

# Oregon State University Hatfield Marine Science Center 2007 - 2008 Annual Report



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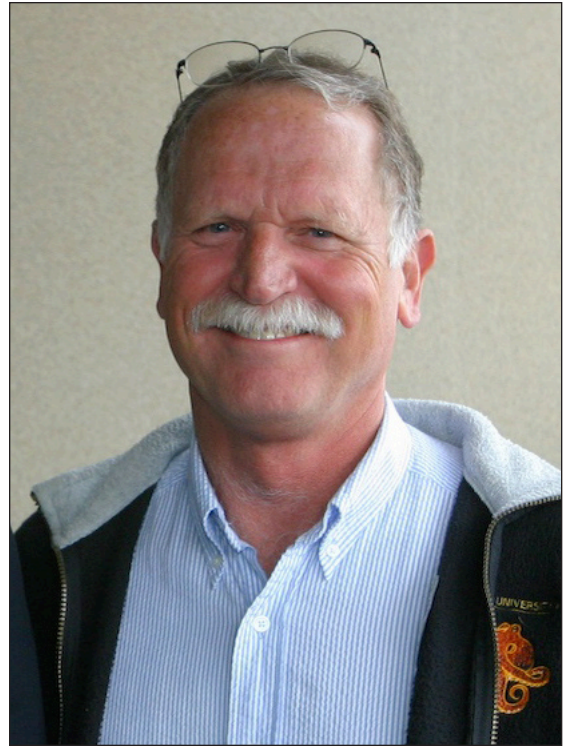
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## Director's Message

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

The Hatfield Marine Science Center raised its sights on a variety of new initiatives in 2007-08. Many of our efforts cross the lines of the eight major components of the HMSC; of the more than 170 publications this year, nearly 40 were co-authored by scientists from two or more of the eight major agency or educational programs on the HMSC campus. Whether planning for new “biodiscovery” research from deep sea organisms or looking at this year’s rapid growth and new research in the Marine Mammal Institute, HMSC is moving forward. Wave energy has become a focal point of renewable energy development in Oregon, and HMSC convened a workshop and has published a document examining how to address environmental concerns that may arise as this technology grows and develops. Research will follow, and we have initiated discussions with the US Department of Energy for funding a National Marine Renewable Energy Center here; in this effort, collaborations go beyond HMSC, and include other OSU colleges in Corvallis as well as diverse universities, agencies, and non-governmental organizations. Of course, all this growth requires new space, and under the auspices of our newly approved Master Plan, we began two efforts – first, plans to renovate much of the west wing of the OSU building will create new laboratory space. Second, plans for the Marine Mammal and Marine Genomics building were jump-started with a proposal to the federal government with State of Oregon matching funding requested.

New programs are also coming together in education at HMSC. The new one-credit weekend courses for OSU students have proven to be very popular and a great introduction to marine science. Our summer internship programs continue to flourish, with the highlight being the expansion of the NSF-sponsored Research Experience for Undergraduates program to encompass students in Corvallis as well as Newport with additional funding from NOAA. The success of the student research projects is highlighted by seeing six of those students make presentations at the Ocean Science Meeting in Orlando, Florida – and two of them received awards for their presentations. Our educational partnerships are growing with the Center for Ocean Science Education Excellence award from NSF, expanding existing ties with the Oregon Coast Aquarium and Oregon Coast Community College and creating new ones with the Oregon Institute of Marine Biology. Our public education programs are top-notch, with dedicated volunteers, a new emphasis on ocean observing systems in our Visitor Center, and a new look with the creative branding and signage from OSU University Advancement.



Hatfield Marine Science Center Director George Boehlert

HMSC’s community partnerships enhance our organization and we do our best to reciprocate. We are thankful to the fishing industry for its collaboration and contribution to research. We collaborate with the City of Newport through the Community Forum to enhance the South Beach area; we have developed the new HMSC Forum series to bring information to the public on timely marine and coastal topics like wave energy and ocean observing systems. In turn, the Lincoln County community has pulled together to support the concept of Yaquina Bay as the infrastructure base for ocean observing systems in the Pacific Northwest.

Success at the HMSC takes many forms, from individual awards and publications to major programmatic accomplishments. The major advances at our center arise from our key strength – the diversity of our staff and our academic and agency partners, combined with a supportive community and stakeholders. This report details the accomplishments of the 2007-08 with an eye to our future.

## 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 2007-2008 was successful and marked continued growth of the Station. COMES is in the process of hiring a new director for the Astoria Seafood Laboratory in order 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).

Based on the *Oregon Invests* database, in 2007-2008 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 80 manuscripts and reports including more than 40 in refereed journals and books. COMES graduated 17 students including 9 MS and 8 Ph.D's. COMES faculty also gave over 80 presentations and organized 9 workshops and conferences. For 2007-2008 it is estimated that for each \$1 million in state dollar expended, COMES faculty leveraged an additional \$3 million in federal grants and private support.

COMES "Signature Programs" in 2007-2008 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 almost \$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 MPA 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:** 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 2007-2008 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 and vessels in understanding salmon genetics and migration.

## **OSU-COMES Seafood Research Laboratory**

**Michael Morrissey, Director**

The OSU Seafood Research Laboratory (SRL) is part of the Coastal Oregon Marine Experiment Station (COMES) and represents a major research component of "OSU on the Coast", spearheaded by the Hatfield Marine Science Center. The Laboratory is involved in seafood research, graduate student training at the M.S. and Ph.D. level and is charged with transferring information to the seafood industry through publications, workshops and meetings. There are currently three tenured or tenure track faculty and ten graduate students at the Seafood Laboratory along with four staff supporting a very diverse and active research program.

It has been an interesting year for Michael Morrissey, juggling Seafood Lab duties with his new position as Superintendent of the OSU Food Innovation Center Experiment Station (FIC) in Portland. One of the positive results is increased collaboration between the two research centers. Several sensory tests were held at the FIC including English sole and an albacore deli-loaf, both getting high marks from potential consumers. A focus group evaluation with both consumers and industry was also run to determine how they would use web-based information about seafood. Although there are increased duties in Portland the Astoria crew has done a great job of keeping up their high-profile research, interacting with the industry, and continuing to keep the lab operating efficiently.

Michael visited Copenhagen in June for his final tour of duty as an international advisor to the SEAFOODplus project which involves 17 countries and 55 research institutions research and is in its final year of a five year cycle. The project was considered one of the more successful mega-projects in the EU and covered a wide range of topics from seafood quality, safety, value-added products and health.

Michael and his graduate student, Rosalee Rasmussen, are conducting research into the DNA-based differentiation of salmon species to prevent economic fraud in the marketplace. They recently completed their first study into the use of an existing method for salmon species identification in commercial products. This study resulted in optimization of the current method to reduce time and materials required for species

identification of lightly processed salmon products, such as smoked salmon and fresh fillets. This work was presented at the Pacific Fisheries Technologists' annual meeting in San Francisco, CA, and at the annual meeting of the Institute of Food Technologists in New Orleans, LA, where Rosalee received a first place award in the graduate student competition of the Aquatic Food Products Division. In addition to their current laboratory research, they also recently published a review article, entitled "DNA-based method for the identification of commercial fish and seafood species" in the Journal of Food Science, Comprehensive Reviews in Food Science and Food Safety, and are now preparing a follow-up article concerning the application of these methods to the detection of fish and seafood substitution on the commercial market.

Dr. Yi-Cheng Su at the OSU Seafood Laboratory supervised two M.S. students of Food Science and Technology and conducted studies to investigate efficacies of refrigerated seawater depuration and frozen storage on reducing *Vibrio parahaemolyticus* in raw oyster for safe consumption. A study conducted by his graduate student, Qianru Yang from China, found that holding raw oysters in recirculating seawater at 5°C for 96 hours could reduce *V. parahaemolyticus* populations in Pacific oysters (*Crassostrea gigas*) by 3.0 log MPN/g without noticeable fatality of oysters. Qianru Yang presented this finding at the 2008 Pacific Fisheries Technologists Meeting and received 2nd prize student poster competition award.

Another study conducted in collaboration with Washington Department of Health and Taylor Shellfish Company, Inc. (Shelton, WA) found that a process of flash freezing followed by storage at  $-21\pm 2^\circ\text{C}$  for five months was capable of achieving greater than 3.52-log (MPN/g) reductions of *V. parahaemolyticus* in half-shell Pacific oyster. The process was validated three times according to the National Shellfish Sanitation Program's post harvest processing (PHP) validation/verification interim guidance for *Vibrio vulnificus* and *Vibrio parahaemolyticus*. Based on this study conducted at OSU Seafood Laboratory, FDA (on August 6, 2008) concurred with approval by the Washington Department of Health for Taylor Shellfish Company, Inc. to label oysters processed in strict accordance with the validated treatment with safety added language as outlined in Chapter XVI of NSSP Model Ordinance.

In addition to seafood safety research, Dr. Su and his technician, Sureerat Phuvasate from Thailand, is conducting a study to develop a lactic acid bacteria fermentation process to be used in chitosan production from shrimp waste produced from the Oregon shrimp industry. The aim of the study is to develop a lactic acid bacteria fermentation process for producing chitosan from Oregon shrimp industry waste and reduces amounts of chemicals being used in current production.

Dr. Su gave a lecture on Microbiology and Sanitation and taught Microbiology Laboratory at the 16th OSU Surimi School in May 2008. He was invited to give lectures on seafood safety at China International Food safety and Quality Conference (September 2007), Ocean University of China (March 2008) and National Taiwan Ocean University (May 2008). He and

his graduate students gave 5 research presentations at the American Society for Microbiology General Meeting, Pacific Fisheries Technologists Annual Meeting and Institute of Food Technologists Annual Meeting.

Dr. Su served on the Editorial Boards of Journal of Aquatic Food Product Technology, Journal of Food Protection and Journal of Food Safety and reviewed manuscripts for 7 professional journals. He received an award from the USDA/CSREES NRI Biological Approaches for Food Safety Program to support a three-year project to develop a low-temperature post-harvest processing for decontaminating *Vibrio parahaemolyticus* in oysters. The aims of the project are to develop a low-temperature post-harvest process for decontaminating *V. parahaemolyticus* in raw oysters to safe levels for consumption and to increase our understanding of *Vibrio*-oyster interactions at different temperatures.

Surimi Research and Outreach. The Surimi Schools, launched by Jae Park in 1993, have continued to expand. The 5th Surimi Technology School Europe, held in September 2007 in Bilbao, Spain, drew 135 attendees from 17 countries. The 16th Annual Surimi Technology School USA, following the 8th Surimi Industry Forum, was held in Astoria in May 2008. Dr. Park also held a Smoked Fish lecture and training session in November, in Astoria, hosted three visiting scientists/post docs, and directed four graduate students.

Dr. Park's group has been working on several research projects, including investigation of fish protein isolates from species such as sardine, mackerel, and catfish, which would open the door to new supply markets for surimi-based seafood. At the Surimi Industry Forum, Park presented an overview of new technologies that demonstrate the potential for using various fish – including colored fish and their byproducts – for protein fish isolate. Of the 36 refereed journal articles on the topic, more than half have been published by Park and his former students and staff.

## Cooperative Institute for Marine Resources Studies

Michael Banks, Director

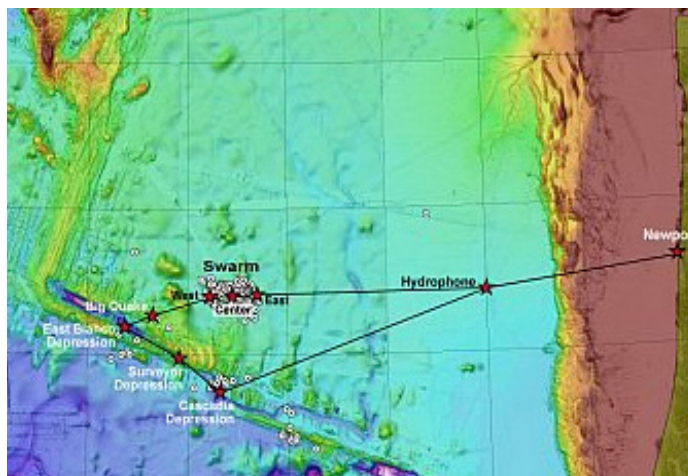
Now in its twenty-fifth year, the OSU/NOAA Cooperative Institute for Marine Resources Studies (CIMRS) develops and offers opportunities for joint research and outreach to a growing community of University and NOAA scientists dedicated to marine science, graduate education, and learning partnerships with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

The Institute's main mission is to bring together research partners from a variety of colleges, departments and agency organizations to address complex multidisciplinary issues relating to the living and non-living components of the marine environment. The Institute thrives because of the vision and commitment of leaders from within the laboratories of its NOAA associates and the OSU Research Office. As a result during the past few years external

research grant funding has tripled, graduate student opportunities have diversified, and many more investigators from a broad range of disciplines are joining together to address research problems of environmental, economic and social importance. No other OSU research institute provides both grant administration and personnel support and review in the manner as provided by an academic department.

The collaborative structure of CIMRS facilitates new ways in which basic research can be applied to understand factors impacting marine resources and their management. An integral part of the OSU Mark O. Hatfield Marine Science Center (HMSC), CIMRS is now administrative home for 28 research staff and 4 research faculty working on collaborative projects with NOAA investigators who also serve as OSU courtesy faculty. Recent highlights include:

1. Detection of a large earthquake swarm (noted on Sunday March 30, 2008) that began within the central Juan de Fuca plate, located ~150 nautical miles west of the Oregon Coast and ~70 km north of the Blanco Transform Fault, leading to a 4-day "event response" cruise on the RV *Wecoma*.
2. An outstanding scientific paper award in the area of ecosystem research to CIMRS co-authors Bill Chadwick, Leigh Evans, and Ron Greene for their contribution to a manuscript entitled: *Submarine venting of liquid carbon dioxide on a Mariana Arc volcano, Geochemistry, Geophysics, Geosystems 7, Q08007, doi: 10.1029/2005GC001152*
3. Significant contribution to the reports "*Ocean Ecosystem Indicators of Salmon Marine Survival in the Northern California Current*" and "*State of the Oceans - Pacific Region.*"



NOAA Vents Program/Oregon State University CIMRS Program Event Response Cruise, RV *Wecoma* April 20-23, 2008, Newport to Newport

Besides the core NOAA funded research projects detailed below, CIMRS research faculty generated over \$690K in FY 2008 alone for independent research projects funded from a variety of funding sources. Externally derived funds for new projects beginning in FY09 exceed this amount even further.

<i>Principal investigator</i>	<i>Funding Agency</i>	<i>Grant Title</i>	<i>Funded Amount</i>
William Chadwick	NSF	Monitoring Inflation at Axial Volcano	\$23,927
R. Dziak/H. Matsumoto	NSF	Real-Time Volcanic Event Detection	\$133,900
D. Mellinger/R. Dziak	NOAA Ocean Exploration	Earthquakes and Endangered Whales: Passive Acoustic Exploration off Greenland and Iceland	\$106,000
David Mellinger	NPGS	Datasets of Odontocete Sounds Annotated for Developing Automated Detection Methods	\$270,000
David Mellinger	IAGC/IAOGP	Passive Acoustic Monitoring System Development for Ishmael, 3-D Sperm Whale tracking and Directional Cardioid Sensor Processing	\$110,200
David Mellinger	ONR	Marine Bioacoustic Signal Analysis	\$28,016
David Mellinger	NPRB	Acoustic Data from the Bering Sea	\$19,478
<b>TOTAL AMOUNT</b>			<b>\$691,521</b>

For Collaborative Research with National Marine Fisheries Service/Northwest Fisheries Science Center, see Section on NWFSC

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

### Graduate students supported through fellowships and joint research projects

The goals of NOAA’s strategic plan are to build sustainable fisheries, to recover protected species, and to sustain healthy coasts. These goals require the support of sound scientific research to build the knowledge base for maintaining economically viable fisheries and, at the same time, minimize anthropogenic impacts on marine ecosystems. The CIMRS director works to match qualified students with projects and courtesy faculty based at the Hatfield Marine Science Center.

Degree	Student	Dept	Thesis
Ph.D.	Rebecca Baldwin	Fisheries and Wildlife	Using Parasite Community Data and Population Genetics for Assessing Pacific Sardine ( <i>Sardinops sagax</i> ) Population Structure along the west coast of North America. Co-Major Professors: Michael Banks, Kym Jacobson NOAA Fisheries Rep: Kym Jacobson, NWFSC
M.S	Marissa Litz	Fisheries and Wildlife	Abundance, distribution, and spawning behavior of the northern anchovy, <i>Engaulis mordax</i> , off the coast of Oregon and Washington Major Professor: Selina Heppell Minor Rep: Scott Heppell NOAA Fisheries Rep: Robert Emmett, NWFSC
M.S	Emily Waschak	Fisheries and Wildlife	Estimating Key Life History Parameters for Selected Species of Rockfish Major Professor: Scott Heppell Minor Rep: Selina Heppell NOAA Fisheries Rep: Grant Thompson, AFSC

## **Marine Mammal Institute (MMI)**

### **Bruce Mate, Director**

The goal of the Marine Mammal Institute's research is to better understand marine mammal conservation and management issues such as population numbers, critical habitats, migrations, behavior, and interactions with human activities (e.g. fishing, oil and gas development, and shipping). In its new iteration, The Marine Mammal Institute (MMI) will be a multi-disciplinary group studying marine mammal ecology, integrating many OSU research, scientific and academic efforts.

The MMI currently consists of 28 faculty, staff, and students. We are currently 4 major subgroups since the addition of two labs in 2006. These include the Whale Telemetry Group, 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 internationally recognized as the definitive 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 Marine Mammal Institute is developing a multi-disciplinary faculty, incorporating the work of experts from the realm of several OSU colleges. As the only Institute of its kind, top researchers from around the globe will utilize their combined efforts to continue the legacy of discovery and preservation of critical habits of target species, and understanding how they interact with their environment and the human activities affecting them.

The 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 will 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 will be 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. FY2008 brought in over \$1.8 million in grant and agency funding, as well as an increase in private donations. 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.

## **Oregon Sea Grant**

### **Bob Malouf, Director**

### **Jay Rasmussen, Interim 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*

Since its origins as one of the original four Sea Grant programs over 40 years ago, Oregon Sea Grant has been an active component of OSU's Hatfield Marine Science Center.

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 delivering quality education programs to youth and other audiences. In recent years our attention has turned to making the university and the HMSC a center for excellence in free-choice learning (where people have a choice in what, how, and when they learn) and in national and international ornamental fish health.

First established at Oregon State University (OSU) in 1967, Oregon Sea Grant had by 1971 become one of the first four Sea Grant Colleges in the nation. With federal, state, local, and private funding totaling about \$5 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. We believe all of the people of the state, the region, and the nation are our stakeholders.

Although the principal offices of the Sea Grant program are on the main campus in Corvallis, it has a large presence at the Hatfield Marine Science Center. The central office for the Sea Grant Extension Program is located at the HMSC, as is the major portion of Oregon Sea Grant's Marine Education Program. In 1997, Oregon Sea Grant also took over responsibility for the HMSC Visitor Center.

Oregon Sea Grant works to further knowledge of the marine and coastal environments of the Pacific Northwest and the forces -- natural and human -- that shape their destiny.

Different components of the Sea Grant program -- research, outreach, and education -- are described in appropriate parts of this report. Examples of youth education, public programming and exhibitry, ornamental fish health, and other focus areas of Oregon Sea Grant are contained in other sections of this report, with linkages 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. Urgent issues -- the decline of once-abundant fisheries, the challenges posed by coastal population growth, the heightened awareness of invasive species, consideration of wave energy potential, and marine reserves -- help propel Sea Grant's research priorities as the program strives to put limited resources where they can do the most good. Many research projects have outreach components, ensuring that the results of cutting-edge science will be put to work on the ground and at sea. 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.

In the past year-plus, Oregon Sea Grant has led a Pacific area regional research and information planning process with our colleagues from the Sea Grant programs of Washington, California, and southern California through 17 coastal workshops in the region. That plan will be completed in 2008 and available for researchers, managers, and others.

Nearly \$500,000 of Oregon Sea Grant-funded competitive projects involving the Hatfield Marine Science Center were funded during the 2007-2008 fiscal year. Research and projects included studying group learning dynamics at the Visitor Center's live animal exhibits; developing methods for reducing the mortality in oyster production; genetic mapping of native oysters; seafloor mapping; self-guided outdoor education; marine lab educational curriculum; understanding mortality of wild-caught marine fish; and supporting fisheries student projects.

### *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 2007/08 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 workshops. A major activity for David was the completion of a new stock assessment for black rockfish, which is a nearshore species that supports a significant marine sport fishery. The assessment was peer-reviewed during fall 2007 and adopted by the Council as the basis for harvest quotas starting in 2009. The new assessment found the stock to be capable of supporting a significantly greater rate of harvest than has been taken in recent years.

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 was also involved with Gil Sylvia in a project funded by Oregon Sea Grant that is developing case studies to help fishing industry members, and others interested in fishery management, learn about stock assessments and their role in fishery management decision-making.

David supervised two graduate students during the year. Cathleen Vestfals, a Masters degree candidate in the Marine Resource Management Program, is working on a project 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. Gladys Macaosip, a Fulbright Scholar from the

Philippines and a Masters degree candidate in the Department of Fisheries and Wildlife, is working 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. It is now how to many introduced fish species.

**Teaching:** During winter 2008 David taught his course “*Fishery Stock Assessment Methods*”. One of the two weekly lectures for the course was given each week in the HMSC studio classroom and televised to the main campus; the other lecture and a computer laboratory session were held each week on the main campus. During spring 2008 David began developing an on-line version of his course “*Dynamics of Marine Biological Resources*”, which will be offered during fall 2008, simultaneously with his regular HMSC offering of this course.

### ***Invasive Species***

**John Chapman, Research Associate**

John’s volunteer presentations, lectures, labs and/or led field trips, on estuary ecology and aquatic biological invasions in 2007-2008 included: ERF Newport, March 2008 “An invasion faster than evolution” J. Chapman, B. R. Dumbauld, OSU Fisheries and Wildlife Departmental Seminar;- Spring Marine Ecology - Zool. 451/551, Fall - Coastal Ecology and Research Management, the Oregon Coast Community College Aquarium Science Program, the HMSC summer intern and adult volunteer program, the Oregon Invasive Species Council, Introduced species of Oregon estuaries 24 Sept. 2008. John also taught the 4 unit Aquatic Biological Invasions FW 421/521 course in July and August

John was the lead or sole author on three 2007 papers in which the origins of the introduced periwinkle *Littorina littorea* were reanalyzed and the earliest known marine introduction to North America (via the Vikings) was resolved. Two field experiments conducted on Swan’s Island, Maine in 2008 in cooperation with John’s daughter, Katie, and Knox College, Illinois, senior projects students Ali Boris and Selena Jones, indicate the periwinkle would be difficult to introduce with solid ballast from sailing ships, as predicted by Chapman et al. These new results indicate that the periwinkle was more likely to have arrived in North America with Viking origins as a seafood introduction.

