on Oregon's central coast with the ultimate goal of habitat-based stock assessments for nearshore groundfish species. Using existing high-resolution bathymetry data, biologists analyzed species-specific locations of individual fish against bathymetry-derived explanatory variables (e.g., seafloor slope, rugosity, Bathymetric Position Index) at various spatial scales to statistically test for habitat affinities.
- Ground-truthing seafloor habitat at Redfish Rocks Reef: MRP partnered with OSU's Active Tectonics Laboratory, the Port Orford Ocean Resource Team, and Golden Consulting to ground-truth newly-collected multi-beam bathymetry data for Redfish Rocks near Port Orford. We have digitally captured archived videotapes containing footage from historical (1993-2008) dives using SCUBA, ROV, and the Delta submersible, and provided these data to our partners for further interpretation. Development of the final interpreted map product is in progress at OSU.

C. HMSC Visiting Scientists

HMSC Visiting Scientists

Maryann Bozza, 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. Through this endowment, HMSC was honored to host Dr. Robert “Bob” Pettit of Arizona State University in 2009. Dr. Pettit spent a month in residence at HMSC, collaborating with researchers from various departments on the potential development of a marine drug and biodiscovery unit at Oregon State University, and took the opportunity to engage the local community through a public lecture on his research.

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 2009	Credit	Course Title	2009-2010 Enrollment
BI 150	4	Introduction to Marine Biology (Newell) - CANCELLED	0
BI 302	4	Biology and Conservation of Marine Mammals (Sumich)	3
BI 421	4	Aquatic Biological Invasions (Chapman)	3
FW 302	4	Biology and Conservation of Marine Mammals (Sumich)	3
FW 421	4	Aquatic Biological Invasions (Chapman)	4
FW 521	4	Aquatic Biological Invasions (Chapman)	1
SED 431	3	Overview of Free Choice Learning (Rowe) - CANCELLED	0
SED 531	3	Overview of Free Choice Learning (Rowe) - CANCELLED	0
SED 808	3	Overview of Free Choice Learning (Rowe) - CANCELLED	0

Fall 2009	Credit	Course Title	2009-2010 Enrollment
AqS 100 (OCCC)	3	Intro to Aquarium Science (M. Mann)	20
AqS 215 (OCCC)	4	Biology of Captive Fishes (M. Mann)	14
AqS 240 (OCCC)	4	Life Support Systems and Design (M. Mann)	14
BI 111	1	Introduction to Marine Life in the Sea: Marine Mammals (Sumich)	7
FW 111	1	Introduction to Marine Life in the Sea: Marine Mammals (Sumich)	2
FW 407/507	1	HMSC Research Seminar (Boehlert)	11
FW 426/526	5	Coastal Ecology and Resource Management (Langdon)	11
FW 441/442	1	Intro to Group Problem Solving (Langdon)	0
FW 454/554	5	Fishery Biology (Heppell)	17
FW 499/599	1	Ecology of Coastal Fishes (Emmett/Weikamp)	6
FW 499/599	3	Whales and Whaling (Baker)	6
FW 520	3	Ecology and Management of Marine Fishes (Heppell)	12
OC 599	3	Math on the Beach (Smyth)	9

Winter 2010	Credit	Course Title	2009-2010 Enrollment
BI 111	1	Introduction to Marine Life in the Sea (Cheung)	11
FW 111	1	Introduction to Marine Life in the Sea (Cheung)	10
FS 199	1	Ecology of Oregon Coastal Forests (Black)	16
FW 407/507	1	HMSC Seminar (Staff)	3

Spring 2010	Credit	Course Title	2009-2010 Enrollment
BI 111	1	Intro to Marine Life in the Sea: Marine Birds (Suryan)	8
BI 450	16	Marine Biology Lab and Lecture (Hacker)	22
FW 111	1	Intro to Marine Life in the Sea: Marine Birds (Suryan)	5
VMB 727	2	Ornamental Fish Medicine (Miller-Morgan)	8
ST 512	4	Methods of Data Analysis (Madsen) - ITV	3
ST 513	4	Methods of Data Analysis (Gitelman) - ITV	4
ST 515	3	Design and Analysis of Planned Experiments (Murtaugh) - ITV	3

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, 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 2009-10, twenty-one 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-two students were selected (through a competitive application process 200 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 2009. In addition, three undergraduate students participated in the HMSC Visitor Center Internship in marine science education. Three undergraduate students participated in the NOAA Hollings Scholar program. Two community colleges students transferring to OSU participated in the COSEE PP PRIME internship. There were two visiting summer undergraduate researchers with EPA. One OSU undergraduate student participated in the state sponsored Professional and Managerial Internships in State Employment (PROMISE) program with the HMSC Academic Programs.

Ten of the REU student interns from the Summer 2009 program presented research posters at the February 2010 American Society of Limnology and Oceanography, Ocean Sciences Meeting, Portland, Oregon. Three of the REU student interns presented at the 2009 Society for the Advancement of Chicanos and Native Americans in Science Conference, Dallas, Texas.

Only HMSC REU students presenting listed. Seven COAS REU students are not included.

Lavelle, Kate*; Hurst, T.; Thermal Tolerance and the Effect of Temperature on Morphological Plasticity of Pacific Cod

Segura, Jasmin*; Peterson, W.; Temporal and Spatial Variation in Species Composition and Toxicity of *Pseudo-Nitzschia* Blooms off the Oregon Coast

Stewart, Amanda*; Suryan, R.; Factors Affecting Intra-Colony Variation in Reproduction of Common Murres, *Uria aalge*

Van Brink, Ashley*; Arkoosh, M.; Determining Phagocytic Activity in Chinook Salmon: Effects of PBDE on Phagocytic Function

Vanegas, Camilo*; Banks, M and Brodeur, R.; Genetic Identification of Larval/Juvenile *Sebastes* Samples for Stock Assessment

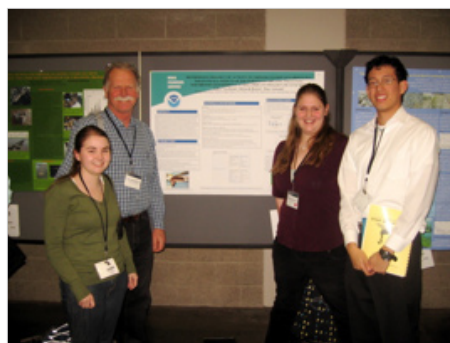
Whitney, Emily*; Black, B.; Geoduck growth patterns reflect climate heterogeneity on the British Columbia coast

During the summer at HMSC several students gained research experience at sea. For example, Camilo Vanegas (working on larval and juvenile rock fish identification) participated in one of the NOAA cruises. Robin Van Dyke accompanied her mentor, Kym Jacobson, on a trip to sample the Columbia River. After the end of the REU program, Natalie Ehrlich remained in the program continuing her research into the school year as an OSU student. Several students who conducted laboratory-based REU projects also gained field experience on the 54-ft coastal research vessel Elakha.

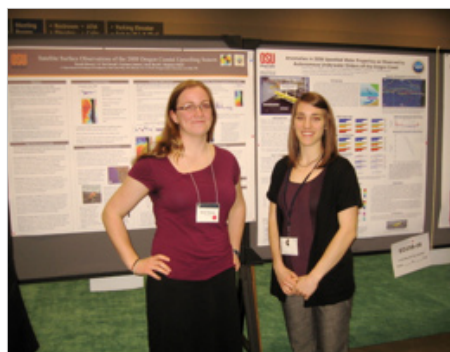
At the end of the 10-week program, all of the REU interns prepared and delivered written reports and oral presentations of their research projects at a symposium attended by faculty, staff, and graduate students. Students also participated in weekly brown-bag lunch meetings at which they discussed their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



