

# Oregon State University Hatfield Marine Science Center 2008 - 2009 Annual Report



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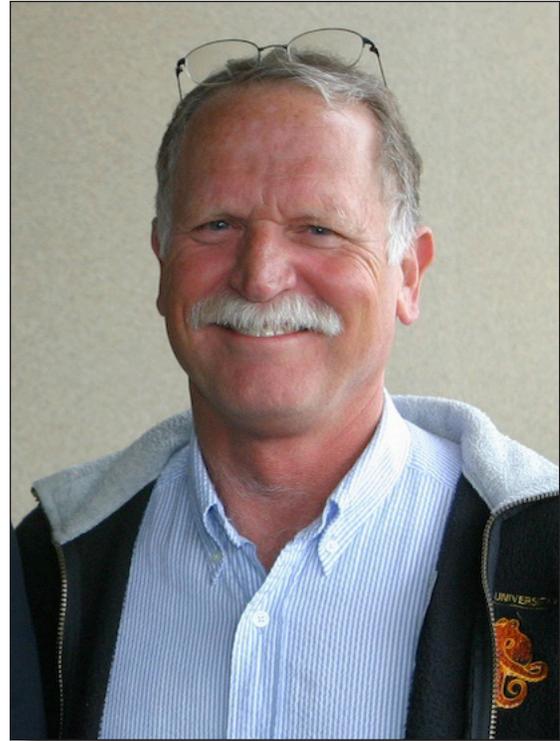
## Director's Message

**Dr. George W. Boehlert, Director**

The twelve month period covered in this annual report has proven to be a very active and dynamic year for the Hatfield Marine Science Center. Despite the economic downturn (and perhaps in some cases because of the downturn), many of our programs have thrived. Stimulus funds have played an important role in developing our facilities. First, state stimulus funds helped rectify deferred maintenance of HMSC's facilities, including earthquake retrofitting of the main OSU buildings, development of a treatment facility for HMSC's seawater effluent, paving of parking lots, and renovation of the education wing and selected laboratories. The ODFW also received state funds to design a new building to house its growing staff and programs. In June, federal stimulus funds brought us within a hair's breadth of constructing the proposed Marine Mammal and Marine Genomics building. HMSC's proposal to the National Institute of Standards and Technology appeared successful, but we failed at obtaining the requisite state matching funds given the state's economic situation; we continue to note, however, that the last OSU research facility at HMSC built by the state of Oregon was the original building constructed in 1965. Had we been successful in funding this 42,000 sq ft building, it would have alleviated overcrowding, permitted growth in several OSU programs at HMSC, and would have made additional space available in the NOAA buildings. We will persevere in our efforts.

New research has also thrived this year. The state's emphasis on renewable energy and the specific objective of developing wave energy has led to diverse research at OSU; HMSC has played a role in the arena of environmental effects, with particular attention to marine mammals in the MMI and other efforts at NOAA and ODFW. This year, OSU was awarded a 5-year grant from the US Department of Energy for the Northwest National Marine Renewable Energy Center. Many of the activities are centered at the HMSC, and it appears that this will represent an area of future growth in research. Other OSU research programs at HMSC (COMES, CIMRS, MMI, and informal education) have also grown.

HMSC's partnerships with the community are highlighted this year by cooperation with the Port of Newport in its quest to bring NOAA's Marine Operations Center for the Pacific to Newport. This effort would bring several research vessels to Yaquina Bay, and is taking place at the same time as the College of Oceanic and Atmospheric Sciences works to propose a replacement for the research vessel Wecoma. These activities, along with HMSC's growing programs, point out the high economic value of marine science in the Yaquina Bay region. Our educational partnerships have resulted in growth of college, K-12, and public education programs. The continued support of our many donors benefits all our programs.



Hatfield Marine Science Center Director George Boehlert

The diversity of programs at the HMSC makes it a real crossroads of marine science. Within OSU, HMSC includes staff from five colleges within the University and is home to five major OSU institutes or programs. The seven different state and federal agency programs provide an added dimension that is unique among marine laboratories. The highlights above give only a small flavor of the accomplishments of the HMSC over the past year. The contents of this annual report reflect the dedication of the leadership and scientific, educational, and support staff of the many OSU and agency programs at the Hatfield Marine Science Center.

## I. RESEARCH

### A. Oregon State University



#### *Programs by Stations and Institutes*

#### **Coastal Oregon Marine Experiment Station**

**Gil Sylvia, Superintendent**

Oregon State University's Coastal Oregon Marine Experiment Station (COMES) includes faculty, staff, and students located at the Hatfield Marine Science Center and the Seafood Laboratory in Astoria. COMES is the largest applied marine research unit in Oregon and the largest Agricultural Branch Experiment Station in the United States dedicated solely to coastal and marine issues. COMES was established in 1988 with support from the Oregon legislature to conduct interdisciplinary and cooperative research to understand, utilize, and sustain Oregon's marine resources, industries, and coastal communities. Under the leadership of Lavern Weber and an advisory board chaired by Captain Barry Fisher, the Station began with three faculty and a handful of graduate students. Eighteen years later the Marine Experiment Station has grown to include 12 tenured faculty, 25 staff and research associates, more than 40 graduate students, and over \$3 million annually in external grants and funds. COMES also works closely with an Advisory Board that includes members representing coastal communities, the fishing and seafood industry, and other businesses and organizations with a stake in supporting research important to coastal communities and the State of Oregon.

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

The year 2008-2009 was successful and marked continued growth of the Station. COMES is in the process of hiring a new director for the Astoria Seafood Laboratory to replace Michael Morrissey who is now Superintendent of the Food Innovation Center in Portland. Michael, however, will remain part time

Director of the Astoria Lab until the hire is complete. The Marine Mammal Endowed program has completed its transition in becoming an Institute (MMI). While this unit now answers directly to the Dean in the College of Agriculture, COMES will continue to coordinate with MMI including administration of joint faculty (Scott Baker and Markus Horning). David Sampson is on a two year leave of absence working at the Joint Research Center in Ispra, Italy. Kathleen O'Malley has joined COMES as the Principal Investigator for the Evolutionary Genetics of Marine Fishes Laboratory.

Based on the Oregon Invests database, in 2008-2009 COMES programs generated over \$12 million in economic impacts and produced an equivalent 30-40 new jobs for Oregon and Pacific Northwest coastal communities. These impacts are the result of research leading to improved utilization of marine resources, increased production of commercially harvested and cultured seafood, development of value-added seafood products, and improved policies for resource management. COMES published over 70 manuscripts and reports including more than 50 in refereed journals and books. COMES graduated 16 students including 9 MS and 7 Ph.D's. COMES faculty also gave over 80 presentations and organized 10 workshops and conferences. For 2008-2009 it is estimated that for each \$1 million in state dollar expended, COMES faculty leveraged an additional \$2.5 million in federal grants and private support.

COMES "Signature Programs" in 2008-2009 include:

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

***Community Seafood Initiative (CSI):*** CSI is a unique partnership between COMES, Shorebank Enterprise Pacific, Oregon Sea Grant, and the Seafood Consumer Center. CSI supports coastal businesses and value-added seafood production. Since 2002 CSI has assisted numerous fishermen and seafood processors in business and market planning, and provided more than \$2 million in investments and loans to coastal seafood companies. CSI has assisted in developing new value added seafood products, delivered numerous seafood demonstrations, and is assisting the Oregon Dungeness Crab Commission in certification by the Marine Stewardship Council (MSC). Molluscan Broodstock Program (MBP) MBP conducts research and outreach with industry partners to improve oyster broodstock and associated economic benefits. Hundreds of million of juvenile oysters produced in the Pacific Northwest are derived from MBP families housed in COMES facilities. The program is responsible for an annual increase of oyster production exceeding \$5 million in farm-gate value.

**OSU Surimi Research and Technology School:** The Astoria seafood laboratory is a world leader in surimi research and education. Surimi researchers have generated millions of dollars in benefits to the local seafood industry in improved product quality, protein utilization, and recovery. The Surimi School trained over 100 international and domestic students in 2008-2009 and the Astoria Surimi School generated over \$100,000 in local expenditures.

**Salmon and Marine Ecology Initiative:** A Partnership between Coastal and Eastern Oregon in salmon ecology research. The program is producing new genetic and ecological research for improving utilization and conservation of salmon and other marine species. The program is responsible for spearheading Project CROOS, Oregon's largest collaborative fishing research project which has trained and employed over 100 salmon fishermen in understanding salmon genetics and migration.

## Cooperative Institute for Marine Resources Studies (CIMRS)

Michael A. Banks, Director

Now in its twenty-sixth 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 Hatfield Marine Science Center (HMSC), CIMRS is now administrative home for 28 research staff and 5 research faculty working on collaborative projects with NOAA investigators who also serve as OSU courtesy faculty. New memberships in the Science Advisory Council were initiated and completed with a meeting in April.

Recent research highlights include:

- A fantastic year for observation of undersea volcanic eruptions: See:  
<http://laueruptions.blogspot.com/>  
<http://nwrota2009.blogspot.com/>  
[http://www.nrc.noaa.gov/ci/hotitems/2009/05\\_cimrs.html](http://www.nrc.noaa.gov/ci/hotitems/2009/05_cimrs.html)
- \$2,196,349 raised from external fund sources and \$30,000 from OSU's Research Equipment and Reserve Fund by CIMRS principal investigators.
- 20 peer review manuscripts dated 2008 & 2009

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.

Principal Investigator	Funding Agency	Grant Title	Funded Amount
W. Chadwick	NSF	Cabled Seafloor Observatory	\$205,374
W. Chadwick	NSF	Monitoring Inflation at Axial Volcano	\$ 21,507
W. Chadwick	NSF	Upgrade GPS Network on Sierra...	\$ 28,626
W. Chadwick	NSF	Strombolian Eruptions, Magma...	\$160,342
R. Dziak/H. Matsumoto	NSF	Real-Time Volcanic Event Detection	\$137,280
Dziak/Matsumoto	NSF	Assessment of T-Wave Processes...	\$410,216
Matsumoto/Mellinger/Dziak	ONR	Acoustic Float for Marine Mammals	\$290,835
D. Mellinger	NPGS	Datasets of Odontocete Sounds Annotated for Developing Automated Detection Methods	\$295,000
D. Mellinger	Univ. St. Andrews	Development of Automated Detection Method from Passive Acoustic ...	\$197,958
D. Mellinger	ONR	Factors Influencing...Gray Whales	\$ 49,045
D. Mellinger	ONR	Automatic Detection of Beaked Whales	\$400,166
		TOTAL	\$2,196,349

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* and  
*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.

**Ph.D. Candidates - Department of Fisheries and Wildlife**

<p><b>Rebecca Baldwin</b></p> <p>Co-Major Professors: Michael Banks, Kym Jacobson</p> <p>NOAA Fisheries Rep: Kym Jacobson, NWFSC</p>	<p>2005-2009</p>	<p><i>Using Parasite Community Data and Population Genetics for Assessing Pacific Sardine (<i>Sardinops sagax</i>) Population Structure along the west coast of North America</i></p>
<p><b>Kevin Thompson</b></p> <p>Major Professor: Selina Heppell</p> <p>NOAA Fisheries Rep: Grant Thompson</p>	<p>2008-2012</p>	

**Ph.D. Candidate - College of Oceanic & Atmospheric Sciences**

<p><b>Jesse Lamb</b></p> <p>Major Professor: Tim Cowles</p> <p>NOAA Fisheries Rep: William Peterson</p>	<p>2008-2012</p>	
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**M.S. Candidate - Department of Anthropology**

<p><b>Christina Package</b></p> <p>Major Professor: Flaxen Conway</p> <p>Minor Rep: Bryan Tilt</p> <p>NOAA Fisheries Rep: Elizabeth Clarke</p>	<p>2007-2009</p>	<p><i>Improving Community Profiles for Oregon Fisheries and Coastal Communities</i></p>
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**Marine Mammal Institute (MMI)**

**Bruce Mate, Director**

The mission of the Marine Mammal Institute is 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 the only institute of its kind, the MMI brings together top researchers from around the globe to continue the legacy of discovery and preservation of critical habits of target species, improving understanding of interactions in their environment, including the impacts of human activities.

The MMI currently consists of 28 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 Coast 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. These goals and values were already in practice within the MMP, and are enhanced with the greater capabilities of the MMI.

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. MMI research and information are used by agencies, public policy makers, scientists, media, educators, and the general public.

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. OSU is looking to donors for half of the building costs.

This year the Marine Mammal Institute gained international recognition with the airing of a National Geographic Channel special, "Kingdom of the Blue Whale" in conjunction with the National Geographic Magazine article, "Still Blue" by Ken Brower, in March 2009. Dr. Bruce Mate was involved in media release events in Los Angeles prior to the airing. He was also part of a 5-day promotional tour for National Geographic Asia in Kuala Lumpur, Malaysia for the premier of the documentary in April of 2009.

## **Northwest National Marine Renewable Energy Center (NNMREC)**

**George Boehlert, HMSC Director**

In September 2008, Oregon State University along with its partner the University of Washington received funding from the US Department of Energy for the NNMREC. The objectives of the Center are to facilitate commercialization of devices for wave/tidal energy, inform regulatory and policy decisions, and close key gaps in understanding. The following topic areas will be 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.

OSU will focus on wave energy and the UW on tidal energy. Robert Paasch of the College of Engineering was principal investigator of the award and is the Center director. Co-principal investigators at OSU are Annette von Jouanne and George Boehlert.

While center director Paasch and several scientists are located on the Corvallis campus, the Center is nominally located at the HMSC where most initial activities will focus on examining environmental effects of wave energy development in the Pacific Northwest, following guidance in a workshop proceedings published in October 2008 (Boehlert et al. 2008). Plans are underway for research on characterization of benthic habitats, assessment of effects on marine mammals (by the Marine Mammal Institute), potential impacts on seabirds, and acoustic characterization of wave energy sites before and after installation. The NNMREC is also working in Newport on developing plans for a “test berth” that will permit testing of diverse wave energy devices in waters near Yaquina Bay. Sarah Henkel joined the HMSC staff as an Assistant Professor (Senior Research) in late June 2009 with NNMREC funding, and will focus her research in the area of benthic ecology. Related work on the social and human dimensions of wave energy development, including work with the fishing industry, is underway through Oregon Sea Grant.

## **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*

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.

Oregon Sea Grant advances knowledge of our coast and ocean through research, education, and outreach and public engagement. Sea Grant is unique among ocean-related programs in integrating these three domains of professional expertise. This integration strengthens our ability to address critical issues and help people solve marine-related problems, create opportunities, and participate knowledgeably in decisions.

In this and other areas within this report, Oregon Sea Grant’s roles are evident in funding research, promoting student experiences, providing public outreach through extension and communication activities and products, using the Visitor Center for public education and the science of informal learning, and delivering quality education programs to youth and other audiences.

First established at Oregon State University (OSU) in 1967, 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 30 programs currently in the National Sea Grant network. Oregon Sea Grant is a part of OSU, but our research, education, and outreach programs are open to all Oregon institutions of higher education.

Although the principal offices of the Sea Grant program are on the main campus in Corvallis, faculty are also housed at coastal offices of OSU Extension, and the program has a large presence at the HMSC. The central office for Sea Grant Extension is located at the HMSC, as is the major portion of Oregon Sea Grant’s marine education activities. In 1997, Oregon Sea Grant also took over responsibility for the HMSC Visitor Center. In recent years our attention at the HMSC has turned to making the Visitor Center a focal point of excellence in free-choice learning and in national and international ornamental fish health.

Examples of youth education, public events and exhibits, ornamental fish health, and other focus areas of Oregon Sea Grant are contained in other sections of this report, with links to the Coastal Oregon Marine Experiment Station and the Colleges of Agricultural Sciences, Science, Oceanic and Atmospheric Sciences, Veterinary Medicine, as well as the Oregon Coast Community College, and the Oregon Coast Aquarium. Oregon Sea Grant is the conduit for National Oceanic and Atmospheric Administration research and outreach grants

awarded competitively by the National Sea Grant College Program. Additional funding comes from the Oregon legislature and occasional collaborative efforts with public and private sources.

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. Over the years, the program's funding emphasis has changed to meet and anticipate the region's changing needs. Critical issues help propel Sea Grant's research priorities as the program strives to put limited resources where they can do the most good. Researchers come from the leading ranks of academic science in Oregon. In some cases, Oregon researchers partner 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.

Over the past two years, Oregon Sea Grant led a Pacific area regional research and information planning process with our colleagues from the Sea Grant programs of Washington, California, and southern California, including 16 workshops throughout the region. The report for the plan was completed in early 2009 and is available for researchers, managers, and others at <http://seagrant.oregonstate.edu/sgpubs/onlinepubs/q09001.pdf>. Stakeholder comments are also available by workshop location or by topic. To access this information, go to <http://seagrant.oregonstate.edu/research/RegionalPlanning/index.html>.

Almost \$500,000 worth of competitive projects involving the Hatfield Marine Science Center were funded by Oregon Sea Grant during the 2008-2009 fiscal year. Research and projects included studying group learning dynamics at the Visitor Center's live animal exhibits; improving participation by stakeholders in fisheries stock assessment; reducing mortality in marine ornamental fish; global visualization (Magic Planet exhibit) and visitors; communicating ocean science; informal science education with marine laboratories and community colleges; and supporting students—including a full-time year-long OSG Natural Resources Fellowship on marine reserves with the Oregon Department of Fish and Wildlife at HMSC.

## *Research Programs by Academic Unit*

### **College of Agricultural Sciences**

#### **Department of Fisheries & Wildlife**

##### ***Fisheries Population Dynamics***

###### **David Sampson, Professor**

**Research:** As in past years, Dr. Sampson's research activities during 2008/09 focused on stock assessment and fisheries management issues. As part of his duties for the Oregon Department of Fish and Wildlife, which funds half his position, David continued to serve as Oregon's representative on the Scientific and Statistical Committee (SSC) for the Pacific Fishery Management Council, attending five regular SSC meetings and several sub-committee meetings and chairing the Stock Assessment Review panel for the 2009 assessment of the Pacific Hake stock. David also served on the Scientific and Technical Advisory Committee to the Oregon Ocean Policy Advisory Council and assisted Susan Hanna (COMES) with organizing and reporting on a technical workshop on economic data and analysis of Marine Reserves, which was held at the HMSC during October 2008.

During the year David continued to serve as the External Coordinator for the University of Miami's Center for Independent Experts, which provides independent peer reviews of fishery stock assessments and other forms of marine science to NOAA Fisheries. As the CIE External Coordinator, David helps administer all science review panels pertaining to Atlantic and Gulf of Mexico resources. His duties include finding suitable candidates for the panels and reviewing and editing the panelists' reports.

David supervised two graduate students during the year. Gladys Macaoisip, a Fulbright Scholar from the Philippines and a Masters degree candidate in the Department of Fisheries and Wildlife, worked on a project to identify the fish species currently residing in Lake Lanao in the Philippines and identify traits that have evidently allowed certain fish species to successfully invade this lake. Lake Lanao was the home of 16 endemic species of cyprinids, but many of these species now appear to be extinct. Cathleen Vestfals, a Masters Degree candidate in the Marine Resource Management Program, conducted research funded by the Oregon Trawl Commission to determine the habitat preferences of canary rockfish and develop maps of areas that could be surveyed to provide better estimates of canary rockfish abundance. Cathleen successfully defended her thesis in June.

**Teaching:** During fall 2008 David taught his course "Dynamics of Marine Biological Resources", as both an on-campus version and an e-campus version. The on-campus lectures were given in the HMSC studio classroom and televised to the main campus.

In April 2009 David began a two-year leave of absence from OSU to take up a position as a Senior Fisheries Scientist working for the European Commission at the Joint Research Center in

Ispira, in northern Italy. He will work there with a group of about 25 fisheries scientists and economists that provide technical advice and support regarding various aspects of European fisheries science and management.

## ***Invasive Species***

### **John Chapman, Research Associate**

The 2008-2009 year proved to be a busy one for John Chapman. His presentations, activities, lectures, labs and field trips on estuary ecology and aquatic biological invasions include:

- Presented at the Oregon Chapter of the Wildlife Society, Salishan, 19 February 2009 "An unnatural arms race between an introduced parasite and its new estuarine hosts in North America: more trouble for juvenile salmon?" J. Chapman, B. R. Dumbauld and T. H. DeWitt
- Gave lectures in two OSU courses; Coastal Ecology and Research Management "Introduced species on the Oregon Coast" (Fall quarter) and Marine Ecology - Zoology 451/551 (Spring quarter)
- Organized and taught the first ECampus course from HMSC (the 4-unit Aquatic Biological Invasions FW 421/521) which completed on 31 July 2009
- Lectured in the OIMB Marine Introduced Species Workshop "Orthione griffenis, an introduced parasite changing eastern Pacific estuary ecosystems?"
- Lead and instructed the amphipod taxonomy/systematics workshop held at the LA County Museum, 13-14 January 2009
- Organized an estuary field trip for the Oregon-Cascades Biology Club in which burrowing competence with size in the *Upogebia pugettensis* was experimentally tested. These new results indicate a long suspected and puzzling pattern in which large shrimp cannot reburrow and provide another clue in unraveling the life history of its introduced parasite *Orthione griffenis*
- Collaborated with Bill Hanshumaker of HMSC and summer intern Erin Cathcart of the adult volunteer "Estuaries" program on a new HMSC Exhibit "Undoing an Invasive Species: The Story of the Blue Mud Shrimp and its Parasite Griffen's Isopod"

John's research on the collapse of native mud shrimp with the introduced isopod *Orthione griffenis* included a search for the remnant mud-shrimp populations in Oregon and central California in January and July 2009, which corroborated extreme declines or absences between Bodega Bay and Elkhorn Slough, California. The area of a small but previously persistent Coos Bay population declined to approximately 10% of its 2008 area in July 2009 and efforts are underway to compare the 2008-2009 Yaquina Bay *Upogebia* survey data with 2002 survey data of the EPA.

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. The 2008 project, initiated in collaboration with Brett Dumbauld (US ARS)

and Ted DeWitt (US EPA), tests whether mud shrimp populations are declining due to extensive infestations of *Orthione*, and was continued into 2009. Whether significant changes have occurred in Yaquina Bay remains unresolved.

John is assisting Michelle A. Schuiteman (marine educator), with a description of a new genus and species of deep water cirrolanid isopod recovered from Leach's Storm Petrel (*Oceanodroma leucorhoa*), which feed only at the very ocean surface at the continental margin. They plan to publish the description in the *Journal of Crustacean Biology*. The on-going study with Judy Miller, Harrisburg High School (2007 - 2009, M. J. Murdock Charitable Trust, Partners in Science visiting summer high school teacher) is in the writing stage for a manuscript on ocean conditions and recruitment.

John co-supervised 2009 REU student, Xeronimo Casteneda with Brett Dumbauld and Katelyn Cassidy on lipofushin aging of *Upogebia pugettensis*. Their work will permit greater understanding of the population dynamics of mud shrimp and the life histories of their parasites.

**Other accomplishments:** John is a continuing member-at-large of the Western Regional Panel, (of the National Invasive Species Panel), serves as president of the South Beach Community Center and for the sixth year organized the May 2009 Newport Sprint Triathlon – fund raiser for the Newport Swim Team and Newport High School National honors society.

### **Proposals submitted:**

- Oregon Sea Grant: "Save the native mud shrimp *Upogebia pugettensis*, from its introduced bopyrid parasite *Orthione griffenis*", ~260 K (response to reviews returned 31 July, full proposal still pending)
- California Sea Grant: "Emergency conservation of the native mud shrimp (*Upogebia*) in response to infection by the introduced parasite, *Orthione griffenis*" ~ \$58K (reviews to full proposal pending)

## ***Marine Fish Ecology***

### **Selina Heppell, Associate Professor**

### **Scott Heppell, Assistant Professor**

This year, the Heppell Lab had two major projects running through our lab at HMSC. The first is focused on recruitment of rockfishes into Oregon estuaries and the second on incorporation and detection of isotopes to the vertebrae of young of the year sharks and rays. We have also been finishing up our laboratory work on Pacific ocean perch, 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. The rockfish recruitment project has included regular dive

surveys of artificial habitats deployed in Yaquina bay and trapping of rockfish in six different estuaries on the Oregon coast. Dive surveys started in March of this year (as they did last year) and will continue through October. At each artificial habitat, divers conduct a visual census of fish on the habitat, and then collect fish using hand-held nets. Fish are identified, counted, and measured, then released back into the estuary. Fin tissue samples are collected from all rockfish captured. Trapping occurs on a bi-weekly basis from May through October in each of six estuaries (Nehalem, Siletz, Yaquina, Alsea, Coos, and Coquille). All captured fish are identified, counted, measured and subsequently released back into the estuary. Fin clips will be used for genetic analysis (through Michael Bank's lab) to confirm species identification. The overall goal of this project is to evaluate the role that estuaries play in the population dynamics of nearshore rockfish species.

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 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. 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 are being collected from each tank on a weekly basis and the specimens will be maintained in captivity until April, 2010.

**On-going student projects based at HMSC include:**

- Field work on the recruitment of juvenile rockfishes into Yaquina Bay and five other estuaries on the Oregon Coast. Project run by Alison Dauble
- 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.

**Teaching Activities:** Scott and Selina Heppell continue to participate in the Fisheries and Wildlife Fall teaching program, and use HMSC classroom and laboratory facilities for these courses. This year, they taught Fishery Biology and Marine

Conservation Biology, and participated in the Coastal Ecology and Resource Management course. Scott taught two weeks of the Marine Biology course in Spring term.

**Marine 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, PhD, is investigating the role of surf zones in the early life history of Chinook salmon. Londi Tomaro, MS, is quantifying the role of juvenile growth and migratory behavior on the survival of mid-upper Columbia River spring-run Chinook salmon. Ruth DiMaria, MS, 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. Pamela Archer, a Marine Resource Management MS student successfully defended her thesis, which examined the efficacy of efforts to re-establish the native oyster, *Ostrea conchaphila*, to Netarts Bay, Oregon, in late summer of 2008. Hilary Browning, a National Science Foundation intern (participant in the HMSC Research Experience for Undergraduates (REU) program) is working on a project to determine if Chinook salmon display stock-specific ocean migration patterns.

**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 post- and pre-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 sculpin (*Oligocottus maculosus*) (Funded by OSU General Research Fund)
- Source identification of golden shiners collection in Diamond Lake, Oregon (Funded by the Oregon Wildlife Heritage Foundation)

#### **Presentations:**

(\* graduate student presentation, \*\* undergraduate student presentation)

2009. Tomaro\*<sup>1</sup>, L. and J. A. Miller. Can the otolith Sr:Ca concentration distinguish naturally spawned and hatchery-reared mid-upper Columbia River Chinook salmon? Validation of a de-facto 'hatchery mark'? American Fisheries Society, Oregon Chapter. Bend, OR  
<sup>1</sup>Best Graduate Student Poster Presentation Award, 2<sup>nd</sup> place
2009. Tomaro\*, L. and J. A. Miller. Can the otolith Sr:Ca concentration distinguish naturally spawned and hatchery-reared mid-upper Columbia River Chinook salmon? Validation of a de-facto 'hatchery mark'? 11<sup>th</sup> Salmon Ocean Ecology, Juneau, AK
2009. Miller, J. A., C. A. Simenstad, and V. Butler. Reconstructing juvenile migratory history of modern and pre-historic Columbia River Chinook salmon. 11<sup>th</sup> Annual Salmon Ocean Ecology Meeting, Juneau, AK
2009. Marin Jarrin\*, J., N. Goehring\*\*, A. Shanks, and J. A. Miller. Sandy beach surf-zones: what is their role in the early life history of Chinook salmon? Pacific Estuarine Research Society Annual Meeting, Bellingham, WA
2009. Marin Jarrin\*, J., N. Goehring\*\*, A. Shanks, and J. A. Miller. Sandy beach surf-zones: what is their role in the early life history of Chinook salmon? 11<sup>th</sup> Annual Salmon Ocean Ecology, Juneau, AK
2009. Archer\*, P., J. A. Miller, D. V. Vander Schaff, and T. D'Andrea. Re-establishment of the native oyster (*Ostrea conchaphila*) in Netarts Bay, Oregon. Pacific Estuarine Research Society Annual Meeting, Bellingham, WA

#### **Awards:**

- Lillian Brucefield Reynolds Scholarship Fund, Londi Tomaro
- Mamie L. Markham Endowment Award, Londi Tomaro
- William Q. Wick Marine Fisheries Award, Jose Marin Jarrin
- Best Graduate Student Poster Presentation Award, 2<sup>nd</sup> place, Oregon American Fisheries Society Annual Meeting, Londi Tomaro

**Teaching:** Dr. Jessica Miller co-taught Early Life History of Fishes (FW474/574) in collaboration with Sr. Lorenzo Ciannelli at OSU's College of Oceanic and Atmospheric Sciences (COAS) during Fall 2008. Fifteen undergraduate and graduate students participated in the course. Students could participate from either the Corvallis or Newport campus because the lectures were broadcast via a video system that links the two campuses.