John participated in a Sea Grant funded survey for the introduced Asian estuary snail, *Assiminea parasitologica* in Coos Bay and Yaquina Bay in May 2008. A. p. was common at the Toledo Boat launch and rare at the Cannon Quarry boat launch, in upper Yaquina Bay. John found the first New Zealand Mud Snails, *Potamopyrgus antipodarum* in Yaquina Bay during this survey.

*Assiminea parasitologica* is the first intermediate host of the human lung fluke *Peragonemus westermani*. The second intermediate host of this fluke is the Chinese mitten crab *Eriocheir sinense*. Mitten crabs are established in San Francisco Bay, and have been collected from the Columbia River. Lung flukes are not uncommon among humans in Asia and are likely

introduced sporadically to North American waters via sputum and feces of visitors and immigrants. A. p. closes the loop for this parasite’s life cycle on this coast. John reexamined Cannon Quarry boat launch in upper Yaquina Bay for this new snail in September while leading the Oregon Invasive Species Council on a tour of the bay and found them in very high densities of A.p., confirming the spectacular expansion of this new invader.

John’s research on the collapse of native mud shrimp with the introduced isopod *Orthonie griffenis* continues. John searched for remnant mud-shrimp populations in Oregon and central California in June 2008, and found their extreme declines or absence from San Francisco Bay and Bolinas Lagoon, California but their persistence at extreme low densities in Coos Bay, Oregon and Morrow Bay, California.

John completed a manuscript for NOAA on estuarine dependence of juvenile coho salmon on the Oregon coast. John’s analyses of coho diets and estuary residence in the Siletz, Yaquina and Alsea estuaries revealed that estuary use is size dependent. Previous studies, based on large hatchery released juveniles overlooked the importance of estuaries for the smaller wild juveniles.

John trained and organized a Lincoln County “Summer Natural Resources” (SNR) student crew to sample burrowing shrimp populations of Yaquina Bay. One SNR project was with Brett Dumbauld (ARS) and Ted DeWitt (EPA) to determine whether their populations are declining due to extensive infestations of the introduced parasitic isopod *Orthonie griffenis*. The SNR crew did the majority of the field work for this study. This work was mentioned in the Aug/Sept HMSC newsletter.

John worked with the SNR crews to collect thousands of ghost shrimp to find their very rare parasite, *Ione cornuta* needed to study bopyrid mate attraction and oceanographic conditions controlling recruitment. The latter study was with Judy Miller, (2007, 2008, M. J. Murdock Charitable Trust, Partners in Science visiting summer high school teacher that he has been sponsoring). John and Judy continued their experimental studies of bopyrid recruitment and found that *Ione cryptoniscan* recruitment to the estuary is most intense during coastal upwelling periods.

John supervised 2007 REU student Craig Brauer on the taxonomy of marine bopyrid cryptoniscans. They used a trapping method developed with Judy Miller to positively identify marine cryptoniscans for the first time. John worked with Teresa Sawyer, OSU Botany and Plant Pathology, on SEM images of these cryptoniscans in 2008 to produce SEM images necessary to complete this project for publication. Recognition of these first bopyrid cryptoniscans to be identified in the region allow greatly expanded opportunities to measure critical species in estuary ecosystem dynamics.

The above work permits research on the global transport of the cryptoniscans and assessment of how *Orthonie griffenis* was introduced to this coast. John reexamined 1990s ballast water samples from a Coos Bay survey, published in Science (provided Maritime Studies Program; Williams College – Mystic Seaport, CT) and DID NOT find cryptoniscans of O. g.

but, instead found several other species. John found *Ione* and *Orthonie* microniscans and cryptoniscans in coastal zooplankton samples provided by Alan Shanks, OIMB. These first confident identifications of marine cryptoniscans are major advances in invasion ecology and ballast water research.

John supervised 2008 REU student Caitlin White on “Bopyrid Isopod Parasite Recruitment and Growth in *Upogebia Pugettensis* and *Neotrypaea Californiensis*”. She presented this work: (White, Caitlin L.; Chapman, John W.; Dumbauld, Brett R.) in October 2008 at the joint meeting of the Argonne Symposium, “Transforming Science and Engineering Education” at the Argonne National Laboratory, Argonne, Ill.

Manuscripts accepted:

Lee II, H, B. Boese, **J. Chapman**, J. Life, P. Clinton, J. Lamberson, D. Specht, D. Reusser Accepted.  
Estuarine and regional scale responses of native and nonindigenous amphipods to climate changes in the Northeast Pacific, *Estuaries*, 38 pp.

Other accomplishments:

John continues as a member of the Western Regional Panel (of the National Invasive Species Panel) and organized the May 2008 Newport Sprint Triathlon – fund raiser for the Newport Swim Team and Newport High School National Honors Society for the fourth year.

Proposals submitted:

Doomed: Is *Upogebia pugettensis*, a native keystone species in West Coast Estuaries, threatened by its introduced parasite, *Orthonie griffenis*? National Sea Grant 218K (denied)

### ***Marine Fish Ecology***

**Selina Heppell, Associate Professor**

**Scott Heppell, Assistant Professor**

The Heppell Lab has been focused on nearshore fish ecology this year, with new projects starting in Yaquina Bay, several other Oregon estuaries and in Port Orford. Three of our master’s students completed their degrees this year: Kate Boersma (flatfish behavior), Marisa Litz (anchovy ecology) and Brett Gallagher (juvenile rockfish settlement and growth). We are completing our work on the impact of maternal effects on spawn timing and offspring quality in Alaskan Pacific ocean perch, working with fisherman Bert Ashley in Kodiak and PhD student Wade Smith with funding through the North Pacific Research Board and the Alaska Fisheries Science Center.

New projects include:

- Juvenile rockfish recruitment assessment with artificial settlement devices (Ali Dauble, MSc student, Markham Research Award recipient, funded through ODFW and CIMRS)
- Analysis of chemical signatures in sharks and rays to identify nursery habitats (Wade Smith, PhD student, Markham Research Award recipient, funded through the National Science Foundation)
- Collaborative research on nearshore rockfish, cabezon

and greenling through a tagging project in Port Orford (Suzanna Stoike, Marine Resource Management student, funded through Sea Grant)

- Analysis of documented changes in fish size and species composition in temperate marine reserves around the world (Heather Reiff, Marine Resource Management student, funded through Sea Grant)

Significant research findings from the Heppell Lab this year include the following:

- Juvenile halibut, rock sole and English sole show different behavioral responses to predation risk, suggesting that there are species-specific strategies for growth and survival in fish that exist in similar habitats (Kate Boersma, Markham First Year award recipient, funded through the Alaska Fisheries Science Center and North Pacific Research Board)
- Anchovy show strong inter-annual variability in abundance and distribution along the Oregon and Washington coasts, and spawn in multiple areas (Marisa Litz, Markham Research Award recipient, funded through the Northwest Fisheries Science Center and the OSU Minority Pipeline Fellowship Program)
- Changes in oceanographic conditions in 2005 vs 2006 affected phytoplankton availability and fat content of 4 species of forage fish (anchovy, sardine, whitebait smelt and Pacific herring), thereby influencing food web dynamics and energy transfer in the California Current ecosystem (Marisa Litz)
- Invasive New Zealand mud snails are spreading into coastal lakes and streams by way of vegetation attached to boat trailers, and are adapting to survive in environmental conditions that exceed the ranges observed in New Zealand (Michael Liu, Markham Research Award recipient, funded through HMSC)
- Rapid growth rates occur in black rockfish juveniles in Yaquina Bay and blue rockfish juveniles on nearshore reefs, exceeding rates found elsewhere (Brett Gallagher, funded through Sea Grant and CIMRS)
- Male, but not female, Dungeness crab in Yaquina Bay show strong site fidelity (undergraduate Group Problem Solving class, funded through Sea Grant and CIMRS)

### ***Marine Fisheries Ecology***

**Jessica Miller, Assistant Professor**

The Marine Fisheries Ecology program grew substantially during its second full year. The lab welcomed two new students: José Marin Jarrin, a PhD student, and Londi Tomaro, a MS student. José comes most recently from the University of Oregon where he completed his MS; he is interested in the ecology of surf zone communities and is exploring the role of surf zones in the early life history of fishes, with an emphasis on Chinook salmon (*Oncorhynchus tshawytscha*). Londi left a position at the Oregon Department of Fisheries and Wildlife (ODFW) to conduct research focused on quantifying variation in riverine and oceanic residence of juvenile mid- and upper Columbia River spring Chinook. She is examining how that variation relates to early

ocean survival. Pam Archer, a Marine Resource Management (MRM) MS student, will soon be defending her thesis, which examined the efficacy of efforts to re-establish the native oyster, *Ostrea conchaphila*, to Netarts Bay, Oregon. Lastly, Nicole Goehring, a summer NSF REU intern from Whitman College in Walla Walla, Washington, joined the lab to work on juvenile Chinook salmon ocean ecology.

Other projects include:

- A collaborative effort with the COMES Marine Fisheries Genetics Lab to determine the mixed stock composition of the Elk River terminal fishery, located on the south coast of Oregon. Here, information from several sources - genetics, scales, otolith chemistry, and coded wire tags - was combined to determine the relative contribution of a local hatchery run and adjacent wild runs to the fall fishery. Such information is needed to understand the potential impacts of fishery activities on local runs.
- As a component of the Collaborative Research on Oregon Ocean Salmon (Project CROOS), aspects of Chinook salmon juvenile migratory history are being reconstructed using adult Chinook otoliths to estimate their size when they initially left riverine environments and when they first entered the ocean. This effort has been focused on Central Valley Chinook salmon, for which there is extensive information on the size and timing of juveniles migrating out of freshwater systems but there is virtually no information on the fitness, or survival to reproduction, for these various migrants. Determining which of the dominant migratory behaviors is represented in returning adults will improve understanding of early ocean survival and potentially aid in-river management efforts.
- In partnership with researchers at the University of Washington and Portland State University, efforts to reconstruct the juvenile migratory history of upper Columbia River Chinook salmon from approximately 350 years ago are underway. Archaeological otoliths collected above Chief Joseph Dam prior to the latest pool rise provide us with the opportunity to examine migratory patterns prior to any hydrological alteration of the Columbia River system.
- Recently, the North Pacific Research Board (NPRB) funded a collaborative research project with researchers at NOAA's Alaska Fisheries Science Center (AFSC) to estimate source contributions and dispersal histories of Pacific cod recruits using otolith elemental composition. A new MS student will be recruited for this exciting project.

Other Activities:

Jessica developed and co-taught a course (Early Life History of Fishes) in collaboration with Dr. Lorenzo Ciannelli at OSU's College of Oceanic and Atmospheric Sciences (COAS), which will be offered again this Fall at HMSC. Jessica also served on the steering committee for the Pacific Estuarine Society Annual Meeting, which was held in February 2008 in Newport, Oregon,

and recently joined the Editorial Board of the Environmental Biology of Fishes as an Associate Editor.

Presentations:

- 2008. Annual Salmon Ocean Ecology Meeting, Nanaimo, BC
- 2008. Pacific Estuarine Research Society Annual Meeting, Newport, OR
- 2007: American Fisheries Society, 137th Annual Meeting, San Francisco, CA

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

**Michael Banks, Assistant Professor**

Our primary mission focuses on the application of genetic principles towards a better understanding of population processes for Pacific salmon and other economically important West Coast fishery species. We focus on methods for resolving hybridized, admixed, or recently diverged populations, and statistical means of determining component estimates for mixtures of such populations in various contexts. We're especially interested in resolving links between genetic loci and life history variance expressed among species.

This past year has been a tremendously productive year in the Marine Fisheries Genetics Program. Our class in Coastal Population Genetics offered in fall 2007 was well received, research support has earned almost \$4 million and we have produced 20 research publications dated either 2007&8! These include: 9 Chinook and 3 coho salmon, 1 coastal cutthroat trout, 2 groundfish, 2 oyster, 2 littorina peer review manuscripts and a computer application. Kathleen O'Malley completed her PhD with excellence recognized internationally as top highlighted article in *Proceedings of the Royal Society B* - a top class European journal. While the caption for this feature: 'Salmon gene determines timing of migration' overstates the comprehensiveness of our findings a little, we are very encouraged by the progress Kathleen's research has achieved.

Although the complete closure of the 2008 Chinook fishery has placed significant constraint on our Chinook salmon ocean distribution studies, this halt has allowed comprehensive analysis of the 2006 and 2007 data in preparation for publication. This has also afforded time for better coordination as this project has expanded to include collaborators in both California and Washington. The project's original website ProjectCROOS has been ungraded and will soon be released under the more encompassing name: PacificFishTRAX. Two of the Chinook manuscripts mentioned above cover baseline genetic data used for stock ID in the ocean distribution project and we have a third baseline paper in final preparation. We are keen to apply results from our clock gene and other genomic approaches to learn more about how stocks utilize different regions of the ocean in both time and space.

I am also pleased to report that our research into the large olfactory receptor gene family has been promising: we have revealed evidence that certain of the genes are most likely under

selection in coho salmon and through collaboration with the NWFSC are currently looking for family related expression differences among these markers.

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

**C. Scott Baker, Associate Professor; Jennifer Jackson, Postdoctoral Fellow; Debbie Steel, Faculty Research Assistant Renee Gibb, graduate student (MSc); Angie Sremba, graduate student (MSc); Alana Alexander, graduate student (PhD); Caroline Antolik, REU summer intern (2007); Ursula Gonzalez, visiting graduate student (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. As well as extending the scope of the Marine Mammal Institute, the CCGL adds to the strength of the established programs in genetics of marine fisheries (Michael Banks) and shellfish (Mark Camara) at HMSC. Research on large whales at the CCGL is pursuing three inter-related themes:

- reconstructing the past,
- assessing the present, and
- conserving the future.

#### **Reconstructing the past of whales and whaling**

To improve our understating of the impact of hunting on the abundance of whales and the ecological role of whales before human exploitation, the CCGL is 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 is currently working on the 'History of whale populations before whaling' in collaboration with Dr. Steve Palumbi (Stanford University), with funding from the Lenfest Ocean Program of the Pew Foundation. Jennifer is working on new analytical methods to improve population dynamic models used previously by the International Whaling Commission by including genetic information on long-term effective population sizes before exploitation 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).

#### **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 with funding from the National Fish and Wildlife Foundation.

Initial results of this first comprehensive description of population structure of humpback whales in the North Pacific were presented at the Biennial Meeting of the Society for Marine Mammal Science in Cape Town, South Africa (November 2007) and the International Meeting for the Study of Marine Mammals (SOMEMMA) in Ensenada, Mexico (May 2008).

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. Funding for this work has been provided by the International Fund for Animal Welfare (IFAW) and the Regional Natural Heritage Program, of the Australian Department of Environment and Heritage. At a recent meeting of the Consortium (February 2008), Debbie and Scott presented results from a large-scale DNA profiling survey of humpback whales, 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, individuals are capable of 'voyaging' between different regions in alternate years. Results of this work were presented to the annual meeting of the Scientific Committee of the International Whaling Commission in Santiago, Chile (June 2008), as part of the Comprehensive Assessment of humpback whales in the Southern Hemisphere.

A worldwide study of genetic diversity and population structure of sperm whales is planned through collaboration with Dr. Roger Payne, Iain Kerr and Dr. John Wise of the *Ocean Alliance*. During her five-year voyage, the *Odyssey* gathered a remarkable collection of samples that will provide new insight into the migration and social organization of this remarkable species. Alana Alexander, an incoming PhD student with the CCGL, has been awarded a three-year international Fulbright Fellowship to undertake this research.

Scott and Jennifer are ongoing participants in a collaborative working group on genetic monitoring, jointly funded by the National Center for Ecological Analysis and Synthesis (NCEAS) and the National Evolutionary Synthesis Center (NESCent). The aim of this group is to develop rigorous practical guidelines for the design of genetic monitoring strategies, and to provide a reference point for improving standards for assessments of population processes and trends. Jennifer attended the first meeting of this working group in March 2008 on behalf of the CCGL. The CCGL have presently undertaken a review of recent developments and best practice in DNA archiving on behalf of this working group.

#### **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. Scott and Debbie traveled to Tokyo, Japan in April 2008, to conduct genetic analysis of whale and dolphin products sold through the Internet (a recent change from the traditional markets). The work this year focused on monitoring the recent hunting of fin whales by the Japanese scientific whaling program and will be featured in a documentary

on the threat of hunting to fin and blue whales, scheduled for the National Geographic Channel in March 2009. The results of a five-year survey of whale products in Korea (Baker et al. 2007), have demonstrated the growing threat of unregulated exploitation of minke whales by fisheries entanglement ('net whaling'). Using a novel capture-recapture analysis based on DNA profiling of 'whalemeat' products, Baker et al. (2007) estimated that more than 800 minke whales have been killed and sold in Korean markets over this five-year period. This level of exploitation represents a serious threat to the survival of the genetically distinct population of minke whales found along the coast of Korea and Japan. The result of these surveys were presented at the meeting of the Scientific Committee of the International Whaling Commission in Anchorage, Alaska (May, 2007) and considered again as part of the In-depth assessment of North Pacific minke whales at the meeting in Santiago, Chile (June 2008).

#### **Other activities**

The future of whaling and the recent expansion of scientific whaling remain thorny issues for international conservation. In February 2008, Scott participated in a PEW Foundation sponsored symposium on the 'A change in climate for Whales' held at the United Nations University, Tokyo, Japan. The symposium considered legal and political solutions to the current impasse within the International Whaling Commission. A report of the discussion can be found at: <http://www.pewwhales.org/tokyosymposium/index.html>

In March 2008, Scott participated in meeting in Paciano, Italy, to discuss the roles of science in the future of whaling, 'Paciano, a conversation about whales and science', Sydney Holt, convener, with funding from Global Ocean. A report of this meeting can be found at: <http://aquacom.fcla.edu/1150/>

#### ***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)**

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.

Investigations of the physiological ecology of aging in pinnipeds took Markus and a team of six researchers from participating institutions to McMurdo Sound, Antarctica from late September through early December 2007, for the second and final of two field seasons. This project "Aging in Weddell Seals: Proximate mechanisms of age-related changes in adaptations to breath-hold hunting in an extreme environment" is funded by the National Science Foundation (NSF), directed by the PEARL, and carried out in collaboration with Dr. Jo-Ann Mellish (Alaska Sea Life Center; ASLC) and Dr. John Lawler (Texas A&M University).

Other participants included Markus' former graduate student Allyson Hindle (Ph. D., Texas A&M University) and M. S. student Jeanette Nienaber (University of Alaska Fairbanks), as well as veterinarian Dr. Pam Tuomi (ASLC) and Drs. Sue and Roger Hill from Wildlife Computers (Redmond, WA).

Over the course of the 2006 and 2007 field seasons, the research team worked with 48 adult Weddell seals from 9 to 27 years of age. Weddell seals are uniquely suited for this project: they have been studied over the past 30 years, providing a wealth of baseline data on population ecology, foraging behavior, as well as diving and reproductive physiology. Many animals are marked as pups, resulting in a large number of known age animals in this population, a must for a study on aging. In addition, the unique location where these seals dive under fast annual sea ice, allows researchers an unusual level of access to the seals in a 'natural laboratory' setting. Using animal-borne telemetry devices, data on dive depths, swim speeds, flipper stroking, feeding activity and electro-cardiograms were recorded. Blood samples and small muscle biopsies were collected and analyzed for indicators of oxidative stress implicated in aging processes, and for effectiveness of protective antioxidant mechanisms. The project is now in its final year of funding, to complete data analysis and publications. See OSU Media release from January 2007 on this project: <http://oregonstate.edu/dept/ncs/newsarch/2007/Jan07/weddell.html>

Kim Raum-Suryan, PEARL Faculty Research Assistant, is directing a remote imaging and monitoring project conducted at, and in cooperation with, 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, Kim will assess attendance patterns in Steller sea lion mother-pup pairs, under funding from the North Pacific Marine Science Foundation. The goal is to compare these to similar patterns collected by other researchers in Alaskan regions, and draw inferences on comparative levels in prey availability. Closely connected to this effort is another project funded by the NSF on "Development and Calibration of Remote Infrared Thermography of Homeotherm Animals." This project is an enhancement of the recently completed development (under NSF and NOAA funding) of the Satellite Linked Data Acquisition and Photogrammetry system (SLiDAP) for conducting three-dimensional photogrammetry on pinnipeds in remote locations. Using remotely collected physical morphometric and thermographic measurements, PEARL researchers can monitor body mass, health, condition and reproductive status of pinnipeds in many coastal areas. Stephen Meck, an undergraduate student (Biology) at OSU in Corvallis, 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.

Markus is continuing a project funded by the Steller Sea Lion Research Initiative (NOAA): "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." This research represents a large scale collaborative effort with co-PI Jo-Ann Mellish (Alaska Sea Life Center). Under this and a related project, four rehabilitated

California sea lions and fifteen juvenile Steller sea lions have been released to date, with recently developed, implanted Life History Transmitters (LHX tags). These devices allow remote monitoring of pinnipeds throughout their entire lives, a first for any marine mammal. This last year has seen the first data returns from the implanted devices. While such returns are no reason to rejoice – each return means that one of the study animals has died – they do prove the viability of the LHX tag concept, and have delivered very valuable initial data on seasonality and causes of juvenile Steller sea lion mortality. This project will continue with further implants scheduled for October 2008 and spring 2009. In a related project, Markus is “Developing information-theoretic models for testing the power and significance of pinniped survival rate estimates using differing monitoring techniques,” under funding from the North Pacific Marine Science Foundation.

Our long-term 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 2007 and 2008, 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. Markus gave the keynote Sea Fest lecture in 2008 entitled “Cool Science: studying seals and sea lions from Alaska to Antarctica”.

### ***Molluscan Aquaculture*** **Christopher Langdon, Professor**

A major focus of the OSU-COMES Aquaculture program at HMSC is the USDA-funded Molluscan Broodstock Program (MBP). This purpose of this program is to develop superior Pacific oyster (*Crassostrea gigas*) broodstock for the West Coast shellfish industry through selection. About 1200 families of Pacific oysters have been produced since the inception of MBP in 1995. These families have been planted at commercial test sites along the West Coast, from Prince William Sound, Alaska, to Tomales Bay, California. Yields of families from MBP selected broodstock after two generations of selection are, on average, 42% greater than those from unselected broodstock, with a realized heritability of 0.57. We are transferring outstanding broodstock families to commercial hatcheries for mass production of seed for the West coast industry that should improve their yields by about 75%.