Summer 2009 – End of Summer HMSC REU Presentations



2010 ASLO Meeting – 2009 HMSC REU students



2010 ASLO Meeting – 2009 HMSC REU students

REU Interns	Undergraduate Institution	Faculty Mentor	Project Title
Castaneda, Xerónimo	California State University Monterey Bay	Chapman, John & Dumbauld, Brett	Use of Lipofuscin to Determine Age Structure of Threatened Mud Shrimp (<i>Upogebia pugettensis</i>) in Yaquina Bay, Oregon
Hoekzema, Kendra	Calvin College	Baker, Scott	Mitochondrial DNA Identity of Stranded New Zealand Sperm Whales in Relationship to Global Diversity
Lavelle, Kate	SUNY, Stony Brook	Hurst, Tom	Thermal Tolerance and the Effect of Temperature on Morphological Plasticity of Pacific Cod
Segura, Jasmin	Humboldt State University	Peterson, Bill	Temporal and Spatial Variations in Species Composition and Toxicity of Pseudo-nitzschia Blooms off the Central Oregon Coast
Stewart, Amanda	University of Oregon	Suryan, Rob	Factors Affecting Intra-Colony Variation in Reproduction of Common Murres (<i>Uria aalge</i>)
Van Brink, Ashley	Elmira College	Arkoosh, Mary	Determining Phagocytic Activity in Chinook Salmon (<i>Oncorhynchus tshawytscha</i>): Effects of Polybrominated Diphenyl Ether (PBDE) on Phagocytic Function
Van Dyke, Robin	College of the Atlantic	Jacobson, Kym	Parasites of Introduced Eastern Banded Killifish (<i>Fundulus diaphanus diaphanus</i>) and Native Threespine Stickleback (<i>Gasterosteus aculeatus</i>) in the Columbia River
Vanegas, Camilo	University of Maryland, College Park	Banks, Michael & Brodeur, Ric	Genetic Identification of Larval/Juvenile Sebastes Samples for Stock Assessment
Wakeman, Kevin	Humboldt State University	DeWitt, Ted	Upper Intertidal Habitat Use by Juvenile Dungeness Crabs (<i>Cancer magister</i>) in the Yaquina Estuary
Whitney, Emily	Whitworth University	Black, Bryan	Geoduck growth patterns reflect climate heterogeneity on the British Columbia coast
HMSC Education Intern	Undergraduate Institution	Faculty Mentor	Project Title
Borgen, Katie	Oregon State University	Hanshumaker, Bill	Develop seafloor microbial fuel cell interactive exhibit
Cathcart, Erin	Oregon State University	Hanshumaker, Bill	Renovate Wentz scope display
Kelleher, Zach	Oregon State University	Hanshumaker, Bill	Prototype interactive exhibit on Faraday's law of induction
Promise Intern	Undergraduate Institution	Faculty Mentor	Project Title
Green, Jenny	Oregon State University	Cheung, Itchung	Hatfield Marine Science Center Brochure and Summer Course Programs Report
NOAA-Hollings Scholars	Undergraduate Institution	Faculty mentor	Project Title
Hoey, Jennifer	University of California, Berkeley	Keller, Aimee	Life History Characteristics of the Curlfin Sole (<i>Pleuronichthys decurrens</i>) along the U.S. West Coast
Lee, Alix	Barry University	Keller, Aimee	Age at length and other life history parameters for redbanded rockfish (<i>Sebastes babcocki</i>) along the US West Coast
Sabal, Megan	Miami University	Weitkamp, Laurie	Diet analysis of juvenile salmonids in relation to water flow in the Columbia River estuary
HMSC COSEE PP PRIME Interns	Undergraduate Institution	Faculty mentor	Project Title
Blamires, Melissa	Southwestern Oregon Community College	Kerry Carlin-Morgan	Oregon Coast Aquarium's Global Climate Change Project
McConville, Sea-oh	Portland Community College	Sally Hacker/Margot Hessing	A laboratory and field study of the interactions between macroalgae and eelgrass in Oregon's estuaries

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 2010 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 16, 2010. Students who had made significant progress towards completion of their research gave brief presentations. Those students being awarded new monies for 2010-11 year displayed posters explaining their proposed research. Their awards are listed below:

Award	Recipient
HMSC Housing Scholarship - To provide free or reduced-rate housing on-site for the duration of the term in which they are enrolled.	Kimberly Frier, Fisheries Management (\$250)
Mamie L. Markham First Year Student Award - 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.	Stephen Meck, Fisheries and Wildlife (\$10,000) Advisor: Markus Horning
Fred and Joan Crebbin Memorial Fellowship - To foster education in the marine sciences by providing financial support to undergraduate or graduate students pursuing marine science related fields at OSU.	Erin Kunisch, Wildlife Science (\$3,000) Advisor: Markus Horning
Lillian Brucefield Reynolds Scholarship Fund - for graduate students engaged in study of marine science at Hatfield Marine Science Center.	Alana Alexander, Fisheries & Wildlife (\$1,000) Advisor: Scott Baker
Curtis and Isabella Holt Education Fund - intended to foster education in the marine sciences by providing financial support to undergraduate or graduate students pursuing marine science studies.	Amy Vandehey, Marine Resource Management (\$6,000) Advisor: Selina Heppell
Walter G. Jones Fisheries Development Award – intended to support an academically qualified graduate student pursuing research which contributes to fisheries development.	None
William Q. Wick Marine Fisheries Award - 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.	Sarikka Attoe, Fisheries and Wildlife (\$3,725) Advisor: Selina Heppell
HMSC Student Teaching Award – intended to recognize undergraduate or graduate student teaching excellence and promise in marine science education at the Hatfield Marine Science Center.	Diana Raper (2010 Winter), Forest Ecosystem Science
Mamie L. Markham Endowment Award - intended to assist graduate or student research utilizing OSU's Hatfield Marine Science Center.	
G. Renee Albertson-Gibb, Wildlife Science (\$10,000) Advisor: Scott Baker	Donald Hawkyard, Fisheries and Wildlife (\$8,700) Advisor: Chris Langdon
Alana Alexander, Fisheries and Wildlife (\$7,727) Advisor: Scott Baker	Joe Haxel, Geosciences (\$8,000) Advisor: Robert Dziak
Tom Calvanese, Marine Resource Management (\$10,000) Advisors: Scott Heppell	Jeremy Henderson, Zoology (\$7,806) Advisor: Sally Hacker
Rebecca Hammer, Wildlife Science (\$8,031) Advisor: Scott Baker	Jose Marin Jarrin, Fisheries and Wildlife (\$8,500) Advisor: Jessica Miller

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 and the Oregon Coast Community College. Oregon State University offers courses at HMSC in Biology, Fisheries and Wildlife, Science and Math Education, Statistics, Oceanography, Veterinarian Medicine and Zoology. The courses are open to undergraduate students, graduate students and professionals, and generally attract 20-25 students per term. In addition, Oregon Coast Community College offers courses at HMSC in Aquarium Science and Biology to community college students and professionals that attract 15-24 students a term. Note: * = use of Interactive Television (ITV) or online course.

Summer 2009 Courses

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

An examination of the biology of whales, pinnipeds, and other marine mammals, include 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.

Fall 2009 Courses

AqS 100 (OCCC). INTRO TO AQUARIUM SCIENCE (Mann) (3)

Examines the history of animal keeping and present-day aquatic animal husbandry industries. Explores the biological processes occurring in the aquarium environment. Learn proper set-up and maintenance of home aquaria.

AqS 215 (OCCC). BIOLOGY OF CAPTIVE FISHES (Mann) (4)

Examines the anatomy and physiology of freshwater and marine fishes and the constraints placed upon them in a controlled environment. Increases an understanding of fish behavior through the use of ethograms.

AqS 240 (OCCC). LIFE SUPPORT SYSTEMS AND DESIGN (Mann) (4)

Examines the role of life support systems in maintaining a balanced, stable aquatic environment. Presents how to design, construct, maintain and troubleshoot semi-closed, closed and open systems.

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 407/507. MARINE SCIENCE SEMINAR (G. 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 (Sc Heppell) (5)

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 499/599. SPECIAL TOPICS IN FISHERIES AND WILDLIFE: 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 2010 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.

FS 199 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.

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

Current topics in marine science research.

Spring 2010 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.

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.

*ST 511. METHODS OF DATA ANALYSIS (Madsen) (4)

Graphical, parametric and nonparametric methods for comparing two samples; one-way and two-way analysis of variance; simple linear regression.

*ST 512. METHODS OF DATA ANALYSIS (Gitelman) (4)

Multiple linear regression, including model checking, dummy variables, using regression to fit analysis of variance models, analysis of covariance, variable selection methods.

*ST 515. DESIGN AND ANALYSIS OF PLANNED EXPERIMENTS (Murtaugh) (3)

Principles of experimental design; uses, construction and analysis of completely randomized, randomized block and Latin square designs; covariates; factorial treatments, split plotting; random effects and variance components.

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.

Miscellaneous Courses of Note at HMSC

ALS 199 – U-Engage: Marine Science (Cheung) (2) 2009 Fall Term

HMSC Mentor Awards

Itchung Cheung, Academic Program Coordinator

Recipients of the HMSC Undergraduate Mentoring Award for their efforts to mentor and foster a lab-wide support system for undergraduate researchers.

Cliff Ryer, NOAA Alaska Fisheries Science Center

Michael Banks, Cooperative Institute for Marine Resources Studies and Coastal Oregon Marine Experiment Station

Hatfield Student Organization (HsO) Activities **Itchung Cheung, Academic Program Coordinator**

President: Londi Tomaro

Vice President: Jose Marin Jarrin

Secretary: Ruth DiMaria

Treasurer: Renee Gibb

Communications Officer: Mattias Johansson

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 created by Oregon Sea Grant and the OSU College of Veterinary Medicine coordinates health management activities at the Hatfield Marine Science Center. The husbandry team consists of a veterinarian (Dr. Miller-Morgan, who manages the program), a veterinary pathologist (Dr. Heidel), a Curator of Animal Husbandry Programs (Dennis Glaze) and three professional aquarists, as well as numerous students, volunteers and interns. Through collaborative relationships with the College of Veterinary Medicine, Oregon Coast Community College, the Oregon Coast Aquarium, and numerous local, national and international industry partners we are helping to train the next generation of aquarium and aquatic veterinary professionals. Further, outreach to the ornamental fish industry has improved health management within the industry.

The Ornamental Fish Health Program is the signature outreach program within the Aquatic Animal Health Program. The Ornamental Fish Health Program (OFHP) provides outreach, education, and service to the ornamental fish industry -- starting at the Hatfield Marine Science Center and then reaching outward to the Pacific Northwest, the rest of the nation and even the rest of the world.

The program works with ornamental fish importers, wholesalers, retailers and hobbyists to improve fish health management; helps facilitate the development of training programs for hobbyists and industry professionals; and works with the national and international ornamental fish industry to research and address health issues associated with collection and transport of these species. From its inception, the educational focus within the Ornamental Fish Health Program has and continues to be on fish health management and hands-on learning experiences. From July 2009 to June 2010, faculty logged in over 700 hours teaching fish health management principles to Aquarium Science Program

practicum students, students doing special projects and student volunteers as well as a 2009 summer pre-veterinary intern, home school parents, and Bio 450/451 students. These students logged over 2000 hours of hands-on husbandry experiences over the past year.