### ***Marine Fisheries Genetics***

**Michael Banks, Assistant 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.

Our busy pace has continued this year with key moments including submission of several large grants (including prospects for our new home in the Marine Mammal, Marine Genomics Building), celebratory graduation of our 3rd PhD student, Marc Johnson and welcoming of Assistant Professor, Kathleen O'Malley who begins her program in Evolutionary Fisheries Genetics. Publication products include novel microsatellites for native oysters (*Ostrea lurida*), confirmation of sandy beach surf-zone use by juvenile Chinook, evidence for selection for an olfactory receptor gene in Coho salmon (our first publication in *Marine Genomics*) and one of a few studies to compare survival and life-history characteristics of unfed fry against smolt release strategies for wild and hatchery Coho salmon.

Collaborative projects include our co-hosting of a Research Experience for Undergraduates student with Rich Brodeur's fisheries oceanography team, where our development of larval rockfish ID tools will hopefully enhance details required for larval recruitment-environmental connectedness studies. Unfortunately complete closure of the Chinook fishery has continued significant constraint on our ocean distribution studies, but hake by-catch studies (actually Chinook) and stock ID with WA Department of fish and Wildlife on the OR-WA border have further strengthened linkages in expanding this project to include collaborators in California and Washington. One high school student was funded by Project CROOS to learn basic GSI tools and applications to fishery management. Our success in applying population genomic tools to investigate migration differences in time has inspired extension of these research interests to determine genetic aspects of how fish orient in space. Other population genomic gains include first time isolation of vomeronasal olfactory receptor (VIR) genes among several rockfish species. It also seems that parasites continue to show promise as an alternative information source for the enigma of sardine population sub-structure and migration in the Northeastern Pacific.

### ***MMI - Cetacean Conservation and Genetic Laboratory (CCGL)***

**C. Scott Baker, Professor; Jennifer Jackson, Postdoctoral Fellow; Debbie Steel, Faculty Research Assistant Becca Hamner, part-time Research Assistant; Renee Gibb (MSc), Angie Sremba (MSc), Alana Alexander (PhD), graduate students; Claudia Hollatz, visiting graduate student from Federal University of Minas Gerais, Brazil (PhD); Ursula Gonzalez, visiting graduate student from University of Baja California (Sur), Mexico (PhD)**

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
- 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 developed 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 and minimum population size during exploitation (Jackson et al. 2008). Results of this work were presented to the annual meeting of the Scientific Committee of the International Whaling Commission in Santiago, Chile (June 2008), and contributed to a recent review of the current conservation listing of humpback whales in Oceania (South Pacific) by the International Union for the Conservation of Nature (IUCN). Jennifer has also been working on an extensive analysis of the molecular evolutionary rates of baleen whales. The results of this analysis have confirmed that baleen whales have the slowest known rates of mutational substitutions in the animal kingdom, perhaps as result of their large size and long generation time (Jackson et al. in press).

#### ***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 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 Baker and Debbie Steel, as Chair and Officer of the Executive Committee of the Consortium, helped to convene the 9<sup>th</sup> annual meeting at the University of Auckland, New Zealand in February 2009. At this meeting, Debbie presented results providing the most comprehensive picture to date, of the fidelity and interchange among the islands of Oceania. Although whales generally show fidelity to regional wintering grounds, individual are capable of 'voyaging' between different regions in alternate years. Renee Gibb presented new estimates of abundance for humpback whales around the Society Islands of French Polynesia, a breeding ground that was unknown to science until the early 1900s. Results of this work have been presented to the annual meeting of the Scientific Committee of the International Whaling Commission as part of the *Comprehensive Assessment* of humpback whales in the Southern Hemisphere. A manuscript describing migratory connections between Antarctic feeding areas and South Pacific breeding grounds, based on matching of DNA profiles (microsatellite genotypes) has been submitted for review. The five matches more than double the previous information on connection between these regions based on nearly 50 years of *Discovery* marking and recovery during periods of commercial whaling (Figure 1).

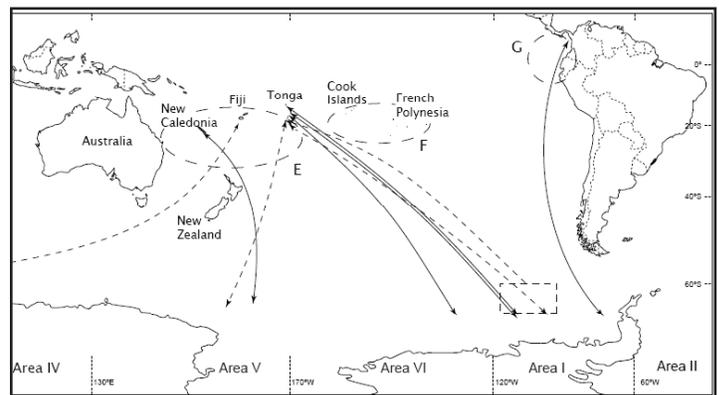


Figure 1: Migratory connections of humpback whales between breeding grounds of Oceania (IWC grounds E, F and G) and feeding Areas of Antarctica established by genotype matching (solid lines) and *Discovery* marking (dashed lines). The dashed box represents uncertainty in the exact location of the recovery of one of the *Discovery* tags

A worldwide study of genetic diversity and population structure of sperm whales is underway through collaboration with Dr. Roger Payne, Iain Kerr and Dr. John Wise of the *Ocean Alliance*. During her five-year voyage, the RV *Odyssey* gathered a remarkable collection of samples that will provide new insight into the migration and social organization of this remarkable species. Alana Alexander, International Fulbright Fellow, is now using molecular markers to analyze the nearly 1,000 samples collected during this expedition.

#### ***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 Becca traveled to Tokyo, Japan in April 2009, to conduct genetic analysis of whale and dolphin products sold in Japan through the Internet

(a recent change from the traditional markets). The work is part of a long-term study of trade in protected whales and dolphins using a portable PCR (Polymerase Chain Reaction) laboratory to identify the species origins of the products. The results of a five-year survey of whale products in Japan were used to estimate the growing threat of unregulated exploitation of minke whales by fisheries entanglement ('net whaling'). Using a novel mixed-stock analysis based on market samples, we have estimated that the number of whales taken from the depleted J stock of minke whales is as large as the number of whales killed in the Japanese scientific whaling program in the North Pacific (Lukoschek et al. in press). 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 her MSc 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 regions populations of Hector's dolphins around the South Island. The results highlight the importance of maintaining corridors for the low levels of dispersal that maintain diversity in each regional population.

#### ***Policy and media outreach***

The future of whaling and the recent expansion of scientific whaling remain thorny issues for international conservation. In May 2009, Scott Baker was invited to Washington, D.C., to testify before a Congressional subcommittee on Insular Affairs, Oceans and Wildlife. His testimony addressed the current deadlock between whaling and non-whaling nations of the IWC, and the scientific implications of Japan's proposal to initiate a 'small-type' coastal whaling program. In June 2009, Scott was a U.S. delegate and Jennifer Jackson was an invited participant to the scientific committee of the International Whaling Commission at the 61<sup>st</sup> meeting in Madeira, Portugal. 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.

Our research on Japanese 'whalemeat' markets was featured in two documentaries that were released in 2009. *'Kingdom of the Blue Whale'*, a production of the National Geographic Channel, included segments on whalemeat markets in Japan and the discovery of a blue/fin hybrid killed during Icelandic scientific whaling and later shipped to Japan for commercial sale. *'The Cove'* is a feature length documentary on the hunting of dolphins in the small Japanese whaling town of Taiji. Directed by world-renown photographer Louie Psihoyos, the documentary features our collaborative research with Japanese scientists on the high level of mercury contamination found in dolphin meat sold in Taiji and elsewhere in Japan. *'The Cove'* won the Audience Choice award at the Sundance Film Festival in January 2009, and is scheduled for theatrical release later this year.

#### ***Research reports to the International Whaling Commission***

**Note:** Reports to the Scientific Committee of the International Whaling Commission are public documents available on request from the Secretariat (The Red House, 135 Station Road, Impington, Cambridge, CB4 9NP UK). The reports are prepared for discussion within the Scientific Committee and for the purposes of management advice, but are not considered peer-reviewed.

- 2009. Renee Albertson-Gibb, Jorge Acevedo, Carlos Olavarría, Anelio Aguayo, Michael Poole and C. Scott Baker. Photo-identification comparison of humpback whales from the Antarctic Peninsula/Strait of Magellan and French Polynesia, (Breeding Stock F)
- 2009. Renee Albertson-Gibb, Michael Poole, Rochelle Constantine, C. Scott Baker. Capture-recapture estimation of abundance for humpback whales of French Polynesia (Breeding Stock F) using photo-identification
- 2009. Renee Albertson-Gibb, Jorge Acevedo, Carlos Olavarría, Anelio Aguayo-Lobo, M. Michael Poole and C. Scott Baker. Photo-identification comparison of humpback whales from the Antarctic Peninsula/Strait of Magellan and French Polynesia, (Breeding Stock F)
- 2009. Debbie Steel, Naoko Funahashi, R.M. Hamner, and C.S. Baker. Market surveys of whale meat in Japan 2008/2009: How many fin whales are for sale?
- 2009. Kristen Ruegg, Eric C. Anderson, C. Scott Baker, Murdoch Vant, Jennifer Jackson and Stephen R. Palumbi. Have Antarctic minke whales increased in abundance because of 20<sup>th</sup> century whaling?
- 2009. Report of the Annual Meeting of the South Pacific Whale Research Consortium - 9<sup>th</sup> February - 12<sup>th</sup> February 2009

#### ***MMI - Pinniped Ecology Applied Research Laboratory (PEARL)***

**Markus Horning, Assistant Professor; Kim Raum-Suryan, Faculty Research Assistant; Lisa Petrauskas, Faculty Research Assistant; Erin Kunisch, Graduate Student (M.S. Dept. Fisheries & Wildlife); Jamie Womble, Graduate Student (Ph. D., Dept. Fisheries & Wildlife); Stephen Meck, Undergraduate Intern; 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.

The PEARL extended 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, through supplemental funding from the National Science Foundation, Office of Polar Programs. Data collection has been completed, and initial results have been published (Hindle et al. 2009, Mellish et al. in press - a). Further analyses are considering the impact of research activities and human disturbance on this well studied species (Mellish et al. in press - b).

The PEARL is continuing the long term monitoring of 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”). Though the primary funding through the NOAA Steller Sea Lion Research Initiative has been exhausted, bridge funding for the continuation of this long-term monitoring project has been secured through the University of Alaska Fairbanks’ PCCRC program and the Alaska Sea Life Center, and additional funding is being pursued. To date, 26 juvenile Steller sea lions have been released with recently developed implanted Life History Transmitters (LHX tags, Horning et al. 2008). LHX devices allow remote monitoring of pinnipeds throughout their entire lives, a first for any marine mammal. Data recovered from these devices allows the determination of incidence of predation (Horning et al. in press), and initial returns suggest a high prevalence of predation – likely by killer whales or sharks – in the Kenai Fjords / Prince William Sound region of Alaska.

Remote monitoring of Steller sea lions at Sea Lion Caves in Oregon is continuing under funding from the National Science Foundation and the North Pacific Marine Science Foundation. 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. Through infrared thermography and three-dimensional photogrammetry, PEARL researchers are hoping to monitor body mass, health, condition and reproductive status of pinnipeds. In 2008, OSU undergraduate Stephen Meck (Biology) conducted a summer internship with PEARL (under additional funding provided by an HMSC Joan Crebbin fellowship), to assist with remote camera setup, data collection and analysis. In 2009, international intern Julia Hager from Germany joined this and other PEARL projects to assist with image and data analysis.

Markus Horning participated in a collaborative project investigating vocal and foraging behavior and energetics of elephant seals off Año Nuevo Island near Santa Cruz in California. This project was initiated by postdoctoral researcher Holger Klinck and by David Mellinger (OSU) in cooperation with Daniel Costa from the University of California at Santa Cruz. PEARL graduate student Erin Kunisch (M.S., Dept. Fisheries & Wildlife) is conducting 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). Stephen Meck is assisting Erin with her project. 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). Lisa Petrauskas left the PEARL after several years of

laboratory work as a Faculty Research Assistant. She has moved to North Carolina.

Long-term PEARL research goals include the integration of these diverse approaches to monitor and predict vital rates and population trends of pinnipeds in the North Pacific and polar regions.

In 2008 and 2009, the PEARL participated in the HMSC Sea Fest annual outreach event, by hosting an interactive booth on West Coast pinnipeds, infrared thermography, and pinniped entanglements by marine debris. The exhibit attracted a lot of attention from visitors of all ages.

### ***Molluscan Aquaculture***

#### **Christopher Langdon, Professor**

A major focus of the OSU-COMES Aquaculture program at HMSC is the USDA-funded Molluscan Broodstock Program (MBP). The 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 two generations of selection, yields of families from MBP selected broodstock are, on average, 42% greater than those from unselected broodstock, with a realized heritability of 0.57. Outstanding broodstock have been transferred to a commercial repository in Netarts Bay, OR, for eventual sale to commercial hatcheries.

MBP is introducing new strains of Pacific and Kumamoto oysters, collected from southern Japan, to improve the genetic diversity of existing West Coast populations. The original broodstock and first generation of each species have been maintained in quarantine conditions and subjected to intensive disease testing. Only disease-free, second generation oysters have been 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 is not known but seems to be related to strong upwelling of deep, acidic water. Acidic seawater conditions on the West coast during upwelling events are similar to predicted global seawater conditions at the end of the century.

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 and rockfish will become increasingly important in meeting our food demands as natural fish stocks decline and fishing becomes more limited. In addition, the ornamental fish industry is expanding globally and there is a need to develop culture techniques to

reduce fishing impacts on sensitive habitats, such as coral reefs. The major bottleneck in rearing marine food and ornamental 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 collaboration with Norwegian aquaculture nutritionists. We are also collaborating with 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**

**Karen Fischer (M.S.), Graduate Research Assistant**

**Amanda Gladics (B.S.), Teaching Assistant and Work Study**

**Student**

**Amanda Stewart, National Science Foundation summer undergraduate intern**

The Seabird Oceanography Lab (SOL) at OSU's Hatfield Marine Science Center (HMSC) is involved in research focusing on marine and estuarine avian ecology and integrated ecosystem studies while providing research opportunities for students and developing educational programs. Now in its third year, SOL continued to expand the breadth of research projects and offered its first short-course in marine bird ecology for undergraduate students (BI/FW 111, Introduction to Marine Life in the Sea – Marine Birds). SOL also contributed to a week -long workshop at HMSC for graduate students from many countries to learn the latest techniques in studying bird migration. This workshop was organized by MIGRATE (Migration Interest Group: Research Applied Toward Education; <http://www.migrate.ou.edu/>), a National Science Foundation funded project, and taught by over a dozen international experts studying bird migration.

Research conducted by SOL spanned the North Pacific, including projects in Japan, Alaska, Oregon, and Hawaii. During this report period, our lab received \$40,000 in funding, authored/co-authored four peer-reviewed papers, and gave thirteen presentations at scientific meetings, seminars, and public forums. Research projects during the past year included: 1) Foraging patterns and marine habitat use of short-tailed albatrosses nesting on Torishima, Japan; 2) Experimental translocation of short-tailed albatross chicks for re-colonization of historical breeding sites in Japan; 3) Albatross foraging and molting areas off Alaska; 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 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 breeding at Kaena Point, Hawaii; 9) Life history strategies and environmental forcing. 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 a 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 ~2,500 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 seventh 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. SOL's 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 a 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.

### ***Albatrosses off Alaska***

During some of our previous analyses of albatross habitat and fishery interactions off Alaska we noticed areas where many of our tagged birds were visiting and spending surprisingly long periods of time. Coupled with albatross feather molt data collected during our at-sea captures in these regions, we began to investigate the hypothesis that albatrosses may go to specific areas to molt during the non-breeding season. SOL investigators are the first to propose such a hypothesis and are continuing to analyze data in hopes of answering this question. If found to be true, this would have important implications for the at-sea conservation of albatrosses and provide critical information for establishing marine important bird areas (IBA) and marine protected areas (MPA).

### ***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. This effort will promote the conservation of seabirds through reduced bycatch (incidental mortality) and help prevent bait loss for fishers, thereby increasing targeted fish catch-per-unit-effort.

### ***Tackling Ecological Complexity: Climate Change and 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 U.C. Berkeley ocean modeling group to study climate change effect on the timing (phenology) of season production cycles and their effect on food web dynamics.

### ***Common Murre Reproductive Biology And Foraging Ecology***

The Yaquina Head Outstanding Natural Area, located in Newport and managed by the Bureau of Land Management, 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. SOL continued research and monitoring at this colony during the 2009 breeding season. This work resumes earlier studies conducted by Dr. Julia Parrish (University of Washington) with hopes of becoming part of the long-term coastal research and monitoring program. Seabird colonies at Yaquina Head are particularly relevant to study since they are adjacent to the Newport Hydrographic Line, providing a perfect opportunity for integrating upper trophic level predators into marine ecosystem studies off Oregon.

#### ***Foraging Ecology Of Two Hawaiian Seabird Guilds: A Comparative Study Of Tuna Birds And Solitary-Feeders***

In collaboration with the University of Hawaii, U.C. Santa Cruz, and Hawaii Pacific University, SOL has begun 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. Seabirds are quickly responding through increasing populations of some species and recolonization by others. Our study involves the at-sea tracking of wedge-tailed shearwaters, red-footed boobies (“tuna birds” where foraging is often associated with schools of tuna) and brown boobies, red-tailed tropicbirds (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 U.C. Santa Cruz, 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.

#### ***Environmental Forcing on Life History Strategies***

SOL and collaborators have synthesized life history parameters from species at multiple trophic levels and different ocean basins to show parallel responses in life history strategies in response to environmental forcing - climate and both top-down and bottom-up drivers. These results have broad applications for understanding and predicting marine community response to climate change. A manuscript documenting these findings was recently published and it is hoped that funding can be secured for further investigations.

## ***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. Organized and chaired the STAC Workshop on Economic Data and Analysis of Marine Reserves, October 21-22, 2009, and served as lead author on the workshop report. Presented the report to the OPAC June 8, 2009.
- Oregon Fishery Policy: Invited lecture “Oregon Marine Fisheries on the Threshold of Change” to the Academy for Lifelong Learning, Corvallis, OR, October 28, 2008.
- Integrating Fishery Management and Markets: Service on the Board of Directors of the Oregon State University Seafood Consumer Center.
- National Fishery Policy: Invited presentation “The Economic Contribution and Economic Potential of U.S Fisheries” at Capitol Hill Ocean Week: The Blue Economy: Understanding the Ocean’s Role in the Nation’s Future, Washington, D.C., June 9-11, 2009.
- National Ocean Policy: Chair of the Social Science Working Group (SSWG) for the NOAA Science Advisory Board (SAB), providing scientific advice to NOAA Administration on investments and implementation of social science within the six line offices of NOAA. Lead author of the SSWG report “Integrating Social Science into NOAA Planning, Evaluation and Decision-Making: A Review of Implementation to Date and Recommendations for Improving Effectiveness. Presentation of the preliminary and final reports to the NOAA Science Advisory Board on October 16, 2008 and March 10, 2009.
- 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: Invited presentation: “Managing the Transition: Distributional Issues of Stock Rebuilding,” at the OECD Workshop on the Economics of Rebuilding Fisheries, Newport, Rhode Island, 21-22 May 2009. Chapter in Workshop Proceedings, in press.
- International Fishery Policy: Service on the Board of Directors of the Institute of Innovative Fishery Management, Aalborg University, Aalborg, Denmark.
- International Fishery Policy: Invited lecture “The Last Frontier in Fisheries”, University of Tromsø, Tromsø, Norway, November 12, 2008.
- International Fishery Policy: Invited lecture, “Economic Theory in Fisheries”, University of Tromsø, Tromsø, Norway, November 12, 2008.
- *International Evaluation*: Service on the Senior Doctoral Degree (post-Ph.D.) Evaluation Committee, University of Aalborg, Denmark. Presentation of the Evaluation Committee Report of the Senior Doctoral Thesis “A Fisheries Management System in Crisis – the EU Common Fisheries Policy”, Jesper Raakjær, University of Aalborg, Denmark, May 12, 2009.

### *Fishing Communities*

- Oregon Working Waterfronts: Collaborated on a Consumer Seafood Initiative research project to develop information on tools to protect working waterfronts.
- Collaborative Management: Book chapter “Sustaining Salmon Fisheries: the Challenge of Collaborative Management” in *Sustainability of the Arctic-Yukon-Kuskokwim Salmon Fisheries*, Charles C. Krueger and Christian E. Zimmerman, eds. Bethesda, MD: American Fisheries Society.

### *Ecosystems*

- Oregon Ocean Policy: Service on the concept development committee for an Oregon Nearshore Institute. The committee was formed at the request of the COMES Board to consider needs and options for promoting nearshore research and education outreach. Climate Change and Fishery Governance: Presentation “Climate Change and Fishery Governance in The Pacific Northwest U.S.: The Case of Columbia River Basin Salmon,” presented at the conference of the International Institute of Fisheries Economics and Trade (IIFET), Nha Trang, Vietnam, July 22-25, 2008.
- Marine Ecosystem Governance: Invited plenary address: “Marine Ecosystem Management and Governance: The Challenges of Implementation” at The Oceans and Coastal Areas Conference, Asker, Norway, April 28-30, 2009.
- Climate Change and Fishery Management: Presentation “Path Dependence, Lock-in and Climate Change in U.S. Fishery Management” at the North American Association of Fisheries Economists Forum, Newport, Rhode Island, 17-20 May 2009.

### *Marine Resource Economics & Marketing*

Gil Sylvia, Associate Professor

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

Research projects include: 1) developing optimal traceability and accountability systems for handling, marketing, and sustaining albacore tuna and salmon; 2) developing education programs for fishery managers; 3) conducting consumer surveys to determine perspectives and values for developing seafood traceability systems; 4) developing market-based approaches for managing the environmental impacts of fishing; 5) developing case studies for improving education in stock assessment and international seafood trade; and, 6) managing the Project CROOS Group

(Cooperative Research on Oregon Ocean Salmon) for using genetic and traceability systems for improving the science and management of ocean salmon.

We continued to work closely on numerous ventures with the Community Seafood Initiative. A key subproject is developing handling and traceability strategies for supporting coastal production and marketing of albacore tuna and troll caught Chinook salmon. This project is supported by grants from state and federal agencies. We also worked with CSI and the Oregon Dungeness Crab Commission in developing information to support MSC certification of the Oregon Dungeness Crab Fishery. We are now completing two research projects funded by Sea Grant. The Project CROOS project is funded from various sources involving five COMES faculty, the Oregon Salmon Commission, National Marine Fisheries Service, Oregon Sea Grant, CSI, and ODF&W. The projects goals include using genetic and oceanographic analysis to reduce harvests of weak salmon stocks while avoiding large area closures, develop new approaches for salmon management, and use digital technology systems for developing information tracking systems for management and marketing. The project is the largest collaborative research program ever undertaken by the Oregon salmon industry and involves over 150 fishermen and vessels. We are now developing a larger and more comprehensive three year project that can collaborate with other West Coast agencies and industries.

These research projects have generated over \$3 million in extramural funding and are supporting five graduate students from the Departments of Agricultural and Resource Economics and Marine Resource Management.

### **College of Forestry**

#### ***Department of Forest Ecosystems and Society***

##### ***Marine and Terrestrial Linkages***

Bryan Black, Assistant Professor

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
- A sclerochronological analysis of growth rate, lifespan, and long-term climate change in Pacific geoduck. Collaborators: Laura Poppick, Bates College, and the Dept. of Fisheries and Oceans Canada Pacific Biological Station
- Age validation of Pacific geoduck using the tree-ring technique of crossdating. Collaborators: Claudia Hand, Shayne MacLellan and Darlene Gillespie, Dept. of Fisheries and Oceans, Canada.
- 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 Institute 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  $^{14}\text{C}$  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.

**Ongoing funded projects include:**

- Shortspine thornyhead ageing and chronology development. NOAA Fisheries Alaska Fisheries Science Center.
- 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

The lab has hosted summer interns. Laura Poppick, an undergraduate at Bates College, worked in the lab during the summer of 2008 as participant in HMSC's National Science Foundation Research Experience for Undergraduates. This summer, Emily Whitney, an undergraduate at Whitworth University, is completing an REU internship.

Carolyn Copenheaver, an Associate Professor in the Dept. of Natural Resources, Virginia Tech, spent Sept and Oct 2008 in the lab as part of her sabbatical. She helped assess the population age structure of Pacific geoduck at a site along the British Columbia coast and also helped complete a manuscript on geoduck, tree rings, and climate reconstructions (see Black et al. 2009 PALAEO-3)

**Invited Keynote Address:**

BA Black. State of the Science: Sclerochronology. Application of tree-ring techniques in marine and freshwater ecosystems. The First American Dendrochronology Conference, June 2008. Vancouver, BC.

**College of Oceanic and Atmospheric Sciences**

**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 2008-2009, group activities were centered on two continuing projects. A highlight of the newest project, funded by the National Science Foundation, has been a set of 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 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 (see photo). Oceanography graduate student Kristina McCann-Grosvenor is collecting data for her Masters thesis through this project. She has become highly proficient in constructing microelectrodes. Undergraduate Vivian Lin, a REU intern from Scripps College, completed a related project measuring oxygen uptake rates in sediment cores from a 15 m station on the shelf. In January, Ms. Lin reported her results in a poster at the annual meeting of the American Society of Limnology and Oceanography held in Nice, France.

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 were staged in a refrigerated laboratory at HMSC. During the field studies it was shown that benthic microbial fuel cells can successfully power a sonic receiver used for tracking tagged marine animals. These studies were led by Oceanography graduate student, Mark Nielsen, who defended his PhD successfully in December.

## College of Science

### *Department of Botany and Plant Pathology*

**Gayle Hansen, Courtesy Associate Professor (Senior Research)**

**Mission and Objectives:** During the 2008-2009 academic year, Gayle Hansen, our marine botanist, continued with her research on the distribution and taxonomy of west coast seaweeds. 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. These studies are particularly important now since biodiversity information is a key factor in determining those areas in Oregon that will be set aside as marine reserves.

**Research:** This year, Gayle's taxonomic expertise and collecting and databasing efforts have given her the opportunity to provide critical biodiversity information on Oregon's seaweeds and seagrasses to non-profit organizations and state agencies that are instrumental in the conservation decisions made in Oregon.