MBP is culturing new strains of Pacific oysters, collected from southern Japan in 2004, that might be resistant to summer mortality – a serious syndrome that results in losses of up to 80% market-sized Pacific oysters on the West coast. Certified, disease-free F2 generation oysters were planted in Yaquina Bay in summer 2008. In addition, new Kumamoto oyster broodstock was collected from Japan in fall 2006 and has been spawned in MBP’s quarantine hatchery in 2007. New Kumamoto broodstock will be of great benefit to the West coast oyster industry as there is evidence that current stocks are inbred. Quarantine procedures are necessary for these new importations to avoid introduction of unwanted diseases, parasites and other “hitch-hiker” organisms.

MBP has also been in the forefront of efforts to help the oyster industry avoid the impacts of high concentrations of *Vibrio tubiashii* on hatchery production of oyster larvae and seed. *V. tubiashii* is a naturally-occurring bacterial species that is pathogenic to oyster larvae, although it has no known adverse effects on humans. MBP developed a seawater-treatment process that kills *V. tubiashii* cells and reduces concentrations of extracellular toxins. This treatment system has been scaled-up and installed in a commercial hatchery in Netarts Bay, Oregon where it has allowed the hatchery to continue to operate, even though larval growth and survival in untreated seawater was very poor.

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 also 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 have received funding from NOAA to continue 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, Assistant Professor-Senior Research**  
**Karen Fischer, Graduate Research Assistant (M.S.)**  
**Hannah Waters, National Science Foundation summer undergraduate intern**

This was the second year of for the Seabird Oceanography Lab (SOL) at OSU’s Hatfield Marine Science Center. The objectives of the newly formed lab include: i) Develop a research program focusing on marine and estuarine avian ecology and integrated ecosystem studies, ii) Provide research opportunities for graduate students, and iii) Participate in developing educational programs at the Hatfield Marine Science Center. Research conducted by SOL spanned the North Pacific, including projects in Japan, Alaska, and Oregon. During the report period, our lab received \$189,000 in funding, authored/co-authored one peer-reviewed paper, one M.S. thesis, and gave eleven 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 recolonization of historical breeding sites. 3) Albatross habitat use and fishery interactions off Alaska. 4) California Current Large Marine Ecosystem chlorophyll hot spots and marine protected areas. 5) Seabird surveys along the Newport hydrographic line. 6) Common murre reproductive biology and foraging ecology at Yaquina Head, Oregon, 7) Life history strategies and

environmental forcing across trophic levels and ocean basins. To view maps and information about SOL's albatross satellite tacking studies visit <http://www.wfu.edu/albatross/> and follow the link to short-tailed albatross studies.

**Short-tailed Albatross, Japan:** This is collaborative study between the Yamashina Institute for Ornithology, the Ministry of Environment, Japan, the U.S. Fish and Wildlife Service, and Oregon State University 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 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 sixth 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. A new 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:** 2007/2008 was the analysis and writing phase of the satellite tracking and dietary stable isotope studies of albatrosses captured at-sea in Alaska. This was the first simultaneous tracking study of all three North Pacific albatross species in an area where they co-occur at sea. Some of the highlights of this research included documenting resource partitioning among species and confirming suspected differences in movement patterns and habitat use of juvenile short-tailed albatrosses, relative to adults and sub-adults. The newly initiated short-tailed albatross fledgling tracking study will further investigate these unique findings.

**California Current Seabird Hot Spots and MPAs:** This is a collaborative study with PRBO Conservation Science and the Farallon Institute for Advance Ecosystem Research. This research included remote sensing data analysis (primarily chlorophyll as an indicator of phytoplankton production) of the California Current System from northern Vancouver Island, British Columbia, to Baja California, Mexico, using nine years of data from the SeaWiFS sensor. Novel analytical approaches were used to identify productivity "hot spots", quantify their persistence through time, and assess habitat-specific long-term trends in primary production. Highlights of results include identification of persistent productivity hot spots that coincided with known areas of high apex predator abundance, as well as identifying other potential areas lacking in survey data to fully evaluate the importance to predators and other highly migratory species. These results are particularly relevant to marine reserve planning. Furthermore, contrasting trends in long-term primary

production of nearshore versus offshore habitats were consistent with changes in some predator populations within respective domains and may reflect the effects of climate change induced upwelling intensification.

**Seabird Surveys Along The Newport Hydrographic Line:** This year, SOL continued seabird and marine mammal surveys along the Newport Hydrographic Line, 1-25 nm offshore of Newport. Dr. Bill Peterson (NOAA-HMSC) conducts long-term biological and physical oceanographic sampling along this line and has allowed observers to join cruises and survey between oceanographic sampling stations. The objectives of this research are to determine distribution and species composition of upper trophic level species in relation to primary production, zooplankton abundance, and physical features. These surveys also will permit assessment of seasonal and annual changes in abundance and distribution that may affect carcass deposition rate on local beaches. Furthermore, these data will contribute to long-term ecological research along this important oceanographic sampling line.

**Common Murre Reproductive Biology And Foraging Ecology:** Yaquina Head is home to possibly 90,000 common murre during the breeding season – one of the largest and most rapidly expanding murre colonies on the west coast. The Bureau of Land Management manages the Yaquina Head Outstanding Natural Area, located in Newport. SOL continued research and monitoring at this colony during the 2008 breeding season in collaboration with Alexis Wills (U.S. Fish and Wildlife Service) and Michelle Schuiteman (Oregon Department of Fish and Wildlife), and Hannah Waters (National Science Foundation intern), who is focusing on murre diet studies and is documenting striking changes in prey species diversity compared to the previous year. 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. Yaquina Head also is a very popular public attraction viewed by thousands of visitors annually.

**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 to understanding and predicting marine community response to climate change. A manuscript documenting these findings has been submitted and it is hoped that sufficient 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.
- *Regional Fishery Policy*: Invited presentation “Economic Incentive Strategies to Protect Fish Habitat” given to the Northwest Power and Conservation Council Science-Policy Exchange, Portland State University, September 12 & 13, 2007.
- *National Fishery Management*: Invited presentation “New Roles for SSCs: Perspectives from the Old Regime” at the National Marine Fisheries Service (NMFS) Workshop on the Magnuson-Stevens Reauthorization Act (MSRA) “Working Together on Implementation,” Washington, D.C., Sept. 23-27 2007.
- *National Fishery Management*: Invited seminar “Rights-Based Management under the Magnuson-Stevens Fishery Conservation and Management Act” to Marine Resource Management Program graduate students, Oregon State University, February 2008.
- *Fishery Management History*: Invited Commentary on *Cod: The Ecological History of the North Atlantic Fisheries*, by George A. Rose, for the International Journal of Maritime History.
- *Integrating Fishery Management and Markets*: Service on the Board of Directors of the Oregon State University Seafood Consumer Center.
- *National Ocean Policy*: Chair of the Social Science Review Panel (SSRP) 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.
- *National Ocean Policy*: Service on the Science Advisory Panel to the Joint Ocean Commission Initiative (JOICI), the combined implementation effort of the US Commission on Ocean Policy and the Pew Ocean Commission.
- *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 “Managing Fishing on the Last Frontier: How did we get here?” to graduate class in marine resource management, University of Tromsø, Tromsø, Norway, October 2007.
- *International Fishery Policy*: Invited lecture “Evolving Forms of Rights-Based Management in Developed

Fisheries” to graduate course in spatial allocation of marine resources, University of Tromsø, Tromsø, Norway, April 2008.

#### Incentive-Based Tools

- *Recreational Fisheries*: Book chapter “Evolution of Property Rights: Lessons of Process and Potential for Pacific Northwest Recreational Fisheries” in *Evolving Approaches to Managing Marine Recreational Fisheries*, Don Leal and Vishwanie Maharaj, eds, Lexington Books, in press.
- *Regional Regulatory Development*: Chair, Independent Experts Panel, an external advisory panel for the development of the trawl individual quota program of the Pacific Fishery Management Council. The *ad hoc* Panel is now disbanded.
- *Fishery Management Costs*: For the Northwest Alaska Fisheries Science Center, completed a review and wrote a report “Monitoring and Enforcement Costs in Limited Access Privilege Programs: A Review of the Evidence.” Presented the report at the November 2007 Workshop on Multispecies Groundfish Monitoring Systems, Seattle, Washington.

#### Fishing Communities

- *Oregon Working Waterfronts*: Collaborated on a Consumer Seafood Initiative research project 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. American Fisheries Society, in press.

#### 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.
- *Salmon Ecosystem Resilience*: Journal article “Institutions for Managing Resilient Salmon Ecosystems: The Role of Incentives and Transactions Costs, in press at *Ecology and Society*.”
- *Population Growth, Climate Change and PNW Ecosystems*: Organized, with Erik Merrill and Steve Waste of the Northwest Power and Conservation Council, an all-day symposium at the annual conference of the Western Division American Fisheries Society May 5, 2008. “Population Growth, Climate Change and Fish Habitat in the Columbia River Basin.” Presented the opening talk summarizing a report of the Independent Science Advisory Board: “Human Population Growth in the Columbia River Basin: Implications for Fish Habitat.”

**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) bioeconomic modeling of the pink shrimp fishery; 2) developing optimal traceability and accountability systems for handling, marketing, and sustaining albacore tuna and salmon; 3) developing education programs for fishery managers; 4) conducting consumer surveys to determine perspectives and values for developing seafood traceability systems; 5) developing market-based approaches for managing the environmental impacts of fishing; 6) developing case studies for improving education in stock assessment and international seafood trade; and, 7) 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 continue to publish work from a Sea Grant sponsored cooperative project with the Oregon Department of Fish and Wildlife and the Astoria Seafood Laboratory focusing on the economics of the Pacific pink shrimp industry. This research focuses on development of a bioeconomic model that shows the relationships of alternative economic objectives and the management, biological, and oceanographic characteristics of the fishery. 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 monies from Oregon Innovation Council and Federal Department of Economic development. 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 have initiated four new research projects including two funded by Sea Grant, and projects funded by USDA, the Oregon Watershed Enhancement Board (OWEB), and the federal government. The OWEB project is a major new initiative and a collaborative project (ProjectCROOS.com) 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 \$3.0 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 Science****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 700-year drought reconstruction for the west Cascade Mountains inferred from tree-ring data. Collaborators: Sarah Shafer of the USGS Corvallis and Rose Kormanyos, Whitman College.
- A dendrochronological reconstruction of Swiss needle cast disease outbreaks in 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 dendroecological analysis of relationships between growth rate and lifespan in North American tree species. Collaborators: Neil Pederson, Northern Kentucky University and Jim Colbert, NOAA

- 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
- Long-term relationships among climate, somatic growth, and recruitment in Acadian redfish and the implications for stock assessment. Collaborators: George Boehlert, HMSC and Ralph Mayo and Jay Burnett, NOAA NEFSC Woods Hole, MA.
- Age validation of Pacific geoduck using the tree-ring technique of crossdating. Collaborators: Claudia Hand 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: 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

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.
- Long-term relationships among climate, somatic growth, and recruitment in Acadian redfish and the implications for stock assessment. 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 also hosted summer interns. Matt Stuckey, and undergraduate at University of California, Berkeley worked in the lab during the summer of 2007 as participant in HMSC's National Science Foundation Research Experience for Undergraduates. This summer Laura Poppick, an undergraduate at the University of California, Berkeley, is completing an REU internship.

## College of Oceanic and Atmospheric Sciences

### *Marine Geochemistry* Clare Reimers, Professor

The overriding objectives of research in Clare Reimers' laboratory are to understand the role of seafloor processes in ocean chemical cycles and to develop new electrochemical tools

for ocean observations of biogeochemical properties.

During 2007-2008 two projects were the focus of group activities. The newest project, funded by the National Science Foundation, was initiated with the development of an instrumented platform that will be used to measure rates of benthic oxygen exchange 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, 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). Therefore laboratory equipment for microelectrode construction and testing was set up this year, and protocols developed for fabricating and selecting the most reliable sensors. Graduate student Kristina McCann-Grosvenor and intern Pascal Brignole were the major players in these efforts.

The second 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 San Diego Bay and the Monterey Submarine Canyon. These studies were led by Oceanography graduate student, Mark Nielsen, who also continued work under a Markham fellowship to determine if sediment electrical resistance measurements can be related empirically to sediment permeability. A REU summer intern, Diane Wu, joined in the benthic microbial fuel cell project as well by initiating laboratory experiments aimed at determining how efficiently added carbon substrates can be converted to electricity.

## College of Science

### *Department of Botany and Plant Pathology*

#### Gayle Hansen, Associate Professor

**Mission and objectives:** During the 2007-2008 academic year, Gayle Hansen, our marine botanist, continued with her research on the distribution, taxonomy and phylogeny of west coast seaweeds. In addition to her research papers, her ultimate goal is to provide comprehensive floristic accounts of the seaweeds in specific areas along the west coast from Alaska to Oregon. These studies are particularly important now since biodiversity information is being used as a part of the formula for determining the areas to be set aside as marine reserves.

**Floristic and distribution studies:** This year, Gayle completed a year-long floristic study of the seaweeds of Willapa Bay, an area in Washington where oysters have been farmed for more than 100 years. Well-known for its invertebrates that were accidentally introduced with oysters, the seaweeds of the Bay had never before been studied. Her research to date has revealed that Willapa Bay has more seaweed introductions than any other site

on the U. S. West Coast. More than 60% of the seaweed species are either introduced or cryptogenic (meaning widespread and of unknown origin), and 7 are new records to the Northwest. In addition to her Washington study, Gayle continued with her studies on Oregon seaweeds, adding biodiversity data to her target sites at Boiler and Netarts Bay.

**Taxonomic and phylogenetic research:** In order to verify the taxonomy of particularly difficult Northeast Pacific seaweeds, more than Gayle's morphological study is required. Molecular techniques must be used to determine the relationship of the species to similar seaweeds around the world. In order to accomplish this task, Gayle has collaborated with scientists and students from a number of countries around the world. This past year she worked with experts from Japan on green seaweeds in the Ulvales and from the Netherlands on red seaweeds in the Ceramiales, Dasyaceae.

**Outreach:** For the public, Gayle completed the algal part of a book entitled "The Alaska SeaLife Center Guide to Marine Life". This book was recently released on CD and includes more than 600 pages of illustrations and descriptions of Alaskan marine algae, invertebrates, fish and birds. In addition, she produced a commercial poster called "Oregon Seaweeds, A Sampler". This poster includes pristine illustrations of 40 of our local seaweed species and is available for purchase at the HMSC and OSU bookstores in Newport and Corvallis.

## Department of Science & Math Education

**Shawn Rowe, Marine Education Learning Specialist;  
Assistant Professor**

Shawn Rowe, Ph.D., represents the College of Science's Department of Science and Mathematics Education at the HMSC as well as the Environmental Sciences Program and the College of Oceanic and Atmospheric Science's Marine Resource Management Program. In addition to his own research, which focuses on developing accessible learning environments and tools for people to learn marine sciences in informal settings like the HMSC's Visitor Center, Rowe oversees or coordinates research and evaluation work by students from the College of Science that involves HMSC visitors. The Visitor Center is a prime laboratory for this research. Between July 2007 and June 2008, Rowe and/or students presented research findings from their work at the HMSC to attendees at the Northwest Aquatic and Marine Educators Conference; the National Association of Research in Science Teaching Annual Meeting; the Outreach Scholarship Conference Annual Meeting; and the International Conference for Science for the Next Society.

Studies underway this year at the HMSC's Visitor Center looked at how multiple stakeholders can be brought into exhibit design processes in meaningful and ongoing ways (Christine Smith -- *M.S. 2007*); how iPods change group learning dynamics and learning outcomes at exhibits (Molly Phipps -- *Ph.D. 2008*); how individuals and groups learn science from complex scientific visualizations of data (Celeste Barthel); how aquariums can be made interactive learning environments (Bill Hanshumaker);

and how learning can be facilitated through interactions with live animals (Shawn Rowe, Noreene Igelzi, Coral Gehrke -- *M.S. 2007*, and Jim Kisiel). Over the course of the year, at least one Science and Mathematics Education student has been in residence at the HMSC every quarter. Two Science and Math Education students, Christine Smith and Molly Phipps, completed their degrees this year based on their research at the HMSC.

Two students working with Dr. Rowe also completed Evaluation and Research Internships at the Oregon Coast Aquarium this year as part of completing their degrees. Eleanor Hodak -- *M.S. 2008*, a Marine Resource Management student, carried out comparative research on conservation messaging at the HMSC and the Oregon Coast Aquarium while preparing new live animal interpretive talks for OCA. Abby Nickels -- *M.S. 2008*, also a Marine Resource Management student, carried out base-line evaluation and research on motivations, conservation attitudes, and expectations of Aquarium visitors. She extended this work to compare motivations of visitors to the OCA, the HMSC's Visitor Center and Marine Discovery Tours, a local eco-tour operator.

As part of an NSF-funded project with Lawrence Hall of Science, Shawn Rowe and Science and Math Education graduate student Celeste Barthel taught the *Communicating Ocean Sciences to Informal Audiences* class during winter quarter. The purpose of the class was to introduce future scientists to communication techniques by giving them the opportunity to use hands-on materials to teach basic science concepts to schoolchildren, adults, and public audiences. Students from Oceanography, Marine Resource Management, Engineering, and Science and Math Education took the class 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.

## Department of Zoology

### Marine Ecology

**Bruce Menge, Distinguished Professor; Jane Lubchenco, 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/Jane Lubchenco, of Sally Hacker and of 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, Jane Lubchenco and Jack Barth as co-PIs 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 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 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 are also based out of the Science Center.

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

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

Gil Rilov (PISCO, Assistant Professor, Senior Research): Carries out studies of species interactions and the influence of larval supply on mussel communities on rocky shores.

Joe Tyburczy (Menge and Lubchenco 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 and Lubchenco Graduate Student, supported by NSERC (Canada) Predoctoral Fellowship and a Mamie Markham Graduate Fellowship): Dafne studies the influence of ocean acidification on larval condition in the inner shelf waters off Cape Perpetua. Her activities at HMSC include sample processing, microscope work, maintenance of cultures of larvae and larval food, and lab experiments.

Margot Hessian-Lewis (Hacker and Menge Graduate Student, supported by a NOAA National Estuarine Research Reserve Fellowship and a Mamie Markham Graduate Fellowship): Margot studies eelgrass communities, with a focus on interactions between eelgrass and macroalgae and how this is affected by nutrient inputs from terrestrial and oceanic sources (runoff

and upwelling). Her activities at HMSC include mesocosm experiments studying how eelgrass growth and interactions with macroalgae respond to controlled variation in density, light and nutrients, sample processing, and staging for field experiments.

Phoebe Zarnetsky (Hacker and Eric Seabloom Graduate Student, supported by a research assistantship from Sea Grant funds): 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*.

### **College of Veterinary Medicine**

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

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

Dr. Miller-Morgan also 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 also 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.

## 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 2007-2008, PCEB has begun transition to a new 5-year research effort in the area of Estuarine Ecosystem Services, while completing work under the existing research plan. 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 estuarine tidal wetlands of the Pacific Northwest. It may be argued that the reason why many ecosystems are in decline is that they are not valued as much as the other activities and products that degrade them due to a lack of public awareness of the many ecologic, economic, societal, and cultural values of ecosystems. Tidal wetland habitats are critically important due to their high biodiversity, productivity, nursery value, importance to threatened or endangered species, and for many other contributions to human well being.

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. As tidal wetland habitats are altered by human actions, so will the sum of the ecosystem services provided by these systems. Research will focus on highly valued services such as healthy fish, shellfish, and wildlife populations, and will evaluate the likely changes in terms of these and other ecosystems services resulting from impacts of current and future alterations of tidal wetland habitats.

The primary products of the research will be generally applicable GIS-based tools capable of estimating the value of 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. 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.

Current projects include research on:

- Estuarine biota-habitat relationships
- Responses of estuarine ecological engineering species (seagrasses, burrowing shrimp) to multiple abiotic stressors
- Factors controlling distribution of native and exotic seagrass species
- Range expansion and reproductive ecology of *Zostera japonica*, a non-native eelgrass in Yaquina bay
- Evaluation of watershed versus oceanic nutrient inputs to Pacific Northwest estuaries
- Assessment of distribution of non-indigenous species in west coast estuaries
- Conducting assessments of west coast estuarine resources

Research activities include large-scale (within and among estuaries) field studies and laboratory investigations of relationships between stressors and effects. PCEB administers and is the database manager for the western component of the National Coastal Assessment (NCA) of EPA, which completed most field sampling in 2006. The program was implemented to determine the condition of estuarine and near coastal resources of Washington, Oregon and California, with additional efforts in Alaska, Hawaii, and the Pacific Island territories. In 2007, the second year of an assessment of coastal condition of the Aleutian Islands of Alaska was successfully completed. During the year, PCEB scientists also published reports on the condition of coastal resources of Oregon and Washington, the Hawaiian Islands, and of condition of tidal wetland resources of Washington, Oregon, and California. Reports are available on line at: <http://www.epa.gov/wed/pages/publications/authored.htm>

During 2007, PCEB scientists led by Dr. Cheryl Brown published a report that was the synthesis of years of research results of field sampling, trend analyses, and a variety of modeling approaches to produce a nutrient criteria case study for the Yaquina Estuary. The case study presents an approach that could be used by the State of Oregon for establishing protective nutrient criteria for this system. Also associated with the nutrient criteria effort, PCEB scientists Pat Clinton, David Young, David Specht and Henry Lee produced a guide to mapping intertidal eelgrass and nonvegetated habitats in estuaries of the Pacific Northwest from infrared aerial photography. These research efforts are examples of work conducted in support of the Office of Water, in specific the coastal water quality criteria program of the Office of Science and Technology. Both reports are available on line at: <http://www.epa.gov/wed/pages/publications/authored.htm>.

Dr. Henry Lee together with Debbie Reusser of USGS (located with PCEB) were co-leads for a workshop on invasive species sponsored by the North Pacific Marine Science Organization (PICES). The workshop was to continue the development of a

common database for marine/estuarine invasive species in the Pacific Rim countries that are members of PICES (Canada, Japan, People's Republic of China, Republic of Korea, the Russian Federation, and the United States of America). The goal is to develop a common database format that will allow the integration of invasive species distributions and natural history data across all six Pacific Rim countries. The database for PICES is evolved from the Pacific Coast Ecosystem Information System (*PCEIS*) that is being developed by EPA and the USGS.

EPA research staff at HMSC consists of 18 federal employees, 2 EPA postdoctoral fellows, and 15 technical and clerical contract support staff. Scientists from the U.S. Geological Survey and the U.S. Dept. of Agriculture, Agricultural Research Service are co-located with EPA scientists. Dr. Gayle Hansen, a marine algologist, is located with PCEB through a guest worker agreement with OSU. PCEB interacts with the HMSC and wider university community both in research and educational programs. A number of PCEB staff scientists hold courtesy faculty appointments with OSU academic departments, and participate in teaching and serve on graduate student committees.