Student Projects include:

- Planning and constructing unique acrylic teaching tools showcasing the comparison of pipe friction loss within different types of tank water delivery systems, and tank life support construction concerning water circulation and flow in and out of the tank.
- Reconstructing a research rack system housing cichlids and supervising their special project assessing a new diet for ornamental fish. Results of this project will have a direct, positive affect on the ornamental fish industry.
- Setting up systems for a project assessing the effectiveness of over-the-counter products claiming to pre-seed the aquarium filtration systems. Again, the results of this project will have a great effect on the industry.
- Mastering basic husbandry skills and completing a project documenting normal neurological responses of Cinnamon Clownfish. This work is leading towards a new method to assess post-collection survival of wild-caught marine ornamental fish.
- Carrying out a project characterizing common bacterial pathogens and antibiotic resistance associated with recently imported freshwater ornamental fish.

The Aquatic Animal Health and Husbandry Teaching Laboratory (AAHHTL) also serves as a showcase of the OFHP approach to aquatic animal health which meets and often exceeds university and federal standards of aquatic animal care. Over 30 tours of the AAHHTL were conducted this year. Participants included the general public, school groups, university faculty and administrators, legislators, aquarium professionals, hobbyists, industry professionals, international students, salmon biologists from across the nation, members of the Grand Rhonde Tribe, and Rotary Club Young Professionals from Brazil.

The HMSC offers numerous teaching opportunities involving marine and fresh water vertebrates and invertebrates. Unique to the HMSC, aquarists are pulled from the ranks of the Aquarium Science Program and Oregon State University graduate students. These student-aquarists serve 1 to 4 years. During this time they gain practical experience managing the daily husbandry of multiple species and diverse animal holding systems. The regular turnover of our aquarist staff has necessitated the development of an on going hiring and training program that is managed by Dennis Glaze. Jose Marin Jarrin, OSU Ph.D. student, was brought on-board in 2008, and then in September 2009 was promoted to senior aquarist. Harrison Baker and Alyssa Harrison, Aquarium Science Students, presently fill the Visitor Center and Wet Lab aquarist positions. These students receive on-the-job training in OFHP methods and procedure. Graduates are making a recordable, positive difference in the industry.

Since the HMSC is part of Oregon State University all aquatic vertebrates maintained are monitored through an Institutional

Animal Care and Use Committee (IACUC). Also, each individual aquatic animal use falls under specific animal care use protocols (ACUPs). Over the last year two IACUC facility inspections occurred, in addition to seven separate ACUP renewals, and several ACUP amendments provided instruction to faculty and graduate students concerning IACUC standards of operation and preparation of ACUP's. Further they have supplied documentation for a detailed HMSC facility description. Oregon Sea Grant husbandry staff support HMSC's aquatic animal researchers through consultation on proper husbandry techniques, training aquatic lab technicians, and acting as site coordinator for IACUC, ACUP and AALAC compliance.

In his capacity as facility clinical veterinarian, Dr. Miller-Morgan carries out weekly medical rounds, supervises the management of medical cases, regularly consults with OSU and federal research facilities on fish health issues and protocol formulation, and facilitates and delivers training opportunities for staff working with aquatic animals.

Programs were greatly enhanced this past year through availability of nearly \$100,000 in BUC funds, allowing us to make significant improvements to the research infrastructure and animal holding capacity within the AAHHTL. In July and August, staff participated in the International Zoo, Exotics and Wildlife Workshop. This 4-week program offered through Wildlife Safari brings veterinary students from across the US and the globe to HMSC and the Oregon Coast Aquarium for 3 days for an introduction to Aquatic animal medicine and management. The emphasis is on the health management of bony fish and sharks. This year we had 25 participants from Brazil, Canada, Korea, England, Germany, Switzerland and the United States. In the fall, staff also collaborate with the Oregon Coast Aquarium to offer a laboratory in fish handling and husbandry. This laboratory, which is part of the VMC 738, a freshman course in animal care, brings 60 veterinary students to the coast where they are exposed to the principles of fish care and handling. In the winter Drs. Miller-Morgan and Heidel and Dennis Glaze teach the laboratory portion of AQS 270, Fish and Invertebrate Health Management in the AAHHTL at HMSC. This year 12 students participated in this class. This spring eleven senior veterinary students participated in the VMB 727, Ornamental Fish Medicine. These students come to the HMSC for one week for a 40-hour overview of ornamental fish medicine. This hands-on course has been very successful in training new graduates about adding pet fish owners to their clientele in private practice. In May staff offered a seminar and workshop, Emerging Health Issues for the Advanced Koi and Pond Fish Hobbyist. 16 hobbyist and retailers from Oregon, Washington, California, Colorado and Illinois traveled to the HMSC for this one-day class. The program was well received and we were encouraged to make this an annual event.

In an effort to further our teaching of OFHP fish health management principles, a detailed aquarist training manual for intern and practicum students was developed; a four hour training program for home school parents titled "The Pet Fish Challenge" and a document designed to aid the beginning aquarist titled "Think Like an Aquarist."

In May 2010, Dr. Miller and Dennis Glaze worked closely with the Visitor Centers exhibitory staff to design the first of its kind octopus camera housing. Typical construction methods available to the exhibit staff presented significant animal health issues. Teamwork and creativity yielded a safe and effectively octopus proof solution. The installation of the octocam has allowed Aquatic Animal Health staff to perform a remote in depth observation study of the animal's behavior, which had been some cause for concern. There are 15 animal exhibits (30,000 gallons) in the Visitor Center, whose population ranges between 300-500 live animals, including our primary attraction, a giant pacific octopus.

Aquarium Science Degree Program - Oregon Coast Community College

Bruce Koike, Director, Aquarium Science Program

Frequently people respond to the question "Who takes care of the fishes at a public aquarium?" by stating "Oh I guess they do need someone!" The Oregon Coast Community College (OCCC) in partnership with the National Science Foundation, the Oregon Coast Aquarium and Oregon State University's Mark O. Hatfield Marine Science Center are developing just those people through the OCCC's Aquarium Science Program.

Since 2002, OCCC has been teaching the discipline of Aquarium Science to motivated individuals. To date 47 individuals have completed their degrees or certificates. A number of these graduates even became employed before their internship, the final class in their study option. In recent years, approximately half of the students enrolled had already earned a bachelor's degree in a life science, and have opted to develop their skills, knowledge and abilities in this specialized discipline.

A crucial phase of the student's growth is the ability to experience real workplace activities with the decision-making, schedule

adjusting and interpersonal communication dynamics which we encounter daily. To accomplish this, students are paired with employees at various agencies and departments at the HMSC. This collaboration consistently rates as a valued experience that is remembered by students well after they have graduated from the program. Each year the NOAA Fish Behavior Laboratory, Oregon Sea Grant, and OSU's Molluscan Broodstock Program have hosted students. Students have worked with a diverse range of animals including octopus, king crab, tropical marine ornamental fish, salmon, halibut, rocksole and other research or exhibit animals.

Even with the completion of the 9,200 sq ft Aquarium Science building at the OCCC Newport Campus, students will need access to such a rich learning environment such as the HMSC. One return benefit that is that a skilled workforce is developed for



Jeffrey Eckmann gently handles a groggy wolf eel as part of a laboratory session in the Fish and Invertebrate Health Management course taught by Oregon Sea Grant Extension Service Veterinarian and College of Veterinary Medicine, Dr. Timothy Miller-Morgan.

these very researchers and aquarium curators to hire. Currently there are 4 program completers who are working at the HMSC. Having the HMSC as a contributing member of this program is a benefit that goes beyond just that moment in time. The positive nature of the relationship between programs and with people will benefit many for years to come.

Sea Grant Youth and Family Marine Education

Nancee Hunter, Director of Education, Oregon Sea Grant

During the 2009-10 year, 10,693 K-14 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.

Two new class programs were added this year to meet newly adopted state science standards; these classes focus on inquiry and engineering. The first class was designed for K-2nd grade students and allows them to "sample" a clam bed in the classroom, identifying different species, and collecting data that can be taken back to the classroom and charted or graphed. The second class developed is a two-hour program for middle and high school students called ROV Challenge. This program introduces students to Oregon Sea Grant funded research being conducted by Remotely Operated Vehicles (ROVs) then allows



Students work with larval oysters as part of a oyster spawning laboratory session hosted by Molluscan Broodstock Program's Hatchery Manager Kiril Chang-Gilhooley. Chang-Gilhooley is a 2007 graduate of the Aquarium Science Program.

them in small teams to design and assemble a mini-ROV to retrieve items from the bottom of a large tank. Once the ROVs are constructed and tested, team members take turns driving the vehicle then choose an operator to compete against other teams. Feedback from teachers regarding these new programs has been very positive. Several teachers stated that the ROV program was able to engage students in their classes that were really struggling in the classroom setting.