- Subtidal Seaweeds of Redfish Rocks and Port Orford, Oregon: With funding from the Nature Conservancy and the

Port Orford Ocean Resources Team, Gayle and Jim Golden conducted a 3-day survey of the subtidal seaweeds and associated epifauna at 6 sites around Redfish Rocks, one of 20 areas along the Oregon coast evaluated for marine reserve status. This survey, conducted with the assistance of Tekna Diving Services, revealed 60 species of seaweed and 126 species of invertebrate epifauna. Of the seaweeds, 12 species were new records for Oregon. The final report was provided to the Nature Conservancy, the Oregon Department of Fish and Wildlife, and to the Ocean Policy Advisory Council. The data from this survey helped to establish Redfish Rocks as one of two areas put forth to the governor for pilot marine reserve status.

- Oregon's Rarely Collected Seaweeds and Seagrasses: In order to better understand Oregon's marine plant biodiversity, Gayle has been verifying the identifications and databasing the label information from collections of seaweeds and seagrasses from Oregon held in museums and universities around North America. To date, she has inventoried 12 major herbaria, and these historical specimens in combination with her current collections amount to more than 10,000 specimens. These records are extensive enough to formulate preliminary checklists for numerous sites along the coast and to determine the species that are rare. The most species rich sites for seaweeds have up to 180 different species. Although many species are common along the Oregon coast, there are some have been collected at only 1-3 sites, making them eligible for rare species status. Through her research, 40 of Oregon's seaweed species have been nominated for inclusion in the Rare and Endangered Species Target Lists maintained by the Oregon Natural Heritage Information Center and by the Nature Conservancy. These lists are used to fortify conservation efforts in Oregon and around the world.
- Seaweeds of Netarts Bay, Oregon: With collecting help from Jim Young and the Nature Conservancy, Gayle conducted a summer and spring survey of the seaweeds of Netarts Bay. By combining the data from these collections with information from the herbarium specimens of earlier collectors like Ed Lippert, she was able provide a checklist of the seaweeds and seagrasses of this bay to the Netarts Bay Today Website posted at: [http://www.netartsbaytoday.org/html/checklist\\_of\\_seaweeds\\_and\\_seag.html](http://www.netartsbaytoday.org/html/checklist_of_seaweeds_and_seag.html)
- Seaweeds of other sites in Oregon: This year, additional collections were completed for numerous sites in central and southern Oregon. These will be curated, labeled, and databased for new records and checklists during the coming academic year.

### **Awards and Outreach:**

- NWAS Phycologist of the Year. Founded 25 years ago, the Northwest Algal Society (NWAS) consists of a group of nearly 200 professional phycologists from the western US and Canada that meet yearly to discuss their scientific research on seaweeds and seagrasses. This year the group presented Gayle with their Phycologist of the Year Award, the highest award given out by this Society, honoring her research and service to this Society.
- Oregon Invasive Species Hotline – Seaweed Expert.

Earlier this summer, Oregon Sea Grant and Oregon CoastWatch hosted a public workshop on Oregon's Coastal Invasive Species. The purpose of the workshop was to train volunteers to recognize and report these potentially hazardous taxa so that their spread can be monitored and controlled. For the workshop, Gayle provided a talk on Oregon's Current and Anticipated Seaweed Introductions and covered the seaweeds for the lab and field trip. As an outcome of the Workshop, she was asked to join the panel of experts that assist Sea Grant when species are reported on the Oregon Invasive Species Online Hotline ([www.oregoninvasiveshotline.org](http://www.oregoninvasiveshotline.org)).

- Introduced Seaweeds of Willapa Bay, Washington. In addition to her studies and meeting presentations on Oregon seaweeds, Gayle provided an outreach seminar on Washington seaweeds for the Hatfield Marine Science Center and also for the Department of Botany and Plant Pathology at OSU. Based on research she completed last year, Gayle talked about the Introduced Seaweeds and Seagrasses of Willapa Bay and whether or not we should expect to see them in Oregon.
- Oregon Seaweeds, A Sampler. Gayle's outreach poster that includes pristine illustrations of 40 of our local seaweeds continues to be available for purchase at the HMSC and OSU bookstores in Newport and Corvallis.

## **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 that research and evaluation work by students from the College of Science involving HMSC visitors. The Visitor Center is a prime laboratory for this research. Between July 2008 and June 2009, Rowe and/or students presented research findings from their work at the HMSC to attendees at the American Educational Research Association and the National Association of Research in Science Teaching Annual Meetings, as well as publishing findings in the journals *Public Understanding of Science* and *Visitor Studies*.

### **Faculty and Student Research at HMSC**

Studies this year at the HMSC's Visitor Center looked at the development and evaluation of an interactive computer kiosk for teaching people to read and understand graphs and to put that knowledge to work interpreting real-time data from Yaquina Bay. Funded through a combination of industry funds, a Holt award, and participating scientists' support (NANOOS), the exhibit was the backbone of a thesis for Sarah Mikulak. In addition,

Céleste Barthel 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. Over the course of the year, at least one Science and Mathematics Education student has been in residence at the HMSC every quarter.

### **Overview of Free-Choice Learning for Education and Outreach**

In the summer of 2008, Dr. Rowe and Dr. Molly Phipps (Science Museum of Minnesota) offered a two-week class introducing educators, resource managers, and outreach professionals to the research base and major concepts behind the Free-Choice Learning Initiative. The class had its largest geographical representation to date this year with students not only from OSU, but also from Washington, D.C. and Anchorage, Alaska. Students used the Visitors Center and the Oregon Coast Aquarium as sites for class work and data collection.

### **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 the HMSC, Oregon Coast Aquarium, and other sites to deliver hands-on ocean science 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 school children, adults, and public audiences. Students from Oceanography, Marine Resource Management, Engineering, and Science and Math Education took the class in winter 2008 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, and middle-school students at SMILE's Middle School Challenge.

As a spin-off of this class, Heidi Schmoock – *M.S. 2007* (OSG) and Shawn Rowe prepared a five-week class for informal educators from the HMSC and the OCA that used similar materials and techniques. Céleste Barthel also offered a similar course for continuing education credits through the department at the Maryland Science Center in Baltimore, MD.

## **Department of Zoology**

### **Marine Ecology**

**Bruce Menge, Distinguished Professor; and Sally Hacker, Associate Professor**

**Mission and objectives:** Three labs in the Zoology department maintain research activities at HMSC: those of Bruce Menge, Sally Hacker and Eric Seabloom. The research focuses on the dynamics of coastal ecosystems, including marine inner shelf, rocky intertidal, estuarine and sand dune habitats. The research is

funded by several sources including private funds from the David and Lucile Packard and the Gordon and Betty Moore Foundations in support of the PISCO project, with Bruce Menge 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, Gayle Murphy, 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, and Hacker and Seabloom's studies of dune ecosystems are also based out of the Science Center.

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

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

Gil Rilov (PISCO, Assistant Professor, Senior Research): Gil carries out studies of species interactions and the influence of larval supply on mussel communities, and studies of spatial and temporal variation in community structure on rocky shores.

Joe Tyburczy (Menge Graduate Student, supported by EPA STAR Predoctoral Fellowship): Joe studies 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 are limited to sample processing and staging of cruises on the R/V Kalipi, a 29' research vessel operated by PISCO.

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.

Margot Hessing-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.

## **College of Veterinary Medicine**

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

Dr. Tim Miller-Morgan's academic home is in the College of Veterinary Medicine, Department of Biomedical Sciences (BMS). 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, Director, Laboratory for Fish Disease Research, to develop an aquatic medicine program within the veterinary college.

Miller-Morgan also has an appointment in 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.

Miller-Morgan and Heidel are involved in an Oregon Sea Grant-funded project to model shipping stress in wild-caught marine ornamental 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 their results to develop recommendations for best management practices for marine ornamental importers. Information on courses taught by Miller-Morgan is contained elsewhere in this report.

In addition, Miller-Morgan has 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 specially trained veterinarians will train and certify retailers. These projects received initial funding from the Associated Koi Clubs of America (AKCA). The training programs continue as fee-based seminars. We have completed beta testing of the best health practices program with eight ornamental pond fish retailers and four certifying veterinarians. The guidelines and training program are currently under revision based upon feedback from the participants in the beta testing.

The work to develop best health practices and biosecurity standards in the ornamental pond fish sector of the industry has resulted in several invitations for Miller-Morgan to speak at international industry meetings about the implementation of such programs. He recently traveled to Israel to speak to members of the Israeli koi 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.

## **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 2008-2009, PCEB has continued 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 ecosystem 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.

Scientists from PCEB and the Center for Coastal Environmental Health and Biomolecular Research of NOAA/NOS published an assessment of ecological condition in coastal-ocean waters along the U.S. continental shelf, from the Strait of Juan de Fuca, WA to the Mexican border, based on sampling conducted in June 2003. This was a large collaborative effort by EPA, the National Oceanic and Atmospheric Administration (NOAA, NOS and National Marine Fisheries Service), Washington Department of Ecology, Oregon Department of Environmental Quality, and the Southern California Coastal Water Research Project, with additional contributions from personnel of Alaska Department of Environmental Conservation, and Moss Landing Marine Laboratories. The study is one of a series of assessments conducted under the Western regional component of EPA's National Coastal Assessment. A key aspect of the study was the assessment of condition of the five NOAA National Marine Sanctuaries compared to that of non-sanctuary waters. There was little evidence of sediment contamination, or of impacted benthic communities. The level of nonindigenous species in the benthic community of the west coast shelf was low relative to that in estuaries. With regard to indicators measured, both Sanctuary and non-Sanctuary waters of the west coast shelf appear to be currently in good condition. The report is available on line at: <http://www.epa.gov/wed/pages/publications/authored.htm>.

PCEB scientists also produced an assessment report of the condition of the soft sediment habitat within the intertidal zone of the states of Washington, Oregon and California, with the exception of the estuarine portion of the Columbia River. The study sampled at 217 sites during the summer of 2002. The results of this assessment study represent the first regional scale survey of the condition of intertidal wetland habitats on the West coast. Findings confirm results from previous National Coastal Assessment studies of west coast estuaries that have indicated sediment contamination issues are limited in extent, but that west coast estuaries have been broadly invaded by nonindigenous species. Further refinement of measurement approaches for plant community and shoreline development indicators are needed. The report is available on line at: <http://www.epa.gov/wed/pages/publications/authored.htm>.

Dr. Henry Lee II of PCEB presented a one-day workshop and demonstration of the North Pacific marine nonindigenous species database at the North Pacific Marine Science Organization (PICES) meeting in Dalian, China. The purpose of the workshop was to continue the development of a common database for marine/estuarine nonindigenous and native species in Pacific Rim countries (Canada, Japan, People's Republic of China, Republic of Korea, Russian Federation, and United States). The goal is to develop a common database format that will allow integration of nonindigenous and native species

distributions and natural history data across all six PICES member countries. The database being developed by EPA and USGS for PICES is unique in that it allows capturing distributional data of both native and nonindigenous species across eight nested hierarchical spatial levels, ranging from major ocean basins (e.g., North Pacific) to individual estuaries and sub-estuaries. The database also lays out a hierarchical schema for natural history and habitat requirements, allowing the integration of physiological requirements with spatial distributions. The database can be used to address various issues related to invasive species, in particular addressing the risk assessment exemption in the draft International Maritime Organization (IMO) ballast water treaty. The integration of native and nonindigenous species distributional and natural history/habitat information allows the database to be used to address a suite of other issues, including identifying marine/estuarine species that may be at high risk to global climate change.

EPA research staff at HMSC consists of 17 federal employees, 1 EPA postdoctoral fellow, 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, Bycatch Reduction, and Aquaculture, and the North Pacific Research Board:

**Fisheries recruitment and climate change:** The Program has an increasing interest in how climate change, both changing seawater temperature and ocean acidification, affects growth and recruitment of larval and juvenile fish and crabs in Alaska. Experimental evaluation of the effects of temperature on larval and juvenile development is continuing with Alaska flatfishes, walleye pollock, Pacific cod, and most recently, red king crab. In this endeavor FBEP scientists are partnering with researchers at Oregon State University and AFSC's Auke Bay Laboratories to evaluate the potential effects of climate change on recruitment of cod and other species in the Bering Sea. This research combines live-animal laboratory experimentation on behavior, nutrition, growth and development, field studies in the Gulf of Alaska and the Bering Sea, biochemical approaches to fish condition, and numerical modeling. Laboratory facilities are now being constructed to test the development and behavior of fishes under low pH conditions, addressing the topic of ocean acidification associated with climate change.

**Habitat requirements and distribution:** Habitat requirements of juvenile flatfishes, Pacific cod, and red king crab are an important focus of the Program. Spatially-explicit habitat models based upon towed camera surveys in Kodiak, Alaska, are being developed for juvenile northern rock sole. Complimentary laboratory experiments in Newport and field trials in Kodiak are underway to evaluate predator-prey relationships involving both fishes and crabs as they are mediated by nearshore substrata (seagrasses, algal beds and worm beds) and other environmental variables such as depth and light level. The ultimate goal is to understand and conserve important nursery habitats, to reduce impacts of fishing practices, and to improve site selection and release strategies for hatchery-reared king crab in the Gulf of Alaska. Habitat studies are partnered with researchers from the University of Alaska and NOAA laboratories in Kodiak and Juneau.

**Fishing gear and survey methods:** The Program continues to make camera and imaging sonar observations on fish behavior around both simulated and real fishing gear to assist in improving fishing gear and reducing bycatch. Emphasis has been placed on improving selectivity for commercially significant flatfishes, Pacific cod and walleye pollock in trawls and understanding bias in surveys conducted with trawls. The primary partners in this research are members of AFSC's gear research group.

**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. Simple indices of 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. In 2008, new models were developed for freezing stress in crabs associated with winter fisheries in Alaska. Mortality predictors will be incorporated into industry-supported fishing experiments with Pacific halibut and snow crabs in 2009.

## Northwest Fisheries Science Center

NOAA Fisheries' Northwest Fisheries Science Center (NWFSC) is headquartered in Seattle and has three research stations in Washington and two in Oregon. The NWFSC'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**

NWFSC's OMI Division provides facilities management and science mission infrastructure support for the NOAA presence at HMSC consisting of the Captain R. Barry Fisher building (BFB), Newport Aquaculture Lab (NAL), Research Support Facility (RSF) and numerous smaller buildings on the site. A significant addition this year is a new \$100K Glycol chilling system providing controlled temperature chilled fresh and salt water for experiments in the Fish Disease Laboratory and Newport Aquaculture Laboratory courtyard. NWFS/OMI continued to manage the operations and maintenance contract through Oregon State University for maintenance of the NOAA buildings.

The OMI IT department continued to provide onsite IT Administration, helpdesk and Network Administrator support to the NWFSC during the past year. Recent improvements this year to the IT system included deploying new data and backup devices with increased capacity and performance; network enhancements were also implemented to tighten security, specifically at the (OSI) Layer 1 & 2 levels.

OMI's Safety and Environmental Compliance Staff (SECO) continued to provide training for all staff, inspections and consultations supporting environmental compliance and safety for the NOAA buildings on campus. SECO staff prepared the site and worked through the 2008 NOAA third party NECSAS review to address all of the findings of that facility safety inspection. Due to the amounts of Hazardous waste shipped from the site for recycling, NOAA at HMSC was designated a small quantity waste generator in 2008 and was directed by Oregon Department of Environmental Quality to develop a Toxics Use and Hazardous Waste reduction Plan (TUHWR) during this reporting period. Because of the need for onsite SECO support to comply with the additional TUHWR and other duties, the NWFSC is funding a half time SECO position at Newport Research Station to provide a daily Safety and Environmental Compliance presence at the facility.

NWFSC OMI staff continued to work closely with OSU to bring all personnel that work in the NOAA buildings into compliance with Federal Security identification policies under Homeland Security Presidential Directive 12 with the latest requirements from the Western Regional Security Office.

### ***Conservation Biology Division (CB):***

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

Dr. Peter Lawson, Dr. Laurie Weitkamp and Heather Stout represent the NWFSC Conservation Biology Division (CB) in Newport. Dr. Lawson's principal research interests focus on effects of climate and habitat change on population dynamics of Oregon natural 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 wetlands and estuary habitat and in rapid wetland assessment for use in restoration prioritizations and wetland permitting issues. Estuary and wetland work is done in collaboration with Oregon Department of State Lands, Oregon Department of Fish and Wildlife, Coos Bay Watershed Council, tribal agencies, and Oregon State University Sea Grant.

***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, 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 NWFSC Fish Ecology Division (FE), Pacific States Marine Fisheries Commission (PSMFC), and OSU staff, has been leading a project to examine the estuarine ecology of juvenile salmon in the lower Columbia River estuary. This program documents the abundance and condition (i.e., food 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 joint project involving fishermen, industry, Oregon State University, Oregon Sea Grant Seafood Initiative, NWFSC 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 we 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's National Marine Fisheries Service, extending the project to the entire West Coast. A major effort for 2009 is development 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 its work. Dr. Lawson is now chair of a Biological Review Team which is reassessing the status of the Oregon Coast coho salmon Evolutionarily Significant Unit. Dr. Lawson is now also a member of the newly-formed Recovery Implementation Science Team, providing 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, AK 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 or field studies to determine how much of the stressor the fish is exposed to

during out-migration, (2) dose-response assessment or laboratory studies to determine if altered health (i.e., immune dysfunction) is observed in salmon after exposure to the stressor and (3) risk characterization, or determining what the extra risk is to salmon populations exposed to the stressor.

Staff and collaborators from many disciplines are involved with these studies and they include the following: Dr. Frank Loge, Dr. Claudia Bravo, Dr. Joe Groff, Erik Loboschefskey, Kai Eder, and Don Thompson from University California Davis; Greg Hutchinson, Josh Osborn, Stacy Stickland, and Ahna VanGaest from Aquatic Farms; Dr. Ed Little from USGS Columbia Environmental Research Center; and Dr. Tracy Collier, Lyndal Johnson, Dr. Nat Scholz, and Gina Ylitalo from the EC Division in Seattle.

**EC LABORATORY STUDIES**

***Disease challenge after exposure to 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 95A. Chinook salmon at smolt stage have been exposed to up to 8 concentrations of retardant for 96 hours, followed by a saltwater challenge in order to determine the impacts of non-lethal product exposures on the adaptability of smolts to saltwater. Fish surviving their transition to saltwater were exposed to a marine pathogen to determine if their susceptibility to disease has been affected by the product’s exposure. The results of these studies will provide threshold values for smolt survival, seawater tolerance, and disease susceptibility that can be used as a basis for evaluating effects following spills in salmonid habitats. The proposed 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 disease susceptibility. 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 recently been submitted to *Aquatic Toxicology*. EC scientists have also exposed juvenile fall Chinook salmon to an environmentally relevant concentration (0.1861 ng/g) of a flame-retardant mixture of polybrominated diphenyl ethers (PBDE mixture: BDE-47, BDE-99, BDE-100, BDE-153 and BDE-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 submitted to

*Environmental Science and Technology.*

***Regulation of immune genes after dietary exposure to***

***contaminants:*** EC scientists also performed microarray analysis on kidney tissues from rainbow trout exposed to PAHs and found that various immunologically relevant genes are influenced by contaminant exposure. Roughly 50 immunologically relevant genes were differentially expressed under pathogen challenge and PAH exposure. The genes were identified by comparing fish challenged with *A. salmonicida* and fed either the control or PAH treated diet. A sample of five immune genes that were differentially expressed under pathogen challenge when the fish were exposed to PAHs was selected to measure transcript number with quantitative PCR. These five genes were not differentially expressed with just PAH exposure (no pathogen challenge).

To determine the effects of PBDEs on the response of immune system genes (see description of experiment above), EC scientists sampled fish on define days 0,1, and 7 post-challenge and samples analyzed with a DNA microarray composed of 1600 immunologically and toxicologically relevant genes. A number of immunologically relevant genes were differentially expressed under pathogen challenge and PBDE exposure. The genes were identified by comparing fish challenged with *L. anguillarum* and fed either the control or PBDE treated diet. Preliminary results show that gene mediators of toxicological function, immune response and regulation of metabolism appear to be 2- fold up regulated in PBDE treated fish exposed to *L. anguillarum*. These dietary studies provide comprehensive profiles of transcriptional response in Chinook salmon after exposure to contaminants and pathogens that can be used to explore mechanistically PBDE- and PAH-induced immunosuppression and potentially predict the effect of these chemicals in human and other animal immune response.

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

EC scientists recently expanded research into host-environment interactions to address the impact of in-river stressors (e.g., dams, barges) on host susceptibility due to the Federal Columbia River Power System (FCRPS). Transport operations, such as raceway and barge loading densities and water volume exchange rates, may contribute to secondary disease transmission. EC scientists are currently examining various fish densities and water volume exchange rates in the laboratory to determine the effect of these parameters on both disease transmission and immune function, and ultimately their contribution to direct mortality. Snake River spring/summer Chinook salmon were raised from the egg stage and exposed to the freshwater pathogen (*Renibacterium salmoninarum*) through infected fish to determine the effect of various fish densities and water flow rates on disease transmission and immune function. Disease transmission was evaluated by the detection of the pathogen DNA in the fish kidneys and gills by conventional and real-time polymerase chain reaction (PCR). Both techniques indicated high levels 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 Federal Columbia River Power

System (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. In the infected individual fish their immune function will be assessed in terms of the activities of complement, lysozyme, and toll-like receptors.

**EC FIELD STUDIES**

***Survey of pathogen prevalence and contaminant exposure:*** To understand the potential impact of pathogens and contaminants on salmon populations from various Pacific Northwest estuaries, EC scientists have evaluated the prevalence of pathogens and the concentration of contaminants, such as PCBs, DDTs and PAHs, in various populations of juvenile salmonids. Studies of juvenile fall Chinook and coho salmon from several Oregon and Washington coastal estuaries revealed that selected bacterial, protozoan, and viral agents are integral components of watersheds, although their intensity and prevalence varied. Contaminants were also found in tissues and stomach contents of Chinook and coho salmon sampled from all estuaries. Chinook salmon had a greater whole body contaminant concentration than coho.

***Lower Columbia River Ecosystem Monitoring Program***

***(LCREP):*** To better understand the spatial extent of contaminant uptake in outmigrating juvenile salmon in the Columbia River Basin, EC scientists initiated a pilot study to measure contaminant concentrations in outmigrating juvenile salmon in the Columbia River Basin. Chemical analyses were completed on stomach contents and whole body samples of Chinook salmon from the Willamette/Columbia Confluence, Kalama/Longview, and West Sand Island. DDTs, PCBs, and PAHs were found in the stomach contents of fish from all sites, with high concentrations in fish from the Willamette/Columbia confluence. In some cases, the average concentrations of PCBs in whole body composites exceeded the NMFS' estimated threshold for adverse health effects. EC scientists have developed a conceptual model, based on existing toxicological information, in order to identify contaminant sources and describe likely models and routes of transport, potential exposure and uptake of toxicant by listed salmon stocks, possible effects on survival and productivity, and regulatory or management issues to be addressed. These studies on salmon from the Columbia River Basin have been expanded to include monitoring outmigrant juvenile salmon from the lower Columbia River and estuary, and reconstructing historical growth rates for returning adults. The growth analysis involved measuring the inter-annuli distance on individual scales collected from Chinook salmon returning to the Columbia River from 1960 to 2000. The annual growth rates were found to correlate with measures of ocean productivity (e.g., Pacific Decadal Oscillation (PDO)). Larger adults and greater inter-annuli distance were found during negative PDO (cooler oceans) cycles.

***AFEP:*** To continue to examine host-environment interactions

due to the FCRPS, roughly 129,000 fish were PIT (Passive Integrated Transponder)-tagged at the Rapid River Hatchery located 40 miles upstream of Lower Granite Dam on the Snake River. Approximately 5,000 fish were collected at Lower Granite, the first dam encountered during outmigration, and barged around the next seven consecutive dams to Bonneville dam. EC scientists challenged both PIT-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 located 73 miles upstream of Lower Granite Dam. 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 Transactions of the American Fisheries Society.

During the 2007 and 2008 outmigration, fish from Rapid River (2007, 2008), Dworshak (2007), and Clearwater (2008) hatcheries were collected after barging and in-river outmigration and their survival and health were examined during holding in net pens located at different locations in the estuary. Data collected in these studies collectively suggest that the health of outmigrants influences delayed mortality, and in turn, the return rate of adults also known as the smolt-to-adult return (SAR) rate. In addition, these studies determined that the health of outmigrants is related to outmigration history, estuary arrival timing, and the hatchery of origin.

In 2007, we found that the health status and incidence of delayed mortality differs with estuary arrival timing of barged and in-river outmigrants. When hatchery-reared Snake River spring/summer Chinook salmon were retrieved from barges at the Bonneville Dam navigation lock and deposited in net pens at replicate sites in the Columbia River estuary, we observed a greater percent cumulative mortality among barged cohorts transported early in their outmigration compared to later at one net pen site and no difference at another net pen site. Conversely, in-river outmigrants that arrived at the estuary earlier were found to experience less delayed mortality than later in-river outmigrants. Barged and in-river fish that died during estuary holding had a statistically significant smaller condition factor than fish that survived. The condition factor is commonly viewed as a qualitative measure of health, and hence, fish that died in the net pens were not as healthy as fish that survived holding. A complete histopathological analysis is underway to ascertain putative causes of death. During 2008, fish gills were collected for ATPase analysis in order to determine the degree of smoltification among the fish with different outmigration histories. We found that fish that were barged early in the season

had lower ATPase levels compared to fish that outmigrated in-river, indicating decreased smoltification. This was consistent with acoustically-tagged hatchery Chinook salmon barged at the same time that had increased estuary travel times and greater estuary mortality than fish with in-river outmigration histories.

In 2007, we found that barged fish from the Dworshak National Fish Hatchery were more susceptible to disease during challenge than barged fish from the Rapid River Hatchery. However, we found no differences in disease susceptibility (e.g., health) in fish from either hatchery with an in-river outmigration life-history. In our estuary net pen work, in 2007 we found a greater incidence of delayed mortality in barged Dworshak fish held in the estuary net pens relative to fish barged from Rapid River Hatchery. Additionally, we found no differences in the incidence of delayed mortality in the estuary net pens in fish from either hatchery with an in-river outmigration history for holding periods less than 14 days. In 2008, freshwater and seawater-influenced sites were used for net pen holding. The seawater-influenced site had significantly less mortality than the freshwater site, suggesting a modulation of the factors resulting in mortality.

To determine the potential contribution of pathogens to primary and secondary infections, and their ultimate influence upon delayed mortality, temporal and spatial pathogen surveys were performed on PIT-tagged juvenile spring Chinook salmon from Clearwater, Dworshak, and Rapid River hatcheries. Fish were collected from each hatchery as well as from Lower Granite, McNary and Bonneville Dams throughout the outmigration periods in 2007 and 2008. Finally, barged fish were collected upon arrival at Bonneville Dam at times concurrent with the collection of fish from the other locations. PCR was used to detect and discriminate between a number of bacterial and viral fish pathogens. High volume water samples were also collected from the barge holds during transport at Lower Granite, and Bonneville dams and compared to water samples collected from the river at these locations to help determine the source of these pathogens. In 2007 and 2008, the primary pathogens detected were *Renibacterium salmoninarum*, *Saprolegneaceae*, and IHNV. *R. salmoninarum* is the causative agent of BKD and was the most prevalent pathogen in both years. However a high degree of variability was observed between years indicating a possible change in the quality of the broodstock and/or environmental factors.

Since contaminants can influence salmon survival and disease susceptibility, EC scientists have collected fish whole bodies and bile during each sampling event from 2006-2008 to estimate the concentrations of PBDE, PCB congeners, PAHs, DDTs and biliary fluorescent aromatic hydrocarbons. A synopsis of those results is currently in progress.

Collectively, the results from these studies suggest that: (1) fish from different hatcheries arrive at the FCRPS and are barged to the estuary in different states of health at different times during the outmigration; (2) barged fish have greater levels of pathogens than in-river fish; (3) pathogen transmission can occur during normal barging operations; (4) unhealthy in-river fish die in the river system during outmigration; and (5) following outmigration,

healthy barged fish are less susceptible to infectious disease than in-river fish.