## National Oceanic and Atmospheric Administration (NOAA)

### *National Marine Fisheries Service*

#### Alaska Fisheries Science Center

##### *Fisheries Behavioral Ecology Program*

Allan W. Stoner, Program Manager

Alaska Fisheries Science Center's Fisheries Behavioral Ecology Program (FBEP) is based in Newport because of world class experimental seawater laboratories on the campus of the Hatfield Marine Science Center. The 10 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:

**Fish recruitment and climate change:** The Program has an increasing interest in how climate change, especially changing seawater temperature, affects growth and recruitment of larval and juvenile fish in Alaska. Experimental evaluation of the effects of temperature on larval and juvenile development is continuing with Alaska flatfishes, walleye pollock, and Pacific cod. In this endeavor FBEP scientists are partnering with researchers at Oregon State University and AFSC's Auk

Bay Laboratories to project the effects of climate change on recruitment of cod and other species in the Bering Sea. This research combines traditional live-animal laboratory experimentation on nutrition, growth and development, field studies in the Gulf of Alaska and the Bering Sea, biochemical approaches to fish condition, and numerical modeling. New studies are underway to investigate vertical migration behavior in larval and juvenile cod.

**Habitat requirements:** Habitat requirements of juvenile flatfishes and Pacific cod are a major focus in the Program. Spatially-explicit habitat models, based upon four years of towed camera surveys in Kodiak, Alaska, are being developed for juvenile northern rock sole. This is being supplemented with laboratory experiments in Newport and field trials in Kodiak to evaluate predator-prey relationships as they are mediated by nearshore substrata (seagrasses, algal beds and sediment types) and other environmental variables such as depth and light level. The ultimate goal is to understand and conserve important nursery habitats, and to reduce impacts of fishing practices. 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 unwanted bycatch. Emphasis has been placed on improving selectivity for commercially significant flatfishes in trawls and understanding bias in visual surveys conducted with underwater vehicles. During 2007, a new partnership was formed with the International Pacific Halibut Commission to explore ways of reducing unwanted bycatch of spiny dogfish in longline fisheries. Laboratory studies are being conducted with larger sharks at the Oregon Coast Aquarium.

**Bycatch Mortality:** FBEP continues to investigate the mechanisms that control mortality in fish when they are discarded from fishing operations (bycatch mortality). Simple indices of fish condition based upon reflex actions have been developed over the last several years to predict capture-related delayed mortality in a variety of fish species. These predictors are being incorporated into fishing experiments and aquaculture research with a wide variety of species in the United States, Canada, and Norway. Extending this line of research, the Program initiated new efforts with Alaska king, tanner, and snow crabs in 2007, and mortality predictors will be tested with a trawl experiment in the Bering Sea during the summer 2008.

#### Northwest Fisheries Science Center

NOAA Fisheries' Northwest Fisheries Science Center (NWFSC) is headquartered in Seattle and has five research stations in Washington and Oregon. The NWFSC's Newport Research Station, the Center's only ocean-port facility, is located on Oregon State University's Hatfield Marine Science Center campus. The Newport Research Station conducts critical research on groundfish, salmon and ocean conditions of the California Current Large Marine Ecosystem (CCLME) and supports 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**

NWFSC's OMI Division provides facilities management and support for the NOAA presence at HMSC consisting of the Barry Fisher building (BFB), Newport Aquaculture Lab (NAL), Research Support Facility (RSF) and numerous smaller buildings on the site. A new roof and gutter replacement for the Research Sport Facility was completed this year and a new larger freshwater filtration system was installed. A new operations and maintenance contract was awarded to OSU this year for maintenance of the NOAA buildings.

C. Barry Semple reported to Newport to provide IT Administration and Network Administrator Support to the NWFSC during the past year. Significant improvements within the intranet were made with the acquisition and deployment of secure network devices; IOT system upgrades and systems security was further augmented through FDCC implementation as mandated by OMB.

OMI's Safety and Environmental Compliance Staff (SECO) continued to provide training, inspections and consultations supporting environmental compliance and safety for the site. SECO completed the Control of Hazardous Energy plan (lock out tag out) and the Newport Research Station Laboratory Safety Plan this reporting period to comply with the last NECSAS review.

A NWFSC OMI senior staff position was assigned to Newport this reporting period to support strategic planning, research vessel activities, interagency coordination and support of NOAA regional collaboration efforts with a focus in Oregon.

NWFSC OMI staff worked closely with OSU to initiate a process to bring all personnel that work in the NOAA buildings in compliance with Federal Security identification policies under Homeland Security Presidential Directive 12.

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

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

Dr. Peter Lawson, Dr. Laurie Weitkamp and Heather Stout represent the Conservation Biology Division (CB) in Newport. Dr. Lawson's principal research interests focus on effects of climate and habitat change on 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. 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, 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.

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

**Salmon Harvest Management:** Dr. Lawson continues to provide technical advice to fishery management agencies through the Scientific and Statistical Committee of the Pacific Fishery Management Council (PFMC). He and Dr. Weitkamp also continued to serve on the Coho Technical Committee of the Pacific Salmon Commission (PSC). A major effort for both the PFMC and the PSC has been to develop methodologies for incorporating genetic stock identification (GSI) in fisheries management.

The Cooperative Research on Oregon Ocean Salmon project (Project CROOS) is a collaborative project with fishermen, industry, Oregon State University, Sea Grant Seafood Initiative, and others. The project goal is to develop techniques for applying GSI, global positioning system, geographic information system, satellite remote sensing, and other technologies to ocean



sampling of Chinook salmon. With the aid of the fishermen 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 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 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, and securing funding. As part of the project Dr. Weitkamp is conducting stomach analysis from fish collected during sampling in 2006. Her goal is to correlate stomach contents with location of capture and local oceanographic conditions.

**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 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) continued to work with the Oregon and Northern California Coast TRT, which considered listed coho salmon along the coast from the Columbia River to Punta Gorda, California. This process involved identifying independent coho salmon populations in the region using genetic, habitat, and behavior information and assessing conditions for viability and recovery of the identified populations and Evolutionarily Significant Units. This work was done in collaboration with 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 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 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: Dr. Frank Loge, Dr. Claudia Bravo, Dr. Joe Groff, Erik Loboschefskey, and Don Thompson, University California Davis, Greg Hutchinson, Josh Osborn, Stacy Stickland, and Ahna VanGaest, Aquatic Farms; and Dr. Tracy Collier, Lyndal Johnson, Dr. Nat Scholz, and Gina Ylitalo from the EC Division in Seattle.

**LABORATORY STUDIES**

**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 PAHs, suffered about 40% cumulative mortality compared to 29% for controls. They also conducted diet studies on juvenile Chinook salmon and found that fish exposed to the flame retardant, PBDE, were more susceptible to the pathogen (*Listonella anguillarum*) than those that were fed the control diet.

**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 polybrominated diphenyl ethers (PBDEs) on the response of immune system genes, EC scientists exposed juvenile fall Chinook salmon to an environmentally relevant concentration (0.1861 ng/g) of a 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 Columbia River. The fish were then challenged by water bath exposure for a 1-hour period to *L. 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. At defined periods post-challenge (0, 1 and 7 days), fish were sampled destructively and portions of their head kidney were 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.

**Characterize the impact of transport operations on disease transmission:** 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 have been raised from the egg stage and will be exposed to a freshwater pathogen (*Renibacterium salmoninarum*) through one or more infected fish to determine the effect of various fish densities on disease transmission and immune function. Immune function will be assessed in terms of the activities of complement, lysozyme, and toll-like receptors in response to the pathogen.

## 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, in conjunction with the Army Corps of Engineers, 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 are currently developing a conceptual model, based on existing toxicological information, 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 then compared to measures of ocean productivity (e.g., Pacific Decadal Oscillation (PDO), fishing harvest, and chemical production practices, to identify the impact of ecosystem variables on size.

**Anadromous Fish Evaluation Passage (AFEP):** EC scientists recently expanded research into host-environment interactions to address the impact of in-river stressors (e.g., dams) on host susceptibility in the Columbia River Basin. 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 conjunction with the Army Corps of Engineers and other NWFSC scientists and has been

published in the *Journal of Aquatic Animal Health*.

This study has been expanded upon to include PIT-tagged salmon from the Dworshak National Fish Hatchery located 73 miles upstream of Lower Granite Dam as well as examining survival of these fish in net pens located in the estuary. Data collected in these studies collectively suggest that the health of outmigrants influences delayed mortality, and in turn, the return of adults also known as the smolt to adult return (SAR) rates. In addition, these studies determined that the health of outmigrants is related to outmigration life-history strategy, estuary arrival timing, and the hatchery of origin.

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 analyses is underway to ascertain putative causes of death.

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, 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 life-history for holding periods less than 14 days. Collectively, the results from these studies suggest that (1) fish from Rapid River Hatchery are healthier than from Dworshak Hatchery, (2) unhealthy in-river fish are culled in the river system, and (3) barged fish are less susceptible to infectious disease than in-river fish.

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 both Dworshak and Rapid River Hatcheries. Sixty fish were collected from each hatchery as well as from Lower Granite, McNary and Bonneville Dams three times throughout the migration period. Finally, barged fish were collected upon arrival at Bonneville Dam at times concurrent with the collection of fish from the other locations. Sixty animals from each hatchery

were tested at each time period and at each location to ensure that we will detect at least one infected animal in a population with 95% confidence. PCR will be used to detect and discriminate between a number of bacterial and viral fish pathogens. High volume water samples have also been collected from the barge holds during transport at Lower Granite, McNary, and Bonneville and compared to water samples collected from the river at these locations to help determine the source of these pathogens.

Since contaminants can influence salmon survival and disease susceptibility EC scientist have collected two composites of 10 whole bodies each during each sampling event to estimate the concentrations of PBDE, PCB congeners, PAHs, DDTs and biliary fluorescent aromatic hydrocarbons.

### 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 (Loge et al., 2005). 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. Our research here at the Hatfield Marine Science Center focuses 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)***

**Dr. Ric Brodeur, Supervisor, Ocean Ecology**

**Dr. Dan Bottom, Supervisor, Estuarine Ecology**

**Dr. 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). Dr. Laurie Weitkamp represents the NWFSC's Conservation Biology Division (CB) in Newport and is also an active member of EOEP. Research programs involve extensive collaboration with scientists from Oregon State University, Oregon Graduate 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: Suzan Pool, Elizabeth Daly, Toby Auth, Jen Menkel, Carrie Johnson, Jason Phillips, Jesse Lamb, Mary Beth Rew; Research Associates: Drs. Hongsheng Bi, Hui Lui, Andrey Suntsov, Jay Peterson, Jim Ruzicka, Jim Colbert, Doug Reese, Linda O'Higgins and Graduate Students: Marisa Litz, Julie Keister, Todd Sandell, and Rebecca Baldwin; Contractors: Paul Peterson, 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 study of salmon feeding and relationships

between feeding preferences and prey, and of the potential impact of salmonid predators on salmon survival. FE scientists also study interrelationships between zooplankton and salmon, sardines, anchovy, and herring. In conducting these studies, scientists use an ecosystem-based approach to investigate the biotic and abiotic factors that control growth, distribution, health and survival of important fish species and on the processes driving population fluctuations. Ultimately, this ecosystem-based research (described in more detail below) will be applied to management of fish stocks off the Oregon coast.

FE scientists study predator/prey relationships among hake, mackerel, forage fishes and juvenile salmon off the Oregon and Washington coasts as part of a project funded by the Bonneville Power Administration. This project is led by Robert Emmett with field assistance from Carrie Johnson, Marisa Litz, Andrew Claiborne, and Paul Peterson. Cruises are conducted every 10 days 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.

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 Graduate Institute. As part of this study, scientists are collecting information on the distribution and abundance of salmon and other species in the upper water column, both in the plume and in coastal waters. These data will be related to ocean conditions and compared to data collected in the 1980s. Scientists are measuring salmonid growth, condition, pathogen load, food habits, and prey fields and relating them to ocean conditions in and around the plume. 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, Todd Sandell, Mary Beth Rew, James Losee, and Elizabeth Daly. This year, a new effort was started involving Drs. Wainwright, Ruzicka, and Colbert, to develop a suite of integrated simulation models for the plume linking ocean physics with plankton dynamics, salmon bioenergetics, and overall food web dynamics. The ultimate goal of these studies is to determine whether the plume represents a favorable feeding location for juvenile salmon.

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, we use 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. This program will improve understanding of why salmon are much more abundant off Washington than Oregon.

**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 two to three times per month at stations from 1 to 25 miles west of Newport. 2007 marks the beginning of the 12th year of these efforts. At each station, Leah Feinberg, 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. The summer of 2005 was unusual in the northern California Current, being characterized by a “warm water event” which resulted in a collapse of the food chain and high death rates of many fishes (including salmon) and seabirds. A perturbation of the normal climate forcing resulted in a delayed start of the coastal upwelling season, from the usual April to late July. Papers discussing the physical forcing and biological response were published in November 2006 in a Special Issue of Geophysical Research Letters. A similar set of events (delayed upwelling) occurred in 2006, however upwelling was initiated by late May, late, but not so late as to cause a problem for seabirds. Observations of ocean conditions early in 2007 have found cold ocean conditions through May, a positive sign.

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. Two visiting scientists from Georgia Tech University, Jeanette Yen and Kimberley Cattonm, spent several weeks working with the Peterson Lab where they filmed euphausiid and pteropod swimming behavior using high-speed digital cameras and lasers. Their interest is in how small animals motate in fluids with low Reynolds numbers.

**Copepod Studies:** Dr. Peterson and Karen Hunter continued analysis of historic data sets collected off Newport to describe long-term changes in hydrographic conditions and zooplankton abundance off the Oregon coast. Recent analysis of these zooplankton data show high correlation between coho salmon survival and zooplankton species and copepod community composition: when waters off Newport are dominated by species with subarctic Pacific (cold water) affinities, salmon growth and survival is high, but when the zooplankton community has anomalously high concentrations of warm water species, salmon do poorly. They also have shown that changes in 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 one to two years.

**Ecological Indicators:** Bill Peterson recently completed a report, "Ocean conditions and salmon survival in the northern California Current off the coasts of Oregon and Washington: taking an ecosystem approach to salmon management" that has been published on the web. This report includes nearly a dozen of ecological indicators of ocean conditions in the northern California Current and shows how some can be used to predict returns of coho and Chinook salmon one year in advance. A web page is now maintained by the Northwest Fisheries Science Center which provide 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.

**Ichthyoplankton Studies:** Dr. Brodeur, Dr, Peterson, Dr. Emmett, and Toby Auth examined ichthyoplankton samples from fixed stations off the Columbia River and 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.

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 2004-2007 (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. A review of the available catch data for larval and juvenile stages of Pacific hake indicate that spawning is widespread over all four years and has led to an increase in the abundance of juvenile hake in the Northern California Current, with substantial implications for the ecosystem and the management of this species. Dr. Andrey Sunstov also completed a study of the trophic ecology of juvenile hake and co-occurring lanternfishes using both direct

diet analysis and stable C and N isotopic analysis to examine possible trophic interactions. Dr. Brodeur is also involved in a similar study on juvenile rockfishes collected in these surveys.

**Biological Production Index:** As part of the NOAA Fisheries And The Environment (FATE) program, Drs. Peterson, Wainwright, and Ruzicka are developing a biophysical model of zooplankton production. This model will be used to reconstruct a time series of plankton production as an index of food supply for juvenile salmonids and other small pelagic fishes. This new ecological index will help improve fish harvest management.

**Regional Plankton Modeling:** In addition to modeling focused on the northern California Current, Drs. Wainwright and Colbert are developing plankton models in collaboration with the North Pacific Marine Science Organization (PICES) with funding from the NOAA Office of High Performance Computing and Communications. These models will be integrated into the U.S. national Earth Systems Modeling Framework, which will allow regional plankton models to be linked with global climate models, with a goal of comparing the climate response of primary and secondary production in the northern California Current and other coastal regions in the north Pacific.

**GLOBEC Investigations:** Zooplankton studies transitioned from the data acquisition to data synthesis phase. Synthesis activities began in 2005 and include 1) synthesis of salmonid studies, including distribution and abundance, trophodynamics and diseases and parasite studies along with determination of habitat requirements of juvenile salmon, and 2) population dynamics of euphausiids. Dr. Hongsheng Bi is developing statistical models of habitat requirements of juvenile salmonids and, with Dr. Bill Peterson and Cheryl Morgan, is developing statistical models that predict coho survival based on measurements of water temperature, chlorophyll, and zooplankton biomass and species composition. Suzan Pool and Drs. Brodeur and Reese are using a different suite of statistical tools (Generalized Additive Models, GIS and Classification and Regression Trees) to examine habitat preferences of juvenile coho and Chinook salmon based on the 2000 and 2002 GLOBEC sampling program.

Companion GLOBEC studies by Drs. Brodeur, Jacobson, and Wainwright and Emmett continued to investigate the distribution, abundance, growth, food habitats, and condition of juvenile salmon off Southern Oregon and Northern California. A number of scientists are contributing to these studies, including Suzan Pool (distribution and habitat associations of nekton and neuston), Todd Miller (feeding relationships among salmon and other nekton using isotopes and diet analysis), Rebecca Baldwin (parasites in sardines), Todd Sandell (pathogens of salmonids), and Dr. Jim Ruzicka (ecosystem models). Determination of associated pelagic nekton, including potential competitors and predators, will provide clues regarding the relationship between oceanographic conditions and the abundance and health of salmon during their first summer at sea.

Dr. Jacobson and Todd Sandell evaluated the ecology of disease and the importance of disease processes that affect salmon

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

Data from these studies were incorporated into broad regional analyses of the distribution, diet, species associations, and parasites of juvenile salmon throughout their distribution along the west coast of US and Canada and in the northern Gulf of Alaska. As part of a large-scale GLOBEC synthesis study of salmon in the Northeast Pacific, Dr. Brodeur co-edited a volume published by the American Fisheries Society in 2007 that examined regional comparisons of salmon distribution and ecology. Studies were made on regional comparisons in distribution (Fisher, Brodeur), feeding (Brodeur, Daly, Miller), parasites (Jacobson, Baldwin) and associated nekton (Pool, Brodeur, Emmett).

**Harmful Algal Blooms:** Dr. Bill Peterson was recently funded by the NOAA/OHAI program to begin 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, after which she enumerated phytoplankton species in plankton samples that Bill's group has been collecting since the year 2000. She has found a high incidence of *Pseudo-nitzschia* 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 NWFSC in Seattle, and with HAB scientists from Oregon State University (P. Stratton) and University of Oregon (M. Woods). Stratton, Woods, O'Higgins and Peterson recently received a five-year award from the NOAA MERHAB program to continue work on ecology of HABs and to develop forecasting capability for HABs in Oregon's coastal waters.

**Coastal Pelagic Species:** Drs. Jacobson and Emmett began a program in 2005 to investigate the migration and stock distribution of small coastal pelagic fishes, initially focusing on Pacific sardines off of Oregon and Washington. This program includes the use of parasites as potential biological markers and is being conducted by Rebecca Baldwin. In 2007 and 2008, we collaborated with personnel from NOAA's Southwest Fisheries Science Center (SWFSC) to conduct a coastwide survey of sardines using acoustics, trawling and egg sampling to estimate spawning stock biomass.

Drs. Richard Brodeur and Doug Reese are collaboration on a project to use LIDAR (laser) technology to survey pelagic

schools from airplanes and comparing abundance estimates to shipboard and moored acoustic arrays. A second survey off the Washington Coast in the summer of 2006 indicate very patchy distribution of schools related to oceanographic features such as fronts and the Columbia River Plume. Geostatistical techniques are being used to examine the proximity of fish schools and individual fish targets to the location of temperature and chlorophyll fronts determined by satellites. Researchers from NOAA's Environmental Technology Lab and University of Alaska, University of Washington, and Oregon State University are also involved in the project.

**Columbia River Estuary Studies:** FE and CB scientists have been regularly sampling the pelagic environment in the lower Columbia River estuary for forage fishes and juvenile salmon. This program is led by Drs. Weitkamp and Jacobson, with assistance from Todd Sandell, Carrie Johnson, Paul Peterson, and others. Information generated from this research includes: the timing of various stocks of juvenile salmon through the estuary and into the ocean, the size and health of juvenile salmon in the lower estuary, the relative abundance of different forage fish species, length/age-frequency distributions, and comparisons to offshore catches of forage fishes. Ultimately this study should identify if estuaries provide a "critical" habitat for a resource (forage fish), which strongly influences salmonid marine survival and the role the lower estuary plays in juvenile salmon life histories.

In collaboration with NWFSC scientists at other laboratories, Dr. Emmett has been conducting a Salmon Time of Release Study funded by the Army Corps of Engineers. This study examines the relationship among time of juvenile salmon ocean entry, physical and biological characteristics of the estuary and nearshore ocean plume environment, and smolt-to-adult return rates (SARs) for spring Chinook salmon reared by the Clatsop Economic Development Committee Fisheries Project (CEDC) in the lower Columbia River. By enhancing our understanding of the linkages between ocean entry and the physical and biological estuarine and ocean conditions smolts encounter, we can optimize SARs by manipulating transportation tactics and hatchery release dates.

A team of researchers led by Dan Bottom and supported by funds from the U.S. Army Corps of Engineers and Bonneville Power Administration 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.

**Coastal Estuary Investigations:** FE scientists, in collaboration with Oregon and Washington Departments of Fish and Wildlife, Oregon State University, and the University of Washington recently completed a project, funded by Oregon Sea Grant, to investigate Salmon River marshes in various stages of recovery following the removal of dikes and tidegates. The project included several phases that examined effects of restoration on salmon and prey resources in the estuary. The final phase of the project tested whether the results from Salmon River apply to tidal marshes in other Northwest estuaries and analyzed the relative contribution of various juvenile life history types to the returning adult population in Salmon River. Although most field studies for the Salmon River project were completed in 2006, the study team will continue to collect adult otolith samples in Salmon River to estimate the proportion of various juvenile life histories in the Chinook salmon spawning population. With Oregon Sea Grant support, the Salmon River study team convened a conference in April 2007 to discuss the concept of ecological resilience and applications for managing salmon ecosystems. Results of the conference will be published in 2008 in a feature issue of the online journal *Ecology and Society*.