During 2009, Sea Grant-sponsored Summer Day Camps at HMSC provided field experiences and hands-on programming for 69 campers ages 7-17. Oregon Sea Grant staff also partnered with several other precollege programs at OSU and at Washington State University to provide additional field experiences for middle and high school aged youth. Washington State University's Upward Bound Program brought 14 campers for 3 days of programming at HMSC. OSU's GEAR UP program brought an additional 25 campers for a field day at HMSC. An excerpt from OSU's GEAR UP program 2009 annual report states a "highlight for students was the fieldtrip to Hatfield Marine Science Center (HMSC), which included hands-on activities such as an estuary investigation and a squid dissection...76% of participants listed some aspect of the HMSC visit as their favorite activity in the post-program survey. Incorporating this off-campus fieldtrip exposed the students to the possibilities for research as an undergraduate student." A total of 238 other campers from organizations such as OSU's 4-H and CAMP programs and the Oregon Zoo also participated in programming at HMSC last summer.

This year, Career Day programs at HMSC opened the eyes of record numbers of students with 174 7th -12th graders participating in activities such as behind-the-scene tours, necropsies, and construction of ROVs. Demand for Career Day was so high we were actually turning large numbers of students away. In post-program evaluations completed by participants, 72% said they were more likely to pursue a career in marine science as a result of having attended the Career Day program. In addition, 44 high school students with the Upward Bound program from Umpqua Community College attended a separate Career Day event designed specifically for them.

Homeschool Days continued to be a popular program, serving 205 students. In addition to the hands-on classes offered for k-12 homeschool students, professional development workshops were run for 26 homeschool educators. The Fall workshop focused on hands-on Oceanography activities, while the Spring workshop provided instruction on how to set up an aquarium and utilize it as a learning tool. Professional development options for parents were added this past year as previous Homeschool Day evaluations indicated that there was a need for professional development opportunities for these educators, especially focusing on science. Attendees of the workshops 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-eight educators participated in the Fall workshop and 24 in the follow-up workshop in the Spring.

A series of two-hour, interactive Family Programs for ages 4 and up were run at HMSC this winter by OSG staff. Topics ranged from tidepools to ROVs (Remotely Operated Vehicles).

Other changes in the Oregon Sea Grant youth and family programs at HMSC, include the departure of Ana Maria Esparza-Smith, the coordinator of the Las OLAS (Ocean Learning Activities in Spanish) program. She will be greatly missed by both staff and the Spanish speaking families she served. Discussions regarding the future of the Las OLAS program are currently underway.

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

And, the remodel of wet labs used by Oregon Sea Grant for education programs at HMSC was finally completed, with new cabinetry, furniture and flow-through tank systems being installed. This project was made possible through state stimulus funds and comments regarding the improvements from both staff and visitors have been very positive.

Oregon Coast Quests: Oregon Coast Quests is a place-based education program 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.

Oregon Coast Quests started in 2007 and has grown to include 25 active Quests in Lincoln County. More than 3000 logs have been made in hidden Quest Boxes by people who've participated in Quests (1000+ in the past year), and more than 1250 Quest Books of directions have been distributed. Over 40 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. 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. Small multi-age family groups, youth/school groups, and adult pairs are the primary audience for the Quest program.

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 18 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 by OSG K-12 programs at HMSC, Yaquina Head Outstanding Natural Area, and through other partnership organizations. A new Quest at Cape Perpetua is due to be unveiled by the end of this fiscal year. This year has been to expand the Oregon Coast Quests program's reach to Quest-building activities and partnerships in new areas, particularly those outside Lincoln County.

This year, three Quest-building Workshops were held to inspire program and community leaders to build Quests in new areas:

- Quest-Building Workshop, Hatfield Marine Science Center, Newport, OR, February 6, 2010 – 5 participants
Outcomes: Lincoln County School District Talented and Gifted Coordinator is planning to make Quests with students in the 2010-2011 school year. Tillamook Estuaries Partnership has expressed an interest in making Quests.
- Quest-Building Workshop, South Slough National Estuarine Research Reserve, Charlestown, OR, April 24, 2010 – 10 participants
Outcomes: With guidance and coordination from Jamie Doyle of OSG, a group is currently making a Quest in downtown Coos Bay. New partners include SSNER, Americorps, the Port of Coos Bay, and the Coos Bay Tourism board.
- Quest-Building Workshop for Precollege Programs, Oregon State University, Corvallis, OR, May 12, 2010 – 9 participants
Outcomes: Several precollege program leaders have expressed interest in making Quests with and/or for youth.

In October 2009, two conference presentations were given to national audiences:

- Glazer, S. and C. Goodwin, "Connecting people and places with Questing." *National Land Conservation Conference*, Oct. 11-14, 2009, Portland, OR.
- Glazer, S. and C. Goodwin, "Questing: Connecting people and places with community treasure hunts." *North American Association for Environmental Education 38th Annual Conference*, Oct. 7-10, 2009, Portland, OR.

Local presentations about Questing include:

- "Brain Train" booth at the Newport Senior Activity Center, October 2009, Newport, OR.
- Goodwin, C. "Exploring communities through clue-directed hunts", Presentation at the Newport Senior Activity Center *Lunch and Learn* program and guided walk of the Newport City Buildings Quest, Sept. 14, 2009, Newport, OR.
- "Fitness for Life" radio program, Guest appearance to discuss the Oregon Coast Quests program. KCUP 1230 AM, July 8, 2009, Newport, OR.

News publications about Quests:

- Updated Quest pages on the HMSC Visitor Center website,

launched Sept 2009: <http://hmsc.oregonstate.edu/visitor/oregon-coast-quests>.

- "Clue-directed adventures could flourish" *The World*, Coos Bay, OR. April 24, 2010.
- "New coast Quest books available" *The News Times*. Lincoln County, OR. Jul 22, 2009.

Support and Awards:

- \$1000 - Precollege programs grant to support the May 12, 2010 Quest-building workshop and follow up. Awarded March 2010.
- Sales of the remaining 2009/2010 Quest Books continue to help fund the OCQ program.

Oregon Coast Quests continues to obtain further funding through a variety of grant proposals and partnerships.

III. RESEARCH AND EDUCATION SUPPORT

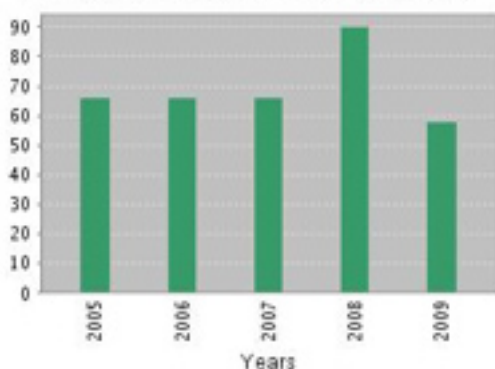
Guin Library

Janet Webster, Librarian

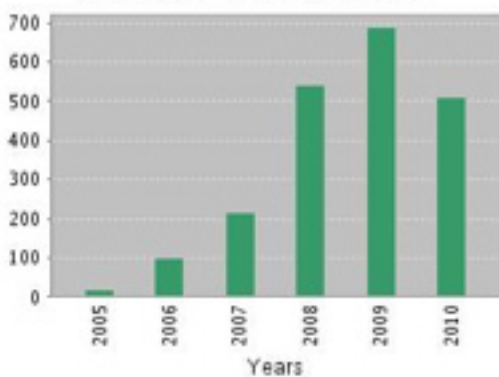
The Marilyn Potts Guin Library continues to be one of the best marine and estuarine libraries in North America. Its strengths are information on the marine and estuarine sciences of the Northeast Pacific region with particular attention on Oregon. As part of the OSU Libraries, this branch serves the 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. The major shift has been to electronic everything - from most of the scientific journals to e-books that allow more than one person to read a book at a time. Our international connections also enhance what we can get and share.

The Library staff members track the publications of those working at the HMSC by compiling the Station Bibliography and examining where people are publishing and what they are using. The two figures below display data from the ISI Web of Science, a database that indexes articles from the major science journals. The data show a slight decrease in publication in these journals but a steady rise in the number of citations to them. This is one indicator of their value and impact on the science of others.

Published Items in Each Year



Citations in Each Year



The Library staff is also interested in HMSC publications that are not as visible in the traditional channels. These include reports such as the California Cooperative Fisheries Investigations Reports and our students' dissertations. We promote depositing these publications in the OSU Libraries' ScholarsArchive, our digital repository. All graduate students must do so with their final work and it pays off in terms of usage and exposure. Two HMSC graduate students are excellent examples. Bob Emmett, a NOAA employee at HMSC and an OSU PhD student, finished his dissertation in 2006. The ISI Web of Science lists one citation to this interesting work on fisheries oceanography while it has had 110 downloads and 450 views from ScholarsArchive (<http://hdl.handle.net/1957/1783>). Kathleen O'Malley's work on clock genes in salmon shows even more dramatic usage. Since being deposited in late 2007, her work has been downloaded 193 times and viewed almost 300 times (<http://hdl.handle.net/1957/7274>). Open access to HMSC research allows others to incorporate our findings into their work. The Guin Library is committed to helping our faculty and students make their research accessible.

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 past year, we completed refurbishing the couches and re-carpeted the Library Seminar Room. The collection was removed from the shelves so those could be seismically upgraded and shifted to accommodate some modest growth. The Library has the best wireless access in the complex including a public network that is easy for our visitors to use. All in all, the various changes have made the physical library more inviting and a great place to be.

Library Displays: Library hosted three exhibits this year.

- Janet Webster created an exhibit titled "Listening to Others: New ideas and how they get ignored, censored and validated." for this year's annual Banned Books Week display
- "At Sea At the Movies" celebrated books, great and not so great, that became great and not so great movies.
- Judy Mullen collaborated with Lisa Mulcahy on an information display about the Mid-Coast Watershed Council.