### ECOLOGICAL RISK CHARACTERIZATION

From the laboratory studies conducted to date, infectious disease within outmigrant juvenile salmon in the Columbia River Basin appears to be strongly modulated by chemical and non-chemical (dams and predation) stressors that influence host-susceptibility. Through the application of a dose (stressor)-structured population dynamic model, EC scientists have shown that chemical and in-river stressors influence host-susceptibility, increasing the mean force of infection by a factor of 2.2 and 1.6, respectively. Using *L. anguillarum* as a model pathogen, they have shown that non-chemical in-river and chemical stressors contribute equally to the cumulative incidence of delayed disease-induced mortalities in Chinook salmon that range from 3 to 18% for estuary residence times of 30 to 120 days, respectively. Within this context, mitigation of the incidence of delayed disease-induced mortality represents a significant component in future management strategies to recover listed salmon stocks, strategies that must focus not only on controlling pathogen numbers, reservoirs, and virulence, but chemical and non-chemical in-stream stressors that influence host-susceptibility.

### WEST COAST CENTER FOR OCEANS AND HUMAN HEALTH

***Fish as Sentinels:*** EC scientists are actively involved in the NWFSC's new West Coast Center for Oceans and Human Health (OHH). This is one of three NOAA Centers established in 2004 to investigate critical linkages between oceans and human health. The Center is a multi-institutional partnership, including representatives from California, Oregon, and Washington. West Coast Center scientists are investigating three main agents that threaten human health—pathogens, marine biotoxins, and toxic chemicals—to assist resource and human health managers in making sound decisions that reduce or eliminate human health risks. EC scientists at the Hatfield Marine Science Center have focused on using fish as sentinels in understanding how (1) contaminants influence the heavy chain variable region of antibody protein and (2) chemicals and other environmental stressors influence the transmission of infectious diseases.

***Fish as Sentinels in Understanding the Impact of Contaminants on Antibodies:*** A number of anthropogenic chemicals modulate the immune system of juvenile Chinook salmon, making them more susceptible to disease. Plaque-forming cells (PFC) are plasma B-cells that produce antibodies specific to an antigen. The reductions in PFC response after contaminant exposure may be due to:

- A reduction of the number of functional plasma B-cells;
- Adverse effects on germline DNA; or
- Adverse effects on the loci of mature B-cells.

Effects on germline DNA may alter recombination or increase mutations when germline cells differentiate into B-cells. Moreover, contaminants may also alter the translation or post-translational modification of mRNA that produces the antibody

protein. Antibody proteins consist of variable conserved regions, wherein the variable region is responsible for antibody specificity in binding and eliminating antigen. If contaminants are affecting the B-cell at any of these states, the potential decrease or loss of function may result in a diminished immunological capacity to bind to and eliminate antigens. We are currently using fish as sentinels to examine the sequence of mRNA that produces the heavy chain variable region of the antibody protein to determine if this region is altered during exposure to selected contaminants.

### ***Fish Ecology Division (FE)***

**Ric Brodeur, Supervisor, Ocean Ecology**

**Dan Bottom, Supervisor, Estuarine Ecology**

**Bill Peterson, Supervisor, Climate Change and Ocean Productivity**

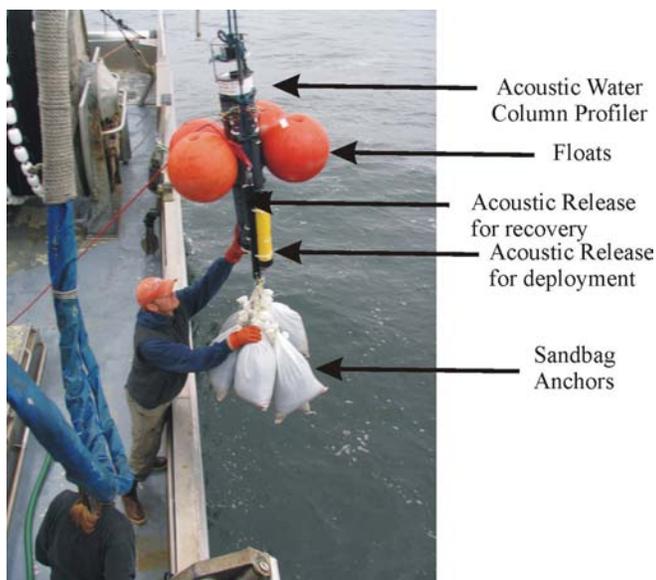
Drs. Ric Brodeur, William Peterson, Kym Jacobson, Dan Bottom, Tom Wainwright and Robert Emmett represent the Fish Ecology Division (FE) in Newport and are all members of the NWFSC's Estuarine and Ocean Ecology Program (EOEP). Research programs involve extensive collaboration with scientists from Oregon State University, Oregon Health Sciences Institute, Canadian Department of Fisheries and Oceans, NOAA's Northwest Fisheries Science Center/Seattle, Alaska Fisheries Science Center, and Southwest Fisheries Science Center, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, the University of Washington, the University of California at Santa Cruz, Virginia Institute of Marine Science, Troy State University and Centro Interdisciplinario de Ciencias Marinas. Current OSU collaborators include Senior Research Assistants: Cheryl Morgan, Leah Feinberg, and Tracy Shaw; Research Assistants: Tristan Britt., Elizabeth Daly, Toby Auth, Marisa Litz, Jen Menkel, Jason Phillips, Jesse Lamb, Mary Beth Rew; Research Associates: Drs. Hongsheng Bi, Hui Lui, Jay Peterson, Jim Ruzicka, Doug Reese, Linda O'Higgins and Graduate Students: Todd Sandell, and Rebecca Baldwin; Contractors: Greg Hutchinson, James Losee, Casey Benkwitt, 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 the study of pelagic habitat use by juvenile salmon feeding and relationships between feeding preferences and prey, the potential impact of salmonid predators on salmon survival and the impact of ocean conditions on survival of salmonids. 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 Marisa Litz and Andrew Claiborne. Cruises are conducted every two weeks during the season 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 increases in abundances of predators/forage fishes may explain the recent declines in juvenile salmonid abundances. This study is also being used to evaluate the abundance of sardines and the affects of ocean conditions on the recruitment of forage fishes.

Dr. Emmett is also working with Dr. Kelly Benoit-Bird and Ph.D. student Amanda Kaltenberg on a study to determine seasonal effects of transporting juvenile salmon from the Snake River to optimize a transportation strategy. Part of this study is investigating the role of fluctuating ocean conditions within season (April-July) on the marine survival of Snake River juvenile salmon. Recent data has shown that when a juvenile salmonid enters the ocean plays a large role in how well they survive. They hypothesize that the temporal abundance of zooplankton (food) and forage fishes (alternative prey for predators) plays a large role in salmon survival. They are measuring forage fishes and zooplankton off the Columbia River using bottom mounted echosounders.



Another major FE investigation involves examining the correlation between salmon growth and survival and the unique physical and biological characteristics of the Columbia River plume. This work is also funded by the Bonneville Power Administration and is being performed in collaboration with scientists from the Oregon Health Sciences University. 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 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, macroparasite communities, food habits, and prey fields and relating them to ocean conditions in and around the plume. New avenues of research are looking beyond actual prey availability to compare prey quality using lipid and fatty acid composition.

There are many scientists involved with salmon growth and survival studies in the plume, including Drs. Peterson, Brodeur, and Jacobson, and Cheryl Morgan, Jesse Lamb, Mary Beth Rew, Todd Sandell, James Losee, and Elizabeth Daly. Drs. Wainwright and Ruzicka are developing a suite of integrated simulation models for the plume linking ocean physics with overall food web dynamics. The ultimate goal of these studies is to determine whether the plume represents a favorable feeding location for juvenile salmon.

In another project funded by the Bonneville Power Administration, Dr. Peterson, Dr. 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, used GIS to map salmon distributions along with oceanographic variables. Hongsheng Bi has been using logistic regression, Poisson 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.

#### ***The RISE Program (Riverine Influences on Shelf Ecosystems):***

This research program is funded by the National Science Foundation to investigate the influence of the Columbia River plume on productivity of the coastal ecosystems off Washington and Oregon. The program is led by Dr. Barbara Hickey (University of Washington) and involves principal investigators Drs. Ken Bruland and Rafel Kudela (University of Santa Cruz), Evelyn Lessard and Parker MacCready (University of Washington), Jonathan Nash, Jim Mourn, Mike Kosro and Ed Dever (Oregon State University), David Jay and Antonio Baptista (Oregon Health Sciences Institute) and Dr. Peterson. The program is investigating the reasons for high productivity within the Columbia River plume and is testing the hypothesis that phytoplankton growth and zooplankton production are higher in waters associated with the plume and in shelf waters off Washington due to the influence of iron and silicate on phytoplankton growth. Jay Peterson is using a Laser Optical Plankton Counter to look at fine scale distributions of zooplankton. Jay has established that high concentrations of zooplankton-sized particles are found at the base of the plume-generated pycnocline and within fronts along the northern edge

of the plume. Tracy Shaw, Leah Feinberg, and Bill Peterson measured spatial variations in egg production by euphausiids and copepods and molting rates of euphausiids in order to determine if secondary production is higher off Washington than Oregon and to determine if there are any productivity “hotspots” off Washington. The project concluded in 2009.

**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. 2009 marks the beginning of the 14<sup>th</sup> year of these efforts. At each station, Jay Peterson, Tracy Shaw and Jen Menkel measured temperature and salinity profiles and collected samples for later analysis of nutrients, phytoplankton, zooplankton and ichthyoplankton. Leah Feinberg is analyzing data from the ten year 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. Since late 2002, the ocean has been warming, productivity has declined and copepod biodiversity has increased to levels near those observed during the 1983 and 1997/1998 El Niño events. Recently the ocean cooled once again, and temperatures reached low values not seen since the 1950s.

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.

**Copepod Studies:** Dr. Peterson continues 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 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 continues to update his “Salmon Forecasting” web page <http://www.nwfsc.noaa.gov>, ‘Ocean Index Tools’. The web page which provides ecological 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) salmon during the BPA surveys discussed above. Further development of the web site and monthly updates are supported by Dr. Hui Liu. Dr. Liu also worked up a 10-year time series of zooplankton samples collected at a station 25 miles off Newport, in slope waters. His focus was on the large sub-arctic copepods, *Neocalanus cristatus*, *N. plumchrus*, *Eucalanus bungii* and *Metridia pacifica*. He is now looking to see if interannual variations in their abundance is useful for forecasting salmon returns or sablefish recruitment.

**Harvest Management Strategy Evaluations:** Dr. Wainwright, Dr. Peterson, and Dr. Peter Lawson have a new project (funded by the NOAA FATE program) to assess the effectiveness of incorporating these ecological indicators into stock forecasts used in salmon harvest management. In collaboration with the salmon management community, they will conduct formal management strategy evaluations (MSEs) to assess the value of ecological indicators in improving salmon harvest management and salmon conservation.

**Ichthyoplankton Studies:** Dr. Brodeur, Dr. Peterson, and Toby Auth continue to examine ichthyoplankton data collected 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

long-term changes in ichthyoplankton densities, diversities, and dominant species in relation to regional and local environmental forcing factors using Generalized Additive Modeling. A new project funded by the FATE (Fisheries and the Environment) Program aims to examine the relationship between winter larval fish and crab abundances and salmon survival the following summer to provide an early indicator of salmon recruitment.

Dr. Robert Emmett and Dr. Brodeur lead a study initiated in 2004 to examine seasonal variation in abundances of juvenile fishes, including rockfish. This project was 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. Jason Phillips and Toby Auth conduct the sampling and process the biological and physical data. Surveys in 2004-2008 (five each year) 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. Dr. Brodeur is using genetically-speciated juvenile rockfishes to examine their diets both visually and by the use of stable C and N isotope ratios.

**GLOBEC Investigations:** Zooplankton studies transitioned from 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 is developing statistical models of habitat requirements and habitat suitability 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. Progress on the euphausiid synthesis work included the establishment of a working group with PICES ("Comparative studies of krill around the Pacific Rim"), Working Group 23, with members from Canada, China, Korea, Japan, Russia and the United States. The working group is co-chaired by Bill Peterson; Tracy Shaw is a member of the working group. Another action item from the krill synthesis work involved a workshop on Krill Biology and Ecology in the World's Oceans, which was recently convened at the 3<sup>rd</sup> International GLOBEC Open Science meeting in Victoria, 22-26 June 2009. HMSC was represented at that meeting by oral presentations by Bill Peterson and Leah Feinberg and a poster presentation by Jennifer Menkel.

**Harmful Algal Blooms:** Dr. Bill Peterson was recently received a five-year award from the NOAA MERHAB Harmful Algal Blooms program (with Dr. Pete Strutton (OSU) and Dr. Michelle Woods (UO) program to continue work on ecology of HABs and to develop forecasting capability for HABs in Oregon's coastal waters. to continue work on Harmful Algal Blooms

in Oregon's coastal waters. A post-doc, Dr. Linda O'Higgins, from the National University of Ireland, Galway, Ireland, joined Bill's group in September 2006, and has since been enumerating phytoplankton species in plankton samples that Bill's group has been collecting since the year 2000. She has found a high incidence of *Pseudonitzschia* in samples collected year-around. Bill and Linda work 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).

***Use of satellite-derived data to better characterize salmon habitats:***

Drs. Hongsheng Bi and Bill Peterson (along with Dr. Ted Strub of Oregon State University) recently received NASA funding for a project based on the observation that changes in the Pacific Decadal Oscillation (PDO) may result in local food chains that have vastly different bioenergetic content, which in turn impacts growth and survival of juvenile salmonids. To better understand linkages between PDO→chl-*a*→copepods→salmon, research carried out during this project will: (1) investigate correlations between variations in direction of dominant transport of water into the northern California Current and food chain structure and salmon survival; (2) identify physical oceanographic features from remote sensing data that appear to be linked with spatial variation in biological features, such as spatial distributions of chl-*a*, zooplankton and juvenile salmon; (3) characterize, using GIS and statistical modeling, the interannual variations in size of suitable habitat for juvenile salmonids using satellite data and in situ observations, then (4) develop forecast indicators of salmon habitat size, salmon growth and salmon survival, using winds, transport, SST and ocean color derived from satellites, as well as our own 10+ years of in situ data sets.

***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. The recovery of four different macroparasite communities from Pacific Sardine caught from Vancouver Island, British Columbia to San Diego, California suggests that Pacific sardines may not be migrating through the entire region of the California Current System. The examination of parasites as potential biological markers has expanded to include northern anchovy, and the potential of parasite genetics in assessing the stock structure of Pacific sardine. In 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. As part of their studies of sardine biology, Andrew Claiborne has been taking otoliths and ageing sardine caught off Oregon each month.

In addition to the sardine biology research, the pelagic fish team is also looking at the unusual recruitment of 0-age lingcod observed during May 2008, the spawning time and growth of northern anchovy and Pacific herring, and the fatty acid conditions of forage fishes. Fatty acids can be used as indicators of ocean/feeding conditions because different phytoplankton

species have different fatty acid signatures.

In fall 2008, Drs. Emmett and Jacobson hosted the ninth annual TriNational Sardine Forum in Astoria, OR. This Forum is where the sardine industry, fishermen, and scientists get together to discuss sardine biology, population abundance assessments, and other issues. The 2009 meeting is scheduled for La Paz, Mexico. In spring 2009, Robert Emmett was appointed to the Pacific Fisheries Management Council, Coastal Pelagic Fisheries Management Team.

**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 Paul Bentley, Marisa Litz, Andrew Claiborne, 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. Additional sampling that is focused on subyearling salmon, samples both lower and upper estuary sites with assistance from Susan Hinton, George McCabe and other scientists from the NOAA Pt. Adams field station. Collections from the Bonneville Dam bypass provides baseline data on outmigrating juvenile salmon prior to reaching the estuary.

In collaboration with NWFSC scientists at other laboratories, Dr. Emmett has been conducting a Salmon Time of Release Study funded by the U.S. 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 smolts encounter, we can optimize SARs by manipulating transportation tactics and hatchery release dates. As part of this research, Andrew Claiborne has been using scales from juveniles and adults to determine if size dependent mortality occurs in these fishes.

A team of researchers led by Dan Bottom and supported by funds from the U.S. Army Corps of Engineers and Bonneville Power Administration (BPA) evaluates the effects of flow management and historic habitat change on juvenile salmon in the Columbia River estuary. The study evaluates fish and prey assemblages within selected tidal wetlands; analyzes historic changes in flow, sediment input, and salmon rearing opportunities throughout the tidal river; and evaluates the effects of habitat change and flow regulation on estuarine food chains supporting juvenile salmon. Dr. Jacobson and Andrew Claxton examine parasite communities of juvenile salmon to provide independent indices of juvenile

salmon diet, habitat use, and habitat health within the Columbia River Estuary. Scientists will also use models to compare the relative effects of river modifications and flow regulation on salmon habitat availability and to evaluate the effectiveness of alternative scenarios for restoring estuarine habitat. In 2007, BPA awarded additional support for the estuarine research team to investigate salmon-habitat relationships and life histories in lower Grays River, a lower Columbia River tributary where tidal wetlands have been restored through dike and tidegate removal. The study examines the use of restored tributary wetlands by juvenile salmon and compares these results with recent data collected in the mainstem estuary. This project will collaborate with other research activities in the lower Grays River by the Lower Columbia River Estuary Partnership, the Columbia Land Trust, and the Columbia River Estuary Study Taskforce.

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

**LCDR Devin Brakob, Newport Program Manager;  
Dr. Patricia Burke, Groundfish Monitoring Program Manager**

FRAM Division science team members, many of whom are located at the HMSC in Newport, conduct studies providing scientific information used as the basis to manage West Coast Groundfish stocks and their ecosystems. The studies involve comprehensive analysis of data from fishery monitoring, fishery-independent resource surveys, and biological investigations. The results provide estimates of the current status and future trends in abundance and productivity of marine fishery resources, evaluations of the potential effects of fishery management alternatives on abundance and yield of living marine resources, and better information on fishery bycatch and other multi-species issues.

Dr. Vladlena Gertseva, Dr. Waldo Wakefield, Lisa Bonacci, Keith Bosley, John Buchanan, Julia Clemons, Mary Craig, Erica Fruh, Melanie Johnson, Dan Kamikawa, Katie McGourty, Jim Miller, Stacey Miller, and Curt Whitmire represent FRAM in Newport. Cooperating staff from institutions outside NOAA include:

- Oregon Coast Community College (OCCC) undergraduate students Sara Firth, Ryan Foyt, and Kristin Titmas;
- Barry University (Hollings Scholar) undergraduate student Alix Lee;
- University of California Berkeley (Hollings Scholar) undergraduate student Jennifer Hoey;
- University of Maine (Hollings Scholar) undergraduate student Kyle Molton;
- Pacific States Marine Fisheries Commission (PSMFC) staff Patrick McDonald, Nikki Atkins, Jennifer Cramer, Jason Eibner, Betty Kamikawa, Mark Lomeli, Omar Rodriguez, Susan Schirripa, and Lou Taylor;
- IAP World Services, Inc. staff Allen Cramer;
- The Data Entry Company (TDEC) staff Carol Ksycinski.

***Stock Assessments and Stock Assessment Research:*** Dr. Vladlena Gertseva became a new member of the FRAM Division stock assessment team in October 2008. Prior to that, Dr. Gertseva worked at Oregon State University’s Cooperative

Institute for Marine Resources Studies (CIMRS) as an Assistant Professor and collaborated with FRAM while developing an assessment for the longnose skate, *Raja rhina*. A paper based on her longnose skate assessment was recently published in the journal *Fisheries Research*. A major activity of Dr. Gertseva this year was the development of a new stock assessment for splitnose rockfish, *Sebastes diploproa*, a long-lived species that is often bycatch in deepwater fisheries. In the assessment, she reconstructed the dynamics of splitnose rockfish back to 1900 and found that the stock of splitnose rockfish off the continental U.S. Pacific Coast is not currently overfished.

In 2009 Dr. Vladlena Gertseva obtained funding from the NOAA Fisheries and the Environment (FATE) program for a multi-disciplinary research project entitled “*Beyond the Spring Transition: Winter Pre-Conditioning of Ecosystem Dynamics and Implications for Sentinel Species and Fisheries*”. The project will involve collaboration among several scientists from Oregon State University as well as the NOAA Northwest and Southwest Fisheries Science Centers, including HMSC researcher Dr. Bryan Black and NWFSC biologist Dr. Peter Lawson. It was previously found that the growth of splitnose rockfish is correlated with climate and environmental variables, including sea surface temperature, ENSO index and Pacific Decadal Oscillation (PDO). Based on her new splitnose rockfish stock assessment, Dr. Gertseva will explore the opportunities to incorporate splitnose rockfish climate-growth relationships into a stock assessment model to enhance understanding the effect of climate on the dynamics of West Coast groundfish stocks.

Dr. Gertseva continues to facilitate broadcasting of the Quantitative Fisheries mini-workshop series from the University of Washington (UW), Seattle to Hatfield Marine Science Center. This workshop series is a collaboration between fisheries stock assessors at the University of Washington’s School of Aquatic & Fishery Sciences and the Northwest Fisheries and Alaska Fisheries Science Centers at NOAA. Within this mini-workshop series, Gertseva also presented a mini-workshop *Estimating ageing error matrices* along with Dr. Andre Punt of UW and Dr. Melissa Haltuch of NWFSC.

Dr. Gertseva serves as courtesy Faculty in the Department of Fisheries & Wildlife at Oregon State University (OSU). She is also a Graduate Faculty member at OSU and serves on a graduate committee for a PhD student in the Fisheries & Wildlife Department, Katelyn Cassidy, whose research deals with population dynamics of the ghost shrimp, *Neotrypaea californiensis*. In the Summer and Fall terms of 2008, Dr. Gertseva taught the course *Introductory Population Dynamics* (FW 320) designed for biology-oriented undergraduate students and delivered online through the OSU Extended Campus. Dr. Gertseva also supervises a student intern from the Aquarium Science Program at Oregon Coastal Community College (OCCC), Sarah Firth, who works in the ageing laboratory at the Hatfield Marine Science Center.

Through a cooperative agreement between NOAA Fisheries and the Pacific States Marine Fisheries Commission, the assessment program continues to collaborate with the cooperative Ageing

Lab based at HMSC and cooperates with NWFSC stock assessors on research projects that enhance future stock assessments. From June 1, 2008 through June 30, 2009, the species and number of associated otoliths aged to support ongoing and future assessments were; sablefish (1,036), darkblotched rockfish (11,901), splitnose rockfish (4,535), greenstriped rockfish (4,328), Pacific Ocean perch (1,425), canary rockfish (780), Pacific hake (5,635), petrale sole (7,280) and Dover sole (2,065). The total number of structures aged for this reporting period includes; production (30,929), cross training (1,622), and double reads (6,434).

**Resource Surveys:** The FRAM survey members stationed at the HMSC, biologists Keith Bosley, John Buchanan, Erica Fruh, Dan Kamikawa, and biological technician Katie McGourty, are responsible for conducting the annual coast wide groundfish trawl surveys. 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 2008 survey season began with the annual “At-Sea Safety” training and survey orientation session at the HMSC for participating students, volunteers, and scientists from other agencies. The chartered fishing vessels *Ms. Julie*, *Noah’s Ark*, *Excalibur* and *Raven* conducted the 2008 West Coast Bottom Trawl Groundfish Survey from May 2008 through October 2008. The survey targets trawlable areas along the U.S. western continental shelf and slope between the Canadian and Mexican borders, in depths ranging from 30 to 700 fathoms. In addition to collecting catch data, survey members collect biological samples and conduct cooperative research projects with and for other agency and university researchers around the country and the world. The 2008 survey was a success, completing 685 stations in 184 fishing days, as well as a three day in-depth study of a hypoxic area found off the Oregon coast.

The 2009 groundfish survey began with the annual “At-Sea Safety” training and Survey Orientation sessions held at the HMSC April 28<sup>th</sup>. The contracted fishing vessels *Noah’s Ark* and *Ms. Julie* embarked upon the actual survey in May and returned in late July. The second pass departs in August aboard the fishing vessels *Excalibur* and *Raven* and is expected to conclude in late October. In addition to FRAM survey members and scientists, participants in the annual bottom trawl surveys usually include graduate students from Oregon State University, the University of Washington, and Moss Landing Marine Laboratories (Moss Landing, CA), as well as two undergraduate Hollings Scholars and Aquarium Science students from Oregon Coast Community College.

Erica Fruh from the survey group is participating in the Division’s collaboration with the NOAA Fisheries’ Pacific Island Fisheries Science Center (PIFSC) and Woods Hole Oceanographic Institution (WHOI) to redesign the SeaBed AUV to overcome the difficulty of monitoring fish populations and habitat in rocky areas.

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

The HCE group continues to be part of the Division's collaborations with Dr. Chris Goldfinger's Active Tectonics and Seafloor Mapping Laboratory (ATSML) at Oregon State University, developing and maintaining 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 collaboration with ODFW and the PSMFC, the HCE group will continue ongoing bycatch reduction and engineering research and initiate two new bycatch projects during the 2009 field season. One new study seeks to test and evaluate the efficacy of an open escape window bycatch reduction device to reduce Chinook salmon and rockfish bycatch in the Pacific whiting fishery. A second project will test footrope modifications designed to reduce the bycatch of groundfish and megafaunal invertebrates, and reduce physical impacts on invertebrates in the ocean shrimp (*Pandalus jordani*) trawl fishery.

The NWFSC's West Coast Groundfish Observer Program and the HCE initiated a pilot project in spring 2008 to integrate seabed classification with commercial fishing activities to investigate whether this type of information would be useful in reducing bycatch in west coast groundfish fisheries. This project is being conducted in the vicinity of Morro Bay, California, as collaboration between the NWFSC's Habitat and Conservation Engineering group and West Coast Groundfish Observer Program, The Nature Conservancy, and Oregon State University's Active Tectonics and Seafloor Mapping Lab. The goal of the project is to capture bottom type using a Qester Tangent QTC VIEW simultaneously with bottom trawling. Questions to be considered include whether high-quality data can be collected during normal fishing operations to inform NMFS about bottom type with minimal impact on fishing operations, and whether patterns in bycatch relate to specific seafloor classifications. The project will continue during 2009.

**Acoustics:** NWFSC/FRAM scientists from the Acoustics group conduct fisheries acoustic surveys and carry out post-cruise analysis of the collected survey data. The acoustics group also supports other fisheries related research projects including examining environmental factors driving the distribution of groundfish species, and the application of acoustic and other advanced technologies to fisheries problems. Major efforts of the FRAM Acoustics group during June 2008- July 2009 included:

An inter-vessel calibration (IVC) conducted in August 2008 off of the coast of British Columbia where Hake backscatter data was collected on the NOAA ships *Miller Freeman* and *Oscar Dyson* during side-by-side and follow-the-leader type transects. The primary goal of the IVC was to determine if there were differences in acoustic measurements between the current survey vessel, *Miller Freeman* and the new FSV class *Oscar Dyson*. The work is crucial to continuing the long-term time series of the hake survey, allowing direct comparison of data collected historically to new data collected with the new FSV *Bell M. Shimada* that is expected to be in service starting in 2010. A number of secondary research objectives carried out on this cruise included: 1) testing a new automated calibration system, 2) collecting target strength measurements of hake, 3) collecting physical oceanographic data (temperature and salinity profiles) at selected sites, 4) collecting stomach samples from Pacific hake for food habits studies, 5) testing a new in net camera system, and 6) collecting Video Plankton Recorder (VPR) data on the *Miller Freeman*.