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

**LCDR Devin Brakob, Newport Program Manager;  
Dr. Michael Schirripa, Supervisor, Assessment and Aging;  
Dr. Waldo Wakefield, Supervisor, Habitat Conservation and Engineering**

FRAM Division science team members, many of whom are located at the HMSC in Newport, conduct studies providing the 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. Michael Schirripa, Dr. Waldo Wakefield, Lisa

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

- 1) Cooperative Institute for Marine Resources Studies (CIMRS) fellow Dr. Vladlena Gertseva;
- 2) Oregon Coast Community College (OCCC) undergraduate student Kristin Titmas;
- 3) University of Maine (Hollings Scholar) undergraduate student Kyle Molton;
- 4) Pacific States Marine Fisheries Commission (PSMFC) staff Patrick McDonald, Nikki Atkins, Jennifer Cramer, Betty Kamikawa, Omar Rodriguez, and Susan Schirripa;
- 5) IAP World Services, Inc. staff Allen Cramer; and
- 6) The Data Entry Company (TDEC) staff Carol Ksycinski.

### **Stock Assessments and Stock Assessment Research**

In September 2007 Michael Schirripa obtained funding from the NOAA Fisheries And The Environment (FATE) program. Part of this money has been used to continue funding a CIMRS Research Associate position who is working with Dr. Schirripa on incorporating environmental indices in the stock assessments. Previous work within this project identified key oceanographic variables that were correlated with annual variations in sablefish recruitment success. This work was formally incorporated into the 2007 sablefish stock assessment. Since the completion of that assessment, FATE-sponsored work has focused on two issues: (1) Testing and improving the capability of assessment software to utilize available ecological indicators and correctly estimate pertinent fishery parameters; (2) Determining data requirements for future FATE studies. The Stock Synthesis Assessment Program (SS-II, Methot 2005) is the primary modeling software used in assessing West Coast groundfish. The research examines the ability of this software to estimate the effect of environmental leading indicators on fish population recruitment dynamics. By producing data inputs to SS-II that originate from designed simulations with known parameter values using an independent fishery simulation model, Dr. Schirripa is testing the ability of SS-II to recover the true underlying effects of the leading indicators on the simulated population, as well as the ability to differentiate between environmental drivers and other potentially confounding effects, such as random variations. This simulation project also has the potential to improve our understanding of a number of important assessment modeling questions, including estimating selectivity, survey catchability, and growth.

In May 2008, Dr. Schirripa co-convened a workshop during the PICES/ICES symposium "Effects of Climate Change on the World's Oceans". The workshop, entitled "Linking Global Climate Model output to (a) trends in commercial species productivity and (b) changes in broader biological communities in the world's oceans", included oral presentations given by scientists from international climate and fisheries disciplines. The goal of the workshop was to facilitate a coordinated international research effort to forecast climate change impacts on the distribution and production of the world's major fisheries, and on the biological communities in which these fisheries are



embedded. The specific objectives of the workshop were: (1) to review the activities of existing programs within each nation, (2) to examine the evidence for climate impacts on production of commercial fish species and other marine life, (3) to discuss the feasibility of developing medium-term to long-term forecasts of climate impacts, (4) to discuss possible responses of commercial fisheries, human communities, and governments to climate-driven changes in marine life, and (5) to identify common or standard approaches to forecasting climate change impacts on commercial species and marine communities and ecosystems. Workshop attendees identified climate scenarios for use in forecasting and then discussed development of forecasting tools for use in predicting climate impacts on commercial fish production and broader marine ecosystems. The workshop provided a forum for discussion of four components needed to complete the forecasts in a timely and coordinated fashion including; IPCC scenarios, predictions of oceanographic impacts, modeling approaches, and regional scenarios for natural resource use and enhancement. Details of these presentations can be found at the PICES web site ([www.pices.int/meetings/international\\_symposia/2008\\_symposia/Climate\\_change/climate\\_workshops.aspx#wsh2](http://www.pices.int/meetings/international_symposia/2008_symposia/Climate_change/climate_workshops.aspx#wsh2)).

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. The Ageing Lab produces ages to support NWFSC stock assessments. In addition to production aging, the Ageing Lab also cooperates with NWFSC stock assessors on research projects that enhance future stock assessments. From July 2007 through June 2008, the species and number of associated otoliths aged to support ongoing and future assessments were; sablefish (5,267), darkblotched rockfish (7,486), Pacific Ocean perch (2,666), canary rockfish (1,676), Pacific hake (6,973), and Dover sole (4,725). The total number of structures aged for this reporting period includes; production (22,752), cross training (2,911), double reads (3,268), and research (1,306). The maintenance of the Ageing Lab inventory for this reporting period included the following; structures (63,268), and species (61).

**Resource Surveys:** The FRAM survey members stationed at the HMSC, biologists Keith Bosley, John Buchanan, Erica Fruh, Dan Kamikawa and biological technician Melanie Johnson, 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 2007 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 2007 West Coast Bottom Trawl Groundfish Survey from May 2007 through October 2007. 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

such as otoliths for fish aging data and stomach samples for prey analysis. Survey members also collect biological samples and conduct cooperative research projects with and for other agency and university researchers around the country and the world. The 2007 survey was a success, completing 722 stations in 184 fishing days.

The 2008 groundfish survey began with the annual “At-Sea Safety” training and Survey Orientation sessions held at the HMSC April 29-30. The contracted fishing vessels *Noah’s Ark* and *Ms. Julie* embarked upon the actual survey in May and will return 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 scientists from the Oregon Department of Fish and Wildlife.

**Habitat Investigations:** The FRAM Habitat and Conservation Engineering (HCE) group, Dr. Waldo Wakefield and Julia Clemons, are located at The Hatfield Marine Science Center. The HCE group is responsible for conducting fish habitat studies off the U.S. West Coast. The group 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. Along the West Coast, a number of regional interdisciplinary groups have come together to apply innovative approaches to the study of fish habitat. In general, these groups have linked the fields of marine geology and fisheries to identify habitat associations of commercially important groundfish species. For Oregon and Washington, the HCE group has formed an interdisciplinary group with geologists from Oregon State University and the NOAA Pacific Marine Environmental Laboratory as well as invertebrate ecologists from Washington State University Vancouver. Examples of other recent and ongoing research projects involving the HCE group include work on fish behavior during interactions with bottom trawls, and stable isotope and dietary studies of demersal fishes.

*West Coast Essential Fish Habitat: Geologic and Geophysical Bottom Character Database and GIS for U.S. West Coast Groundfish* - The database and GIS project for West Coast Essential Fish Habitat is a joint effort between Dr. Chris Goldfinger’s Active Tectonics and Seafloor Mapping Laboratory (ATSML) at Oregon State University and the FRAM division. Initiated in 2001, the goal of this program was to create and use a comprehensive, helpful and easily accessible, multi-layered GIS database and associated CD-ROM based products for groundfish habitat assessment in the Pacific Northwest. The database for Oregon and Washington has been linked to an integrated habitat database for California (Dr. Gary Greene at Moss Landing Marine Laboratories and Mary Yoklavich at Southwest Fisheries Science Center). For the first time, marine researchers working along the U.S. West Coast have an integrated map of structural habitat for the entire region (San Diego, CA to Cape Flattery, WA). In addition, the combined GIS database for California,

Oregon and Washington was used in the recently completed Essential Fish Habitat Environmental Impact Statement for West Coast groundfish.

Version 1.0 of the maps for Oregon and Washington was completed in 2003. Since delivery of the interim maps, work has continued through 2008 on updates of the habitat maps. Information from this project feeds directly into the development of a new "PaCOOS, West Coast Habitat Data Portal" which includes a map viewer environment, providing access to various marine habitat data through an online mapping service (ArcIMS map server). The development of this website is being led by Dr. Elizabeth Clarke (NWFSC FRAM Division Director) as collaboration between the Northwest Fisheries Science Center, Oregon State University's ATSMML, Pacific States Marine Fisheries Commission, Alsea Geospatial Inc. and PaCOOS (Pacific Ocean Observation System). The data portal can be accessed via the Internet at: <http://pacoos.coas.oregonstate.edu/>.

*Oregon Seafloor Mapping Workshop* – On March 18-19, 2008 an Oregon State Seafloor Mapping Workshop was held at the LaSells Stewart Center on the Oregon State University campus. The workshop was organized by Dr. Chris Goldfinger (OSU) and Dr. Waldo Wakefield (NMFS NWFSC FRAM Division, HCE) and sponsored by the National Marine Fisheries Service (NWFSC and NW Region), the Oregon Governor's Office, Oregon Sea Grant, OSU's Cooperative Institute for Marine Resources Studies, OSU's Active Tectonics and Seafloor Mapping Lab and the Oregon Department of Fish and Wildlife. The workshop was attended by over 70 participants, representing federal and state agencies/offices, the Oregon Governor's Office and State Legislature, environmental organizations, the fishing industry and other private industries. With over 20 presentations and three workshop sessions, the workshop covered a wide range of issues, including current knowledge of the seafloor off Oregon, the application and demand for high-resolution maps, developments in seafloor mapping techniques and data delivery, habitat assessment and modeling in the Pacific Northwest, the marine reserves process in Oregon, overviews of mapping needs/efforts in California and Washington, and seafloor mapping initiatives for Oregon. Information from the workshop, including Power Point presentations, is available at: <http://activetectonics.coas.oregonstate.edu/omcmg/>.

*West Coast Bycatch Reduction Research: Fish Behavior During Interactions with Bottom Trawl* - Since 2004 the NWFSC has collaborated with the Oregon Department of Fish and Wildlife (ODFW) on a bycatch reduction research project to obtain baseline information on the behavior of demersal fishes when overtaken by a bottom trawl. In situ information of this nature is critical to the future development of species-selective trawls and bycatch reduction devices for West Coast groundfish fisheries. In this project a conventional low-light video was used in conjunction with a DIDSON (Dual-frequency IDentification SONar) ultrasonic imaging sonar to document and categorize fish behavior in response to interaction with a selective flatfish bottom trawl.

Summer 2007 marked the third field season for this research project. The project represents the first successful application of

a DIDSON sonar in bottom-tending mobile fishing gear, which produced dual observations of fish-trawl interaction with co-registered video and sonar imaging. A novel set of mounting frames provided a stable platform for sonically imaging all areas in front and in the mouth of the trawl (footrope, headrope, wings and footrope mud cloud form). DIDSON imaging of Pacific halibut, lingcod, Pacific hake, skates and flatfish will help inform the second phase of the project, namely assessing the methods to reduce bycatch. Information was gathered on trawl performance, in the form of observational data on the speed and direction of fish movement, herding behavior, wing interactions, and footrope and headrope effects. The 2007 field season continued studies initiated in 2006 that focused on deploying the DIDSON sonar system to obtain information on diel differences in response to contact with the trawl foot rope in the absence of artificial light. Data from the 2007 cruises are currently being analyzed. Preliminary information from this project was presented at the 2008 Western Groundfish Conference in Santa Cruz, California.

#### Acoustics

In addition to coast-wide bottom trawl surveys for groundfish, FRAM scientists from the Acoustics group, by employing advanced underwater acoustics technology, conduct both surveys and fisheries related research projects including survey data collection and analysis, research on environmental factors driving the distribution of groundfish species, and the application of acoustic technology to fisheries problems. Major efforts of the FRAM Acoustics group during July 2007- June 2008 included:

Completion of the 2007 US-Canada Joint Pacific Hake integrated acoustic and trawl survey. This survey was conducted from 16 June until 24 August 2007 aboard the NOAA ship *Miller Freeman*. The survey effort covered the area from Monterey, California (36°N), to southeast Alaska near Cape Muzon (55°N). The U.S. scientific team included Lisa Bonacci, the FRAM acoustician stationed in Newport, as well as OSU Oceanographer Steve Pierce and OSU graduate student Irene Watts. While Pacific hake were detected from Monterey Bay (36°N) to Dixon Entrance (54°N), the continuous aggregations seen in the 2005 survey were not observed during the 2007 survey. Aggregations of hake were observed from San Francisco to Point Arena, North of Cape Mendocino and off of Northern Oregon to the tip of Washington. Few hake were observed off of southern Oregon and Canada this survey. The area of highest concentration in Canadian waters was off the northeastern tip of Vancouver Island, BC.

Based on the acoustic survey, the coast-wide estimates of Pacific hake abundance totaled 0.88 million metric tons, a decrease from the 1.26 million tons estimated from the 2005 survey. Mid-water trawling showed that the range of smaller individuals (Age-1 and Age-2 fish) extended further north this summer than in previous surveys. Additionally more one year olds were seen during the 2007 survey than in previous surveys. Overall, the population was dominated in all geographic areas except Monterey by Age-8 hake. These fish, the 1999 year class, contributed about 43% of the total coast-wide biomass. In Monterey, Age-2 hake dominated, making up 63% of the biomass in this area.

During the 2007 survey oceanographic data were also collected in collaboration with scientists at Oregon State University. Vertical profiles of temperature and salinity data were collected using a Sea-Bird conductivity-temperature-depth (CTD) device at locations along designated acoustic transects. In conjunction with the CTD casts, vertical profiles of dissolved oxygen (DO) were collected using a Sea-Bird oxygen sensor that was attached to the CTD. In this way scientists were able to collect information about the location and extent of the low oxygen zone found off the Oregon coast during the time of this survey. Of special interest, was an area of low oxygen (<0.8 ml/l) beginning just south of Newport. In addition, ADCP data were also recorded along with acoustic data to provide the information on flow field within the survey area.

After completing the 2007 Pacific Hake survey, the acoustics team conducted several days of an inter-vessel calibration utilizing hake acoustic backscatter measurements. These measurements were taken on the NOAA ships *Miller Freeman* and *Oscar Dyson*. This work will continue in August 2008 when the group has approximately 22 days of ship time for work off of British Columbia.

**West Coast Groundfish Observer Program:** The West Coast Groundfish Observer Program entered its seventh 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 coast including two at HMSC: the Oregon and Washington observer coordinator, Allen Cramer, and data debriefer/data quality controller, Jennifer 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 2008 and held multiple annual refresher safety training for returning observers and FRAM's at-sea survey staff at the HMSC. HMSC's facilities and proximity to the docks make it a great place to train. Program outreach has included staff members volunteering at the 2008 HMSC Seafest, including coordination of the Science Zone. Other outreach conducted on a continuous basis is the aiding in fish specimens collection and working with the bottom trawl survey to update and improve an extensive species identification guide.

## 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.

**Acoustic Monitoring Project:** (Dziak Lead-PI, Matsumoto, Haxel, Fowler, Lau) The Acoustic Monitoring Project of the PMEL Vents Program provides wide-area, continuous seismic monitoring of global ridge systems using low-frequency acoustics. The primary focus of the effort is in using the U.S. Navy SOSUS hydrophone arrays to provide real-time monitoring of the JdFR/Gorda systems to queue event response efforts by PMEL/OSU - Vents scientists and colleagues. Additionally, we maintain and deploy both autonomous and near real-time (via satellite) hydrophone technologies for acoustic characterization of remote regions of the global oceans.

There are five main experiments/projects that were our research focus this past year; 1) Northeast Pacific volcanic event detection, 2) analysis of earthquake and volcanic tremor data recorded on an OBH array from Brothers Volcano (New Zealand) to evaluate the magma and subcrustal hydrothermal systems beneath the caldera floor, and 3) analyze the seismic activity recorded on our EPR hydrophone array from the January 2006 seafloor spreading event at 9EN, 4) analyze the Antarctic hydrophone data for seismo-volcanic activity as well as with the ubiquitous icequakes and iceberg harmonic tremor, and 5) begin analysis of Indian Ocean acoustic data recorded during hydrophone array deployments from September 2006 to January 2008.

**Exploration of Submarine Volcano off New Zealand Using an Autonomous Vehicle:** In a collaborative program with Woods Hole Oceanographic Institution, GNS Science (New Zealand) and IFM-GEOMAR (Germany), and funded by the NOAA Ocean Exploration Program, surveys conducted with the deep-water autonomous vehicle ABE off the German research vessel *Sonne* produced the first high resolution map of an active submarine arc volcano. The main focus of the cruise was to map in high resolution the caldera of Brothers volcano, located 400 km NE of New Zealand along the Kermadec volcanic arc. Multiple sensors deployed on ABE during 7 dives to the caldera produced co-registered layers of bathymetry, total magnetic field, water temperature and conductivity, water turbidity, electrical redox potential (Eh), and (on some dives) pH. The success of this approach is underscored by the robust correlations made between the crustal magnetization, submarine geomorphology and hydrothermal indicators in Brothers caldera. This in turn provided unique and valuable discoveries, including a previously unknown active hydrothermal vent field located along the western caldera wall at Brothers, and confirmation of a probably ancient hydrothermal vent field located in the southeastern part of the caldera. Details about the cruise are available on the

Ocean Exploration website at <http://oceanexplorer.noaa.gov/explorations/07fire/background/plan/plan.html> and the final cruise report can be downloaded from [http://oceanexplorer.noaa.gov/explorations/07fire/logs/aug16/media/nzasrof07\\_cruisereport\\_final.pdf](http://oceanexplorer.noaa.gov/explorations/07fire/logs/aug16/media/nzasrof07_cruisereport_final.pdf).

**Geophysical Monitoring and Seafloor Mapping at Submarine Volcanoes:** (Andra Bobbitt, Dr. William Chadwick, Susan Merle) The goal of this program is to better understand how submarine volcanoes work. Our efforts continue to be divided between projects focused on 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 that is in its tenth year. 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 probably risen by more than 1.5 m since the 1998 eruption. We will be repeating these measurements next summer (with NSF funding) to see if this trend is continuing. This is the first time that volcanic inflation has been documented at an active submarine volcano and it shows how the magma supply to the volcano changes with time. One of the goals at NeMO is to document a complete volcanic cycle at a submarine volcano.

We also continue to participate in the Submarine Ring of Fire program, a multidisciplinary international project that has included seafloor mapping and submersible dives on active volcanoes in the Mariana and Kermadec volcanic arcs in the W Pacific. In 2004 and 2006, we participated in expeditions that included ROV dives at submarine volcanoes in the Mariana arc, including NW Rota-1 volcano, which had been actively erupting during previous visits. This year we submitted a grant proposal to NSF, which they have indicated will be funded, to return to NW Rota-1 in order to make repeat observations and to carry out long-term monitoring experiments. This expedition will probably be scheduled in the spring of 2009.

Both NeMO and the Submarine Ring of Fire programs present opportunities for public outreach through the NeMO and the NOAA Ocean Exploration web sites:

<http://www.pmel.noaa.gov/vents/nemo/>

<http://oceanexplorer.noaa.gov/explorations/06fire/>

In both these projects, when CIMRS scientists are at sea periodic updates are posted on the web and these are often featured in public lectures at the Hatfield Marine Science Visitor Center during the expeditions. In addition to this oceanographic research, Chadwick continues to stay active in fieldwork related to volcano monitoring on land. This effort is focused on GPS monitoring networks on two active volcanoes in the Galapagos islands: Sierra Negra and Fernandina. Chadwick recently

received an NSF grant to continue this work, which will involve fieldwork to add two new GPS stations to the network at Sierra Negra. This project provides a valuable comparison to the results from observations at submarine volcanoes.

Helium Isotope Laboratory: NeMO Expedition. In August 2007 the NeMO (New Millennium Observatory) expedition used the ROV Jason II deployed from the mother ship *R/V Atlantis* to collect vent fluid samples at various sites on the Juan de Fuca Ridge off the Oregon coast. Leigh Evans participated in the expedition, and used special gas-tight titanium samplers to collect hydrothermal fluid samples on Axial Seamount, at a new site on the Cobb Segment, and at the Main Endeavour vent field on the northern Juan de Fuca Ridge. A total of 22 vent fluid samples were collected for dissolved gas analysis. For the sites within Axial Seamount caldera and on the Endeavour Ridge, these collections represent the most recent of a decade long time-series of vent fluid collections.

Aeolian Arc Expedition. In Oct.-Nov. of 2007, John Lupton participated in an expedition aboard the Italian ship *R/V Urania* devoted to exploring the submarine volcanoes of the Aeolian Arc. The Aeolian Arc consists of a suite of volcanoes in the southern Tyrrhenian Sea southwest of Naples, the most famous being Stromboli, which is erupting continuously. During the 11-day expedition, the *Urania* conducted water column surveys over 12 of the Aeolian Arc submarine volcanoes, and subsequent analysis of the dissolved helium in the water samples found evidence for hydrothermal activity on 5 of these volcanoes.

Cascadia Earthquake Swarm. On Sunday March 30, 2008, a large earthquake swarm began within the central Juan de Fuca plate, located ~150 nautical miles west of the Oregon coast and ~70 km north of the Blanco Transform Fault. The swarm was detected by Robert Dziak's acoustics group using the SOSUS submarine hydrophone array. A response cruise aboard the *R/V Wecoma* departed Newport, Oregon on Sunday, April 20th with Ron Greene serving as chief scientist assisted by Matt Fowler, Susan Merle, and Bill Hanshumaker (all of HMSC). The focus of the expedition was to search for water-column plumes that might indicate expulsion of hydrothermal or crustal fluids and/or seafloor volcanic activity. The *Wecoma* also deployed a hydrophone mooring to the east of the swarm area during the transit to the swarm site. On Tuesday, April 22, a second separate earthquake swarm began on the northern Gorda Ridge. In response to this new swarm, the *Wecoma* expedition was extended by 2 days and the ship was diverted to the northern Gorda Ridge. The *Wecoma* returned to Newport on Thursday morning, having completed 11 CTD casts, including 2 casts on the northern Gorda Ridge, which are being analyzed for helium isotopes and other properties in NOAA Vents laboratories. The hydrophone remains on seafloor to continue monitoring seismic activity

NW Lau Spreading Center. In April – June of 2008, Ron Greene from the Helium Isotope Laboratory went on a long expedition in the south Pacific aboard the Australian ship *R/V Southern Surveyor*. During the 40-day expedition, the ship conducted bathymetric mapping, dredging, and water column surveys of

the NW Lau Spreading center (NWLSC). The NWLSC is a spreading zone in the northern Lau Basin situated between Fiji and Tonga and associated with the Tonga subduction zone. It is of particular interest because the NWLSC lavas may have been affected by the trace of the Samoan hot spot as it migrated to its current position. The expedition found considerable evidence for hydrothermal activity along the spreading center axis and also dredged several excellent submarine basalt samples. Analysis of the basalt and water samples from this expedition are underway here at the HMSC.

**Marine Mammal Acoustics:** (David Mellinger, Sharon Nieukirk, Sara Heimlich, Holger Klinck) To acoustically monitor areas of the world ocean not covered by existing fixed hydrophone arrays, CIMRS and PMEL scientists have developed autonomous moored hydrophone instruments to record acoustic energy from both underwater seismic activity as well as that from whale calls. These instruments are capable of recording frequencies from 1 - 1000 Hz, and can record data for over a year before servicing is required. The hydrophones are designed to be deployed as an array of independent instruments whose geometry can be determined by the needs of the experimenter in order to localize acoustic sources of interest.