Staff activities: Janet Webster, the librarian, chairs the Oregon Library Association's Legislation Committee. She was elected chair of 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 chairs the OLA's Support Staff Division. She continues to 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

Fast paced would be the best way to describe the past year for HMSC Facilities. In addition to the normal facilities work of taking care of HMSC researchers, staff and students needs, much effort was spent making sure operations and maintenance work was done in a timely manner. In addition, Facilities was wrapping up the final stages of the *Go Oregon* stimulus package. The many *Go Oregon* projects are making the HMSC campus a better place to work, study and do research.

Completed this year is an extensive remodel of many of the laboratories at HMSC. All the laboratories in the Education wing have been thoroughly remodeled. An additional lab remodeling was done for the Benthic Ecology researchers and Avian Ecology Lab. The completion of a seismic retrofit to the Main Building will enable the structure to better stand a severe seismic event. In addition, completion of a seawater disinfection system added to the Main Building's west wing and the Visitor Center will enable researchers to use antibiotics and other medicines to treat fish diseases and enable research on non-native and quarantined animals without fear of affecting the local estuarine environment.

A complete retrofit of all the potable water and sewer systems and fixtures was completed during the last year. All related fixtures and appliances in the Main Building were retrofitted to low water flow devices that will reduce our use of water substantially. Considerable effort has been spent assisting Maryann Bozza, HMSC Program Manager, make preparations for the upcoming shoreline stabilization project to be completed this winter. This has been a collaborative venture with most of the agencies on campus taking a part in moving this forward.

Ship Operations

Peter Zerr, 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. 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. In 2009 her 181 days of scheduled operations were funded by the National Science Foundation, NOAA and the Office of Naval Research. Science missions are being led by researchers from Oregon State University, Oregon Health & Science University, University of Washington, University of Maryland, Johns Hopkins University, the Navy, and NOAA. Major projects in 2009 included: some time spent in the shipyard in Seattle, Washington, the NSF funded Science and Technology Center for Coastal Margin Observation and Prediction (CMOP) off the

Oregon coast and in the Columbia River, Tropical Atmosphere Ocean Project (TAO) mooring maintenance around the equator, and a variety of work off the coasts of Oregon and California. Our 2010 scheduled work included deploying some test moorings for the new Ocean Observatory Initiative, continuation of the CMOP work along the Oregon Coast and in the Columbia River, and another 41 day cruise down past the Equator with science work around the Clipperton Islands and a port call in Manzanillo Mexico after the cruise.



Jeff Crews, 1st Mate, and Daryl Swensen, MarTech Superintendent, give Mexican Naval Oceanographic Institute members a tour of the R/V *Wecoma* while docked in Manzanillo, Mexico.

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 newly acquired 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. It has been a busy summer here with several UNOLS and NOAA vessels mobilizing science cruises from the OSU dock.

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

IV. PUBLIC OUTREACH & EXTENSION

OREGON SEA GRANT EDUCATION

Sea Grant, Visitor Center

Nancee Hunter, Director of Education, Oregon Sea Grant

Visitor Center – Public Programming Highlights:

Daily public programming events for the summer included Octopus and Wolf-Eel Feedings, Estuary Walks, and OceanQuest. Approximately 600 people participated in the guided estuary tours, and over 1000 people attended the auditorium program on deep-sea research.

“Shark Day” was in response to an entangled Great White Shark obtained from the Oregon State Police. In coordination with Selena and Scott Heppell (F&W, OSU), we included OSU students in a public dissection of the shark. This was set up the Visitor Center with a necropsy table, shark, video microscope and overhead video camera for projection both on a flat screen and into the auditorium. The video taped dissection was also promoted on the Visitor Center Website. Approximately 600 people attended the event. We also collaborated with Brion Benninger (OHSU) in his research on spinal accessory nerve origin and evolution, by providing him with two specimens: a white shark (*Carcharodon carcharias*) and a broadnose 7-gill shark (*Notorhynchus cepedianus*). These samples will help determine the trophic level of the dominant prey of this white shark. Media coverage included: Oregon Public Broadcasting, KPAM, Oregonian, Depoe Beacon, KATU, Channel 2, News-Times, KOIN TV, NW Sportsman Magazine, OSU, and KEZI, ABC radio.

We also conducting the following presentation -- “Killer Instincts: Unraveling a Marine Murder Mystery: a necropsy on 8 foot broad-nose 7-gill shark” for teachers attending the Oregon Science Teachers Association annual conference. The necropsy revealed that the 7-gill shark was likely killed by an orca (killer whale). This three and half-hour workshop was attended by a steady stream of Oregon science teachers, who provided very positive feedback.

“Fisheries Day” activities included a special media event highlighting the new *Science for Sustainable Fisheries* exhibition, as well as a grand opening. With the assistance of volunteers, we marinated and barbequed twelve albacore tuna loins and served them to the public; in addition to smoked sablefish. Attendance was just over 1000. Newport News-Times ran a photograph of all of the people involved with the development of the *Science for Sustainable Fisheries* exhibition and the public appeared delighted with the event.

Visitor Center – Exhibit Development Highlights:

Octocam - Live streaming Web Cam: Exhibit staff installed two new Web cameras -- an underwater camera focusing on the octopus in its environment and an external tank view focusing

on the live interpretive programming. The cameras run 24/7 and have allowed Internet visitors all over the world an opportunity to watch and learn about the octopus. Three times a week marine educators offer live feeding programming for on-site visitors, which now is available to on-line viewers. The first week of the Octocam launch saw record days of over 128,000 hits on the Visitor Centers Octocam web page. Since the initial launch, the Octocam gets an average of 40,000 hits per day. The addition of the web Octocam has increased traffic to the Visitor Center entire web site by 20 times 2008s average. The Octocam provides marine education staff the opportunity to host individual web based sessions with remote k-12 classrooms. Significant press coverage surrounded the Octocam rollout. Local media outlets: KATU, The Oregonian, The Statesman Journal, and Democrat Herald. Internet media coverage: CNET, Pharyngula, NerdCore, and Associated Press.

Talk Science: A computer based, network updated interactive exhibit was given to the Visitors Center by the Science Museum of Minnesota. The exhibit allows visitors to participate in the Talk Science network – a collection of up to date science news articles and interactives that encourage feedback and dialog with the public. We have become contributing members of the Talk Science network, and are designing two exhibits (reading satellite data and climate change), that will debut in the near future on all Talk Science kiosks throughout the US.

Magic Planet: In efforts to make the Magic Planet Spherical display system a more functional learning tool, exhibit staff working in partnership with NOAA Pacific Services to rewrite its core display software. The new software allowed for the creation of 5 new oceanographic science modules, one of which utilizes datasets created by COAS partners.

Signage Standardization: A significant exhibit signage upgrade was performed by 20 student volunteers from Linn-Benton Community College’s Graphic Design program. In 2 days, 380 man-hours were spent redesigning interpretive displays, standardizing signage systems, printing and mounting new signs, and building a new inquiry display systems.

Science for Sustainable Fisheries: Ongoing collaboration with Seafood Commodity Commissions succeeded in developing a large public exhibit including copy/design layout, 3 digital picture frames, DVD and flat screen monitor, freeze-dried shrimp (painted), and 3 fishing vessel replicas, crab pot, nets, and Project CROOS Fisherman Sampling Kit. Over 80,000 people had the opportunity to interact with this exhibition since its installation in August.

Refractometer Exhibit: Installed refractometer exhibit to illustrate how salinity can be measured. This hands-on exhibit is installed next to the LOBO computer as an attempt to engage children and extend their parents’ involvement. Signage is undergoing formative evaluation.

Upgrades to Computer Interactive: 8 very popular computer based science exhibits that have been in operation since 1995 underwent significant programming upgrades to bring them

into current operating system standards. During this operation much of the graphic, digital video, and photographic content was upgraded and replaced to reflect current capabilities.

Wave Energy Exhibit Upgrade: Commissioned contractor to build a durable “hands-on” component to demonstrate Faraday’s Law, the scientific principle central to the *Wave Energy* kiosk. Intern (Zach Kelleher) evaluated exhibit component for visitor attraction and engagement.

Free-Choice Learning Research

Oregon Sea Grant Extension’s Free-Choice Learning Program has entered its 6th year supporting research on the marine science learning that happens when people visit science museums, zoos, and aquaria in their leisure time, making conscious choices about what they want to learn, where they want to learn, and how they want to learn. Such free-choice learning makes up the majority of learning we engage in throughout our lives, and most people’s knowledge about marine and ocean sciences comes from these informal channels people choose in their leisure time.

The primary goal of the Oregon Sea Grant Free-Choice Learning Program (FCLP) is to carry out research and education on lifelong free-choice learning. 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.

Free-choice learning research, led by Shawn Rowe, Ph.D., focuses on developing accessible learning environments and tools for people to learn marine sciences in informal settings like the HMSC’s Visitor Center. Rowe also oversees and/or coordinates research and evaluation work by students from OSU’s College of Science involving HMSC and Oregon Coast Aquarium visitors. The Visitor Center is a prime laboratory for this research. Between July 2009 and June 2010, Rowe and/or students presented research findings from their work at the HMSC to attendees at the 2010 AGU Ocean Sciences Meeting, the American Educational Research Association and the National Association of Research in Science Teaching Annual Meetings, the Visitors Studies Association Meeting, the Western Museums Association Meeting, the Sea Grant Climate Workshop, the Science on a Sphere Network meeting, and the Aquarium and Zoological Association annual meeting. In addition, research findings were published in the journals *Public Understanding of Science*, *Visitor Studies*, and *Tourism in Marine Environments*.