In March of 2009 a pilot study was conducted to develop a survey method for widow rockfish (*Sebastes entomelas*) using a combination of acoustics and underwater video. This work took place off the central Oregon coast onboard the *F/V Excalibur*. Lisa Bonacci, from the Acoustics Group (Newport) led this project with the help of Dr. Waldo Wakefield from the Habitat Conservation and Engineering Group (Newport) and the valuable input of Captain and crew. Sixteen successful tows were completed and more than 800 nautical miles of acoustic trackline data was collected. Review of video footage showed that fish could be clearly seen, identified, counted, and measured, and bycatch was minimal. Based on the sampling results, a set of future survey locations off of the central and northern Oregon coast were identified.

Currently, the group is preparing for the 2009 US-Canada Joint Pacific Hake integrated acoustic and trawl survey. This survey will be conducted from 27 June until 29 August, 2009 aboard the NOAA ship *Miller Freeman*. The survey effort will cover the area from Monterey, California (36°N), to the northern extension of the hake which varies from year to year. Scientific crews are composed of both U.S. and Canadian scientists. The U.S. scientific team from Newport will include Lisa Bonacci, the FRAM acoustician stationed in Newport, Julia Clemons who works with both the FRAM Acoustics and Habitat groups, as well as OSU Oceanographer Steve Pierce. Additional scientific cooperators will be conducting research on specific legs of the survey as well.

**West Coast Groundfish Observer Program:** The West Coast Groundfish Observer Program entered its eighth 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, observer program staff are stationed along the entire West Coast. The program has added a new member to the Hatfield family: debriefer Jason Eibner who will join data debriefer/data quality controller, Jennifer Cramer, and the Oregon and Washington

observer coordinator, Allen Cramer. Observers are responsible for collecting catch and discard estimates, species composition data, and biological specimens in West Coast groundfish fisheries. The program conducted its thirteen-day training course for new observers in March 2009 and held multiple annual refresher safety training classes for returning observers and FRAM's at-sea survey staff at the Hatfield Marine Science Center. HMSC's facilities and proximity to the docks make it a great place to train. Program outreach has included staff members volunteering at the 2009 HMSC Seafest event. Observer staff has also helped in giving fish identification and physiology classes to grade school children through HMSC's education program and providing fish specimens for the students to dissect. Finally, program staff worked with the bottom trawl survey to update and improve an extensive species identification guide and assisted in the Southern California Hook and Line survey. A significant new focus for the Observer program in 2009 and beyond will be the design for monitoring a new West Coast trawl fishery catch share program.

## 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.

***Lau Basin Expedition:*** (John Lupton, Bob Embley, Susan Merle, Ron Greene) In November 2008, the NOAA Vents Program launched an expedition to the northern Lau Basin aboard the U. Washington ship *R/V Thompson*. The expedition, which lasted about 16 days, went in and out of Apia, Western Samoa, and included a number of HMSC scientists, including John Lupton (chief scientist), Bob Embley, Susan Merle, and Ron Greene, as well as other scientists from NOAA/PMEL in Seattle, U. of Washington, U. Texas Austin, IGNS in New Zealand, ETH in Zurich, and ANU in Canberra Australia. The northern Lau Basin is situated just southwest of Samoa, and consists of a series of spreading centers or rift zones associated with the subduction activity along the Tonga-Kermadec Arc. In addition to these rift zones, the northern Lau Basin is populated with many volcanic cones and calderas. The work at sea focused

on multi-beam mapping of seafloor bathymetry and water-column surveys for hydrothermal plumes. During one of these surveys over a rift zone called the Northeast Lau Spreading Center (NELSC), a complex suite of water-column plumes was detected at several levels up to 700 m above the seafloor. Water samples from these plumes contained volcanic glass shards and extremely high hydrogen concentrations. Taken together, these findings pointed to a seafloor eruption occurring on the NELSC either during or shortly before our survey. At West Mata volcano about 70 km northeast of the NELSC, we also detected unusual plumes over the volcano summit highly enriched in suspended particles, helium, hydrogen, and CO<sub>2</sub>. The particles consisted mainly of sulfur and Fe-oxyhydroxides. Multi-beam surveys conducted with the shipboard EM300 system showed extensive areas of high backscatter on the flanks of the volcano. The high backscatter and the plume characteristics pointed to ongoing and long-lived eruptive activity at West Mata.

***NE Lau Spreading Center Response Cruise:*** (Bob Embley, John Lupton, Susan Merle, Leigh Evans) Based on the exciting results from the November expedition to the Lau Basing an effort was successfully mounted for a short response cruise that took place May 5-13, 2009 using a combination of funding from the National Science Foundation and the NOAA Ocean Exploration program. Bob Embley and John Lupton (both NOAA) and Susan Merle and Leigh Evans (both CIMRS) were part of an interdisciplinary team of scientists that made 7 dives with the remotely operated vehicle Jason-2 on board the T. G. Thompson. A major find of the expedition was the discovery of a vigorous ongoing seafloor eruption at 1200 meters depth on the West Mata submarine volcano where a very intense plume signal was discovered in November 2008. Vigorous activity at two separate vents, including exploding lava bubbles and active lava flows were observed for the very first time at this site, which is a step up in activity in "explosivity index" and almost 700 m deeper than NW Rota-1 (discovered in 2004 in the Mariana arc). The VENTS contingent collected many samples of gases and fluids and hours of high definition video for analysis over the next year. A second site of intense hydrothermal plumes discovered in November lying about 35 km SW of the Mata site along the Northeast Lau Spreading Center was also investigated on two dives of Jason-2. A young lava flow was mapped below the area of but no significant hydrothermal activity was associated with it.

Bob Dziak's Acoustic Monitoring group also participated in the NE Lau program with a rapid deployment of a moored hydrophone in December which was recovered on the May cruise. A special session at the 2009 Fall Meeting of the American Geophysical Union will highlight some of the initial results of the Lau program (as well as the recent results from the NW Rota-1 site).



Figure 1: Eruption of the Hades Vent, summit (1205 m) of West Mata submarine volcano, northeastern Lau Basin

**Geophysical Monitoring and Seafloor Mapping at Submarine Volcanoes:** (Bill Chadwick, Bob Embley, Susan Merle, Andra Bobbitt) The goal of this program is to better understand submarine volcanic eruptions and their impact on the ocean environment. Our efforts continue to be divided between long-term volcano monitoring in the NE Pacific and seafloor mapping and exploration in the W Pacific. In addition, an on-going project in the Galapagos islands provides the opportunity to compare volcanic activity on land and underwater.

NeMO (New Millennium Observatory) is a long-term multidisciplinary project at Axial Volcano in the NE Pacific. This project involves arrays of seafloor and water-column instruments, and sample collection systems for documenting chemical, biological, hydrographic and geologic changes in and around the summit caldera. Axial volcano last erupted in 1998 and monitoring data have shown that it has been reinflating ever since. Precise pressure measurements in 2000-2007 showed that the caldera floor at Axial is being uplifted at a rate of about 13 cm/yr, and has risen by more than 1.5 m since the 1998 eruption. These measurements will be repeated next summer to see if this trend is continuing in an effort to anticipate the timing of Axial's next eruption. This is the first location where volcanic inflation has been documented at an active submarine volcano.

An expedition in April 2009 returned to NW Rota-1, an actively erupting submarine volcano in the Mariana arc, W Pacific, for a dive series with the remotely operated vehicle *Jason*. Since the previous visit in 2006, a large new cone had built up at the eruptive vent that is as high as a 12-story building and as wide as a city block. The biological community at the volcano was also more robust with much higher populations of previously observed species along with new arrivals. The 2009 expedition focused on making coordinated visual and acoustic observations of the eruptive activity, sampling of hydrothermal fluids, volcanic gases, lava, and biota, and deploying long-term monitoring instruments that will be recovered during our next expedition in spring 2010. NW Rota-1 is the first site where deepsea volcanic eruptions were observed. Text, images, and video from the 2009 expedition were posted at <http://nwrota2009.blogspot.com>.

**Ocean Acoustics:** (Bob Dziak, Haru Matsumoto, Dave Mellinger, Sharon Nieu Kirk, Sara Heimlich, Any Lau) The PMEL Ocean Acoustics project continues its effort to detect and monitor seafloor volcanic areas as well as quantify the distribution of endangered cetacean species throughout the world's oceans. Hydrophones were deployed near the Scotia Volcanic arc, south Atlantic ocean, in a project sponsored by Korean Ocean Polar Research Inst and Dept of Energy. This project will look for volcanic activity and acoustic blockage in region for nuclear test verification. Five hydrophones deployed in the Bransfield strait, 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 also recovered and re-deployed a hydrophone at the actively erupting NW-Rota-1 volcano, providing the first long-term record of seafloor explosion activity ever made. lastly, NSF funded deployment of 12 hydrophones in the Lau basin back-arc spreading centers in January 2009. This hydrophone array will be used to look at volcanic activity in the region and address seismo-acoustic propagation and are deployed contemporaneously with a 60-instrument Ocean Bottom Seismometer array. The US Navy SOSUS hydrophone array continues in its 18th year of continuous, real-time data collection of north Pacific ocean sound. This year we installed new, digital encryption devices and time signal generators to improve communication lines between Newport and Whidbey Island NAS and have implemented new detection software to facilitate rapid data processing.

New technology developments include the purchase of an ocean glider, which is a fully autonomous, buoyancy self-controlled float that can provide horizontal and vertical ocean profiles. Work is underway to install a hydrophone on the glider to deploy near an active volcano next Fall. The marine mammal acoustics group continues to develop detector algorithms for glider based recordings of beaked whales. Support from ONR will allow purchase of 3 additional vertical profiling floats in addition to the glider this coming year, with a planned test deployment of these instruments off Bermuda to record the calls of beaked whales.

## US 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 heat stress and bacterial infection alter gene expression patterns in Pacific oysters:*** Oyster farmers in the Pacific Northwest experience occasional but catastrophic crop failures when the combined effects of high temperatures and bacterial pathogens cause "Summer Mortality Syndrome." The Shellfish Genetics Program examined the effects of heat stress and bacterial infection on gene expression in stress-tolerant and stress-susceptible Pacific oyster families and identified numerous candidate genes that potentially affect survival under stressful conditions. This is an important step in developing a program of genetic improvement that directly targets genes through marker-assisted selection aimed at enhancing resistance to Summer Mortality Syndrome.
- ***Helping to develop a research plan to address emerging problems in shellfish hatcheries:*** The Shellfish Genetics Program worked closely with the Pacific Coast Shellfish Growers Association, Oregon State University, the University of Washington, NOAA, and the Washington Department of Fisheries and Wildlife as part of the Shellfish Seed Emergency Committee (SSEC) assembled by the Pacific Coast Shellfish Growers Association. The SSEC developed a detailed action plan to address the catastrophic mortalities impacting oyster seed production in commercial hatcheries in Washington and Oregon. Because these hatcheries are the only suppliers of seed oysters to a large number of very small oyster farms, these small growers cannot operate unless they can obtain oyster seed for planting. The action plan developed by the SSEC is specifically intended to stabilize seed availability to these small farms.
- ***Developing genetically rigorous protocols to address emerging challenges and opportunities:*** With funding assistance from the USDA's Cooperative State Research, Education, and Extension Service, the Molluscan Broodstock Program (MBP) has, since 1995, selectively bred Pacific oysters for enhanced meat yield to improve the industry's profitability in the shucked meat market. Recently, however, severe problems with oyster seed production in commercial hatcheries potentially caused by ocean acidification and a shift in oyster markets toward the more lucrative half-shell trade have put a premium on larval survival under stressful

conditions and product quality traits such as shell shape and color, shell/meat ratio, and meat quality. Addressing these new challenges involves a shift from single- to multi-trait selection that requires reliable estimates of the genetic correlation structure between traits and of multi-trait genetic merit. The Shellfish Genetics Program worked closely with MBP to design genetically rigorous protocols that will help the breeding program make the transition from a simple, single-trait approach designed to address earlier challenges and priorities to a modern, genetically rigorous, multi-trait genetic improvement scheme capable of addressing current problems and opportunities for the cultured oyster industry in the Pacific Northwest.

- ***Studying the genetic basis of shell pigmentation in Pacific oysters:*** Markets for cultured oysters are rapidly shifting from shucked meats destined for cooking toward the live half-shell trade, making traits such as shell shape and color more economically important. In collaboration with the Molluscan Broodstock Program, the Shellfish Genetics Program studied the genetic basis of shell pigmentation in Pacific oysters and demonstrated that this character is under very strong genetic control - possibly due to the influence of a single major gene in at least some families. This knowledge sets the stage for selective breeding to develop oyster strains with desirable shell pigmentation patterns and thus increase the profitability of oyster farming in the Pacific Northwest.
- ***Showing that remnant populations of native Olympia oysters have strong genetic structure:*** Due to intense interest in restoring the native Olympia oyster Pacific Northwest estuaries, several efforts are underway that either include or propose using hatchery-produced seed oysters to re-stock depleted populations. Without knowledge of the existing genetic structure among remnant populations, these well-intended efforts could inadvertently alter their genetic composition in ways that compromise population or even the entire species' long-term viability. The Shellfish Genetics Program developed new, species-specific genetic markers and used them to analyze samples from populations ranging from British Columbia to San Francisco Bay. We found that remnant Olympia oyster populations show higher levels of genetic differentiation than expected based on studies of other oyster species, probably as a consequence of the shorter duration of the free-swimming larval stage, but potentially as a consequence of human activities such as harvesting, habitat degradation, and translocation. These results provide valuable baseline knowledge for resource managers and restoration practitioners designing and implementing restoration efforts that do no genetic-level harm to existing populations and for monitoring their effects and efficacy.

The objective of the shellfish ecology program is to investigate the ecological role that shellfish aquaculture plays in west coast estuaries and to use the knowledge gained to design shellfish grow out, harvest and pest/predator control practices that are economically and environmentally sustainable.

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 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 (*Neotrypaea californiensis*) recruitment continues to be very low in all estuaries, while mud shrimp recruited extensively to Yaquina Bay and Tillamook Bay in Oregon in 2006 and 2007 with lower recruitment in 2008 and 2009. Mud shrimp (*Upogebia pugettensis*) populations have collapsed in Washington estuaries and these shrimp did not recruit to our monitoring sites in Willapa Bay and Grays Harbor. 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 was modified and successfully used to examine the age of ghost 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. They should also enable us to quantitatively examine population dynamics of shrimp in these estuaries and an effort to use the same ageing technique for mud shrimp was implemented in 2009. Low shrimp recruitment should be reducing the need to control them in Washington estuaries, but shrimp are still abundant outside the growing areas and growers still report need for control, so experiments to examine movement of larger shrimp were implemented in 2009. Experiments with ultrasound like that used for industrial cleaning and cell disruption as a possible alternative to the current pesticide for controlling shrimp were also conducted at HMSC.
- Studying the effects of shellfish aquaculture on estuarine habitats utilized by juvenile English sole, salmon and other important fish and invertebrates. The intent of this effort is 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 used to track use of these intertidal habitats by fish and invertebrates. This effort targets juvenile English sole because they have been shown to utilize intertidal areas and inhabit West Coast estuaries as nurseries during their first year of life.

## 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 2008-09, the Oregon Coast National Wildlife Refuge Complex had eight permanent employees, three temporary Biological Technician and 2 AmeriCorps members located at the HMSC. At the Refuge Complex south coast unit office in Bandon, Oregon, one permanent employee and numerous volunteers were present this year. 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 Siletz Bay, Nestucca Bay, and Bandon Marsh refuges. In May 2009, with the assistance of The Nature Conservancy, the USFWS acquired a key 80 acre parcel of pasture land at Nestucca Bay NWR. This parcel, located just north of Pacific City, Oregon, is one of only two wintering sites used by the entire world population of the Semidi Islands Aleutian cackling goose, which numbers only about 140 birds. The parcel is essential to the long-term protection of the Semidi birds, and bringing it into the Refuge System will permanently protect one of their most important wintering sites. Funds for the acquisition came from a special land conservation fund established by Congress under the Federal Land Transaction Facilitation Act of 2000. The Act authorizes the purchase of private "inholdings" from willing sellers in western states whose acreage is surrounded by or located next to certain lands under the management of the Bureau of Land Management, U.S. Forest Service, National Park Service, or the Fish and Wildlife Service. In early 2008, Siletz Bay NWR was the first National Wildlife Refuge in the nation to receive funds in accordance with this Act.

Post restoration monitoring of anadromous fish use continues on the Millport Slough Unit of Siletz Bay NWR where a 100-acre tidal marsh restoration project was constructed in October 2003. In the spring and summer of 2007 an 82-acre tidal marsh restoration project was constructed on the Little Nestucca Unit of Nestucca Bay NWR. The newly restored marsh is functioning well and receiving heavy use by juvenile salmonids and other fish. Pre and post restoration monitoring is being conducted by the Confederated Tribes of the Siletz Indians and the USFWS Columbia River Fisheries Program Office. Planning for a 430-acre tidal marsh restoration project on Bandon Marsh NWR continued this year and construction will begin in August 2009, continuing into 2010. The restoration project is linked to a \$4.2 million transportation project that will raise and improve the adjacent county road. The Federal Highway Administration is handling the road design and construction portion of the project which is scheduled for 2010.

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. Research on Leach's Storm-Petrels, initiated in 2004, continued this year as well. The storm-petrel work is being done on Saddle Rock within Oregon Islands NWR in cooperation with the University of Oregon. Continuing from last year is the investigation of the use of radar to develop non-intrusive (off-site) methods for population monitoring of this nocturnal species. ABR Inc. of Forest Grove is leading this research effort.

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 2009 Oregon "Best of Show" winner was Sarah Kang, a 16 year-old student from Portland who submitted a colored pencil drawing of a pair of Barrow's Goldeneye. 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. Bill Medlen, Invasive Species volunteer at Siletz Bay NWR, is working on his second year as a volunteer with the USFWS and has provided over 1,000 hours of time since January. Nestucca Bay National Wildlife Refuge opened to public use in October and has been regularly visited by a steady stream of locals and out-of-towners.

### *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 four 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 2008-2009, the Newport Field Office celebrated a number of accomplishments:

- Completed 13 restoration or habitat assessment projects under the Coastal Program which enhanced or restored 6 miles of stream and riparian habitats; 150 acres of wetlands; and 30 acres of upland. We also restored or opened fish passage to over 4 miles of stream by replacing 3 culvert barriers; participated in a number of conservation partnerships and land protection activities; and contributed to a number of other efforts for the benefit of threatened species, coastal ecosystems, and local communities. We anticipate a total of over 20 active projects in FY10 and are continuing to implement our Coastal Program strategic plan to focus our restoration, education, and assessment opportunities on habitat types most in need of protection and restoration along the Oregon Coast.
- 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 approximately 50 volunteers. Nearly 1,000 butterflies emerged from the augmented pupae and caterpillars. To improve habitat, volunteers and Service staff also planted early blue violets, the host plant for Oregon silverspot larvae, at several locations. Seeds were also collected from a number of nectar plants to be propagated by NRCS for future habitat restoration efforts, and nectar plants were planted this year at 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 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. A Final Draft HCP and a Draft Environmental Impact Statement were released for public review in November 2007; the final EIS and HCP is expected in late summer to Fall 2009.
- Coordinated volunteers and biologists for the Western snowy plover and Black oystercatcher surveys along the Oregon

Coast and presented survey data on Black oystercatchers at the meeting for “Shorebird Science in the Western Hemisphere” in Boulder, Colorado.

- Supported a number of recovery projects and habitat restoration for sensitive species on the Oregon Coast.

## 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:** During the summer of 2008, community groups and citizens developed proposals for sites to be considered for further evaluation as potential marine reserves. The Oregon Ocean Policy Advisory Council (OPAC), a marine policy advisory body to the Governor, received 20 proposals for consideration. In November 2008, OPAC developed final recommendations to the Governor. OPAC recommended a total of six areas to move forward in the marine reserves process:

- Four areas were recommended to move forward for further development and evaluation, with additional socioeconomic and ecological information to be gathered, as well as more extensive collaboration among ocean users, coastal communities, and other interested parties.
- Two additional areas were recommended for designation as pilot marine reserve sites beginning in the summer of 2009, following appropriate rulemaking and baseline data collection. These areas were recommended for pilot marine reserve designation as they were considered to already have extensive community collaboration, sufficient existing biological and socioeconomic information, and broad community support.

The 2009 Oregon state legislature passed House Bill 3013, which directs state agencies to implement the OPAC recommendations and directs ODFW, in consultation with others, to develop a work plan for implementing those recommendations during the 2009-2011 biennium. The 2009 Oregon state legislature also granted ODFW funds to implement this next phase of the marine reserves process. ODFW is currently developing the marine reserves work plan and will hire new staff in the summer and fall of 2009 to conduct the work. ODFW also plans to partner with academic scientists, the fishing industry, ocean users, community groups, and others to assist in implementing the marine reserves work over the next two years.

**Expanded Shellfish Program:** MRP’s shellfish program expanded in 2008 with the addition of four new permanent positions and seven limited duration positions. Some of those positions were made permanent this year. 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.

In 2008 and 2009, the Oregon Department of Fish and Wildlife set about to assess the clam populations in Coos Bay. The goal of the project was to document the location, habitat and abundance of gapers, butters, cockles, and native littleneck clams. ODFW selected Coos Bay because of several large development projects proposed for that area. Information gathered by this project will inform biologists and educate managers, providing a baseline for monitoring future changes in the estuary. With field work finished, the project staff is wrapping up their evaluation and reports. In June they delivered their findings at a public meeting in Charleston.

With the success of the limited-duration Coos Bay Shellfish and Estuarine Assessment, the legislature approved assessment of other estuaries in Oregon. ODFW will be hiring new positions to accomplish the expanded shellfish and estuary assessment. This program will be based in Newport.

**Commercial Dungeness Crab Fishery Management:** MRP staff continue to work with the commercial crab fleet and processors to monitor and refine recently enacted pot limit and logbook requirements. This year the MRP, along with the Oregon Dungeness Crab Commission, will host another Oregon Dungeness Crab Summit to review the pot-limit program and discuss several issues facing the fishery.

After last season's successful multi-agency effort to recover derelict crab pots and other fishing gear, the agency succeeded in getting a \$700,000 federal economic stimulus grant to continue the work on a larger scale. The grant will help fund the removal of 180 metric tons of derelict crab pots and other fishing debris over two field seasons.

**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 2008-2009 was implementation of Marine Mammal Protection Act Section 120 authority to manage California sea lions preying on threatened and endangered salmonids at Bonneville Dam on the Columbia River. Related work included completion of the 13th season of marking California sea lions in Astoria and initiation of a California sea lion acoustic tracking study at Bonneville Dam. Other program activities included: participation in the Northwest Marine Mammal Stranding Network; completion of the eighth year of a mark-resight survival study on Steller sea lions; and analysis of pinniped fecal samples. The Marine Mammal Program also had two manuscripts accepted for publication in 2008-2009: Use of chi-square tests to analyze scat-derived diet composition data (Marine Mammal Science), and Movements of male California sea lions captured in the Columbia River (Northwest Science). 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, Washington Department of Fish and Wildlife, and Columbia River Inter Tribal Fish Commission.

**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.

#### **2008-09 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 underway 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:** Recent and planned studies include acoustic tagging of cabezon and various rockfishes on nearshore rocky reefs to examine movements generally and also movements in response to hypoxia.
- **Black rockfish research:** MRP researchers are in the seventh 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 the backbone of 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.
- **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 china, vermillion, tiger, and copper rockfish, as well as kelp greenling.
- **Ageing studies:** Recent and planned research has focused on using dendrochronological methods to validate annuli for species like aurora and redbanded rockfish. A new method for more efficiently generating otolith thin-sections for analysis of age and growth has also recently been developed.
- **Hypoxia effects on seafloor communities:** ODFW's Marine Habitat Project partnered with Oregon State University's (OSU) Partnership for Interdisciplinary Study of Coastal Oceans (PISCO) to document and describe the ecological effects of hypoxia events on fish and seafloor communities. MRP researchers conducted remotely operated vehicle (ROV) survey work from OSU's R/V Elakha offshore of Cape Perpetua during May – August 2007, and again in June 2008. In concert with PISCO's oceanographic data collection efforts (e.g., temperature, salinity, dissolved oxygen content), which documented the spatial extent and degree of hypoxia in the study area over a seasonal time scale, we 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 redfish rocks:** ODFW's Marine Habitat Project surveyed benthic habitat and fish communities at Redfish Rocks Reef, a nine

km square area of high-relief rocky reef just south of Port Orford on Oregon's south coast. The MRP Habitat Survey Team coordinated the study with the Port Orford Ocean Resource Team (POORT), a community-based fishing interest group actively exploring innovative community-based fisheries management approaches. POORT secured funding for a multi-beam bathymetry survey of the study area to generate a habitat map. The survey is planned for summer 2008. Our survey has built upon past work that our project has conducted at Redfish Rocks, which included a sidescan sonar survey and SCUBA surveys of habitat and the fish community. This effort is a continuation of our ongoing research efforts to map, spatially analyze and characterize nearshore rocky reefs and quantify species-habitat associations.

## C. HMSC Visiting Scientists

### *HMSC Visiting Scientists*

#### **Ken Hall, Program Manager**

Scientists from all over the world come to the HMSC to share knowledge, collaborate, and advance their own investigations, leaving both visitor and host richer for the exchange. Support for long-term visits is available through the Lavern Weber Visiting Scientist Fellowship endowment, named in honor of Lavern Weber, who directed the HMSC between 1977 and 2002.

In addition to frequent visits from OSU faculty and graduate student researchers from the main campus in Corvallis, the following visiting scientists from other institutions were hosted by individual faculty members, research groups or agency units at the HMSC during 2008-09:

**Nathan Bacheler**, Postdoctoral researcher, OSU College of Oceanic & Atmospheric Sciences – *hosted by Mattias Johansson, MFGL*

**Ian Bradbury**, Postdoctoral Fellow, Biology Department, Dalhousie University, Canada – *hosted by Michael Banks, CIMRS*

**Mike Canino**, NOAA Alaska Fisheries Science Center, Seattle – *hosted by Tom Hurst, NOAA AFSC*

**Kathy Cashman**, Dept of Geological Sciences, University of Oregon – *hosted by Bill Chadwick, CIMRS*

**Carolyn Copenheaver**, Dept. of Forestry, Virginia Tech – *hosted by OSU Asst. Prof. Bryan Black, HMSC Forest Ecosystems and Society*

**Anna Elz**, Northwest Fisheries Science Center-- *hosted by Laurie Weitkamp, NOAA NWFSC*

**Jennifer Fisher**, UC Davis Bodega Marine Laboratory,  
**Tessa Francis**, University of Washington – *hosted by Ric Brodeur, NOAA NWFSC*

**Claudia Hollatz**, Biological Sciences Institute, Universidade Federal de Minas Gerais, Brazil - *hosted by Scott Baker OSU MMI*

**Kevin Hovel**, San Diego State University – *hosted by Brett Dumbauld, USDA ARS*

**Peter Kube**, Commonwealth Scientific and Industrial Research

Organisation (CSIRO), Australia – *hosted by Mark Camara, USDA ARS*

**Mary Moser**, Northwest Fisheries Science Center, Seattle – *hosted by Laurie Weitkamp, NOAA NWFSC*

**Bill Muir**, NOAA Fisheries, Northwest Fisheries Science Center, Cook, WA – *hosted by Bob Emmett, NOAA NWFSC*

**Jodie Pirtie**, Ph.D. candidate in Fisheries and Ocean Science, Univ. of Alaska, Fairbanks – *hosted by Al Stoner, NOAA AFSC*

**Visily Titov**, NOAA Center for Tsunami Research, PMEL, Seattle – *hosted by Bill Chadwick, CIMRS*

**Knut Vollset**, University of Bergen, Norway --*hosted by Thomas Hurst, NOAA AFSC*

#### **International delegations:**

Natural resource managers from Primorsky Krai (far east) region of Russia – *hosted by Ken Hall, HMSC*

Graduate Institute of Mathematics and Science Education, National PingTung University of Education, PingTung, Taiwan – *hosted by Shawn Rowe, Oregon Sea Grant*

## II. EDUCATION

### *Student Enrollment Statistics*

Ichung Cheung, Academic Program Coordinator

For a description of courses, see pp 46-48.