To identify whale calls in the large data sets collected by the autonomous hydrophones, automatic signal detection methods are being developed. Dr. Mellinger's automatic detection program, Ishmael, includes the ability to detect calls by use of several techniques. This software has been used to detect calls of blue and minke whales from Atlantic Ocean hydrophones, of right and sperm whales from the Gulf of Alaska hydrophones, of right whales on hydrophones on the Scotian Shelf, of blue whales in the Indian Ocean, of blue whales off the Antarctic Peninsula, and over other species elsewhere. Analysis of these data continue, with the goal of assessing seasonal distribution of species.

In 2006, three autonomous hydrophone instruments were deployed in the eastern Bering Sea in collaboration with NOAA's National Marine Mammal Laboratory. These instruments were configured for collecting sounds of North Pacific right whales, a highly endangered species of large whale. Two of these instruments were recovered in spring 2007 and the other in summer 2006. The data revealed the presence of right whales in the southeastern part of the Bering Sea, but not in the north-central part. The earliest right whale call in 2006 was recorded in June 2006 and the latest in November, with calling peaking in August and September. The next year, one call was heard in April, an exceptionally early date for this species, before the instruments were recovered the next month. Plans are also underway to look in the recordings for evidence of blue whales, fin whales, sperm whales, and other large whale species. In addition, the recordings contain sounds of pinnipeds, specifically walrus and bearded seals.

A related project involves bowhead whales in the Beaufort Sea north and east of Barrow, Alaska. The aim of this study, which is a large collaboration involving many institutions, is to understand the factors that influence bowhead whale seasonal distribution. The component of the project done at HMSC involves analyzing

long-term recordings with automatic detection software to find bowhead whale sounds and thus estimate the seasonality of bowhead whales in the area. Candidate detections are found by the software, after which an analyst manually checks the candidates to verify their accuracy.

A similar project is ongoing in the Atlantic, where five autonomous hydrophone instruments were deployed in July 2007 to record calls of right and other whales. These instruments will be recovered in July 2008 and, pending further funding, the data analyzed for calls of right and other whales. These data will extend a study of whale occurrence on the Mid-Atlantic Ridge that began in 1999 with the deployment by Dr. Robert Dziak of autonomous hydrophones on more southerly parts of the Ridge. Analysis of those data are ongoing, with the aim of understanding seasonal movements of blue, fin, and minke whales in relation to habitat factors.

For effective automatic detection, it is necessary to have, in addition to software, a library of target-species sounds that can be used to train and test detection algorithms. A project commenced in July 2006 to develop such a library, beginning with sounds of several species of beaked whales -- cryptic and poorly understood species that have become of high concern because of the impact of naval sonar and noise from the marine oil industry. In this project, recordings of beaked whales are being gathered and annotated so they can be effectively used in to develop optimum automatic detection methods. At present, the archive contains approximately 13,500 individually annotated whale vocalizations.

Work is also underway on hosting a conference. The conference, the Second International Conference on Acoustic Communication by Animals, will be held Aug. 12-15 at Oregon State University's LaSells Stewart Center. Approximately 175 people are presenting their work, and many more participants are expected.

Finally, we are initiating three projects. Holger Klinck is interested in developing an acoustic tag with a lifetime of weeks -- significantly longer than extant tags, which last just 1-2 days. He plans to perform a pilot project to study elephant seal vocalizations using these tags, and we have been preparing for this project by meeting with other seal researchers (notably Markus Horning of HMSC and Jan Hodder of the Oregon Institute of Marine Biology), studying tag designs, applying for permits, etc. The second project getting under way is to use acoustically equipped ocean gliders to detect beaked whales; work is underway on methods for automatically detecting these whales using a low-computational-cost algorithm suitable for the glider. This project is being done in collaboration with a glider group at the University of Washington. The third project, a collaboration led by the University of St. Andrews in Scotland, aims to estimate whale population density from fixed hydrophones, which includes both autonomous and cabled hydrophones. This done using several statistical approaches to distance sampling, including cue counting within a given geographic area, estimation of the detection range probability distribution, and localization and tracking of marine mammals.

## US Department of Agriculture

### *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 growing 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 project is to combine quantitative and molecular genetics techniques to develop improved breeding stocks for Pacific Northwest shellfish aquaculture. This program works in close collaboration with the Molluscan Broodstock Program to address economically important factors such as growth rate/efficiency, reproduction, survival, disease resistance, and product quality.

This past year, the ARS program in Shellfish Genetics focused on 4 major topics:

1. Using microsatellite DNA markers to determine the parents of oysters from plantings of mixed families. The ability to reconstruct pedigree information provides a powerful tool for conducting high intensity selective breeding while minimizing the deleterious effects of inbreeding depression.
2. Identifying patterns of gene expression in selected oyster strains that are associated with enhanced tolerance to heat stress and bacterial pathogens using DNA microarrays, cDNA-AFLP genome scans, and quantitative PCR. At present, summer mortality due to heat stress and bacterial pathogens causes substantial and sometimes catastrophic losses on oyster farms. By determining which genes are important for responding to heat stress, it will eventually be possible to directly select for genotypes that are more likely to survive.
3. Mapping quantitative trait loci that affect growth and survival in oysters. By identifying specific regions of the genome containing genes that enhance growth and survival makes it possible to a) select directly on these regions rather than on the traits they determine and b) narrow the search for specific functional genes to a small portion of the entire oyster genome.
4. Examining the genetic structure of native Olympia oyster populations. There is intense interest in restoring native

oysters, but almost nothing is known about whether or not there are genetic-level differences among the remaining populations that might impact the success of restoration efforts.

The long-term goal 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 has focused on two areas:

1. Examining the life history 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. Shrimp population monitoring efforts were continued in four coastal estuaries and results suggest that ghost shrimp recruitment continues to be relatively low in all estuaries, while mud shrimp recruited extensively to Yaquina Bay and Tillamook Bay in Oregon in 2006 and 2007 and moderate recruitment occurred in 2008. Mud shrimp did not recruit to our monitoring sites in Willapa Bay and Grays Harbor in Washington. A collaborative project with Dr. John Chapman at HMSC indicates that a parasitic bopyrid isopod is influencing reproduction in mud shrimp populations and that another species of bopyrid isopod has little effect on ghost shrimp populations. Shrimp life history is being examined for vulnerable periods such as recruitment of juveniles to the benthos and mating and molting during larger juvenile and adult life stages. A method using the ageing pigment lipofuscin was modified and used to examine the age of ghost shrimp. Shrimp populations in the above estuaries appear to have similar age classes present, but distinct differences in growth rate of shrimp were found in Willapa Bay and size clearly does not reflect age.
2. Studying the effects of shellfish aquaculture on estuarine habitats utilized by juvenile English sole, aslmon and other important fish and invertebrates in order to develop 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. Maps and a GIS were completed for Willapa Bay this year showing the intertidal distribution of eelgrass, burrowing shrimp and aquaculture. An underwater video system is being developed to track use of these habitats by fish and invertebrates.

## U. S. Fish and Wildlife Service

### *Oregon Coastal Field Office*

**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 2007-08, the Oregon Coast National Wildlife Refuge Complex had eight permanent employees, two 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. With the assistance of The Nature Conservancy, the USFWS acquired two parcels of private land at Siletz Bay NWR totaling 42 acres. Funds for the acquisitions came from the Federal Lands Transaction Facilitation Act (FLTFA) where funds are generated from the sale of excess BLM lands. Siletz Bay NWR was the first National Wildlife Refuge in the nation to receive funds in accordance with this act. The James H. Stanard Family Foundation also made a generous gift of funds towards the acquisition of one of the parcels at Siletz Bay. The parcels were refuge inholdings, and both provide opportunities for wetlands restoration and enhancement. At Nestucca Bay NWR, negotiations with a private landowner are nearing completion for acquisition of a key parcel of land within the refuge boundary. Acquisition of this parcel using FLTFA funds has already been approved.

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 with construction expected to occur in 2009 and 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. In addition, the USFWS is working with the OSU Cooperative Wildlife Research Unit to conduct a complete inventory of nesting double-crested cormorants along the Oregon coast. After many years of effort the Catalog of Oregon Seabird colonies was published this year by the USFWS and contains data on all sea bird nesting colonies on the Oregon coast from 1901-2004.

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. New this 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 429 artwork entries supported by 35 teachers and parents from 33 public, private, and home schools across the state. The 2008 Oregon "Best of Show" winner was Christine Swanson of West Linn who drew a pair of Northern Pintails titled "Pintails in the Snow. Completing work under a NFWF grant, educators hired through the AmeriCorps National Service Program brought the Shorebird Sister Schools Program to almost 700 4th and 5th grade students from Astoria 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. As part of its outreach efforts the refuge completed a brochure titled "Seabirds of the Pacific Northwest." Aimed at residents and coastal visitors the brochure covers life history and identification of seabirds, the threats facing these species and ways visitors can both enjoy and protect them. In addition, volunteers were critical to Refuge Complex operations this year. Bill Medlen, Invasive Species volunteer at Siletz Bay NWR, has given over 800 hours of time this year, clearing an estimated 20 acres of invasive plants and removing 7,000 pounds of trash and invasive plants. Ten Refuge Interpretation volunteers, stationed at viewing decks overlooking refuge rocks and islands, worked from May to September, giving more than 3,000 hours of their time and speaking with over 50,000 coastal visitors.

### *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 2007-2008, the Newport Field Office celebrated a number of accomplishments:

- Completed 13 restoration or habitat assessment projects under the Coastal Program which enhanced or restored 115 wetland and upland acres, restored or opened passage on 4 miles of stream, and provided a number of other benefits to threatened species, coastal ecosystems, and local communities. Anticipate approximately 14 projects will continue or be initiated in FY08.
- Initiated implementation of a strategic plan, completed in 2006 for our Coastal Program 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 1,500 pupae and 800 caterpillars on the north and central Oregon coast, with the assistance of approximately 50 volunteers. A total of 836 butterflies emerged from the augmented pupae and caterpillars. To improve habitat, volunteers and Service staff also planted 4,000 early blue violets, the host plant for Oregon silverspot larvae. Seeds were also collected from a number of nectar plants to be propagated by NRCS for future habitat restoration efforts.
- Contributed to Western snowy plover recovery efforts throughout the state including predator control, nest protection and monitoring, habitat restoration, law enforcement, and public education.
- Worked with Oregon Parks and Recreation Department to develop 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.
- 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*

**Bill Herber, Interim Program Manager**

As part of the Oregon Department of Fish and Wildlife (ODFW) Fish Division, the Marine Resources Program 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 70 seasonal or temporary positions. The annual program budget is approximately \$5 million: about 50 percent comes from federal sources and the remainder from state general fund and other state funds from license fees and commercial fish fund.

**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. ODFW watershed (regional) management is handled from the upstream estuary environment to inland freshwater outflows. MRP works in cooperation with the regional staff to coordinate this interface.

U.S. ocean fisheries are managed at the federal level through the Magnuson-Stevens Fishery Conservation and Management Act (MSA). This federal law forms the framework around which the west coast states regulate fisheries in state and federal waters. The law established an area from shore to three miles that 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 viewed as more conservative than those set in the federal process.



**Developing Marine Reserves in Oregon:** In March Governor Ted Kulongoski designated ODFW as the lead agency in his effort to establish marine reserves in Oregon. Marine reserves would be areas within Oregon's Territorial Sea, or adjacent rocky intertidal area, protected from all extractive and development activities, except as necessary for monitoring or research. MRP staff works with the Oregon Ocean Policy Advisory Council (OPAC) to determine sites for marine reserves through a comprehensive, collaborative process. OPAC is a legislatively-mandated marine policy advisory body to the Governor of Oregon.

Oregon Sea Grant, with assistance from ODFW, is leading the outreach for the state's marine reserves process. As part of that effort, the public is participating in proposing areas within Oregon's state waters to be considered for further evaluation as potential marine reserves. Proposals developed collaboratively with ocean users, coastal community members and other interested parties will have priority consideration. State agencies, working with the public, will collect detailed information about the sites and more thoroughly evaluate their suitability as marine reserves following funding by the 2009 legislature. After the evaluation, suitable sites will be considered for designation as marine reserves through a public rulemaking process.

For more information about Oregon's process to develop marine reserves, please visit the Oregon Marine Reserves website (<http://www.oregonmarinereserves.net>) or contact Cristen Don at the Oregon Department of Fish and Wildlife at (541) 867-4741.

**Expanded Shellfish Program:** MRP's shellfish program expanded in 2008 with the addition of four new permanent positions and seven limited duration positions. With the new permanent positions, the 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 addition, the limited-duration project began shellfish resource and estuarine habitat surveys in Coos Bay. This research project revisits work done by ODFW in the 1970s, to determine whether there have been changes in the number of bay clams in Coos Bay in the intervening 30 years.

**Commercial Dungeness Crab Fishery Management:**

Following pot limit rules instituted for the first time for the 2006-07 season, data collected by the MRP showed no significant changes in landings patterns in the commercial Dungeness crab fishery. MRP staff continued to work on issues in this fishery. 2007-08 season saw logbooks required for the first time so ODFW can now track location-based effort (individual vessel information is kept confidential). Responding to requests to allow adjustments to pot limits, ODFW conducted a public process to examine potential permit stacking plans. After several months of meetings, ideas, and discussions, no single plan was acceptable to the bulk of the fleet. Permit transfers or vessel sales remain as the way for crabbers to adjust the number of pot they can fish.

ODFW continues to work with the crab fleet to recover lost crab pots after the close of the season. Contractors completed 11 trips during the fall of 2006 and 2007 as part of a multi-agency grant.

Those trips recovered more than 250 derelict pots. More recently, a temporary rule allows vessels to bring in as many as 50 derelict pots at a time for the remainder of the season.

**Marine Mammals:** Planning for and implementing MMPA Section 120 lethal removal authority for California sea lions at Bonneville Dam dominated marine mammal staff time for the last six months (November 2007-April 2008). Work included: leading numerous interagency planning meetings; commenting on draft environmental assessment; overseeing non-lethal hazing activities; conducting capture and marking operations; briefing the Oregon Fish and Wildlife Commission and the US Marine Mammal Commission; pursuing funding through the Northwest Power and Conservation Council; providing written testimony for litigation in federal court; and finally implementing the permanent relocation authority granted by the court. The latter resulted in a total of six animals put into permanent captivity at Sea World prior to the premature halt of trapping for the 2008 season.

Other work included: preparing a manuscript summarizing five years of research on California sea lions in the Columbia River; participating in the Northwest Marine Mammal Stranding Network; planning and participation in a public forum on Pinniped-Fishery Interactions; participating at the annual Pacific Scientific Review Group meeting; participating at the Oregon Chapter meeting of The Wildlife Society; complying with marine mammal research permit conditions (report writing; application renewal); and analyzing pinniped fecal samples.

**2007-08 Research**

**Surveying Shrimp Grounds:** In June 2007 MRP researchers surveyed four areas on the Nehalem Bank in a comparative study to evaluate the effect of shrimp trawl bottom impacts. Two of the mile-square areas surveyed were within the Essential Fish Habitat area recently closed to trawling and two were just outside the area. The researchers successfully deployed the MRP's remotely operated vehicle (ROV) off of a commercial shrimp vessel to record visual data that will be evaluated for possible trawl impacts. A survey of the same areas will be done in five or six years to study trawl impact recovery over time.

**Reducing Fishery Bycatch:** MRP researchers continued work on projects directed at reducing bycatch in West Coast commercial fisheries. ODFW-funded research on the selective flatfish bottom trawls conducted in 2000-2003 showed that these low-rise nets with cut-back head-ropes maintained flatfish catches while reducing the catch of overfished rockfish species by 50 percent to 90 percent, which led to implementation of federal rules requiring the use of selective flatfish trawls for all trawl fishing inside 100 fathoms off Oregon, Washington and northern California. ODFW is continuing to work with the pink shrimp fishing fleet and state regulators to enhance the progress made with pink shrimp bycatch reduction grates in trawl nets

**Studying the Movement Patterns of Rockfish:** In the spring of 2006, MRP research staff initiated a study to look at movement patterns of a variety of rockfish in the Siletz Reef area. Understanding the movements of these long-lived fishes provides valuable information to scientists and fisheries managers, who are tasked with managing these commercially important species. The study uses surgically implanted acoustic tags and a 10 x 5 km grid of moored acoustic receivers to track an individual fish's depth and movement throughout the grid. Yelloweye and canary rockfish are of primary interest, but researchers also tagged black and quillback rockfish.

**Black Rockfish Research:** MRP researchers are in the sixth 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 in pectoral muscle tissue to assure tags are not lost and prevent non-reporting of tags. ODFW staff count and scan fish at charter and private docks then collect tags and biological information if a tag is found. This information also may assist in understanding fish survival rates and improve accuracy of black rockfish stock assessments.

**Fish Maturity and Ageing Studies:** Work continues on maturity studies to develop improved 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 and cabezon. Age information is critical for fishery stock assessments.

**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 multibeam 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 ODFW Marine Habitat Project's 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**

On visits ranging from a single day to weeks or months, 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. The Lavern Weber Visiting Scientist Fellowship was created to foster such interactions, providing support for long term visits. Named in honor of Lavern Weber, who directed the HMSC between 1977 and 2002, the program is funded by donations to the endowment and matching funds from the OSU Research Office.

In July 2007, the HMSC welcomed Gordon Kruse, Professor of Fisheries and Ocean Sciences at the University of Alaska Fairbanks, as the first visiting scientist under the recently endowed program. Kruse investigated the relationship between English sole larval abundance and availability of prey, and how this dynamic affects recruitment success for this important North Pacific fish species. He engaged in collaborative research with OSU, ODFW, and NOAA Fisheries researchers at HMSC and completed several manuscripts during his 6-month stay. Kruse also contributed to the educational enterprise at HMSC, sharing his extensive knowledge of fisheries biology and resource management with students in two OSU Fisheries and Wildlife courses during the fall term. He presented three guest lectures and lead a computer lab in which the students conducted their very first stock assessment using the “catch-survey analysis” procedure currently used to manage some crab fisheries in Alaska. In addition to presenting scientific seminars at HMSC and in Corvallis, Kruse delivered a presentation in the HMSC Visitor Center on November 11 geared toward the general public, addressing the question of how climate change impacts fisheries of the North Pacific.

Other visiting scientists hosted by individual faculty members, research groups or agency units at the HMSC during 2007-08:

**Jeannette Yen**, School of Biology, Georgia Institute of Technology – *hosted by Bill Peterson, NOAA NWFSC*  
**Vladimir Gertsev**, Rybinsk State Academy of Aviation Technology (Russia) - *hosted by Vladlena Gertseva, CIMRS*  
**Sabrina Lovell**, EPA National Center for Environmental Economics (NCEE) – *hosted by Henry Lee, EPA PCEB*  
**Nuno Simao**, University of Brest, France – *hosted by Bob Dziak, CIMRS*  
**Richard Brill**, Fisheries Science Dept., Virginia Institute of Marine Science - *hosted by Michael Davis, NOAA AFSC*  
**Ursula Gonzalez-Peral**, Universidad Autónoma de Baja California – *hosted by Scott Baker, MMI*  
**John W. Ferguson**, Fish Ecology Division, NOAA Northwest Fisheries Science Center, Seattle - *hosted by Michael Banks, CIMRS*  
**Dan Cooper**, NOAA Alaska Fisheries Science Center, Seattle – *hosted by Tom Hurst, NOAA AFSC*

**Won Sang Lee and Minkyu Park**, Korean Polar Research Institute – *hosted by Bob Dziak, CIMRS*  
**Robert Francis**, School of Aquatic & Fishery Sciences, University of Washington – *hosted by Selina Heppell, OSU F&W Dept.*  
**Fred Sharpe**, Alaska Whale Foundation, Seattle – *hosted by OSU MMI*  
**Phillip Clapham**, NOAA Alaska Fisheries Science Center, Sand Point Lab – *hosted by OSU MMI*  
**Stephen Palumbi**, Stanford University, Hopkins Marine Station – *hosted by Scott Baker, MMI*  
**Aaron Thode**, Scripps Institution of Oceanography – *hosted by David Mellinger, CIMRS*  
**Leslee Parr**, School of Biological Sciences, San Jose State University – *hosted by Brett Dumbauld, USDA*  
**Greg Johnson**, NOAA PMEL, Seattle – *hosted by Bill Chadwick, CIMRS*  
**Paul Wade**, NOAA National Marine Mammal Laboratory, Seattle - *hosted by Bill Chadwick, CIMRS*  
**Whitlow Au**, Marine Mammal Research Program, Hawaii Institute of Marine Biology, University of Hawaii – *hosted by David Mellinger, CIMRS*  
**Richard Feely**, NOAA PMEL, Seattle - *hosted by Bill Chadwick, CIMRS*  
**Dan Nichol and Dave Sommerton**, NOAA Alaska Fisheries Science Center, Seattle – *hosted by Al Stoner, NOAA AFSC*  
**Judith Denkinger**, Universidad San Francisco de Quito, Instituto NAZCA de Investigaciones Marinas – *hosted by Bruce Mate, MMI*  
**Neil Bogue, Matt Grund, Jim Luby, and Geoff Schilling**, Applied Physics Laboratory (APL), University of Washington – *hosted by David Mellinger, CIMRS*  
**Stephanie Moore**, School of Oceanography, University of Washington – *hosted by Bill Chadwick, CIMRS*  
**Pascal Brignole**, MISSAO, University Sud Toulon-Var (France) – *hosted by Clare Reimers, COAS*

#### International delegations:

Nanjing Agricultural University delegation (four faculty)  
 Governor Irwandi Yusuf’s delegation from Aceh, Indonesia (ten members)  
 Ocean University of China delegation (four faculty members)

## II. FACILITIES

### HMSC Facilities

**Randy Walker, Facilities Manager**

Facilities was busy this year doing maintenance and upgrading systems needing attention that have been overlooked because of the volume of construction performed in the past few years. Many upgrades to the stand-by power system have now been accomplished. In addition, new plumbing for potable water was installed in the East wing of the 900 building. This has solved a long-standing problem impacting research.

Phil Rau, a plumber, was added to the Facilities department team at the end of November 2007. Mr. Rau worked closely with other team members to install an in-house autoclave that was recovered from a lab remodel and was no longer in use. This project has been a welcome addition to HMSC as it allows researchers to perform sterilization work closer to their laboratories.

Facilities provided integral support for OSU's institutional branding effort at HMSC this past year, working in concert with the University Advancement office. New banners, plaques, and signs were installed around the Visitor Center, including an informational display about OSU's research vessels. Facilities also re-positioned the Yellow Submarine that greets visitors as they approach the main entrance, constructing a new base mount for the popular icon.

Over the past year, Facilities has provided project direction and oversight for crews from the Angell Job Corps vocational training program in erecting an outdoor picnic shelter adjacent to the dining hall in the HMSC housing complex. Preparatory work was also completed for a new temporary dock facility to support research and small boat needs of HMSC. The dock is nearly complete and the pilings that will hold the dock in place will be driven during the Winter 2008-09 in-water work period.