Studies this year at the HMSC’s Visitor Center shifted focus slightly from studies aimed mostly at the development and evaluation of exhibits to studies of the efficacy of various types of professional development for scientists, educators, volunteer communicators, and K-12 teachers. External funding from the Holt Marine Education Award, the Oregon Department of Education, NOAA, and the National Science Foundation supported the work of 5 students from Science and Math Education and 1 student from Environmental Sciences as well

as some time for Dr. Rowe and Nancee Hunter (Director of Education, Oregon Sea Grant). In particular, a team of faculty, staff, and students funded by Sea Grant and NOAA continued work on development of the Magic Planet, spherical display system at HMSC, studying how individuals and groups learn science from complex scientific visualizations of data using the Magic Planet Spherical Display System as a research platform. The Magic Planet is a one-meter diameter digital sphere. In addition to basic research on what and how people learn from the Magic Planet and the related exhibit Science on a Sphere at Maryland Science Center and the Bishop Museum in Hawaii, the team also created new programming for the sphere and evaluation tools for understanding how it works as a learning tool for national dissemination later in summer 2010.

Dr. Shawn Rowe and Dr. Jim Kisiel, California State University, Long Beach, continued 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. Presentations of the findings were made at the American Educational Research Association meeting in Denver this year.

Student research this year includes: continued work on the efficacy of professional development for informal educators; research done on Magic Planet and the Science on a Sphere, including evaluation; work 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; work with Lincoln County School District teachers collecting data on their learning, their teaching, and their facilitation of field experiences for students; and 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, some of which was funded by a Holt Marine Education Award. In addition to this work, the HMSC Volunteer Coordinator, Becca Schiewe, enrolled in the OSU master’s degree in Free-Choice Science Learning. Becca brings her experiences and activities from the classes she is attending in the college of science to her work on the floor, benefiting volunteers and visitors.

Communicating Ocean Sciences to Informal Audiences

Every winter, the Department of Science and Mathematics Education offers the Communicating Ocean Sciences to Informal Audiences Class. While the class is taught on campus, all of the students travel to HMSC, Oregon Coast Aquarium and other sites to deliver hands-on ocean sciences activities. The purpose of this National Science Foundation funded class is to introduce future scientists to communication techniques by giving them the opportunity to use hands-on materials to teach basic science concepts to schoolchildren, adults, and public audiences. Students from Oceanography, Marine Resource Management, Biology, Zoology, Atmospheric Sciences, Engineering, and Science and Math Education took the class in winter 2010 and delivered hands-on activities on marine biology and physical oceanography to audiences at the HMSC and the Oregon Coast Aquarium, high-school students at OSU’s Salmon Bowl, middle-

school students at SMILE's Middle School Challenge, and families at SMILE and HHMI funded family science nights.

As a spin-off of this class, a new five-week class for informal educators from HMSC was established that uses reflective practice techniques and activities to promote on-going, long-term professional development. This is the third professional development program for informal educators piloted at HMSC.

The Center for Ocean Science Education Excellence-Pacific Partnerships

The Center for Ocean Science Education Excellence-Pacific Partnerships is a partnership between HMSC, Oregon Institute of Marine Biology, Oregon Coast Aquarium, South Slough National Estuarine Research Reserve, Oregon Coast Community College, and Southwest Coast Community College to develop education programming and research opportunities for community college students, faculty, informal science educators, and marine education volunteers in Oregon, Washington, California, and Hawaii. In addition to supporting the evaluation redesign of the Oregon Coast Aquarium volunteer training, COSEE -- Pacific Partnerships also supported workshops at HMSC, OSU main campus, and California Polytechnic University, San Luis Obispo for ocean scientists, graduate students, and post-docs on communicating sciences through partnerships with outreach and education institutions. The COSEE – Pacific Partnerships continued to lead the state in the development of a Coastal Master Naturalist Program this year, with the piloting of curriculum modules. Some of this work was presented at the Ocean's conference in Portland in 2010.

Dr. Rowe's ongoing collaboration with Lawrence Hall of Science at the University of California, Berkeley to create communications and learning theory training opportunities for informal educators also continued this year. With ongoing NSF funding, a team of free-choice learning practitioners ran professional development workshops for educators and floor staff at HMSC and at informal science institutions from the central California Coast. This work was presented at the National Association of Research in Science Teaching Annual Conference in Philadelphia.

Math-Science Partnership

This year, several Oregon Sea Grant staff became involved in the OCAMP (Oregon Coast Aquatic and Marine science Partnership) program with the Lincoln County School District, Oregon Coast Aquarium, Yaquina Head Outstanding Natural Area, Oregon Hatchery Research Center, OSU and others. This multi-year research and professional development project is grant funded (\$900K) through the Oregon Department of Education and was the only one awarded this past year through their Title IIB Math Science Partnership (MSP) program. Thirty-two K-12 teachers from Lincoln County School District and their students are involved in this project. Since its inception in August 2009, over 70 hours of professional development has been offered for the teachers. In addition, a portion of the teachers are involved in a Professional Learning Community and receive additional support in the form of mini-grants, mentored field experiences, and classroom visits by scientists and informal educators. Four

of these teachers selected HMSC as their field site, bringing their students to HMSC for two days of programming and received pre- and post-field visits.

Undergraduate Student Internship Program

This annual internship program provides the opportunity for undergraduates to gain practical experience at public interpretation of current marine research by delivery of daily programming both on the Yaquina estuary and in the Hennings auditorium. The interns acquire skills in project management, interacting with the public and developing informal science educational materials. They work in partnership with state or federal marine science researchers and learn important project management skills, such as developing a project timeline complete with milestones and identifying the critical path to develop a portfolio piece that should be useful in gaining future employment. This year's interns included:

Erin Cathcart, a senior at OSU (Fisheries and Wildlife) worked with Dr. John Chapman (OSU)

- Renovated Wentz scope display
- Prepared and mounted parasitic isopod specimens
- Installed live support system for mud shrimp
- Developed and evaluated signage

Katie Borgen, a junior also in Fisheries and Wildlife, worked with Dr. Claire Reimers (CIMRS) and her graduate assistant

- Developed seafloor microbial fuel cell interactive exhibit
- Determined visitors' baseline electrical knowledge
- Developed and evaluated signage

Zach Kelleher, a senior at OSU in Biology/Marine Biology worked with Flaxen Conway (Oregon Sea Grant)

- Evaluated visitor response to existing Wave Energy exhibit
- Ascertained frequently asked questions
- Surveyed visitors' background re: wave energy
- Prototyped interactive exhibit on Faraday's law of induction

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 & visitor operations manager, one part-time staff, and one student. During the high season months of June through September, the store also employs an additional 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 created last year continues to thrive. HMSC logo merchandise are the most popular items and have been mailed all over the United States. Visitors coming to the area order many identification guides for their trip to the coast, and educators do purchase many of the Sea Grant "Oregon Coast Quest" guide books, which have become the bestseller for the website. Because of the interest in the live octopus camera recently installed in the Visitor Center, interest in octopus-themed items has risen in the website orders and requests.

The Bookstore Manager is responsible for print media ads, and more local ads were added this year, including the local magazines for passengers flying in and out of Newport Airport, a Cultural Arts magazine, Oregon Coast Magazine, and many other local and state publications. In order to promote OSU and HMSC locally, the Bookstore Manager also attends Chamber after-hours events to connect with local businesses and community members and represents Oregon Sea Grant on the HMSC Sustainability Committee.

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

During FY09/10, the HMSC had 72 volunteers who contributed 7,003 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 23 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 of our volunteers 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): the potential biological impacts of wave energy, pinniped research, watershed restoration, burrowing shrimp research, and tsunami preparedness. Two volunteers attended the 2009 Pacific Northwest Docent and Volunteer Association Conference during October 1-3 held at the Seattle

Aquarium.

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.

Coastal Ecosystem Learning Center (CELC) **Nancee Hunter, Director of Education, Oregon Sea Grant**

Coastal America is a partnership of federal agencies, state and local governments, and private organizations working together to protect, preserve, and restore our nation's coast. The Coastal America Learning Center Network educates and involves the public in protecting our national coastal and ocean ecosystems. Most of the 23 Learning Centers are aquariums but several marine science centers and museums are also part of this dynamic network. HMSC and the Oregon Coast Aquarium serve as a joint Learning Center. In total the CELC network directly reaches over 20 million visitors every year and indirectly reaches several hundred million people through educational outreach programs. Several related activities occurred this year, including:

- *North American Protected Area Network (NAMPAN) Outreach:* With the designation of the Vancouver Aquarium in Canada in October 2009 and the previous designation of the Veracruz Aquarium in Mexico June 2007, the Coastal America Learning Center Network now extends throughout North America. Recognizing the value of this network, NAMPAN is seeking to collaborate with the learning centers to coordinate outreach on marine protected areas. A representative from our Learning Center attended the initial planning meeting to develop this concept.
- *Earth Day Campaign:* This year marked the 40th anniversary of Earth Day. Our Learning Center participated in the Coastal America effort to encourage Americans to commit to four things that they can do throughout the year to benefit the environment. An Earth Day newsletter filled with activities and other useful resources was sent to teachers throughout the state of Oregon to support these efforts. In addition, we linked to the "4 for 40 Initiative" website, full of fun ideas for people who want to do more for their environment and asks them to commit to 4 personal actions (e.g. use less water, walk and bike if possible etc, plant an organic garden etc.). The site includes additional information about environmental issues, fun environmental games, and applications to calculate your personal carbon footprint. It also directs people to the Coastal America Learning Centers where they can learn more about our coasts and oceans and get involved in local restoration and protection efforts.
- *Ocean Interpretive Stations:* Over the last two years Coastal America has been implementing an initiative to establish mini "Ocean Halls" at the Learning Centers to promote public understanding of current ocean issues. The first phase of the effort has been the installation of Ocean Today Kiosks at the Learning Centers, which link the centers to the Smithsonian Ocean Hall data feed. HMSC has a kiosk in place and an additional kiosk will be installed at the Oregon Coast Aquarium next year.