Summer 2008	Credit	Course Title	2008-2009
BI 299	4	Special Topics: Introduction to Marine Biology (Newell)	7
BI 302	4	Biology and Conservation of Marine Mammals (Sumich)	5
BI 421	4	Aquatic Biological Invasions (Chapman)	1
FOR 371	3	Eco and Adventure Tourism (Staff) - CANCELLED	n/a
FW 302	4	Biology and Conservation of Marine Mammals (Sumich)	4
FW 421	4	Aquatic Biological Invasions (Chapman)	0
FW 499	3	Special Topics in Fisheries and Wildlife (Evans III) - CANCELLED	n/a
FW 521	4	Aquatic Biological Invasions (Chapman)	1
FW 599	3	Special Topics in Fisheries and Wildlife (Evans III) - CANCELLED	n/a
GS 199	4	Special Topics: Marine Science: Principles, Processes and Significance	5
SED 431	3	Overview of Free Choice Learning (Rowe)	1
SED 531	3	Overview of Free Choice Learning (Rowe)	3
SED 808	3	Overview of Free Choice Learning (Rowe)	1
ST 521	4	Introduction to Mathematical Statistics (Thielman) - ITV	3
ST 522	4	Introduction to Mathematical Statistics (Irvine) - ITV	3
Fall 2008	Credit	Course Title	2008-2009
AqS 100 (OCCC)	3	Intro to Aquarium Science (M. Mann)	17
AqS 215 (OCCC)	4	Biology of Captive Fishes (M. Mann)	11
AqS 240 (OCCC)	4	Life Support Systems and Design (M. Mann)	13
BI 101 (OCCC)	4	Biology of Captive Invertebrates (I. Cheung)	23
FW 407/507	1	HMSC Research seminar (Boehlert)	9
FW 426/526	5	Coastal Ecology and Resource Management (Langdon)	9
FW 431/531	4	Dynamics of Marine Biological Resources (Sampson)	7
FW 441/442	1	Intro to Group Problem Solving (Langdon)	0
FW 454/554	5	Fishery Biology (Heppell)	14
FW 464/564	3	Marine Conservation Biology (Heppell)	32
FW 474/574/OC 574	4	Early Life History of Fishes (Ciannelli/Miller)	14
FW 499/599	1	Ecology of Coastal Fishes (Emmett/Weikamp)	3
FW 499/599	3	Whales and Whaling (Baker)	4
FW 499/599	2	Stock Assessment seminar (Gertseva)	5
Winter 2009	Credit	Course Title	2008-2009
AqS 226(OCCC)	3	Biology of Diverse Captive Species (Mann)	12
AqS 232 (OCCC)	4	Nutrition and Reproduction of Captive Fishes and Invertebrates (Mann)	12
AqS 270 (OCCC)	4	Fish and Invertebrate Health Management (Miller-Morgan)	13
BI 102 (OCCC)	4	General Biology (Schuiteman)	23
BI 111	1	Introduction to Marine Life in the Sea (Cheung)	8
BI 234 (OCCC)	4	Microbiology (Duerr)	14
BI 570/670	4	Community Structure and Analysis (McCune)	3
FW 111	1	Introduction to Marine Life in the Sea (Cheung)	9
FW 407/507	1	HMSC Seminar (Staff)	3
MCB/GEN 555	4	Genome Expression and Regulation (Merrill)	3
ST 511	4	Methods of Data Analysis (Schaefer)	5
Spring 2009	Credit	Course Title	2008-2009
AQS 220 (OCCC)	4	Biology of Captive Invertebrates (Mann)	15
BI 111	1	Intro to Marine Life in the Sea: Marine Mammals (Sumich)	9
BI 450	16	Marine Biology lecture (Hacker)	19
FW 111	1	Intro to Marine Life in the Sea: Marine Mammals (Sumich)	3
FW 473	4	Fish Ecology (Noakes)	4
FW 507	1	FW Seminar (Chen)	2
ST 512	4	Methods of Data Analysis (Gitelman)	4
VMB 727	2	Ornamental Fish Medicine (Miller-Morgan)	6

## Internships at HMSC

Itchung Cheung, Academic Program Coordinator

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

In 2008-09, nineteen 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 HMSC Visitor Center Education internship or the NSF-funded "Research Experience for Undergraduates" (REU) program. Twenty-two students were selected (through a competitive application process) to participate in the REU program, which paired each student intern with a faculty mentor to work on a defined research project over a 10-week period during the summer of 2008. While all of the interns demonstrated a significant level of accomplishment with their research projects, several of the students developed projects that have a life beyond the 10-week summer program. In addition, three undergraduate students participated in the HMSC Visitor Center Internship in marine science education. Two undergraduate students participated in the NOAA Alaska Fisheries Science Center and Northwest Fisheries Science Center internship. One OSU undergraduate student participated in the state sponsored Professional and Managerial Internships in State Employment (PROMISE) program with the HMSC Academic Programs.

Vazquez, Norma; Banks, M.: Evaluation of MHC diversity as a means to study mate choice in quillback rockfish (*Sebastes maliger*)

Fitzgerald, Lanaya; Brodeur, R.: Interactions Between Jellyfish and Fish: Predation versus Commensalism

Camp, Ariel; Ryer, C H.: Density-dependent habitat selection in juvenile English sole (*Pleuronectes vetulus*)

Lin, Vivian; Reimers, C.: Assessing oxygen flux and physical characteristics of permeable sediments from the Oregon shelf

Waters, Hannah; Suryan, B.: The effects of time-lag and ocean conditions on common murre (*Uria aalge*) productivity

White, Caitlin; Dumbauld, B.; Chapman, J.: Bopyrid isopod parasite recruitment and growth in *Upogebia pugettensis* and *Neotrypaea californiensis*. Oral Presentation

During their summer at HMSC several students gained research experience at sea. For example, Lanaya Fitzgerald (working on jellyfish and Pacific tom cod fish interactions) arrived early to participate in one of the cruises aboard the RV Miller Freeman. Joel Craig also arrived early and participated in several research opportunities at HMSC prior to the official start of the program. Roxana Aguirre-Robertson and Caitlin White accompanied their mentors, Brett Dumbauld and John Chapman, on a trip to Willapa Bay, Washington. After the end of the REU program, Kiya Wilson 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 they attended a weekly research seminar series.



Summer 2008 – HMSC Visitor Center Interns

Four of the REU student interns from the Summer 2008 program presented research posters at the February 2009 American Society of Limnology and Oceanography, Ocean Sciences Meeting, Nice, France. Two of the REU student interns presented at the 2009 19th Annual Argonne Symposium for Undergraduates in Science. One REU student intern presented at the 2008 Society for the Advancement of Chicanos and Native Americans in Science Conference, Salt Lake City, Utah.



Summer 2008 - HMSC Student Interns (REU, COSEE)

HATFIELD MARINE SCIENCE CENTER ANNUAL REPORT 2008-2009

REU Interns	Undergraduate Institution	Faculty Mentor	Project Title
Aguirre-Robertson, Roxana	California State University Los Angeles	DeWitt, Ted & Dumbauld, Brett	How population density and shrimp size affects the geometry of <i>Upogebia pugettensis</i> burrows in the Yaquina Estuary
Camp, Ariel	Hofstra University	Ryer, Cliff	Density-dependent habitat selection in juvenile English sole ( <i>Pleuronectes vetulus</i> )
Fitzgerald, Lanaya	Oregon State University	Brodeur, Ric	Interactions Between Jellyfish and Fish: Predation versus Commensalism
Goehring, Nicole	Whitman College	Miller, Jessica	Interannual Comparison of Juvenile Chinook Growth, Residency, and Diet
Lin, Vivian	Scripps College	Reimers, Clare	Assessing oxygen flux and physical characteristics of permeable sediments from the Oregon shelf
Poppick, Laura	Bates College	Black, Bryan	The growth and lifespan relationship in the Pacific Geoduck
Pros, Megan	Monmouth College	Peterson, Bill	The hypoxia phenomenon on the Pacific coast: Can copepod ( <i>Calanus marshallae</i> ) eggs hatch in extremely low levels of dissolved oxygen?
Vazquez, Norma	California State University Monterey Bay	Banks, Michael	Evaluation of MHC Diversity as a Means to Study Mate Choice in Quillback Rockfish ( <i>Sebastes maliger</i> )
Waters, Hannah	Carleton College	Suryan, Rob	The effects of time-lag and ocean conditions on common murre ( <i>Uria aalge</i> ) productivity
White, Caitlin	Lawrence University	Chapman, John & Dumbauld, Brett	Bopyrid isopod parasite recruitment and growth in <i>Upogebia pugettensis</i> and <i>Neotrypaea californiensis</i>
HMSC Education Intern	Undergraduate Institution	Faculty Mentor	Project Title
Canfield, Sean	Oregon State University	Hanshumaker, Bill & Hildenbrand, Katey	Fisheries exhibit renovation
Graves, Jasmine	Oregon State University	Hanshumaker, Bill; Rowe, Shawn & Hunter, Nancee	Rhythms of our Coastal Waters
Lindborg, Valerie	Seattle Pacific University	Hanshumaker, Bill; Knight, Pat & Hunter, Nancee	Oregon Sea Grant Education web page
Promise Intern	Undergraduate Institution	Faculty Mentor	Project Title
Bein, Rithy	Oregon State University	Cheung, Itchung	360° Virtual Tour of the Hatfield Marine Science Center
NOAA - Hollings Scholars	Undergraduate Institution	Faculty Mentor	Project Title
Colton, Amanda	University of New England	Hurst, Tom	Visual and olfactory cues leading to aggregations of Pacific cod and walleye pollock in prey patches
Van Thiel, Lauren	University of South Carolina - Columbia	Weitkamp, Laurie	Ecology of juvenile salmon in the Columbia River estuary
HMSC COSSE Interns	Undergraduate Institution	Faculty Mentor	Project Title
Duerr, Fred	Oregon Coast Community College	Jacobson, Kym	Ecology of Host-Parasite Interactions of Anadromous and Marine fishes
Jabin, Alicia	Chemeketa Community College	Miller-Morgan, Tim	Behind the Scenes at Hatfield Marine Science Center's West Wing
Pernarelli, Amy	Rogue Community College	Carlin-Morgan, Kerry	Splash! Beneath the Surface of the Oregon Coast Aquarium

**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 2009 Markham 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, 2009. Students who had made significant progress towards completion of their research gave brief presentations. Those students being awarded new monies for 2009-10 year displayed posters explaining their proposed research. Their awards are listed below:

AWARD	RECIPIENT
<b>HMSC Housing Scholarship Request</b> - to provide free or reduced-rate housing on-site for the duration of the term in which they are enrolled.	Brett Anderson, Fisheries & Wildlife (\$250) Billy Wood, Fisheries & Wildlife (\$250)
<b>Mamie L. Markham First Year Student Award</b> - 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	Rebecca Hamner, Wildlife Science (\$10,000) Advisor: Scott Baker
<b>Fred and Joan Crebbin Memorial Fellowship</b> - to foster education in the marine sciences by providing financial support to undergraduate or graduate students pursuing marine science related fields at OSU.	Noreene Ignelzi, Science & Math Ed. (\$2,600) Advisor: Lynn Dierking
<b>Lillian Brucefield Reynolds Scholarship Fund</b> - for graduate students engaged in study of marine science at Hatfield Marine Science Center.	Londi Tomaro, Fisheries & Wildlife (\$1,000) Advisor: Jessica Miller
<b>Curtis and Isabella Holt Education Fund</b> - intended to foster education in the marine sciences by providing financial support to undergraduate or graduate students pursuing marine science studies.	Michelle Mileham, Environmental Studies (\$6,000) Advisor: Shawn Rowe
<b>Walter G. Jones Fisheries Development Award</b> – intended to support an academically qualified graduate student pursuing research which contributes to fisheries development.	Samanan Poowakanjana, Food Science & Technology (\$1,300) Advisor: Jae W. Park
<b>William Q. Wick Marine Fisheries Award</b> - 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	Jose Marin Jarrin, Fisheries & Wildlife (\$4,000) Advisor: Jessica Miller
<b>HMSC Student Teaching Award</b> - intended to recognize undergraduate or graduate student teaching excellence and promise in marine science education at the Hatfield Marine Science Center	Angie Sremba (2008 Fall), F&W; Mattias Johansson (2009 Winter), F&W; Amanda Gladics (2009 Spring), MRM
<b>Mamie L. Markham Endowment Award</b> <i>intended to assist graduate or student research utilizing OSU's Hatfield Marine Science Center</i>	
Renee Bellinger, Fisheries & Wildlife (\$9,000) Advisor: Michael Banks	Angela Sremba, Fisheries & Wildlife (\$7,242) Advisor: Scott Baker
Elena Fernandez, Fisheries Oceanography (\$10,225) Advisor: Thomas Hurst	Londi Tomaro, Fisheries & Wildlife (\$9,431) Advisor: Jessica Miller
Amanda Gladics, Marine Resource Management (\$6,700) Advisors: Robert Suryan, Michael Hart	Jamie Womble, Fisheries & Wildlife (\$9,640) Advisor: Markus Horning
Alison Iles, Zoology (\$7,638) Advisor: Bruce Menge	

## Course Descriptions

**chung 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 2008 Courses

GS 199. MARINE SCIENCES: PRINCIPLES, PROCESSES AND SIGNIFICANCE (Cheung) (4)

An introduction to the interdisciplinary field of marine science focusing on principles in the marine environment, biological processes and the significance of current and future environmental problems our oceans face. Covered topics include the marine environment as a habitat, ecological and biological concepts, and current research issues in marine science.

BI 299. INTRODUCTION TO MARINE BIOLOGY (Newell) (4)

An introduction to sea creatures in the Oregon coast, from plankton to whales. Students discover the unique adaptations of marine organisms, the functionality of their morphology, their incredible diversity and the importance of their ecological roles. Students learn where and why organisms live as they visit the natural marine environments.

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.

SED 431.OVERVIEW OF FREE-CHOICE LEARNING (Rowe) (3)

Examines learning that occurs when people believe they have choices over what and how they learn, how much time they spend learning, and what their sources of information are. Covers current research on learning in museums, aquariums, zoos, botanical gardens, science centers, after-school programs, media and apprenticeships.

\*ST 421/521. INTRODUCTION TO MATHEMATICAL STATISTICS (Thielman) (4).

Probability, random variables, expectation, discrete and continuous distributions, multivariate distributions.

\*ST 422/522.INTRODUCTION TO MATHEMATICAL STATISTICS (Irvine) (4).

Sampling distributions, Central Limit Theorem, estimation, confidence intervals, properties of estimators, and hypothesis testing.

### Fall 2008 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 101 (OCCC) General Biology (Cheung) (4)

Investigates the diversity of organisms, principles of ecology, and effects and consequences of ecosystem alteration by humans.

BI/FW 111. MARINE LIFE IN THE SEA: MARINE MAMMALS (Sumich) (1)

This course will introduce the biology of whales, pinnipeds, and other marine mammals occurring in the North Pacific Ocean through a combination of lectures and field experiences, and completion of group projects. Topics will focus on a general overview of adaptations of mammals to a marine existence; reproduction, feeding, and migratory behavior. This course is intended for first and second year Biology or Fisheries and Wildlife undergraduates, non-degree students, and teachers.

\*FW 322. INTRODUCTORY POPULATION DYNAMICS (Gertseva) (3)

Principles and concepts of population dynamics related to fish and wildlife populations; methods of estimating abundance and mortality; models for population and yield analysis.

\*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)**

Study of the ecology and management of coastal marine and freshwater ecosystems as well as natural resources, emphasizing experimental (participatory) learning in a field station setting.

**\*FW 441. INTRODUCTION TO GROUP PROBLEM SOLVING (Langdon) (1)**

Introduction to group dynamics, problem analysis and problem solving paradigms. Students will form groups, select problem area and faculty/resource professional mentors, and develop an initial work plan to follow in FW 442 and FW 443. Each group will make an oral presentation of their problem and initial plan on a fisheries and/or wildlife topic.

**\*FW 442. PROBLEM DEFINITION AND ANALYSIS IN FISHERIES AND WILDLIFE (Langdon) (2)**

Student groups working with mentors will define the problem selected in FW 441, collect and review relevant information, and develop a problem analysis plan on a fisheries and/or wildlife topic.

**\*FW 454/554. FISHERY BIOLOGY (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 464 Marine Conservation Biology (Heppell) (3)**

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

**\*FW/OC 474/574. EARLY LIFE HISTORY OF FISHES (Ciannelli) (4)**

This course is an overview of diversity of development patterns in fishes; emphasis on morphology, life history, and evolution.

**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 431/531. DYNAMICS OF MARINE BIOLOGICAL RESOURCES (Sampson) (4)**

Strategies of marine fishery management. A synthesis of the principles of population dynamics for single- and multi-species systems from the viewpoint of a marine resource manager.

**Winter 2009 Courses****AQS 226 (OCCC) Biology of Diverse Captive Species (Mann) (3)**

Examines the basic husbandry requirements and the most

commonly experienced health ailments of different phyla found in public aquarium animal collections. Reviews the natural history and wild-population status of selected species.

**AqS 232 (OCCC). NUTRITION AND REPRODUCTION OF CAPTIVE FISHES AND INVERTEBRATES (Koike) (4)**

Examines the reproductive strategies of fishes and invertebrates in a controlled environment and the manipulation of environmental and physiological parameters that initiate reproduction. The nutritional requirement of selected aquatic animals throughout their life history is explored. Industry standards for food handling and HACCP requirements are also discussed.

**AqS 270 (OCCC). FISH AND INVERTEBRATE HEALTH MANAGEMENT (Miller-Morgan) (4)**

Reviews the common infectious and non-infectious diseases of captive fish and invertebrates. Examines the common techniques of fish and invertebrate health management.

**BI 102 (OCCC) General Biology (Schuiteman) 4 cr.**

Investigates the principles of cell division; Mendelian, population, and molecular genetics; evolution, natural selection and origin of species; and animal behavior.

**BI 234 (OCCC). MICROBIOLOGY (Duerr) (4)**

Presents a survey of bacteria and other micro-organisms, emphasizing their impact upon human health. Includes discussion of infection, immunity, common pathogens, and methods and mechanisms of control.

**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. Through lectures, lab and field exercises, students will examine important marine organisms in their habitat; exploring their ecological niches and adaptations to their environment along the Oregon coast.

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

Current topics in marine science research.

**\*FW 599. FISHERY STOCK ASSESSMENT METHODS (Sampson) (3)**

Explores in detail some of the techniques used for assessing exploited populations of fish and other biological resources. Provides students with an understanding of the assumptions and mathematics underlying stock assessment techniques. Illustrates applications of stock assessment methods through the development and use of computer spreadsheet programs.

**\*ST 411/511. METHODS OF DATA ANALYSIS (Schaefer) (4)**

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

**\*MCB/GEN 555. Genome Expression & Regulation (Merrill)**

(4) Prokaryotic and eukaryotic systems will be used to describe recent advances in understanding transcriptional and posttranscriptional control mechanisms. Topics include: microbial, yeast and mouse model systems; transcriptional control mechanisms; RNA processing, silencing and microRNAs; protein synthesis and posttranslational modification; microarray- and mass spectrometry-based expression genomics.

\*BI 570/670. Community Structure and Analysis (McCune) (4) Quantitative methods for the analysis of biotic communities, including community concepts, estimation of community composition parameters, theoretical aspects of multivariate methods of analyzing species-importance data, and overview of multivariate tools; hands-on computer analysis of data sets.

### Spring 2009 Courses

AqS 220 (OCCC). BIOLOGY OF CAPTIVE INVERTEBRATES (Mann) (4)

Reviews the life history and captive care requirements of invertebrates commonly cultured in the aquatic animal industry/profession.

BI 103 (OCCC). GENERAL BIOLOGY (Schuiteman) (4)

Investigates the principles of animal structure (anatomy) and function (physiology); human (and comparative) reproductive, nervous, circulatory, immune, digestive, respiratory, and urinary systems; plant structure and function; nutrition, growth and reproduction.

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 life and environment on the Oregon coast, including rocky shores, sandy beaches, mud flats, bays, estuaries, and watersheds. Through lectures, lab and field exercises, students will examine important marine organisms in their habitat; exploring their ecological niches and adaptations to their environment along 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.

\*FW 473. FISH ECOLOGY (Noakes) (4)

Behavior of fishes as a mode of accommodation to various ecological and evolutionary constraints. Importance of heritable and learned patterns to population and community dynamics.

Application of behavioral studies to the solution of management problems.

\*ST 412/512. 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.

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

To provide advanced instruction in the common aspects of ornamental fish medicine to forth 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

- International workshop on migratory birds and tracking technology (NSF-MIGRATE) July 29 – August 1, 2008
- Ocean Renewable Energy pilot course March 16-17, 2009

### *Hatfield Student Organization (HsO)*

**Londi Tomaro, President**

The HsO has had a successful year. We diversified our fundraising efforts and have increased the number of activities that we host and participate in at HMSC. The 2008 holiday raffle was a fun event with participation by much of the HMSC community. We raised approximately \$600 and donated half of this to the Lincoln County Humane Society. We commissioned two t-shirt designs and have those t-shirts available for sale. We also ran a pizza booth at SeaFest as a fundraising activity. Finally, we have recently begun collecting deposit-qualified bottles and cans from locations around the HMSC complex in cooperation with the sustainability committee.

Much of the fundraising that we do goes to support student travel awards. These awards help students travel to and attend scientific meetings at which they present their research. This past year the HsO solidified an agreement with the HMSC for matching funds so that we can offer three additional student travel awards. We are now able to offer six travel awards per year. Over the past year we have provided support for a diverse range of conferences and symposia including marine mammal genetics, early life history of fishes, and otolith science.

Our fundraising efforts also allow us to host a variety of scholarly and outreach events that provide exposure for graduate student research as well as increase the profile of graduate student research within the larger community. This spring we hosted a scholar exchange between the graduate students from the Oregon Institute of Marine Biology and the Hatfield Marine Science Center. This annual event facilitates scholarly and social interaction between the two marine labs. As part of this exchange we organized a workshop on effectively communicating

science to the public and to other researchers. The workshop was presented by Shawn Rowe an Oregon Sea Grant Marine Education Specialist. Additionally, the HsO participated in HMSC's SeaFest outreach event. We created and staffed an interactive educational booth that encouraged children to think about the habitats utilized by a variety of marine organisms. We also promote scientific discussion and sharing research progress and results within the Hatfield community. Each Tuesday during the academic year graduate students and other Hatfield community members meet at the Rogue Brewery to discuss a scientific paper of interest to the group. The research interests of graduate students at HMSC are quite varied so the paper topics and discussions range broadly. The students from the HsO also participate as speakers during the HMSC seminar series. This year six graduate students presented at three seminars during the spring and summer terms.

Building community within the broader Hatfield community is a focus of the HsO. To this end we host several social events throughout the year. Each Wednesday morning we facilitate a donuts and social hour. This event is a great place for people from different agencies and offices to interact. We organized the second annual HMSC Olympics as a fun way to interact with the summer interns and the rest of the Hatfield community. This was a good time for those participating and those watching and we hope to increase the number of teams participating next year. We also hosted two BBQ's for the summer interns to help welcome them to the Hatfield community. In addition, we have hosted two HMSC cook-offs each year, beginning with our chili cook-off in the winter of 2008. These events showcase the culinary skills of various people at Hatfield and provide a chance to socialize, taste good foods, and create community within HMSC. Finally, we recently organized a weekly pick-up soccer game for all comers. The HsO officers believe that it is not only important for the graduate students to be a part of the Hatfield community, but also to be active in the wider Newport community. Individual members are active in a variety of community events. As a unit the HsO also participates in community-wide events. For example, we entered a team in both the Newport sprint triathlon and the survival suit races that are part of the Blessing of the Fleet celebration.

Thank you to all of the Hatfield community for the support that you give to individual graduate students and to the HsO throughout the year.

### ***Ornamental Fish Health Programs***

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

The Ornamental Fish Health Program, part of Oregon Sea Grant Extension and the College of Veterinary Medicine, was created to provide educational programming and service to the ornamental fish industry in Oregon. It is designed to assist wholesalers, retailers, and hobbyists to succeed in the rearing, husbandry, and health care of ornamental aquatic animals in the aquarium or pond environment.

The program continues to have a strong collaborative relationship with the Oregon Coast Community College Aquarium Science Program (AQS), <http://www.occc.cc.or.us/aquarium/index.html>, the Oregon Coast Aquarium, <http://www.aquarium.org/>, and the OSU College of Veterinary Medicine, <http://oregonstate.edu/vetmed/>.

Tim Miller-Morgan was one of the co-developers of the Aquarium Science Program and continues to work very closely with Bruce Koike, AQS Program Director and Instructor, on course development and the refinement of existing coursework. Miller-Morgan initiated and currently leads the biweekly Grand Rounds at the Oregon Coast Aquarium and the Hatfield Marine Science Center, which are required for all students participating in the second practicum. During Grand Rounds, students present and discuss active medical cases and common health problems at each facility from the standpoint of husbandry and health management. In 2006, Dennis Glaze, an AQS program graduate, became Miller-Morgan's Aquatic Animal Health & Husbandry Specialist. In 2007, Glaze also took on the duties of Curator, Animal Husbandry Programs for all Sea Grant-administered areas at the HMSC. This expansion of his duties ensures the uniformity of our animal husbandry in that we model high quality animal health management throughout all of our programs.

Miller-Morgan teaches AQS 270, *Fish and Invertebrate Health Management*. This course, which is offered every winter quarter, introduces students to the basic principles and practices of health management in re-circulating aquarium systems. Further, in 2008, Miller-Morgan initiated a new AQS course, *Husbandry of Fish in a Research Setting*. In addition, he teaches and lectures in a number of courses within the College of Veterinary Medicine, including a section of VM 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 VM 738, *Animal Handling and Husbandry-Introduction to Fish Husbandry and Handling* and teaches VM 790, *Ornamental Fish Medicine*, a 35-hour course that teaches senior veterinary students the basic skills they need to begin practicing fish medicine.

The Ornamental Fish Health Program has also developed a partnership with Wildlife Safari in Winston, Oregon and Dr. Modesto McClean, their head veterinarian. McClean has developed a six-week International Zoo, Exotic and Wildlife (IZEW) Workshop. This workshop allows veterinary students from all over the world an opportunity to work with many non-traditional species at Wildlife Safari and other facilities throughout Oregon. IZEW students spend two days in Newport participating in seminars and wet labs that introduce them to the medical management of fish and sharks at the Hatfield Marine Science Center and the Oregon Coast Aquarium. Typically 12-20 students and graduate veterinarians participate each year. Recent participants have hailed from Mexico, Germany, Switzerland, Holland, Spain, Portugal, Canada, England, and the United States. The program has become so popular that two separate workshops are now offered in June and August.

We also offer a number of volunteer, and formal practicum, externship and internship opportunities for students with an interest in fish and invertebrate health management. Students are integrated into the daily activities of our research and teaching laboratory at the Hatfield Marine Science Center and also have the opportunity to participate in weekly medical rounds at the Oregon Coast Aquarium and develop one or two independent research or education projects. Participants in this program have included Aquarium Science students, pre-veterinary students, and OSU graduate students.

### ***Aquarium Science Degree Program - Oregon Coast Community College***

**Bruce Koike, Director, Aquarium Science Program**

Since the inception in 2002 of Oregon Coast Community College's Aquarium Science Program, the Hatfield Marine Science Center (HMSC) has been an active partner in this initiative. This technical degree program equips motivated learners with the skills, knowledge and abilities to be successful in caring for aquatic animals. In total 104 students have "experienced" what the HMSC has to offer.