As always, we are looking forward to serving the researchers and staff at HMSC during the next 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 18 vessel-operating institutions in the University-National Oceanographic Laboratory System. The COAS 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 2008 her 170 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 the NSF funded Science and Technology Center for Coastal Margin Observation and Prediction (CMOP) off the Oregon coast and in the Columbia River, Mixing Measurements at the Equator on the TAO mooring, and a variety of work off the coasts of Oregon & California, and in Puget Sound.

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 of 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 three science vans in the pool including an isotope van, a general-purpose van and a "cold laboratory" van. 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/)

### III. EDUCATION

#### *Student Enrollment Statistics*

Ichung Cheung, Academic Program Coordinator

Summer 2007	Credit	Course Title	2007-2008
BI 299	4	Introduction to Marine Biology (Newell)	6
BI 302	4	Biology and Conservation of Marine Mammals (Sumich)	7
FW 302	4	Biology and Conservation of Marine Mammals (Sumich)	3
FW 499/808	3	Scientific Methods in Conservation Biology (Heppell)	Cancelled
SED 431/531	3	Understanding Free Choice Learning for Education and Outreach (Rowe)	Cancelled
ST 521	4	Introduction to Mathematical Statistics (Thielman)	3
ST 522	4	Introduction to Mathematical Statistics (Irvine)	3
WR 406	1	Writing with the Tides: A Creative Writing Workshop (Barrington)	1
WR 506	1	Writing with the Tides: A Creative Writing Workshop (Barrington)	0
WR 808	1	Writing with the Tides: A Creative Writing Workshop (Barrington)	1
WR 406 workshop	0	Writing with the Tides: A Creative Writing Workshop (Barrington)	5
Z 565	3	Marine Conservation Science and Policy (Lubchenco)	23
Fall 2007	Credit	Course Title	2007-2008
AqS 100 (OCCC)	3	Intro to Aquarium Science (M. Mann)	17
AqS 215 (OCCC)	4	Biology of Captive Fishes (M. Mann)	13
AqS 220 (OCCC)	4	Biology of Captive Invertebrates (M. Mann)	12
AqS 240 (OCCC)	4	Life Support Systems and Design (M. Mann)	12
FW 407	1	HMSC Research seminar (Boehlert)	3
FW 507	1	HMSC Research seminar (Boehlert)	6
FW 426	5	Coastal Ecology and Resource Management (Langdon)	11
FW 526	5	Coastal Ecology and Resource Management (Langdon)	1
FW 442	2	Problem Definition and Analysis in Fisheries and Wildlife (Heppell)	5
FW 454	5	Fishery Biology (Heppell)	12
FW 554	5	Fishery Biology (Heppell)	5
FW 474	3	Early Life History of Fishes (Miller)	11
FW 574	3	Early Life History of Fishes (Miller)	7
FW 520	3	Ecology and Management of Marine Fishes (Heppell)	17
FW 590	6	Coastal Genetics and Conservation (Banks)	6
FW 499	2	Stock Assessment seminar (Gertseva)	6
FW 599	2	Stock Assessment seminar (Gertseva)	5
FW 499	3	Whales and Whaling (Baker)	7
FW 599	3	Whales and Whaling (Baker)	1
Winter 2008	Credit	Course Title	2007-2008
AqS 232 (OCCC)	4	Nutrition and Reproduction of Captive Fishes and Invertebrates (Koike)	13
AqS 270 (OCCC)	4	Fish and Invertebrate Health Management (Miller-Morgan)	12
BI 234 (OCCC)	4	Microbiology (Duerr)	14
FW 507	1	HMSC Seminar (Heppell)	3
FW 599	4	Fishery Stock Assessment Methods (Sampson)	2
ST 511	4	Methods of Data Analysis (Schaefer)	5
BI 111	1	Intro to Marine Life in the Sea: Habitats (Cheung)	15
FW 111	1	Intro to Marine Life in the Sea: Habitats (Cheung)	4
Spring 2008	Credit	Course Title	2007-2008
AQS 220 (OCCC)	4	Biology of Captive Invertebrates (Mann)	4
BI 103 (OCCC)	4	General Biology (Fritz)	19
FW 473	4	Fish Ecology (Noakes)	3
ST 512	4	Methods of Data Analysis (Gitelman)	4
FW 507	1	FW Seminar (Chen)	2
BI 450	8	Marine Biology lecture (Hacker)	22
BI 450 Lab	8	Marine Biology Lab (Hacker)	22
BI 199	1	Intro to Marine Life in the Sea: Marine Mammals (Sumich)	9
FW 199	1	Intro to Marine Life in the Sea: Marine Mammals (Sumich)	9
VMB 727	2	Ornamental Fish Medicine (Miller-Morgan)	3

## *Internships at HMSC*

### **Itchung Cheung, Academic Program Coordinator**

Internships are recognized as one of the best learning experiences a young person can have in preparing for almost any profession. For those contemplating careers in marine science education, research, or resource management, 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 2007-08, twenty-five students took advantage of internship opportunities offered by OSU and partner agencies at HMSC. Students secured positions by applying directly to the researcher or agency hosting the internship, or by applying to the HMSC Visitor Center Education internship or the NSF-funded "Research Experience for Undergraduates" (REU) program. Twenty 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 2007.

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. One undergraduate student participated in the NOAA Alaska Fisheries Science Center internship and one OSU undergraduate student received valuable administrative experience in Academic Programs through the state sponsored Professional and Managerial Internships in State Employment (PROMISE) program.

Seven of the REU student interns from the Summer 2007 program presented research posters at the March 2008 American Society of Limnology and Oceanography, Ocean Sciences Meeting, Orlando, Florida.

Benkwitt, C.\*; Brodeur, R.; Daly, E.; Hurst, T.: Diel Feeding Chronology, Gastric Evacuation and Daily Food Consumption of Juvenile Chinook Salmon in Coastal Waters. Poster Presentation.

Brauer, C. E.\*; Chapman, J.: Trapping Bopyrid Isopod Cryptoniscans for Taxonomy. Poster Presentation.

Fulton, D. P.\*; Kurapov, A. L.; Springer, S. R.; Allen, J. S.; Hickey, B.M.; Barth, J. A.; Kosro, P. M.: Effects of the Columbia River Plume on the Dynamics of Upwelling Off Oregon. Poster Presentation.

Nace, T.\* and Goni, M. A.: Origin and Distribution of Organic Matter Derived from the Umpqua, Klamath and Eel Rivers. Poster Presentation.

Payton, J. R.\*; Hawkyard, D. M.; Langdon, C. J.: Use of Wax

Beads to Facilitate Bioencapsulation of Oxytetracycline by *Artemia salina* Nauplii. Poster Presentation.  
Salahuddin, Z. Q.\*; Ryer, C.H.: Phototaxis and Habitat Preference by Juvenile English Sole. Oral Presentation. Received second place in the Outstanding Student Presentation category.

Stuckey, M. J.\*; Black, B. A.: High Resolution Reconstructions of Sea Surface Temperatures from Pacific Geoduck Growth Increment Chronologies. Poster Presentation. Received Outstanding Student Poster Award at meeting.

During the summer at HMSC some students gained research experience at sea, in some cases before or after the REU project. For example, Casey Benkwitt (working on juvenile Chinook Salmon) arrived early to participate in one of two cruises aboard the RV Miller Freeman. Jessie Martinez accompanied her mentor, Brett Dumbauld, on a trip to Willapa Bay, Washington. After the end of the REU program, Daniel Fulton and Andrew Sherman remained in the program continuing their research through the end of summer. Students who conducted laboratory-based REU projects 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.



HMSC Interns, Summer 2007

<b>REU Interns</b>	<b>Undergraduate Institution</b>	<b>Faculty Mentor</b>	<b>Project Title</b>
Antolik, Caroline	Eckerd College	Baker, Scott	Diversity and differentiation of mtDNA among humpback whales ( <i>Megaptera novaeangliae</i> ) on both the tropical feeding grounds and the Antarctic feeding Areas of the South Pacific Ocean
Benkwitt, Casey	Bowdoin College	Brodeur, Ric	Diel feeding chronology, gastric evacuation and daily food consumption of juvenile Chinook salmon in coastal waters
Brauer, Craig	Illinois Wesleyan Univ.	Chapman, John	Soliciting sex for bopyrid taxonomy
Jarvis, Marley	Carleton College	Peterson, Bill	Molt cycle and molting behavior of krill ( <i>Euphausia pacifica</i> ) off the Oregon Coast
Martinez, Jessie	Carleton College	Dumbauld, Brett	Does intertidal aquaculture create an edge effect on habitat use by estuarine fish?
Payton, Jamila	Univ. of Arkansas at Pine Bluff	Langdon, Chris	Use of wax beads to facilitate bioencapsulation of oxytetracycline by <i>Artemia nauplii</i>
Salahuddin, Zahirah	Univ. of Maine	Ryer, Cliff	Phototaxis and habitat preference of juvenile flatfish
Stuckey, Matt	Univ. of Calif. Berkeley	Black, Bryan	Networks of geoducks chronologies: the potential for sea surface temperature reconstructions.
Wollschlager, Jennifer	Eckerd College	Banks, Michael	Evidence of Selection in a Vomeronasal Type 1 Pheromone Receptor Gene in Fishes of the Family Embiotocidae
Wu, Diane	Cornell Univ.	Reimers, Clare	Increasing Power Generation in Benthic Microbial Fuel Cells through Supplementation with Lactate
<b>HMSC Education Intern</b>	<b>Undergraduate Institution</b>	<b>Faculty Mentor</b>	<b>Project Title</b>
Alvard, Charlotte	Oregon State University	Hanshumaker, Bill	Guardians of the Forest - Sea Otter Genetics
Heesacker, Kirsten	Oregon State University	Hanshumaker, Bill	Short Tailed Albatross Research
Johnson, Jessica	Oregon State University	Hanshumaker, Bill	Green Sea Turtle Project
<b>Promise Intern</b>	<b>Undergraduate Institution</b>	<b>Faculty Mentor</b>	<b>Project Title</b>
Maxwell, Grady	Oregon State University	Cheung, Itchung	Academic Program Development at HMSC
<b>NOAA</b>	<b>Undergraduate Institution</b>	<b>Faculty mentor</b>	<b>Project Title</b>
Erin Seale	California State University Fullerton	Hurst, Tom	Vertical Distribution of Pacific Cod Larvae with Varying Light Intensity

**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 2008 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 17. Students who had made significant progress towards completion of their research gave brief presentations. Those students being awarded new monies for 2008-09 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.	Anthony Doan (\$250)
<b>Captain Fred Anderson Memorial Award</b> - To support educational expenses for new high school graduates from Lincoln County, Oregon	Bo Johnson, Toledo High School (\$500)
	Nick Price, Newport High School (\$500)
	Beth Stam, Toledo High School (\$500)
<b>Anja Robinson Shellfish Fellowship</b> - intended to support graduate students research in shellfish aquaculture	Alicia Aagesen, Microbiology (\$800) Advisor: Claudia Hase
<b>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.	Stephen Meck, Biology (\$2,600) Advisor: Markus Horning
<b>Lillian Brucefield Reynolds Scholarship Fund</b> -for graduate students engaged in study of marine science at Hatfield Marine Science Center.	Jose Marin Jarrin, 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.	Sarah Mikulak, Marine Resource Management (\$6,000) Advisor: Nancee Hunter/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.	Rebecca Baldwin, Fisheries & Wildlife (\$1,300) Advisor: Michael Banks/Kym Jacobson
<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	David Stick, Fisheries & Wildlife (\$4,000) Advisor: Mark Camara

<b>Mamie L. Markham Endowment Award</b>	
intended to assist graduate or student research utilizing OSU’s Hatfield Marine Science Center	
Alisha Aagesen, Microbiology (\$9,000) Advisor: Claudia Hase	G. Renee Gibb, Fisheries & Wildlife (\$7,242) Advisor: Scott Baker
Alana Alexander, Fisheries & Wildlife (\$10,225) Advisor: Scott Baker	Jose Marin Jarrin, Fisheries & Wildlife (\$9,431) Advisor: Jessica Miller
Rebecca Baldwin, Fisheries & Wildlife (\$6,700) Advisors: Michael Banks, Kym Jacobson	Kristin McCann-Grosvenor, Oceanography (\$9,640) Advisor: Clare Reimers
Katelyn Cassidy, Fisheries & Wildlife (\$7,638) Advisor: Brett Dumbauld, Chris Langdon	Wade Smith, Fisheries & Wildlife(\$6,000) Advisor: Selina Heppell
Alison Dauble, Fisheries & Wildlife (\$7,992) Advisor: Scott Heppell	



## Course Descriptions

### Itchung Cheung, Academic Program Coordinator

HMSC offers a wide range of courses within the interdisciplinary field of marine science through Oregon State University and the Oregon Coast Community College. Oregon State University offers courses at HMSC in Anthropology, Biology, Fisheries and Wildlife, Philosophy, Science Education, Statistics, Writing 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 Polycom

### Summer 2007 Courses

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

An introduction to sea creatures in the Oregon coast, from plankton to whales. Discover their unique adaptations, the functionality of their morphology, their incredible diversity and the importance of their ecological roles. Learn where and why organisms live as you visit their natural 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.

\*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.

WR 406/506. WRITING WITH THE TIDES: A CREATIVE WRITING WORKSHOP (Barrington) (1)

A writing workshop with a focus on the ocean and the natural world with Judith Barrington, a poet and memoirist who has published three collections of poetry, a prize-winning memoir, and a text on writing literary memoir which is used all across the United States and in Australia and Europe.

Z 465/565. MARINE CONSERVATION SCIENCE AND POLICY (Lubchenco) (3)

Introduces the science-policy interface of ocean resource management. Through discussions, lectures, and independent projects, students will learn how policy is formulated at the

state and federal levels, and the role of science in that process. Emphasizes current topics, such as ecosystem-based management.

### Fall 2007 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 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.

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.

\*FW 407/507. MARINE SCIENCE SEMINAR (G. Boehlert) (1)  
See list of seminar series speakers.

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

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

FW 431/531. DYNAMICS OF MARINE BIOLOGICAL RESOURCES (Heppell) (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.

\*FW 441. INTRODUCTION TO GROUP PROBLEM SOLVING (Heppell) (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 (Heppell) (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/OC 474/574. EARLY LIFE HISTORY OF FISHES (Miller) (3)**

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

**\*FW 499. STOCK ASSESSMENT SEMINAR (Gertseva) (2)**

This class is mostly based on lectures (first five weeks) followed by discussion of contemporary assessment research with stock assessment scientists (last three weeks). Topics covered in lectures include: assessment data sources, population dynamics models, statistical techniques to fit models to data, biological reference points, and making recommendations to managers.

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

This is a lecture and lab course that applies basic ecological principles to fisheries management to promote sustainable fisheries and conservation. The course covers a range of marine ecological processes, fish life history and population dynamics, and community and ecosystem responses to fishing and natural variability.

**FW 590. COASTAL GENETICS AND CONSERVATION (Banks) (3)**

This course is a hands-on application of molecular population genetics in coastal fishery management and conservation, study design, DNA extraction, PCR, analysis techniques, paper review and write-up.

**FW 499/599. WHALES AND WHALING (Baker) (3)**

This course investigates the interplay through discussions on a range of topics from the evolutionary origins of whales, to the Revised Management Procedure of the International Whaling Commission and the ethics of 'scientific whaling'.

**Winter 2008 Courses**

**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 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.

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

Current topics in marine science research.

**\*FW 599. FISHERY STOCK ASSESSMENT METHODS (Sampson) (2)**

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.

**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.

**\*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.

**Spring 2008 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 (Fritz) (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. Prerequisite: None. This sequence need not be taken in order, although some carryover from one term to the next does occur.

**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)  
This course is a hierarchical approach to the study of fish ecology. The course will stress the importance of communication in science, especially in the form of written summaries and reports. The course will consider the factors affecting individual biology and behavior of fishes, the ecology of populations, proximate and ultimate factors of public affects on fish ecology and to demonstrate the relevance of basic ecological principles to fisheries management and provide opportunities for students to evaluate ecological models, including computer simulations.

\*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 fourth year veterinary students. To provide background in husbandry of ornamental fish so that students will be able to discuss husbandry problems with owners of these species.

To discuss practice management as it relates to incorporating ornamental fish into a practice.

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

**Dr. 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 and 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.

It 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> and the Oregon Coast Aquarium, <http://www.aquarium.org/>.

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. 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 was also appointed Curator of 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 will coordinate 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.

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

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

This past June the fourth graduating class of Aquarium Science students at Oregon Coast Community College (OCCC) walked across the stage during commencement ceremonies. This class of 13 individuals represented the program's largest graduating class. A total of 35 individuals have now completed their studies in Aquarium Science, a program that began in 2003.

Though graduation celebrates the successful completion of each student's course of study, the value of the degree is tied closely to the teaching of aquatic animal husbandry job skills, a sense of connectivity with the broader community, and placement of students into work environments during their studies. The placement of students in these work situations is a hallmark of the program. This is where the Oregon State University's Mark O. Hatfield Marine Science Center (HMSC) and other entities such as the Oregon Coast Aquarium, Oregon Hatchery Research Center, and Oregon Department of Fish and Wildlife fish hatcheries serve the Aquarium Science learning community.

A number of organizations at the HMSC have embraced these motivated students by including them in positions where students actively learn about, then conduct the duties and activities related to aquatic animal care and research. Groups such as the Fish Behavior Laboratory (NOAA), the Molluscan Broodstock

Program (Oregon State University), Oregon Sea Grant, the HMSC Public Aquarium helped develop students during the past year. This mentoring relationship enables students to achieve a higher level of understanding, and a broader array of job skills. Several of these organizations have gone on to employ students or graduates in various capacities. As students seek internship opportunities to close out their studies, the experiences gained at the HMSC reflect a strong motivation and an enthusiasm for the aquatic animal husbandry profession. Students are currently interning at the Seattle Aquarium, Oregon Coast Aquarium, the Florida Aquarium (Tampa), Walt Disney World-The Seas with Nemo and Friends (Lake Buena Vista, Florida), Monterey Bay Aquarium (Monterey, California), and the World of Wet Pets (Beaverton, Oregon).

The program calls upon subject area expertise to interact with students. This broader picture approach included presentations by HMSC based personnel on the topics of seabird conservation, invasive species, climate change, marine reserves, marine resources and amphibian husbandry. In addition to knowledge gain, these encounters also enable students to recognize that professionals highly value the student's efforts to learning and to be engaged.



Aquarium Science students display the fruits of a gelatin food laboratory. The "gel food" is used to feed fishes at numerous public aquarium including the Hatfield Marine Science Center and the Oregon Coast Aquarium.

This active involvement by the HMSC at both an organizational and personnel level truly enriches the experiences of students who sometimes make a significant relocation and commitment to study Aquarium Science at OCCC. Without these opportunities available at the HMSC, creating an equally effective program would be difficult.

In closing there are exciting times ahead as the Aquarium Science Program continues to mature. Architectural plans for an Aquarium Science building continue to be refined with a potential start to construction in 2009. This new complex will allow for the instruction of this discipline within a spaces designed to support its instruction.

## ***Guin Library*** **Janet Webster, Librarian**

The Marilyn Potts Guin Library continues to be one of best marine and estuarine libraries in North America. The collection focuses 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. Information continues to migrate from print to electronic and users are now expecting the later. The Guin Library can offer access to a plethora of scientific information because it is part of the OSU Libraries, regional consortia and an international network of marine and aquatic libraries. In today's global information society, the library remains an essential part of HMSC as one means of connecting people with the information they need to create knowledge.

Our projects and resulting accomplishments for the Fiscal Year 2008 address the OSU Libraries Strategic Plan. This Plan focuses on improving access to library resources through better searching tools and more digital materials as well as tailoring services to different users groups including undergraduates, graduate students and faculty. Three examples demonstrate our approach.

- Tailored services – Students all know how to find information efficiently and effectively, or so they think. Google has made searching ubiquitous and simple. Yet, students can be overwhelmed with information and struggle to synthesize it. The Guin Library staff works with individual students as well as groups. Janet Webster and Andrea Wirth, a librarian at the Valley library, developed a two hour orientation to information use for new COAS graduate students. Professor Webster tailors the program for other groups throughout the year including summer interns and fisheries undergraduates. Information literacy is critical in our information society.
- Digitization of materials – The OSU Libraries recognized the value of student work. Theses and dissertations provide important information on new methods and ideas. In the past, people wanting to use OSU theses had to either go to Corvallis or request the print copy by sent to them. Now, the OSU libraries staff digitizes a thesis whenever it is requested so the user can have timely access and future users will not have to re-request.
- Archiving unique materials – The Journal of Oregon Ornithology and Studies in Yaquina Studies in Natural History (formerly Studies in Oregon Ornithology) have long been part of the Guin Library collection. The editor, Range Bayer, is a valued employee of the HMSC and one of the state's foremost birders. The OSU Libraries worked with him to digitize the two journals and deposit them in the OSU ScholarsArchive. This move will archive them permanently while making them more accessible as the Archive is searchable by Google and other web search engines.

<http://ir.library.oregonstate.edu/dspace/handle/1957/7951>

<http://ir.library.oregonstate.edu/dspace/handle/1957/8288>

**Library Displays:** We work towards mounting three to four exhibits annually. This year, we presented four with help from others.

- In celebration of Banned Books Week, our annual display focused on more subtle forms of censorship.
- A lovely collaboration between Donna McCoy, a Newport photographer and HMSC volunteer, and Julie Howard, an Oregon Sea Grant staff member, promoted the connection between science and art.
- The Sustainability Committee in collaboration with the Library Staff promoted sustainability in your personal life.
- In memory of Dr. Joel Hedgpeth’s contribution to marine science and his role at HMSC, Susan Gilmont put together a wonderful exhibit titled Sui Generis: Highlights of the Career of an American Original.

**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. As an active member of the International Association of Aquatic and Marine Science Libraries and Information Centers, she worked with Brian Voss, the librarian at NOAA PMEL, on a comprehensive review of the publications program of the North Pacific Marine Science Organization (PICES). Their final report was enthusiastically accepted by the PICES Governing Council and recommendations are being implemented to better promote PICES publications to the world.

Susan Gilmont continues as the archivist for the OLA’s Support Staff Division.

Judy Mullen is developing a more stream-lined process to collect the publications authored by people at the HMSC.

- A word on statistics: These show trends in how people are using information.
- The slow decrease in number of items checked out suggests that people are using more of the collection electronically including digital reports.
- The demand for the library’s materials remains high as digital copies of articles are sent worldwide.
- The price of materials steadily climbs and the budget does not. This shows in a slow declines in the number of books purchased. The dramatic drop in number of journal issues checked reflects our switch to electronic journals. Students are starting to read more material online and printing a little less.