OCEAN Partnership Award: Led by the Learning Center leaders, Nancee Hunter (Director of Education, Oregon Sea Grant at HMSC) and Kerry Carlin-Morgan (Director of Education, Oregon Coast Aquarium), the Ocean Conservation and Education Alliance Northwest (OCEAN) is a growing network of education organizations throughout the Pacific Northwest. The goal of this Alliance is to support local students becoming the most “ocean literate” students in the country. Some other shared goals of the partners are to unite organizations with strong marine science education missions to focus on ocean literacy for the public at large, to enhance K-12 science teaching by using the ocean as a basis for teaching science, technology, math, and engineering (STEM) concepts, and to develop, implement, and evaluate professional development for educators and visitor learning experiences. In April 2010, OCEAN was awarded with a Coastal America Partnership Award - the highest level of national recognition for collaborative efforts that combine resources to accomplish coastal restoration, preservation, protection, and education projects.

Ocean Literacy: “Ocean literacy” is an understanding of the ocean’s influence on people, and peoples’ influence on the ocean. Five years ago, discussions began among educators at Oregon Sea Grant education program at Oregon State University’s Hatfield Marine Science Center (HMSC), Oregon Coast Aquarium (OCA), and the Lincoln County School District, with an initial goal to improve local students’ ‘ocean literacy.’ Since then, the partnership has grown to include more than a dozen local, state, federal, and university agencies and organizations, and the network is expanding to encompass the entire Pacific Northwest. The effort now aims to unite organizations with strong marine science education programs to focus on ocean science literacy not just in K-12 schools, but also in public venues like HMSC.

Ocean literacy goals are infused throughout all education activities, exhibitry design principals, and public communications messages.

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, through participation in public processes, and through partnerships with Lincoln County School District and a number of local organizations including the Fisherman’s Wives, the Newport Library and the Chamber of Commerce. The “Friends of HMSC” group serves to communicate our activities to a broader audience. Regionally, 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 on 2009-2010, including the Siletz Fire Department, Lincoln County Farmers Market, Newport Jazz Festival, Newport Symphony, Partnerships in Education, Toledo City Council, Waldport City Council, and Yaquina Bay Economic Foundation. Schools are a particular area of focus for HMSC researchers and staff volunteering their time, and volunteer activities during 2009-10 included the International Baccalaureate program at Newport High and science fair. Other community activities included invasive species removal, beach clean-ups and a 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, and fisheries issues were hosted by HMSC in the past year (see below). Several elected officials have visited HMSC for briefings on marine topics of interest to their constituents. HMSC also participated as a partner in two large events in June 2010 celebrating the infrastructure development for HMSC’s newest South Beach neighbor, NOAA’s Marine Operations Center – Pacific, which serves as home port for four ships of NOAA’s research fleet.

Numerous other meetings by public and private organizations made use of HMSC facilities for meetings this past year, including:

- Aug 07 Roundtable with Congressman Schrader
- Aug 20 Port of Newport, NOAA – NOAA Port kick-off meeting
- Aug 26 Lincoln County Board of Commissioners, OSU SeaGrant Extension, NNMREC – Wave Energy Community Forum
- Sept 06 Briefing regarding NOAA Port for Senator Wyden
- Sept 17 Oregon Wave Energy Trust (OWET) – NNMREC wave energy presentation
- Sept 21 OSU Oregon Cooperative Fish and Wildlife Research Unit - International Workshop on Smoltification
- Sept 30 Oregon Department of Environmental Quality – Hazardous Waste Training
- Oct 11 Klamath Audubon Society
- Oct 23-25 Flip Nicklin photography workshop
- Oct 28 Oregon Department of Administrative Services
- Oct 29 The Confederated Tribe of the Grande Ronde
- Nov 16 Siuslaw National Forest Program Managers
- Nov 17 City of Newport, South Beach Planning
- Nov 18 Dungeness Crab Commission
- Dec 5-6 OR Parks & Recreation Dept - Whale Watch training
- Dec 21 American Red Cross – Blood Drive

Feb 7 Coast Range Association
Feb 18 US Fish & Wildlife - National Coastal Wetlands Restoration workshop
Mar 15 ODFW - Green Sturgeon ESA
Apr 16 SEIU - union members meeting
Apr 21-25 US Fish & Wildlife – Volunteer training workshops
Jun 3 Town Hall with State Representative Jean Cowan
Jun 11 Newport Chamber of Commerce – Ambassadors’ visit
Jun 24 Surfrider Association

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Friends of the 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.

In 2009-2010, the Las OLAS program (Ocean Learning Activities in Spanish) continued its innovative outreach to Spanish-speaking families with school-aged children in Lincoln County. The program culminated in June 2010 with an activity and reception honoring the retirement of Las Olas founder AnaMaria Esperanza. The Visitor Center will continue to engage the Spanish-speaking community with outreach activities. Other activities sponsored by the Friends of the HMSC included a well-attended public lecture, “Squid Invasion!” by Professor William Gilly of Stanford University, an expert on Humboldt squid, as well as three issues of HMSC’s donor newsletter, *Upwelling*.

The Friends of HMSC remain a key source of support for graduate student research at HMSC. In total, over \$93,000 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.

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, 2009, and June 30, 2010.

Contributors of \$10,000 or more

Anonymous
The Northern Forum
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Janet Gray Webster ‘95 & Stephen A. Webster

Seminars presented at HMSC from July 2009 to June 2010

DATE	NAME	AFFILIATION	TITLE
July 2, 2009	Alana Alexander & Angie Sremba	Graduate Students Hatfield Marine Science Center	<i>HsO Graduate Student Research Presentations</i>
July 9, 2009	Sean Hayes	NOAA Southwest Fisheries Science Center	<i>From Ridge Tops to Wave Tops, exploring the life history of Central California Steelhead in stream, estuarine and ocean habitats</i>
July 16, 2009	Corey Garza	Assistant Professor California State University Monterey Bay	<i>A landscape based approach to testing dynamic models of benthic marine communities</i>
July 20, 2009	Phil Clapham & Julia Ivashchenko	NMML, Seattle, WA	<i>A Whale of a Deception: Soviet Illegal Whaling and the MOSCOW Project</i>
July 23, 2009	HMSC Faculty Mentor Panel	Hatfield Marine Science Center	<i>Research Ethics</i>
July 30, 2009	Silvana Acevedo	Department of Primary Industries, Queenscliff, Victoria, Australia	<i>The horizontal and vertical distribution of fish eggs and larvae in relation to the proposed desalination plant for Victoria, Australia</i>
August 6, 2009	Blaine Griffen	University of South Carolina	<i>From individual behaviors to population patterns: understanding invasions from the bottom up</i>
August 13, 2009	Sarah Henkel	Hatfield Marine Science Center	<i>Response to environmental stressors in native and invasive kelp species</i>
August 20, 2009	Research Experience for Undergraduates	Xerónimo Castañeda, Kendra Hoekzema, Kate Lavelle, Jasmin Segura, Amanda Stewart, Ashley Van Brink, Roin Van Dyke, Camilo Vanegas, Kevin Wakeman, Emily Whitney	<i>Mini Symposium - Results of research REU's did during 10 week internship at HMSC</i>
August 27, 2009	Nadine Constantinou	PhD research student, University of New South Wales, Australia	<i>The spatial and temporal distribution of leopard seals off Eastern Antarctica</i>
October 1, 2009	Bryan Black	Assistant Professor, Senior Research. Dept. of Forest Ecosystems and Society, Hatfield Marine Science Center	<i>Rockfish, seabirds, and the importance of wintertime ocean conditions in the central California Current Ecosystem</i>
October 8, 2009	Brad Buckley	Portland State University	<i>Environmental genomics reveals the capacity to respond to heat stress in marine fishes</i>
October 13, 2009	Ed Dever	OSU COAS	<i>The NSF Ocean Observing Initiative (OOI): Long term ocean observing infrastructure for the NE Pacific</i>
October 15, 2009	Ben Laurel	NOAA Alaska Fisheries Science Center	<i>Navigating the Pacific using an Atlantic roadmap: ecological and early life-history comparisons between two cod species, Gadus macrocephalus and G. morhua</i>
October 22, 2009	Yanming Gong	Reimers Lab, College of Oceanic and Atmospheric Sciences, OSU	<i>Development of Low Temperature Proton Exchange Membrane Fuel Cell Technology</i>
October 29, 2009	Matthew Johnson	USGS Forest & Rangeland Ecosystem Science Center	<i>Inter-seasonal movements, winter range use, and migratory connectivity of Black Oystercatchers</i>
November 5, 2009	John Lupton	NOAA Vents Program, HMSC	<i>Hydrothermal systems and recent eruptive activity in the Northern Lau Basin, south Pacific Ocean</i>
November 10, 2009	George Pettit	Regents Professor, Arizona State University	<i>From Africa to Phase III human cancer clinical trials.</i>
November 11, 2009			<i>From marine organism constituents to human cancer clinical trials</i>
November 12, 2009	Mick Haller	Associate Professor, School of Civil & Construction Engineering, OSU	<i>Wave Observations and Modeling at Newport, Oregon</i>
November 19, 2009	Merrick Burden	Fisheries Economist, Environmental Defense Fund (formerly with Pacific Fishery Management Council)	<i>The Pacific Groundfish Trawl Rationalization Program: Opportunities, Challenges, and Lessons learned</i>
December 3, 2009	Suam Kim	Department of Marine Biology, Pukyong National University, Korea	<i>Fisheries and climate change in East Asian seas</i>