In the past year Aquarium Science students have completed their studies while another cohort embarked on their educational course. The program has attracted national interest with individuals from 20 states making the decision to relocate to the Oregon Coast to study Aquarium Science. For many of these students, this was the first opportunity to be at a marine research facility. What a grand experience to spend days at Oregon State University's Hatfield Marine Science Center developing and sharpening aquatic animal husbandry skills and expanding their knowledge base. The program also hosted three Oregon State University graduates who already had earned a Baccalaureate degree in Biology. Students also contributed to the science knowledge base by assisting graduate students and scientists in various research activities.

To some degree these experiences contribute to the successful placement of program graduates. Local employers include the Oregon Coast Aquarium, Oregon Department of Fish and Wildlife, Oregon Sea Grant, and two research groups at HMSC, NOAA-NMFS Fish Behavior Laboratory and the Molluscan Broodstock Program. In total, 15 graduates were hired by the groups listed. The composite placement of program graduates is 93%.

The HMSC also supported the learning experience of 3 students who were awarded Project SHARKS scholarships. Project SHARKS (**S**cholars **H**aving **A**quatic **R**esourcefulness, **K**nowledge and **S**kills) is funded by the National Science Foundation to open the doors to those with a financial need, increase student retention and be inclusive of individuals from traditionally underserved groups. Scholarships enabled awardees to reduce the amount of time spent working in a paid capacity. As a result, students were able to volunteer in the HMSC's Visitors Center and attend HMSC sponsored seminars.

Even with the opening of OCCC's Central Campus in Newport, the Aquarium Science Program will continue to rent classroom and laboratory space. It is obvious that relationship between OCCC's Aquarium Science Program and the HMSC is mutually beneficial and vibrant.

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

**Program Growth:** Oregon Sea Grant's Marine Education Program at the Hatfield Marine Science Center (HMSC) has seen some dramatic changes in staffing over the last year. In addition to the new Marine Education Program Coordinator, who began in November 2008, five new part-time educators were hired in January 2009. All of the new educators have multiple degrees in marine science and/or education, and significant experience in formal and informal education. In addition to a wealth of experience, they have brought with them a great deal of enthusiasm and many new ideas for programming and marketing.



The education staff is moving forward with the creation of several new programs. This year a new inquiry-based lab, *Investigating Fish Senses*, has been incorporated into the school program options. In this program, students design their own experiments to test their hypotheses about what senses fish possess and how they use them. The class has been well received by both participants and educators. In addition, a new class called *Clamming it Up* was developed and field-tested. Previously, only one school program for K-2<sup>nd</sup> grade students was available. This presented a problem when students were brought to the HMSC over multiple years and had to repeat the same program. The new program allows students to learn about a variety of clams and their adaptations, dig for clams in the classroom, identify the various species, and then take data back to their classroom to graph and chart with their teacher. It too has been well received by both students and educators.

Career Day has been revamped into CSI (Careers in Science Investigation), a hands-on, interactive program designed to allow students to get their feet muddy, their hands wet, and their questions answered by a variety of scientists from OSU, NOAA, ODFW, and others. Fifty students attended the Spring CSI

program, which included individual high school students and one class from Bandon High School. Feedback from the event was very positive.

A new summer day camp was developed for the 2008 season called Oceanography Camp. This new offering provides campers with the opportunity to gain an understanding of engineering by constructing a remotely operated submersible vehicle.

Our Spring Home School Days program, held March 20, had filled to capacity by the beginning of February. As a result, we are considering adding an additional day of programming in the future to accommodate the demand.

Scout programs continue to be very popular. In the fall of 2009, we are considering adding programs that will enable the Boy Scouts to satisfy their *Nature* and *Fish and Wildlife Management* merit badge requirements.

Oregon Sea Grant's family programs have also continued to grow in the last few months. With a growing number of Hispanic students and English Language Learners in Lincoln County, the Las OLAS (Ocean Learning Activities in Spanish) program works to help bridge the learning gap and better meet the educational needs of these students and their families. In 2008-2009, Las OLAS hosted nine family night programs, with 267 students and their families participating and receiving Spanish language educational materials on topics ranging from tsunami preparedness to seafood safety. The Quests and Las OLAS program coordinators also received a small grant from the Northwest Aquatic and Marine Educators (NAME) to translate an existing Oregon Coast Quest into Spanish. The translation will make this educational Quest, located at the popular Big Creek Park, more accessible to a significant sector of the local population.

The OSG education staff has also been working to develop new web pages to highlight our programs and provide additional resources for educators. Pre- and post-visit materials are also being created for our programs that show alignment with newly adopted state standards and provide enrichment activities to extend learning outside of HMSC.

**Educator Workshops:** OSG education staff participated in several educator workshops this past year. In November 2008, OSG hosted Part 1 of NOAA's Learning Ocean Science through Ocean Exploration workshop at OMSI in Portland. Part 2 was held in April 2009.

In January 2009, the Oregon Coast Quests Coordinator participated in a Science and Math Investigative Learning Experiences (SMILE) workshop in which 70 participants learned how to create their own educational Quests to be used as a tool to teach math and science to their students. Also in January, OSG staff hosted the Ocean Sciences and Math Collaborative Project (OSMCP) workshop at the HMSC. Community college instructors were led through a series of hands-on, inquiry-based activities that they could utilize to increase proficiency in their students. Both workshops were very well received by

participants.

In February 2009, two workshops were held at the HMSC focusing on using near-time/real-time data to engage and educate various audiences. The first workshop targeted the Oregon Coast Aquarium, HMSC, and OSU Pre-College Programs staff. The second workshop targeted Lincoln County public school teachers. These workshops included a number of speakers and hands-on activities. Educators learned how data is collected, processed, and visualized, and how to interpret the visualizations. They also learned how scientists utilize near-time and real-time data in their research and how educators can utilize similar data with their own students to make connections. Both workshops received excellent marks from participants.

**Program Challenges:** The teaching facilities at the HMSC are currently undergoing much needed renovations (new floors, paint, cabinetry, and windows). Unfortunately, this has created a definite challenge to staff as they try to juggle program needs, thousands of students, and the constraints of construction. With the loss of one of our wet labs, programs have been shifted to smaller classrooms. This not only limits the number of students, it results in many classes being split, with twice as many educators required to teach the same number of students.

The economic downturn had a serious impact on the K-12 school programs this year, with numbers falling below 9000 (in recent years, enrollment has been over 12,000). Through grant funds obtained by Shawn Rowe, we were able to facilitate field trips by local schools by covering transportation costs. Additional funding has been secured to continue this practice on a limited basis.

Enrollment for the 2009 summer camps is also lower than normal, and several scholarships have been awarded to campers with financial need.

We have been working with numerous partners to identify educational needs throughout the state, writing grants to seek funding, and looking at how our existing programs may be expanded or modified to address these needs.

#### **Oregon Coast Quests:**

Overview: The Oregon Coast Quests program is a place-based education program at Oregon Sea Grant that uses self-guided, clue-directed hunts to encourage the general public to explore and gain appreciation for special outdoor places. Since its inception in 2007, the program has continued to grow and generate participation from the community.

A Quest brings *explorers* to a special *place*, which connects them to the *community*.

- *Explorers* – Includes families, school groups, teachers, youth groups, community leaders, and senior citizens. Quests have been incorporated into local school and youth group programming.
- *Place* – Quests are located in outdoor, publicly accessible areas that possess natural beauty, unique or critical habitats, or are examples of cultural, historical or natural history.

Current Quests are located in federal, state, and city parks, on a university campus, adjacent to public school grounds, on Head Start preschool property, and in a downtown commercial district.

- *Community* – Includes park officials, private landowners, schools, youth groups, businesses, and conservation groups. These experts share their knowledge about a place or topic with others through Quests.

The Oregon Coast Quests program operates under the leadership and coordination of Sea Grant marine educator Cait Goodwin. Sea Grant Director of Education, Nancee Hunter, oversees the program. Additionally, Marine Learning Specialist and Assistant Professor Shawn Rowe is committed to the long-term evaluation and promotion of the Oregon Coast Quests program through the use of resources and students in the Free-choice Learning Graduate Program at Oregon State University.

**Audience:** Questing is a self-guided activity suitable for people of all ages. Since 2007, more than 2000 signatures have been left in Quest Box guest books. Most Quests are undertaken by small, multi-age family groups, youth groups, or adults traveling either alone or with one other person.

**Education:** To date, Oregon Coast Quests has worked directly with more than 130 students to create Quests for the guidebook, and with at least 300 students on guided Quest visits. This year’s primary educational focus has been to train Quest-builders (teachers, community leaders, etc.) to build Quests on their own with youth groups, and to encourage youth groups to take advantage of existing Quests for self-guided field trips.

**Quest-Building Services:** Oregon Coast Quests generates income by providing Quest-building services to other organizations.

- Staff at Yaquina Head Outstanding Natural Area received grant funding to hire OCQ to build three new Quests on their site.
- The City of Newport commissioned OCQ to work with youth in a city afterschool program to build a Quest highlighting Newport’s city buildings (Fall 2008).
- OCQ conducted a workshop session for SMILE in Corvallis (Jan 2009).
- OCQ conducted a workshop session for OSMCP in Newport (Jan 2009).
- OCQ created an indoor Quest for the HMSC/OSU Visitors Center (spring 2009).
- OCQ is conducting a Quest-building youth camp session for HMSC (June 2009).

**Awards Received:**

- \$2080 from the Siletz Tribal Charitable Contribution Fund to print 720 copies of *The Oregon Coast Quests Book, 2009/2010 Ed.* and donate Quest Books to school and public libraries in Lincoln County.
- \$1000 from Ms. Jeanette Hofer in June 2009.
- \$250 from the Northwest Aquatic Marine Educators for the translation of one Quest into Spanish with the help of Las OLAS Coordinator, Anamaria Esparza-Smith.

**Quest Books:** Oregon Coast Quests generates income from the sale of Quest Books. OCQ publishes a book of directions to Quests in Lincoln County every year in June. Each year, the book size expands, and the number of books that have been distributed to the public has increased. Thanks to the grant from the Siletz Tribe, this year was the first time OCQ has been able to offer a 40% wholesale discount to retailers.

QUEST BOOK	2007/08 (1 <sup>st</sup> Ed.)	2008/09 (2 <sup>nd</sup> Ed.)	2009/2010 (3 <sup>rd</sup> Ed.)
<b>Publication date</b>	June 2007	June 2008	June 2009
<b>Number of Quests</b>	8	15	23, plus one bilingual Quest
<b>Number of pages</b>	54	106	152
<b>Retail price</b>	\$3.00	\$6.00	\$6.00
<b>Number of pages books distributed</b>	300	400	280 to date

More than 2000 signatures have been left in Quest Box guest books since the Oregon Coast Quests program began in 2007.

**Evaluation:** Quests are evaluated through the comments left in the guest books in Quest Boxes, and through survey questionnaires.

### III. PUBLIC OUTREACH & EXTENSION

#### OREGON SEA GRANT EDUCATION

##### *Sea Grant, Visitor Center*

**Nancee Hunter, Director of Education, Oregon Sea Grant**

The Oregon State University (OSU) Hatfield Marine Science Visitor Center offers adults and children a unique, dynamic environment in which to discover and enjoy a lifelong exploration of marine science. Managed by Oregon Sea Grant since 1997, the Visitor Center's exhibits and programming use the theme of *Patterns* to highlight the process and products of research conducted by OSU and associated governmental agencies. This dynamic is a fundamental attribute of science and is the underlying fabric that connects our exhibits and programming. The Visitor Center staff, along with OSU students studying free-choice learning, also conduct research on devices, methods, and concepts for informal learning processes that advance the art of public education.

The Hatfield Marine Science Visitor Center reaches more than 150,000 visitors annually. These visitors come from around the Pacific Northwest and beyond to participate in high-quality, place-based programs, including wet labs, featured lectures, exhibits and demonstrations, videos, and field-based experiences. Admission to the HMSC Visitor Center is free, although donations are encouraged to support the program.

In 2008-2009, Visitor Center staff organized, coordinated, and promoted *Sea Turtle Saturday*. This event featured a public necropsy on an approximately 200-lb. green sea turtle, auditorium presentations by Drs. Selena Heppell and Larry McKenna, from OSU, and Brad Nahill, from Ocean Conservancy. With assistance from volunteers, we held a Leatherback Coloring Contest for the kids. Over 850 people attended this event, providing some very positive comments. Both the auditorium programs and coloring contests were well attended.

In addition, we conducted public necropsies on three salmon sharks. We set up a video camera over the necropsy table and projected the entire operation on both a large flat screen in the Visitor Center and on the screen in the Hennings Auditorium. Using a video microscope and monitor, participants were able to see magnified images of different tissues. Dr Brian Benninger, Oregon Health Science University, assisted during the public necropsy, tracing out and removing the spinal accessory nerve from the salmon sharks.

With the assistance of several volunteers, Public Marine Education Specialist Bill Hanshumaker participated in *Discovery Days* on campus, setting up public displays and offering hands-on activities using live marine invertebrates and marine mammal biofacts. More than 3450 people attended this four-day event.

Visitor Center staff also re-installed *Pattern Puzzles*, 12 exhibits that challenge participants to solve mathematical and spatial puzzles. During the 10 weeks these extremely popular and durable puzzles were on the floor, they offered an interactive way to engage thousands of school children in fun, active learning. We are planning for a more formal evaluation process next year and are hoping to be able to involve a graduate student in the process.

Hanshumaker also served as a major advisor to the following three undergraduate summer interns between June 24 and September 3. In this role, he mentored students with their public presentation skills and provided project management training.

- Jasmine Graves, an OSU fisheries and wildlife senior, worked with the Sea Grant Education staff to aid in the implementation of a data visualization education plan highlighting a new, cutting edge exhibit including a global spherical display system (Magic Planet). Principal Investigators were Shawn Rowe and Nancee Hunter.
- OSU biology senior Sean Canfield assisted with the development of an *Oregon Fisheries* public exhibit at the HMSC. The overarching goal behind the renovation of this exhibit is to build a better public understanding of Oregon's major fisheries. The Principal Investigator was Kaety Hildenbrand.
- Valerie Lindborg, a biology senior at Seattle Pacific University, worked with Sea Grant staff to develop and update the Sea Grant Education web site, making it an easy to use, fun to explore, intuitive web site for the general public to use to find information about our VC and K-12 programs/offers. Principal Investigators were Pat Kight and Nancee Hunter.

##### *HMSC Visitor Center Bookstore*

**Nancee Hunter, Director of Education, Oregon Sea Grant**

The HMSC Visitor Center Bookstore provides the visiting public, students, and staff with quality books, clothing, and other educational materials. 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 services manager, one part-time permanent staff and one part-time student. Volunteers assist in the store during special events or as needed throughout the year.

The bookstore promotes the HMSC through author presentations, book signings, and other special events, including the Lincoln County Glass Float Drawing and promotion which is held each year between November and January. During this period, hundreds of visitors and local residents follow a map to local participating sites and attractions, where they can enter the drawing for two floats available at each location. The HMSC Bookstore is one of the featured locations.

The bookstore manager attended an American Bookstore Association four-day conference in Salt Lake City, UT in January.

The theme of the workshops during the annual conference focused on the recession and how to best survive and thrive in a depressed economy. She gained a great deal of insight on how many bookstore owners and managers are re-creating their stores to accommodate the needs of their customers. There were also many managers who shared their ideas about reduced staffing and other financial aspects of the decrease in sales and traffic. Also discussed was the national trend in buying local and how to get involved on a community level with this important change in how consumers use their limited funds to purchase and learn.

In November, the bookstore manager created an online secure shopping site for the bookstore. This has been quite successful and highlights the logo merchandise for the Hatfield Marine Science Center and many educational books and supporting materials related to the ocean and the science of the natural world. The bookstore manager has been quite pleased with the regular sales from the store and plans to increase the items offered on the site in the next year.

The bookstore/visitor services manager is also responsible for print media promotion for the Visitor Center, including the mailing or dropping off of rack cards and other promotional materials as requested by the general public, local businesses, or community members.

### ***HMSC Visitor Center Volunteers***

#### **Nancee Hunter, Director of Education, Oregon Sea Grant**

Volunteers are critical to the success of the Visitor Center. They greet many of the more than 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. Volunteers also contribute to the Visitor Center by feeding animals each week, assisting in exhibit maintenance and development, and organizing our video collection. A few of our volunteers are involved in the training of our summer interns. Many volunteers also contribute greatly to the success of the HMSC's annual open house known as SeaFest. Their enthusiasm for learning and desire to share information creates memorable experiences for visitors of all ages.

During 2008-2009, 71 volunteers contributed 6,072 hours of service to Visitor Center operations. There were 77 volunteers on record, with six inactive. New volunteers were recruited throughout the year, mostly through word of mouth, resulting in an additional 25 individuals being added to the volunteer corps.

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): wave energy development; sustainable practices at the HMSC; wildlife on the Robinson Crusoe Island; and the Marine Mammal Stranding Network. Ten volunteers attended the 2008 Pacific Northwest Docent and Volunteer Association Conference held September 11-13 at the Oregon Coast Aquarium and HMSC.

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

### ***Marine Extension***

#### **Jay L. Rasmussen, Associate Director and Extension Program Leader, Oregon Sea Grant**

Oregon Sea Grant advances knowledge of our coast and ocean through research, education, and outreach and public engagement. Outreach and engagement are major elements of Oregon Sea Grant at the Hatfield Marine Science Center and are expressed in faculty and programming at the Center primarily through the Oregon Sea Grant Extension program.

Extension education is a discipline (some would even call it a science) that is awarded advanced degrees at some universities. But it is also an art. Sea Grant Extension programs appear in many forms. Typically they are university-based educational programs that seek to apply knowledge and understanding gained through research to aid individuals and groups. Programs that extend university knowledge require a dedicated group of individuals whose advanced education, training, and expertise may involve many segments of biology, sociology, economics, public policy, engineering, and a host of other related fields.

A Sea Grant Extension professional is known by many names -- specialist, educator, marine adviser, and agent. Each professional works directly with people in coastal-related communities and at informal education venues, like the Hatfield Marine Science Center. Extension professionals are also schooled in approaches that can be used to facilitate information transfer.

"Extension work might be defined as designing activities that effect behavior change through constituent-driven programs focused on outcome-based objectives using a variety of educational processes and techniques over a continuum of time."  
-- *Fundamentals of a Sea Grant Extension Program, 2000*

Oregon Sea Grant's Extension program includes 20 field- and campus-based faculty members with approximately 16 FTE funded by Oregon Sea Grant, OSU Extension Service, or other sources. In addition, Oregon Sea Grant's Marine Communications, Education, and Extension programs are seamlessly linked. Sea Grant Extension faculty are located in nine counties, at the Hatfield Marine Science Center, and at OSU campuses in Astoria, Corvallis, and Portland. We have a long-standing and successful cooperative sharing arrangement with California Sea Grant for their north coast Marine Advisor to provide programming across state boundaries. We collaborated with the OSU Seafood Laboratory and the Community Seafood Initiative to hire a seafood product specialist, who works out of Astoria.

The Oregon Sea Grant Extension program leader is also the associate director of Oregon Sea Grant. As one of five program areas within the OSU Extension Service, Sea Grant Extension

is an integral part of Extension, and OSU Extension Service, in turn, provides a broad geographic presence, programmatic assistance, and funding support to Sea Grant Extension. A strong, cooperative relationship exists formally and informally with the Extension dean and director and with the program leaders of Sea Grant, Agriculture, Forestry, Family and Community Development, and 4-H. In fact, Sea Grant shares program responsibilities with the Forestry and Agricultural Extension programs -- particularly in the watershed team area. New programs are being developed with 4-H Extension as well. Sea Grant Extension's plan relates to the NOAA plan and serves regional and national needs, often around our major theme areas of fisheries and seafood, ecosystems and watersheds, and marine education.

Sea Grant Extension faculty are part of the university's academic structure. Faculty members have academic homes in colleges and departments, with all the privileges and responsibilities of other university faculty. Oregon Sea Grant Extension faculty members are in six colleges and many more departments, reflecting the diversity and capacity of the program. Colleges include agricultural science, food science, forestry, liberal arts, oceanic and atmospheric sciences, science, and veterinary medicine. Among the departments are agriculture and resource economics, bioresource engineering, biomedical sciences, fisheries and wildlife, food science and technology, geosciences, math and science education, oceanic and atmospheric science, political science, and sociology.

Several major Sea Grant Extension programs with faculty located at other venues have a direct interface with the HMSC. These include topic areas of wave energy, marine reserves, genetic tracking and traceability of salmon and other species, marine debris, invasive species, watershed health, master naturalist programming, interpretative signage for bayfronts, and others.

Oregon Extension faculty members housed at the HMSC include Dr. Tim Miller-Morgan, Extension Veterinarian, Aquatic Pets, with the College of Veterinary Medicine and ornamental fish health programming; and Dr. Shawn Rowe, Marine Education Learning Specialist, Oregon Sea Grant Extension; Assistant Professor, Department of Science and Math Education, College of Science, who is the co-director of the Center for Ocean Sciences Education Excellence – Pacific Partnerships. The research and teaching elements of their programs are contained in other sections of this report and their outreach programs follow:

***Free-choice Learning:*** For the last five years Oregon Sea Grant Extension has supported 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 Initiative (FCLI) -- led by Dr. Shawn Rowe, Marine Education

Learning Specialist, Oregon Sea Grant -- 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.

Through Rowe's work in the Department of Science and Mathematics Education, our website <http://seagrant.oregonstate.edu/freechoice/index.html>, conference presentations, and professional development offerings, the Free-Choice Learning Initiative continues to disseminate information about HMSC and OSU program offerings, activities, and project findings to students and professionals in formal and informal sciences around the region and country.

Evaluation and education opportunities were expanded significantly over 2008-2009. The work of the NSF-funded Center for Ocean Science Education Excellence, Pacific Partnerships (COSEE PP) began in earnest this year. This five-year effort partners the 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's volunteer training, COSEE -- Pacific Partnerships also supported workshops at the HMSC, OSU main campus, Portland State University, and Oregon Health Sciences University for ocean scientists, graduate students, and post-docs on communicating sciences through partnerships with outreach and education institutions. COSEE -- Pacific Partnerships also took the lead in supporting the development of a Coastal Master Naturalist Program this year. Modeled on successful similar programs nationwide, the CMNP seeks to develop the next generation of highly trained volunteers engaging in ocean sciences education, stewardship, and citizen science.

Rowe's ongoing collaboration with the 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. Based on similar, previous work, Celeste Barthel, Heidi Schmoock and Rowe continued to develop and deliver classes in Communicating Ocean Sciences to Informal Audiences (COSIA) for educators and floor staff at the HMSC, Oregon Coast Aquarium, and Maryland Science Center.

***Faculty research for 2008-2009:*** The free-choice learning research agenda continued to develop from June 2008 to July 2009. Shawn Rowe, who heads up the Free-Choice Learning Initiative, and Dr. Jim Kisiel, California State University, Long Beach, continued their two-year research project studying engagement and learning from interactions with live animals in touch tanks at the HMSC, Oregon Coast Aquarium, and both

the Aquarium of the Pacific and Cabrillo Marine Aquarium in Southern California.

Rowe, working with Nancee Hunter and graduate student in Science and Mathematics Education Céleste Barthel also began research on learning from and teaching with large-scale spherical display systems using a NOAA-funded exhibit, Magic Planet – a one-meter diameter digital sphere. In addition to basic research on what and how people learn from the Magic Planet and the related Science on a Sphere exhibit at the Maryland Science Center, the team also participated in creating professional development opportunities for marine educators at the HMSC, Oregon Coast Aquarium and K-12 teachers from Lincoln County using Magic Planet and other platforms to teach and learn science using real-time and near real-time data.

Rowe also collaborated with Dr. Kerry Carlin-Morgan, Director of Public Programs at the Oregon Coast Aquarium in the evaluation and redesign of the aquarium's volunteer training program. With help from Science and Mathematics Education graduate students Ron Crouse and Robyn Anderson, as well as Heidi Schmooch – *M.S. 2007* (OSG), the team redesigned the curriculum and manual and is carrying out research on subsequent changes to volunteer self-efficacy.

**Student research for 2008-2009:** In addition to her work with Shawn Rowe and Nancee Hunter, Céleste Barthel began research this year on the efficacy of professional development for marine educators working in informal science education institutions. In particular, Barthel began interviews with educators at the Oregon Coast Aquarium, HMSC, Maryland Science Center, and the National Aquarium in Baltimore, MD to identify barriers to and supports for the implementation of practices learned as part of professional development.

Marine Resource Management graduate student Sarah Mikulak was awarded a Holt Education Award to support her work helping visitors construct, understand, and interpret graphical data. Her exhibit, developed with a combination of funding from the Holt award, NANOOS, and the private company Wetlabs, was installed at the HMSC for testing, research, and development this year.

Environmental Sciences graduate student Michelle Mileham also began research on best practices for educating volunteers to communicate effectively about controversial topics. Michelle developed a series of professional development workshops this year on Marine Protected Areas for volunteers from the HMSC, Oregon Coast Aquarium, CoastWatch, and Friends of Yaquina Bay Lighthouse. Michelle was awarded a Holt Education Award to continue her work toward her master's thesis.

**Ornamental Fish Health:** The Ornamental Fish Health Program (OFHP), supported by Oregon Sea Grant and the College of Veterinary Medicine, has completed a busy sixth year solidifying existing programs and expanding into new areas. Dr. Tim Miller-Morgan is the extension veterinarian overseeing this program.

The purpose of the Ornamental Fish Health Program (OFHP)

is to provide educational programming and service to the ornamental fish industry in Oregon and it's designed to assist wholesalers, retailers, and hobbyists with the successful rearing, husbandry, and health care of ornamental aquatic animals in the aquarium or pond environment.

We continue to disseminate health and husbandry information to the ornamental fish industry through our new blog, Words from a Wet Vet, <http://blogs.oregonstate.edu/wetvet/> and our updated web site, <http://seagrant.oregonstate.edu/extension/fishhealth/index.html>. Miller-Morgan also frequently consults with local ornamental fish producers, importers, retailers, and hobbyists on health and husbandry issues, USDA accreditation, and health inspections for interstate and international animal shipments. These consultations originate not only in Oregon, but come from areas throughout the Pacific Northwest and the nation. In addition, recent consultations with stakeholders in Israel, India, United Kingdom, and Belgium continue to give an international flavor to the program. Miller-Morgan was invited to speak at the recent Indaquaia 2009, in Kokatta, India. This is a trade show and educational program for ornamental fish industry professionals in India. He was asked to discuss biosecurity and how the principles of biosecurity could be applied within the Indian ornamental fish industry. Miller-Morgan continues to work with local koi, goldfish, and aquarium clubs.

Miller-Morgan is co-developer of a Koi Dealer best health practices program that aims to provide a method for koi dealers to become certified by specially trained veterinarians who adhere to specific best practices. This program was developed by a group of veterinarians actively working in the area of ornamental fish health management. The group has completed beta testing of this program with eight koi dealers and five veterinarians in private practice. The program should be publicly available in early 2010.

In addition, Miller-Morgan has coordinated, co-coordinated, and instructed in multiple industry and veterinary professional seminars and workshops throughout the year, including: Biosecurity for the Pond Fish Owner, Lynwood, WA; Koi Herpes Virus 101, Battle Ground, WA; A Veterinarian's Perspective of the Israeli Koi Industry, Portland, OR; The Koi Health Academy in Reno, NV; Basic Koi Health Management for Hobbyists, Point Defiance Zoo and Aquarium, Tacoma, WA; Aquatic Veterinary Medicine Sessions (27 hours), American Veterinary Medical Association Annual Conference, New Orleans, LA; International Zoo, Exotic and Wildlife Medicine Workshop – Fish Medicine Session, HMSC, Newport, OR; Biosecurity for Ornamental Fish Breeders and Fish Disease Management for Ornamental Fish Breeders, Indaquaia 2009, Kolkata, India.

The Ornamental Fish Health Program continues to consult with ornamental fish importers, wholesalers, and retailers regarding emerging health management issues and the development and implementation of biosecurity protocols within these facilities. We are currently working with seven ornamental fish facilities in the Pacific Northwest.

The Ornamental Fish Health Program's teaching and research laboratory continues to host numerous students from the Oregon Coast Community College's Aquarium Science Program who

seek hands-on training in fish and invertebrate husbandry and health management. These students participate in one of three guided learning programs: Volunteer Aquarist Aides (20 hour minimum), Practicum Experiences (50 hours minimum), or Internships (400 hour minimum). In the past year we have provided these learning experiences for eight Volunteer Aquarist Aides (average of 148 hours), three practicum students and 1one intern. We have also hosted one COSEE intern from Chemeketa Community College and an OSU Pre-Veterinary Student Intern.

During the past year we have led or facilitated at least 20 interactive back-wing tours of our teaching and research facility. Using an outline and script developed by OFHP staff and students, these tours continue to increase in popularity and demand.

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

Oregon Sea Grant Director of Education, Nancee Hunter, stays active with Coastal America and the Coastal Ecosystem Learning Center's Network. In addition, the Oregon Coast Aquarium has involvement from Kerry Carlin-Morgan, Director of Public Programs. There are monthly conference calls to keep everyone up to speed on what is happening at the national level and among the network. We also receive professional development training as part of these calls. For instance, last month we were joined by Charlotte Vick, the Content Director for Google Ocean. Charlotte taught the group how to use different features and layers on Google Ocean and also provided some insight as to how aquariums could benefit from using the Google Ocean application.

To highlight our collaborative work around ocean literacy, we recently nominated the partnership among Oregon Coast Aquarium, Lincoln County School District and Oregon Sea Grant/Hatfield Marine Science Center for the 2009 Coastal America Partnership Award. The project contributes to Coastal America's mission to protect, preserve and restore coastal resources, and to expand ocean literacy efforts. As part of this collaboration, we have promoted stewardship projects, organized a team for the student summit, helped develop and participated in the Coastal America national poster/art contest, acquired and displayed the Ocean Today kiosk, and presented on the benefits of being a Coastal America Ecosystem learning Center. We have also conducted several teacher professional development workshops and marine education summits (geared toward informal marine science educators). In fact, due to the success of a joint marine education summit conducted by the Oregon Coast Aquarium and Oregon Sea Grant, the National Marine Sanctuary Foundation has requested a similar meeting for their own staff, to be held in conjunction with the National Association of Zoos and Aquaria Conference (to be held in Portland, Oregon) in September, 2009.

***SeaFest 2008 Poster Contest:*** K-12 students from Lincoln, Linn and Benton Counties, participated in the Coastal America National Student Art Contest. This Art Contest, organized in

conjunction with HMSC's annual open house, SeaFest, provided an opportunity for students to participate in a nation-wide contest aimed at increasing the level of ocean literacy in our youth and general public. Students from five age groups created artwork based on the Seven Essential Principles of ocean literacy and then submitted their work to either the Oregon Coast Aquarium or HMSC, their Regional Coastal Ecosystem Learning Centers. The first, second and third place winners from each age group and from each CELC advanced to the National Competition and while none of the Oregon participants made it to the national competition, we had a terrific display of over 100 posters during SeaFest at the Hatfield Marine Science Center.

***The Ocean Today Kiosk:*** HMSC unveiled their newest exhibit, the Ocean Today Kiosk, for SeaFest, 2009. The Ocean Today Kiosk at HMSC was made possible by a generous hardware donation from the Panasonic Corporation. The Kiosk is a stunning addition to the Center, inspiring and educating visitors and generating positive feedback. The new installation allows U.S. government institutions to reach an important international audience with relevant ocean and coastal messages, data and information. It consists of a 32-inch, independently-operated, touch-screen display, and a 42-inch echo monitor above. This arrangement allows multiple groups to simultaneously interact with the content.



A dynamic interface comprised of ocean imagery and video clips, invites visitors to explore several content areas. When a visitor touches the screen, the content areas are revealed to show the most recent information on ocean sciences today, ocean news, recent discoveries, and ocean life. Eventually, the kiosk area will accommodate a specially designed sound dome that will envelop visitors, as well as a ticker-tape reader to highlight current events and fun facts about our ocean. The kiosk enhances ocean literacy among visitors through an enticing multi-media experience. It also provides timely content that complements the Smithsonian Ocean Hall and Ocean Portal and that is updatable and diverse on current and foundational ocean topics. Through user testing and evaluation we will ensure that the kiosk is user-friendly.

***Civic Activities***

**Ken Hall, HMSC Program Manager**

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, people who work at HMSC are known in their local communities for their volunteerism and service to schools, charitable and public service organizations, youth recreation and sports, and in the visual and performing arts communities.

Many boards and elected bodies have HMSC personnel serving in leadership positions, including the Lincoln County Cultural Coalition, 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. At Yaquina View Elementary School, the annual spring science fair and geography week are two events involving all grade levels in science-related activities, led by volunteers from the HMSC community. For the 2009 science fair, volunteers representing EPA, NOAA, OSU, and USDA served as mentors to students, helping them design projects and assemble their displays, contributing at least 1.5 hours per week in the classrooms for about six weeks prior to the fair, which took place on May 14-15.

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 fisheries stock assessments and other coastal resource management issues have been hosted by Oregon Department of Fish and Wildlife, US Fish and Wildlife Service and other governmental and non-governmental organizations.

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

- Jul 29-Aug 1 National Science Foundation – Migrate Course on Avian Movements & Migration Technology
- Aug 8 Oregon Public Broadcasting Salon Series
- Aug 18-21 OSU Science Education – Teacher Training
- Aug 27-29 OSU Media Fellowship program
- Sept 12 Oregon Senate and House Committees on the Environment & Natural Resources
- Sept 13 Pacific Northwest Docent & Volunteer Association conference
- Sept 16 Coast Watch & NAME convention
- Sept 24-25 Oregon Invasive Species Council
- Sept 30 OSU Institute of Water & Watersheds - Water Roundtable
- Oct 11 Coast Hills Running Club
- Nov 12 Oregon Dungeness Crab Commission
- Nov 25 Oregon Trawl Commission
- Dec 4 South Beach Urban Renewal Plan Open House
- Dec 8 Governor's Task Force on Comprehensive Revenue Restructuring
- Jan 14 Port of Newport commission

- Jan 30 U.S. Navy - Public Meeting
- Jan 31 University of Oregon – Labor Education
- Feb 6 Lincoln County Schools – Climate Change Dialogue
- Feb 20 Oregon Marine Mammal Stranding Network
- Mar 14 Oregon Association of Plumbing, Heating & Cooling Contractors
- Mar 16-17 Oregon Institute of Technology - Wave Energy pilot course
- Mar 16-10 Pacific Salmon Commission - Chinook Technical Committee
- Mar 21 American Albacore Commissions - Marine Stewardship Council Program
- Mar 25 Oregon Museum of Science & Industry – Student group visit
- Apr 2 Seafood Consumer Center
- Apr 14 Oregon Department of Environmental Quality
- Apr 23-29 Washington State Sea Grant - Fishery Plant Monitor Training
- Apr 27 “Synthetic Sea” -- Plastic Debris in the Marine Environment (public education event)
- May 3 Film screening “The Politics of Sand”
- May 6-7 Oregon Parasitologists
- May 15 Oregon Ocean Policy Advisory Council
- May 17 Coast Range Association Board Meeting
- May 29 Wave Energy Roundtable with US Senator Merkley
- June 16 Oregon Public Broadcasting - Think Out Loud radio program re: Wave Energy
- June 20 – Oregon Trawl Commission
- Monthly meetings of Yaquina Birders and Naturalists

***SeaFest 2009***

**Ken Hall, HMSC Program Manager**

The Hatfield Marine Science Center welcomed over 5,000 attendees to SeaFest, the Center's annual open house and marine festival on Saturday, June 27, 2009. The visitor count broke previous years' attendance records and solidified the event's reputation as a family favorite and attractor for out-of-town visitors to the coast. Nearly ¾ of the arriving vehicles had one or more children in the group, and event organizers reported handing out over 1,200 “ocean passports” and prizes at the Kids Zone booth. Exhibitors in the Science Zone also reported a non-stop flow of visitors beginning shortly after 10 a.m and running through the end of the day.



Local food vendors and live music on the entertainment stage made the outdoor food/music pavilion at SeaFest a popular resting spot for families. .

With some 30 scientific exhibitors set up in and around the NOAA Barry Fisher Building, visitors were able to meet the scientists and ask questions about the diverse marine habitats and species they study -- from whales and pinnipeds to tiny zooplankton, phytoplankton, and fish of all sizes. Dozens of interactive exhibits, displays, and demonstrations throughout the site reflected the various ways in which researchers at HMSC demonstrate "leadership through science" -- the theme of this year's SeaFest.



ODFW's Marine Resources Program staff enjoyed interacting with visitors of all ages checking out the live shellfish exhibit and rare fish species display.

Out at the dock, visitors were welcomed aboard on OSU's research vessel *Elakha* and a US Coast Guard vessel for tours. Scientists and resource managers from ODFW's Marine Resources Program were also at the dock, with crab pots in the water and live shellfish on display, along with rare fish species and other organisms of interest to the public. Although the RV *Wecoma* was being prepared for a cruise and thus unavailable for public tours, OSU oceanographer Miguel Goni was there with a dockside display explaining the objectives of his upcoming cruise on the *Wecoma* to study sea - river sediment flows off the Oregon and California coasts.



Visitors to the OSU dock were welcomed aboard the RV *Elakha* and the US Coast Guard vessel moored alongside her for guided tours.

Primary funding and organizational support for SeaFest 2009 was provided by Oregon State University and cooperating agencies/institutions, including the National Oceanic & Atmospheric Administration, Oregon Coast Aquarium, Oregon Department of Fish & Wildlife, US Environmental Protection Agency, and US Fish and Wildlife Service. The HMSC is grateful for the support

provided by major community sponsors: the Confederated Tribes of Siletz Indians, City of Newport, Georgia-Pacific of Toledo, and Landwaves, Inc. We also thank our partners in the fishing and conservation communities, the U.S. Coast Guard, and many local businesses and smaller community sponsors that helped with funding, promotion, advertising, and contribution of prizes for Kids Zone and the "Ocean Passport" activity.

Credit for the success of SeaFest 2009 is shared by the planning committee, led by event coordinator Jeff Lichtman (serving through the AmeriCorps LINKS program), the scientists who put together exhibits and activities and engaged the public in learning about our research, the Ship Operations staff for their support of activities at the dock, and HMSC facilities crew and other helping hands who carried the heavy load of setting up tents, tables, providing outdoor water and electricity hook-ups, and other logistical support. Finally, the HMSC gratefully acknowledges all those who volunteered their time and talents, including HMSC Visitor Center volunteers, Newport Police Volunteers, Oregon Coast Aquarium, RSVP of Lincoln County, and the many individual citizens who provided key logistical support and helped visitors make the most of their experience at SeaFest.

### *Friends of the HMSC*

#### **Ken Hall, HMSC Program Manager**

The Friends of Hatfield Marine Science Center is a membership organization composed of donors and supporters of HMSC's research and education mission. During the 2008-09 year, financial contributions from the Friends provided support for a wide range of programs, activities, and specific needs, including innovative marine science education programming for the general public and targeted audiences. Thanks to the generous contributions of John Sherman, the Las OLAS program (Ocean Learning Activities in Spanish) was once again able to continue its innovative outreach to Spanish-speaking families with school-aged children in Lincoln County, serving over 30 families last year.

The Friends of HMSC remain a key source of support for graduate student research at HMSC, with endowed funds providing over \$82,000 in fellowships and scholarships this past year. Donor-funded scholarships also supported students at the undergraduate level, including an OSU biology student pursuing marine mammal research, housing stipends for Corvallis-based OSU students taking courses in Newport,

Other activities sponsored by the Friends of HMSC during 2008-09 included a return of the popular "Science on Tap" lecture series on March 18th, featuring NOAA Fisheries biologist Laurie Weitkamp speaking on Pacific salmon biology and ecology before an audience of about 40 people. It was great to see Friends of HMSC at this event and others throughout the year, including the Markham Symposium and at SeaFest.

***Donor Honor Roll***

The Honor Roll recognizes HMSC's annual supporters who have made outright gifts or pledge payments between July 1, 2008, and June 30, 2009. Donors making new pledges will be recognized in the appropriate level as their payments are received.

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**Seminars presented at HMSC from July 2008 to June 2009:** The HMSC's weekly science seminars, held on Thursday afternoons in the Guin Library Seminar room, allow scientists from various institutions to share information about current or recent research findings and provide opportunities for stimulating discussions and interchange.

DATE	NAME	AFFILIATION	TITLE
July 3, 2008	Markus Horning	Pinniped Ecologist, Marine Mammal Institute, Hatfield Marine Science Center	<i>Consummate and consumed predators: orcas, pinnipeds, and the predator pit</i>
July 10, 2008	HsO Students	Hatfield Marine Science Center Graduate Students	<i>Multiple Graduate Student Research Presentations</i>
July 17, 2008	Anthony D'Andrea	OSU Oceanic & Atmospheric Sciences	<i>Burrowing shrimp as ecosystem engineers in Pacific Northwest estuaries</i>
July 31, 2008	Mark P. Miller	USGS Forest and Rangeland Ecosystem Science Center	<i>Using Genetic Markers in Analyses of Natural Populations</i>
August 7, 2008	HsO Students	Hatfield Marine Science Center Graduate Students	<i>Multiple Graduate Student Research Presentations</i>
August 14, 2008	Bob Lackey	Professor & Senior Fisheries Biologist, OSU and EPA	<i>Science, Scientists, and Policy Advocacy</i>
August 21, 2008	Research Experience for Undergraduates	Mini Symposium - Results of research REU's did during 10 week internship at HMSC	<i>Roxana Aguirre-Robertson, Ariel Camp, Lanaya Fitzgerald, Nicole Goehring, Vivian Lin, Laura Poppick, Megan Pros, Norma Vazquez, Hannah Waters, Caitlin White</i>
October 2, 2008	Bill Chadwick	CIMRS/NOAA Vents Program	<i>Lessons learned from an erupting submarine volcano</i>
October 9, 2008	Ian Bradbury	Oceanography Dept. and Marine Gene Probe Lab Biology Department Dalhousie University Canada	<i>Marine connectivity: changing paradigms and challenges for sustainable fisheries</i>
October 16, 2008	Carolyn Copenheaver Bryan Black	Assoc. Professor Virginia Tech Department of Forestry Asst. Prof., HMSC Forest Ecosystems and Society	<i>Pacific geoduck, tree rings, and high-resolution recruitment and climate histories in the northeast Pacific</i>
October 23, 2008	Laurie Weitkamp	Research Fisheries Biologist, NOAA Fisheries/Northwest Fisheries Science Center	<i>Where in the ocean are they? Chinook and coho ocean migration patterns inferred from coded wire tag recoveries</i>
October 30, 2008	Jennifer Fisher	Bodega Marine Lab, University of California Davis	<i>Larval retention and cross-shelf migrations in a zone of strong coastal upwelling</i>
November 6, 2008	Angelique White & Ricardo Letelier	College of Oceanic and Atmospheric Sciences, OSU	<i>Assessing the feasibility and risks of controlled upwelling</i>
November 13, 2008	Daniel Bottom	NOAA National Marine Fisheries Service	<i>Salmon Life Histories, Habitat, and Food Webs in the Columbia River Estuary</i>
November 20, 2008	Knut Vollset	University of Bergen, Norway	<i>Habitat utilization in the pelagic: what determines the distribution of early life stages of fish?</i>
December 4, 2008	Bill Peterson	NOAA NW Fisheries Science Center, HMSC	<i>The impact of greatly improved ocean conditions in 2008 on salmon and other marine organisms</i>
December 11, 2008	Kirsten Grorud-Colvert	University of Miami Rosenstiel School of Marine And Atmospheric Sciences (now at OSU-PISCO)	<i>Predation in marine reserves and its impact on the early life histories of newly-settled coral reef fishes</i>
January 8, 2009	James E. Kaldy	U.S. Environmental Protection Agency	<i>Using 15N stable isotopes and macrophytes to determine nutrient sources to Pacific Northwest Estuaries: Case studies from Oregon and Alaska</i>
January 15, 2009	Nathan Bachelor,	COAS, OSU	<i>Factors influencing the mortality and distribution of red drum in North Carolina estuaries</i>

**HATFIELD MARINE SCIENCE CENTER ANNUAL REPORT 2008-2009**  
**PUBLIC OUTREACH AND EXTENSION**

<b>DATE</b>	<b>NAME</b>	<b>AFFILIATION</b>	<b>TITLE</b>
January 22, 2009	Claudia Hollatz	PhD candidate, Universidade Federal de Minas Gerais, Brazil	<i>Amazon River dolphins: high phylopatry due to restricted dispersion at large and short distances</i>
January 29, 2009	Mary Moser	Northwest Fisheries Science Center, Seattle	<i>There's a sucker born every minute: lamprey biology, migration, and passage</i>
February 5, 2009	Peter Ruggiero	Department of Geosciences, OSU	<i>Is the intensifying wave climate of the U.S. Pacific Northwest of more concern than sea level rise?</i>
February 12, 2009	Anne Nolan	Department of Geosciences, OSU	<i>Climate change impacts on snow, glaciers and water resources in the Pacific Northwest</i>
February 13, 2009	Fabian Gomez	Master's Student at University of Concepcion, Chile	<i>Environmental variability and small pelagic fishes of Chile</i>
February 19, 2009	Visily Titov	NOAA Center for Tsunami Research, Seattle	<i>Progress in Tsunami Forecasting</i>
February 26, 2009	Becca Hamner	Research Associate, Marine Mammal Institute, OSU	<i>Population structure of the New Zealand endemic Hector's dolphin: Do the dots connect?</i>
March 5, 2009	Clare Reimers	OSU Oceanic & Atmospheric Sciences	<i>Benthic-Pelagic Coupling at Ocean Margins</i>
March 12, 2009	Kevin Hovel	San Diego State University	<i>Landscape ecology in the marine environment: habitat structure and scale interact to dictate survival, diversity, and behavior in essential fish habitats</i>
March 19, 2009	Chris Langdon	Coastal Oregon Marine Experiment Station, OSU-HMSC	<i>Opportunities and challenges of Offshore Aquaculture in the Pacific Northwest</i>
March 31, 2009	Emanuele Di Lorenzo	School of Earth and Atmospheric Sciences, Georgia Institute of Technology	<i>ENSO and the North Pacific Gyre Oscillation: a paradigm for Pacific Low-Frequency Variability</i>
April 2, 2009	Peter Kube	Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia	<i>Advancing aquaculture selective breeding in Australia</i>
April 9, 2009	Mike Canino	Alaska Fisheries Science Center	<i>Across the Great Divide: ice-age demography imprints contemporary genetic population structure of Pacific cod</i>
April 16, 2009	Jeremy Shakun	Dept. of Geosciences, Oregon State University	<i>Ice Age Lessons for Global Warming</i>
April 23, 2009	Shawn Rowe	Oregon Sea Grant Extension/OSU Dept. Of Science and Math Education	<i>How can we make them get it?</i>
April 30, 2009	Anna Elz	Northwest Fisheries Science Center	<i>DNA Barcodes for Species ID: the Forensic Marine Voucher Collection</i>
May 14, 2009	Julia Hager	Alfred Wegener Institute for Polar and Marine Research, Germany	<i>Ecology of sea ice algae in the Weddell sea, Antarctica</i>
May 21, 2009	Ruth DiMaria	OSU/HMSC Graduate Students	<i>Source contributions of Pacific cod juveniles in the south-eastern Bering Sea</i>
	Dafne Eerkes-Medrano		<i>The impact of ocean hypoxia on coastal marine invertebrate larvae</i>
May 28, 2009	Janet Webster	Guin Library, Hatfield Marine Science Center	<i>Open Access in Publishing: options for researchers</i>
June 4, 2009	Bill Muir	NOAA Fisheries, Northwest Fisheries Science Center, Cook, WA	<i>Effects of Migration Through the Columbia River Hydro-power System, Past and Present</i>
June 11, 2009	Tessa Francis	University of Washington	<i>Estimating community metrics of coastal ecosystems, and the effects of shoreline urbanization on aquatic-terrestrial coupling in lakes</i>
June 18, 2009	Bob Lackey	OSU Department of Fisheries and Wildlife	<i>Science, Scientists, and Policy Advocacy</i>
June 25, 2009	Londi Tomaro	Hatfield Marine Science Center	<i>HsO Graduate Student Research Presentations</i>
	Mattias Johansson		

## IV. RESEARCH AND EDUCATION SUPPORT

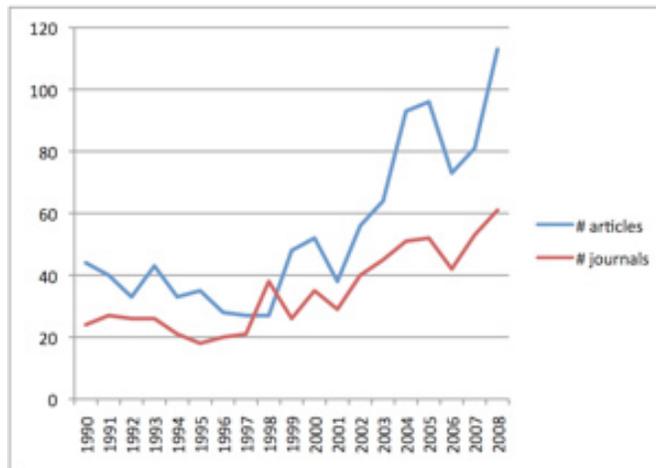
### Guin Library

Janet Webster, Librarian

The Marilyn Potts Guin Library continues to be one of best marine and estuarine libraries in North America. It 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.

Given the current economic conditions, a stagnant library budget, and escalating costs of scientific information, the OSU Libraries is responding in several ways. We identified \$1.2 million in journals to cancel over the next fiscal year. This subtly undermines the some of the unique character of our collections. At the Guin Library, many of our smaller, international and more focused titles will no longer be available. It makes it harder for some of our researchers to keep up with the latest in their fields. Cancelling titles is the downside. The situation makes us become more resourceful in terms of collaborations and more vocal about the need for changes in how we communicate science.

The traditional model of scientific communication relies on the journal. Yet, as more journals become available electronically, scientists look for the article rather than the journal. This is especially true with students – the next generation of scientists. At the same time, publishers are charging more for the journals. There is a movement to change this model. Open Access is a term referring to making information freely available to all. Some journals are completely open access while others are limited requiring the author to pay additional charges to ensure that their work is open beyond the subscription base. Libraries also offer authors a place to deposit their work, digital repositories. The OSU Libraries developed ScholarsArchive several years. But faculty member have been slow to use it. The staff of the Guin Library continues to work with our users to encourage them to consider open access when making publication decisions. Janet Webster is actively involved in the effort. Her HMSC seminar in May described the issue in terms of HMSC researchers. Publishing by HMSC authors continues to increase as do the places where they publish. The costs also grow. The Guin Library works to make sure HMSC researchers and student have access to information, even as the landscape changes. 20% of the publications in the 2007/2008 were accessible to everyone. We intend to improve that in the coming year.



Graph 1: Articles published by HMSC authors and journal where they appear.

Journal Title	1990	2008	% change
<i>Marine Ecology Progress Series</i>	\$3100	\$4125	133%
<i>Canadian Journal of Fisheries &amp; Aquatic Sciences</i>	\$210	\$1085	517%
<i>Aquaculture</i>	\$948	\$4350	459%
<i>Fisheries Research</i>	\$258	\$2544	986%
<i>Journal of Experimental Marine Biology &amp; Ecology</i>	\$1612	\$5593	347%
<i>Journal of Shellfish Research</i>	\$50	\$175	350%
<i>Deep Sea Research Part II</i>	\$684	\$4128	604%
<i>JGR - Solid Earth</i>	\$1460	\$4826	331%
<i>Geochemistry, Geophysics, Geosystems</i>	N/A	\$1148	N/A
<i>Journal of Fish Biology</i>	\$548	\$3787	691%

Table 1 lists the most popular journals for HMSC authors, their comparative subscription cost to the Guin Library, and change in cost over 18 years.

**Library Displays:** Library staff work created three to four exhibits this year year.

- In celebration of Banned Books Week, Guin Library student workers, Chelsea Comstock and Jessica Sampson, created a display that featured books of interest to them. It was a great learning experience for them.
- Judy Mullen took her interest in the sustainable food issue and created a provocative display that challenged people to think about where their dinner came from.
- Susan Gilmont mounted a display on bad science that explored the ethics of distorting or fabricating data as well as plagiarism.

**Staff activities:** Janet Webster, the librarian, chairs the Oregon Library Association’s Legislation Committee and serves on 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 was elected chair of the OLA’s Support Staff Division. She was honored as OLA’s Library Support staff of the Year. Judy Mullen serves on the HMSC Sustainability Committee.

## HMSC Facilities

Randy Walker, Facilities Manager

The preceding year was a good one for the HMSC Facilities department, as a great deal was accomplished in making sure the needs of all that work at HMSC were met. The HMSC Facilities crew maintains labs, classrooms, and offices for Oregon State University faculty, students, and staff, while also taking care of building maintenance needs for the Visitor Center, Guin Library, student housing complex, and grounds maintenance for the entire 49-acre campus. In addition, the HMSC Facilities department has responsibility for maintenance of the seawater system and some infrastructure support of federal and state agency programs co-located onsite, including NOAA's Alaska Fisheries Science Center, Northwest Fisheries Science Center, the US Department of Agriculture (Agricultural Research Service), and elements of the US Environmental Protection Agency's Pacific Coastal Ecology Branch lab.

During the last year, Facilities carried out several construction and renovation projects, including completion of a new picnic shelter in front of the student housing complex, and installation of a long-awaited basketball court for the use of researchers, students, and guests. Following up on recommendations from a 2007 workshop on seawater-related research infrastructure, Facilities moved ahead with replacement of the delapidated dock for small boats and research. This dock was built using a team approach with a local contractor that allowed HMSC to finish this project at an attractive price.

In addition, the Facilities department provided key assistance in securing funding for several important projects from the State legislature's 'Go Oregon' economic stimulus bill. Some of these have been completed, while others are still in progress. New stainless steel gutters have been installed around most of the OSU buildings, and a complete plumbing retrofit of HMSC/OSU was conceptualized, designed and construction started in late spring of 2009.

A complete renovation of the teaching laboratories began in March of this year, which will provide students of all ages an opportunity to learn in an appropriate environment. Also completed during 2008/2009, was the rehabilitation of the parking lots and roads at the HMSC Campus. A new effluent treatment system was begun and is currently nearing the final construction that will allow researchers and scientists to work with fish diseases, invasive species and non-native fish at HMSC

Other projects that have moved from planning stages to implementation in recent months include: seismic safety enhancements to the 900 building; remodeling of the outside doors and hardware; and remodeling of the West-wing offices and laboratories. During this time, facilities has been in negotiation with Oregon Department of Environmental Quality to agree upon permitting for discharge from the chlorine treatment systems on campus.

HMSC facilities ended the year on a positive note and is looking forward to another great year.

## 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 17 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 are 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, John Hopkins University, the Navy, and NOAA. Major projects this year include: 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 equator with a port call in the Galapagos Islands, and a variety of work off the coasts of Oregon and California.

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. Additional information on OSU's Research Vessels can be found at the following website [www.shipops.oregonstate.edu/ops/wecoma/](http://www.shipops.oregonstate.edu/ops/wecoma/)



## PUBLICATIONS

**KEY:** \* = Student, \*\* = Student at OSU Seafoods Research Lab, **Bold** = at HMSC <sup>1</sup> = OSU, <sup>2</sup> = NMFS, <sup>3</sup> = PMEL, <sup>4</sup> = EPA, <sup>5</sup> = ODFW, <sup>6</sup> = USDA <sup>7</sup> = HMSC Intern

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