HATFIELD MARINE SCIENCE CENTER ANNUAL REPORT 2009-2010
PUBLIC OUTREACH AND EXTENSION

DATE	NAME	AFFILIATION	TITLE
December 10, 2009	Virginia Butler	Department of Anthropology, Portland State University	<i>Evidence for Anadromous Salmonids in the Upper Klamath Basin Based on DNA and Geochemistry Analysis of Archaeological Remains</i>
January 7, 2010	Muyin Wang	JISAO, University of Washington	<i>Arctic climate feedbacks: global implications</i>
January 14, 2010	Ed Brook	Department of Geosciences, OSU	<i>Past gas: The ice core record of greenhouse gases and climate</i>
January 21, 2010	Edward D. Houde	University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory	<i>Solving the Recruitment Problem, the Holy Grail of Fisheries Science</i>
January 22, 2010	Edward D. Houde	University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory	<i>Men and Menhaden: Fisheries, Policy and Management in Chesapeake Bay</i>
January 28, 2010	John E. Stein	Deputy Science Director, Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, WA	<i>Ocean Acidification and Sea Level Rise: How do we tell the story?</i>
February 4, 2010	George Waldbusser	College of Oceanic and Atmospheric Sciences Oregon State University	<i>Coastal Acidification: Causes and Consequences to Bivalves</i>
February 11, 2010	Thomas Therriault	Research Scientist, Fisheries and Oceans Canada, Nanaimo, British Columbia	<i>Interactions between invasive tunicates and shellfish aquaculture: lessons learned</i>
February 18, 2010	Amelia Whitcomb	Alaska Fisheries Science Center (Seattle), National Marine Fisheries Service, NOAA	<i>Reproductive Parasitism of Snailfishes (Liparidae) on the Golden King Crab (Lithodes aequispinus) in the Aleutian Islands</i>
February 25, 2010	Joshua Mackie	San Jose State University	<i>Strangers on boats - genetic twists in hull-fouling introductions</i>
March 4, 2010	Mary Hunsicker	School of Aquatic and Fishery Sciences, University of Washington	<i>The role of cephalopods in marine food webs and fisheries</i>
March 11, 2010	William F. Gilly	Hopkins Marine Station, Stanford University	<i>Ecology of Humboldt Squid (Dosidicus gigas)</i>
March 19, 2010	George Rose	Memorial University of Newfoundland	<i>Atlantic cod spawning in Newfoundland</i>
April 8, 2010	Amanda Gladics & Jose R. Marin Jarrin	OSU/HMSC Graduate Students	<i>Graduate Student Symposium</i>
April 15, 2010	Roger Denlinger	US Geological Survey, Vancouver, WA	<i>Simulation of catastrophic outburst floods from Pleistocene glacial lake Missoula</i>
April 22, 2010	Joseph Dietrich	NOAA-NWFSC, Environmental Conservation Division	<i>Boatloads of Bugs: Pathogen prevalence, disease transmission, and delayed mortality among Chinook salmon barged through the Columbia River Power System</i>
May 6, 2010	Dave Mellinger	CIMRS, Oregon State University/HMSC	<i>Monitoring marine megafauna using sound</i>
May 13, 2010	Kenneth J. Lohmann	Department of Biology, University of North Carolina at Chapel Hill	<i>Navigation, Natal Homing, and the Geomagnetic Imprinting Hypothesis for Sea Turtles and Salmon</i>
May 20, 2010	Bill Chadwick	CIMRS & NOAA Vents Program	<i>The 1980 eruption of Mount St. Helens: Looking back 30 years</i>
May 27, 2010	Hilairy Hartnett	Arizona State University	<i>Biogeochemical transformations of dissolved organic carbon: new insights from electrospray mass spectrometry</i>
June 3, 2010	Astrid Scholz	Ecotrust	<i>Getting territorial about the sea: mapping the multiple uses of Oregon's ocean</i>
June 17, 2010	Jon Erlandson	University of Oregon & Oregon Museum of Natural and Cultural History	<i>Children of Neptune: The role of the sea in human prehistory</i>
June 24, 2010	Bob Lackey	Oregon State University and EPA	<i>Science, Scientists and Policy Advocacy</i>

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

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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	2,600,000	9%
Oregon Department of Fish & Wildlife	5,967,000	21%
Vents Program - Federal	1,168,000	4%
Nat'l Marine Fisheries Service - NWFSC	6,173,000	22%
Nat'l Marine Fisheries Service - AFSC	1,401,859	5%
US Department of Agriculture - ARS	714,373	3%
US Fish & Wildlife Service	9,899,000	35%
US Geological Survey	500,000	2%
Total State & Federal Agency Budgets	\$28,423,232	100%
FUNDING SOURCES		
<u>Direct State Funding</u>		
HMSC	2,280,492	
COMES	1,604,205	
MMI	21,523	
CIMRS	310,387	
Guin Library	237,434	
Extension Sea Grant	499,048	
Total Direct State Funding	\$4,953,089	10.2%
<u>Other State Funding</u>		
Matching Funds (Endowments)	195,585	
Student Fees (TRF)	2,123	
Total Other State Funding	\$197,708	0.4%
<u>Sponsored Research and Education Programs</u>		
Nat'l Oceanic & Atmospheric Admin. (NOAA)	4,511,686	
Nat'l Science Foundation (NSF)	1,143,152	
U.S. Dept. of Agriculture (USDA)	617,068	
Office of Naval Research (ONR)	964,587	
Department of Defense	10,272	
Department of Energy (DOE)	876,984	
Department of Interior (DI)	127,300	
Other Federal Agencies	6,068	
Oregon Dept. of Fish & Wildlife (ODFW)	0	
Other Oregon Agencies	142,574	
California Dept of Water Resources	159,428	
Foundations & Other Organizations	1,274,031	
Sub-Contracts from other Universities	135,994	
Total Sponsored Research	\$9,969,143	20.5%
<u>Other Funding</u>		
Self-Funding Units	795,425	
COAS-Ship Operations	3,717,772	
OSU Foundation	565,924	
State & Federal Agency Budgets	28,423,232	
Total Other Funding	\$33,502,353	68.9%
<u>TOTAL FUNDING:</u>	\$48,622,292	100%

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	540,662			Ship Support/Operations	3,125,291		
Visitor Center Support	76,582			Ship Support & Communications	17,481		
Non-Sponsored Research	0			Ship Scientific Equipment	575,000		
Non-Sponsored Education	108,744			Total Ship Operations:	\$3,717,772		
Sponsored Education	0			Sponsored Research-Reimers	359,406		
Sponsored Research	563,170						
Total Research Administration:		\$1,289,158	6.4%	Total COAS:		\$4,077,178	20.2%
<u>Physical Plant</u>				<u>Education Programs</u>			
State Support	1,572,491			Extension	475,544		
Federal Support	688,104			Sea Grant	303,669		
Other Sponsored Activity	2,123			Visitors Center	131,405		
Total Physical Plant:		\$2,262,717	11.2%	Sponsored Programs	93,727		
<u>Coastal Oregon Marine Experiment Station (COMES)</u>				Self-Funded Programs	48,701		
Administration	370,142			Total Education Programs:		\$1,053,046	5.2%
Non-Sponsored Research	894,201			<u>Housing</u>			
Cost Shared to Sponsored Research	74,934			Self-Funded Operations	82,744		
Self-Funded Programs	86,423			Total Housing:		\$82,744	0.41%
Physical Plant-State	24,975			<u>Bookstore</u>			
Extension	0			Self-Funded Operations	164,495		
Endowment	0			Total Bookstore:		\$164,495	0.8%
Sponsored Research	1,992,552			<u>Other</u>			
Total COMES:		\$3,445,228	17%	Guin Library	237,434		
<u>Cooperative Institute for Marine Resource Studies (CIMRS)</u>				OSU Foundation & Gifts	75,974		
Administration	260,520			Network Service/Computer Support	171,768		
Non-Sponsored Research	32,475			State Agencies (through OSU)	1,169		
Physical Plant-State	17,392			Federal Agencies (through OSU)	20,220		
Sponsored Research	5,016,578			Total Other:		\$506,564	2.5%
Total CIMRS:		\$5,326,965	26.4%	TOTAL HATFIELD MARINE SCIENCE CENTER:			
<u>Marine Mammal Institute</u>						\$20,199,060	100%
State End Match - Admin.	171,663						
State Support Director's Salary-Admin	21,523						
Self-Funded Fee Programs	219,904						
OSUF Funds	489,950						
ARF Funds	20,323						
Sponsored Research	1,069,602						
Total MMI:		\$1,992,965	9.9%				