<b>Guin Library General Statistics</b>	<b>2005- 2006</b>	<b>2006- 2007</b>	<b>2007- 2008</b>
Number of items checked out & renewed	3,505	3,033	2735
Number of items loaned to other libraries	1,522	1,725	1729
Number of books, etc. added to the collection	962	687	702
Journal issues physically checked in	610	553	585
Number of copies on photocopiers & printers	135,935	122,794	103,869

## IV. PUBLIC OUTREACH & EXTENSION

### OREGON SEA GRANT EDUCATION

#### *Sea Grant, Visitors Center*

Nancee Hunter, Sea Grant Education Director

**Visitor Center:** The OSU Hatfield Marine Science Center Visitor Center (HMSC VC) 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 HMSC 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.

**Exhibit Development:** The HMSC VC employs an exhibit development process that begins with front-end analysis to determine the audience needs. After the audience's baseline knowledge is determined, exhibit themes are developed and subjected to formative evaluation. Formative evaluation consists of reiterate evaluations and redesign of display copy and exhibit prototypes. Long-term cognitive/affective outcomes can be measured through summative evaluation – contacting the survey participants via the web long after they've left the Center.

The following represents some of the new exhibits that were funded and/or developed in academic year 2007-08:

- ❖ **VC Branding Initiative** (initiated and funded by Luanne Lawrence, Vice President of University Advancement) Through the generosity of Luanne Lawrence, The Visitor Center received numerous new signs -- designed by OSU's graphic design team. They all have a similar look and feel and highlight some of our special features (e.g., our Giant Pacific Octopus). In addition, they provide more of an OSU presence at the HMSC. One of the favorites is the giant octopus that greets visitors as they approach the front doors of the Visitor Center.

- ❖ **Magic Planet -- Spherical Display System:** The NOAA-funded Magic Planet will be the centerpiece of a larger exhibit, called "The Rhythms of Our Coastal Waters." This exhibit will focus on remote sensing and complex scientific visualizations using near and real-time data. The Magic Planet display, unveiled at the HMSC's annual SeaFest (open house) on June 28, 2008, is a three-foot globe that allows the visitor to view and explore dynamic digital media of the planet's atmosphere, oceans, and land.



Other displays that are part of the larger exhibit focus on remote sensing, both locally (in Yaquina Bay) and regionally. Other partners in exhibit production include the Oregon Coastal Ocean Observing System (OrCOOS), OSU's Cooperative Institute for Oceanographic Satellite Studies, and WetLabs (in Philomath).

- ❖ **Oregon Fisheries:** This year, we gained support for the updating and new development of a public exhibit aimed to build public understanding of Oregon's major fisheries. The exhibit is being funded by four seafood commissions and is scheduled to be completed by summer 2009.
- ❖ **Earthscope "Active Earth" Kiosk:** A kiosk has been donated to the Visitor Center from Incorporated Research Institutions for Seismology (IRIS) -- a university consortium sponsored by the National Science Foundation (NSF). They are also paying for a Free-choice Learning graduate student to conduct evaluation on two programs developed for the kiosk -- Active Earth and Cascadia Subduction Zone
- ❖ **Pattern Puzzles:** The theme of this year's third annual *Pattern Puzzles* exhibition was mathematics. Working with Dr. Olga Rowe (OSU), we selected 13 puzzles to be featured in the Visitor Center from April 6 through June 14. Dr. Rowe carried out research on staff and visitor points of view about presenting math in the Visitor Center. Findings showed that both visitors and staff had a limited view of mathematics as number operations, were nervous about talking about math and math concepts, and did not see math as having practical

applications in science or everyday life. On the other hand, both staff and visitors were enthusiastic about the idea of including more math in exhibits and saw the Visitor Center as a potential helper in teaching and learning math for both children and adults. Rowe's findings were reported at the National Association of Research in Science Teaching Annual Conference.

- ❖ **Patterns of Sound:** Two renovated exhibits called *Patterns of Sound* were installed, using the sound files and sonograms provided Dr. David Mellinger (OSU, CIMRS). These exhibits enable participants to hear the sounds of marine mammals, earthquakes and ice, while simultaneously visualizing the pattern that the sounds make.

**Public Programming:** Special events for public education are scheduled monthly and promoted through the OSU Hatfield Marine Science Center Visitor Center's web site: <http://hmsc.oregonstate.edu/visitor/current.html>

This year's education events included the following:

*Public Dissection of an Adult Harbor Seal.* This specimen was obtained from Jim Rice (Marine Mammal Stranding Network) and followed the new necropsy protocol. We set up an overhead mirror, a video scope with monitor and a video link into the auditorium. Over 100 people took advantage of this educational opportunity

*Ninth Annual "Fossil Fest."* This event included fossil identification, a fossil swap, and displays of fossils from the local area. Both the North America Research Group (NARG) and the Oregon Paleo-Lands Institute staffed tables with additional fossils. Activities for children included *Grow Your Own Living Fossil*, where kids received seeds and instructions on growing a *Metasequoia* and *Geologic Time Machine*, where kids spun the geologic time machine to win a fossil. Presentations included *From Coelacanths to Seals: 400 million Years of Shifting Surf and Changing Climates on Oregon's Dynamic Coast*, by Dr. Ellen Morris Bishop of the Oregon Paleo-Lands Institute and *Fossil Insects, A Most Improbable Happenstance*, presented by Dr. William Orr of the University of Oregon. More than 1,100 members of the general public took advantage of this free-choice learning opportunity.

*Earth Day* programming focused on the theme of global climate change. Auditorium presentations were provided by Dr. Mark Hixon (Department of Zoology), Dr. Peter U. Clark (Department of Geosciences), Dr. Karen Shell, and Dr. Jeffrey Shaman (College of Oceanic and Atmospheric Sciences).

*OceanQuest '07* highlighted the deep-sea research conducted by the Pacific Marine Environmental Laboratory (PMEL) Vents program. This multimedia auditorium presentation uses underwater video captured off the Oregon coast (Axial Mount), the Marianas Islands, and Antarctica. The PowerPoint presentation includes stunning video of undersea eruptions and complex chemosynthetic communities.

*Gentoo Penguins: Parallel Adaptations to Northwest Seabirds.* This new PowerPoint presentation was delivered during International Migratory Bird Day to members of the interested public at both Yaquina Head (BLM) and the HMSC.

NOAA's *Ocean Explorer* website was updated this year, in collaboration with Joe Flood (NOAA) and Pat Kight (Sea Grant) and now features photos, captions, researcher biographies, and sound files captured from Antarctica to help create more opportunities for interaction (<http://oceanexplorer.noaa.gov/explorations/06sounds/welcome.html>).

*Whale Watch Week (Spring '08).* Daily activities included a public Marine Mammal Program, *Whale Tales* (storytelling for children), marine mammal videos in the auditorium, the posting of sightings of migrating gray whales, and special marine mammal displays and exhibits featured throughout the Center. On selected days, a volunteer demonstrated gray whale calf skeleton preparation. New signage and displays were developed and installed for this event and two educators were trained on how to conduct the marine mammal presentation. We had over 7,800 visitors during this spring's Whale Watch Week.

### **HMSC Visitor Center Volunteers** **Nancee Hunter, Sea Grant Education Director**

**Volunteer Program:** The HMSC had 70 volunteers who contributed 5,853 hours of service to Visitor Center operations. There were 89 volunteers on record this year, but some were inactive. New volunteers were recruited throughout the year, mostly through word of mouth. This recruitment method enabled us to add 15 individuals to the volunteer corps.

Volunteers are critical to the success of the visitor center. They greet many of the 150,000+ annual visitors, orient them to the center, and provide educational information related to live animals and exhibits in addition to general marine science. Furthermore, volunteers contribute to the Visitor Center by feeding animals each week, assisting in exhibit maintenance, organizing the volunteer library, and one volunteer is preparing a gray whale calf skeleton for display. 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.

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): coastal geology, interpretive techniques, sea lion entanglement, and climate change. Five volunteers attended the 2007 Pacific Northwest Docent and Volunteer Association Conference October 11-14, which was held at the Woodland Park Zoo in Seattle, Washington.

The volunteers' efforts are not only recognized on a daily basis, this year they were also celebrated at a summer picnic at the

volunteer coordinator's residence, and again at a banquet in April during National Volunteer Appreciation Week.

**Bookstore:** Oregon Sea Grant's 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. Two volunteers also work each week in the store to assist the staff.

The bookstore promotes the HMSC through author presentations, book signings, and other special events, including the Lincoln County Glass Float Drawing and promotion held from November to January annually. Hundreds of visitors and local residents follow a map to local participating sites and attractions, where they can enter the drawing for two floats at each location. The bookstore is one of these locations and this year one of the volunteers who started the program to read children's stories during *Whale Watch Weeks* was one of the lucky winners of a glass float, and the other winner was a 10-year-old child from Eugene.

The bookstore manager attended the four-day Museum Store Association Conference held in Tampa, Florida in April 2008, with financial assistance from a matching funding award given by OSU. She attended many workshops, the vendor show, to locate unique educational materials for the store, and was able to connect one-on-one with other professionals in the museum industry.

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.

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

The mission of the Youth and Family Marine Education program is to educate and inspire students of all ages about marine life and the ocean itself in an interactive and positive learning environment. This year we accomplished this mission and experienced an exceptional year for reaching new audiences through a variety of education programs and hands-on experiences which included summer camps, field trip programs, online education, workshops, and outreach experiences. Our education programs are led by an education staff who not only help make all of these activities possible, but extraordinary.

Last summer we offered our ever-popular summer camps focused on marine biology and oceanography. Geared toward upper-level

students, these camps offer the opportunity to get experience in the field, work with scientists, carry out their own projects, and participate in hands-on experiences.



For the younger campers, Coastal Adventures I introduces them to the coastal environment, where they learn about habitats by collecting animals and providing habitats for those animals, while Coastal Adventures II reinforces the information learned in Coastal Adventures I. One of our day camp attendees wrote a letter attributing her decision to go into the marine science field to her experiences in our day camps.

Though we had students from both year-round and summer schools visiting during the summer, September marked the beginning of our school group programs. This year we taught approximately 12,000 students, not only from Oregon, but also California, Idaho, Montana, Texas, Washington, and Wyoming. Coursework was fine-tuned to better meet the needs of our audience, based upon changes in national science standards, partnerships with the Lincoln County School District, evaluations, and surveys conducted throughout the year.

Specifically, we hired an outside evaluator to conduct an evaluation of the marine education programs. The evaluation was conducted through interviews, written evaluations, and focus groups with participating teachers and students.

- *Interviews* -- Telephone interviews were conducted with a sample of 17 teacher participants. Eleven teachers who have visited HMSC in the past were interviewed. In addition, six Lincoln County School District teachers participated in a free field trip offer to the HMSC, followed by an interview.
- *Written Evaluations* -- 125 students and six teachers who participated in the free field trip offer completed written evaluations following their field trip to the HMSC.
- *Focus Groups* -- Immediately following their free field trip, students were asked questions regarding their favorite parts of the program, and offered suggestions they had for improvement.

The results highlighted important aspects of the instruction and of the programming. We found that the instructors have an important impact on the program and have been influential in teachers' decisions about returning to the program. Teachers listed the following as important attributes or behaviors for instructors to be successful: the ability to connect with



students, being enthusiastic, a positive attitude toward students, being knowledgeable about subject matter, using age appropriate strategies, the ability to assess the group's needs and expectations, moving around the room and working with all students, lecturing in little chunks, limiting lecture/teacher talk, emphasizing hands-on learning, pacing the program so that it is not rushed, and communicating roles and expectations to chaperones. The results highlighted ways the teachers feel the marine educators are successful at implementing the above-listed instructional strategies, and ways they feel the marine educations are deficient. This information is useful in developing future professional development goals.

The evaluation also highlighted visiting teachers' motivating factors for bringing their students to the marine education programs. Teachers responded that they come for the hands-on component, the knowledgeable and enthusiastic instructors, the outdoor component, and the range of activities for different age groups. They also discussed suggestions for improvement to the educational programs. Some of these suggestions for improvement were discussed above, in the context of marine education instruction. Teachers suggested we add more technology and/or more updated classes, provide more marine organisms per student in the classrooms, provide students with visuals, outlines, or note-taking materials at the tables, and reduce class size.

At the conclusion of the evaluation, the evaluator met with the education director and marine educators to discuss the results of the evaluation and to develop a plan for addressing areas for improvement as highlighted in the evaluation. To date, there have been two specific methods for addressing the specific needs for improvement as highlighted in the evaluation: (1) professional development, and (2) curriculum development.

A five-week professional development workshop entitled *Communicating Ocean Sciences for Informal Audiences*, taught by Shawn Rowe, Marine Education Learning Specialist for Oregon Sea Grant and Assistant Professor of Science and Math Education at Oregon State University, addressed some of the suggested areas for improvement at the instruction level. Currently, curriculum development and class restructuring is underway in order to address areas for improvement at the program level. Future efforts to improve the marine education program at the instruction and program level will be in part guided by the results of the evaluation report.

Our Home School program filled before the registration deadline, prompting us to offer another Home School program in the spring, with the same outcome. The Las OLAS (Ocean Learning Activities in Spanish) program grew in participation, offering translated curriculum and interpretation of our classes, thus expanding our programs to even more Spanish-speaking students and their families. AnaMaria Esparza-Smith, the Las OLAS Coordinator, offered the family night programs once a month with up to 40 participants in attendance. Funding from Sea Grant and a donation by an individual donor made this possible.



AnaMaria Esparza-Smith with a group of Las OLAS students

For the third year, an outreach program called *A Day at the Bay* in Tillamook was a great success. Part of the program includes training high school students to be facilitators for elementary students and then going to the beach together for additional programming.

The Career Day event for high school juniors and seniors was another success. Students were able to hear presentations from scientists, take an interactive tour, learn about careers in marine science, and learn about opportunities offered here at the HMSC.

In addition, we served approximately 300 boy and girl scouts from around Oregon and Washington. Oregon Sea Grant education staff also attended the Northwest Aquatic and Marine Educator Association Conference in Astoria, the Oregon Science Teachers Association Conference in Portland, and the National Marine Education Association in Portland (Maine).

**Oregon Coast Quests:** The Oregon Coast Quests Program is a relatively new 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 the outdoors. This unique program continued to grow this past year, generating interest and participation from the community.

A Quest brings *explorers* to a special *place*, connected 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, on or 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. More than 25 community organizations help with funding, hosting/maintaining Quest sites, building new Quests, or selling Quest Books.

The Oregon Coast Quest 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 Education Learning Specialist and Assistant Professor, Dr. 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.

### Quest Book

1. Three hundred copies of the 1st edition of the Oregon Coast Quests Book, printed June 2007, were sold to the public at \$3/book.
2. Oregon Sea Grant published the 2nd annual edition of the Oregon Coast Quests Book in June 2008. This 106-page spiral bound book contains the directions for 15 Quests in Lincoln County (representing an increase of 47% more locations from last year's book). Five hundred copies were printed and are being marketed to the public this year at \$6/book.
3. To date, explorers seeking hidden Quest boxes have made more than 800 log entries, each indicating that a participant completed a Quest and found the hidden box.

**Education and Outreach:** Oregon Coast Quests encourage community members to go on Quests and to build new Quests.

1. In February 2008, we held a three-hour Quest-building training workshop for 18 participants. Four of these participants went on to create and build new Quests with their students or institutions (Crestview Heights School, Yachats Youth and Family Activities Program, Lincoln City Parks and Recreation, and the Bureau of Land Management). Two more participants (Girl Scouts and State Parks volunteers) are still in the process of creating Quests. Another workshop is planned for winter 08/09.
2. Oregon Coast Quests conducted on-site Quest-building activities for youth groups. Last spring, curriculum development and direct instruction by Oregon Coast Quests resulted in Quests made by students at schools in Toledo, Lincoln City, and Waldport. This year, more instruction is planned for youth or school groups in Newport, Toledo, and Waldport. Seven of the 15 Quests in the new book were created by local Lincoln County youth.
3. Oregon Coast Quests was contracted to build Quests in Lincoln City (D River Invasive Species Quest) and Newport (Yaquina Head History Quest). Another Yaquina Head Quest is currently being developed under contract.

**Sustainability:** Oregon Coast Quests has developed a sustainability model to ensure the Quest program continues and is meeting the primary program goal. We intend to grow and expand the program to reach more communities in Lincoln County and beyond, serve as a model for new programs in the region, and develop evaluation tools to assess the impact of Quests on learning and relationships to nature and community. To reach this end, Oregon Coast Quests has developed and now implements a fee schedule for workshops and teaching services.

Oregon Coast Quests also continues to seek and leverage funds from funding agencies committed to place-based educational programming:

1. We are waiting to hear from The Conservation Fund regarding the application we submitted with partners in Vermont, Michigan, West Virginia and California. Our two-year proposal focuses on building a national Quest model, expanding the activity to new regions, and developing assessment tools that will help us evaluate the impact of the program. The Conservation Fund received 500 applications, and we are in the narrowed applicant pool of 36 for the 20 available awards.
2. A grant proposal to the Lincoln County Community and Economic Development Fund has been submitted to help offset the costs of fees to the Lincoln County community.
3. We are applying for an Environmental Education Program Grant from the Gray Family Fund of the Oregon Community Foundation.

### Marine Extension

**Jay Rasmussen, Interim Director, Oregon Sea Grant**

The mission of Oregon Sea Grant Extension's program is to educate Oregonians by delivering research-based, objective information to help them solve problems, develop leadership, and manage resources wisely. Sea Grant Extension is one of five Extension areas at Oregon State University. The others are Agriculture, Forestry, 4-H, and Family and Community Development.

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 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 Education and Extension programs are seamlessly linked. Our 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 significant 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.

In mid-2008, the following HMSC faculty members have appointments ranging from full time to quarter time with Oregon State University: Fawn Custer, Rebecca Schiewe, Dennis Glaze, Bill Hanshumaker, Nancee Hunter, Tim Miller-Morgan, Shawn Rowe, Jay Rasmussen, and Lynne Wright. Schiewe covers Visitor Center volunteer and interpretative duties, with assistance from an interim museum education assistant, and a number of marine educators -- on contract -- provide youth education experiences. Dennis Glaze has been a lead in ornamental husbandry efforts, along with our aquarists. Julie Howard and Maureen Collson provide outstanding support to our programs. And we have had a growing number of interns and graduate students over the past year. More information on the activities of those mentioned above is contained in college or other sections of this report.

Oregon Sea Grant, recognizing the special value and opportunities around informal education at the HMSC established the new position of Director of Education. Nancee Hunter, former Director of Education Outreach at the National Geographic society, was selected for this new position in early 2007.

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 HMSC include Dr. Tim Miller-Morgan, Extension Veterinarian, Aquatic Pets, with the College of Veterinary Medicine and programming in ornamental fish health; and Dr. Shawn Rowe, Marine Education Learning Specialist, Oregon Sea Grant Extension; Assistant Professor, Department of Science and Math Education, College of Science; Co-Director, Center for Ocean Sciences Education Excellence -- Pacific Partnerships. The research and teaching elements of their programs are contained in other sections of this report. The following highlights their extension focus.

**The Ornamental Fish Health Program (OFHP)**, supported by Oregon Sea Grant and the College of Veterinary Medicine, has completed a busy fifth year solidifying existing programs and expanding into new areas. 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 Ornamental Fish Health E-Newsletter and web site, <http://seagrants.oregonstate.edu/extension/miller-morgan.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, United Kingdom, and Belgium continue to give an international flavor to the program. Miller-Morgan was invited to speak at the recent International Workshop on Cyprinid Herpes Virus-3 (Koi Herpes Virus) in Cessarea, Israel. He was asked to discuss his current work related to Koi Herpes virus education among pond fish retailers in the United States and his current project to develop Best Health Practices for ornamental pond fish retailers. Miller-Morgan continues to work with local koi, goldfish, and aquarium clubs.

The program continues its relationship with the Associated Koi Clubs of America (AKCA) Koi Health Advisor (KHA) Program,

<http://www.akca.org>. This program is in its seventh year of training selected koi hobbyists to become health and husbandry advisors to their fellow hobbyists. The program has trained approximately 250 Koi Health Advisors throughout the country, with 27% of these graduates living in Oregon, Washington, and Idaho. Miller-Morgan serves as the national veterinary advisor to this program, an instructor in the wet labs, and provides continuing education opportunities for Koi Health Advisors in the Pacific Northwest. He has published numerous articles in KOI USA (the AKCA magazine). Dr. Miller-Morgan was invited to speak and moderate two sessions on the KHA/Veterinarian interface and assessing web-based information at the 2008 AKCA annual seminar in Jacksonville, FL.

Dr. 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 Retailer/Wholesaler in Richland, WA, Las Vegas, NV, Bothell, WA, and the HMSC, Newport, OR; The Koi Health Academy in Reno, NV; Basic Koi Health Management for Hobbyists at the Point Defiance Zoo and Aquarium in Tacoma, WA; Basic Fish Health Management, Corvallis, OR; Aquatic Veterinary Medicine Sessions, American Veterinary Medical Association Annual Conference, Washington D.C.; International Zoo, Exotic and Wildlife Medicine Workshop – Fish Medicine Session, the HMSC, Newport, OR.

**Free-choice Learning** -- More people visit science museums, zoos, and aquaria in the United States in any year than attend all professional sports combined. They do this 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. Yet, the learning that occurs and the way people use these informal science learning sites, as well as science media, for learning about science, technology, and culture is not well understood. To better understand how this learning occurs, Oregon Sea Grant has established a Free-Choice Learning Initiative (FCLI) to carry out research and education on lifelong free-choice learning. Through its ongoing partnership with the Institute for Learning Innovation (ILI) in Annapolis, MD and the Ph.D. 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 Center Visitor Center and Marine Education programming to carry out research, evaluation, and education in free-choice learning.

The free-choice learning research agenda continued to develop from July 2007 to July 2008. In particular, Dr. Shawn Rowe, who heads up the Free-Choice Learning Initiative, and Dr. Jim Kisiel, California State University, Long Beach, were awarded a two-year competitive grant to study engagement and learning from interactions with live animals in touch tanks at HMSC, Oregon Coast Aquarium, and both the Aquarium of the Pacific and Cabrillo Marine Aquarium in Southern California.

The Free-Choice Learning Initiative also supports students

carrying out research projects in learning in out-of-school environments. This year the initiative continued financial and academic support for five research projects, four of which resulted in the granting of degrees. Christine Smith – *M.S. 2007*, an M.S. student in the Department of Science and Math Education, completed her work redesigning and evaluating the Molluscan Broodstock Oysters Exhibit in the Visitors Center. Molly Phipps – *Ph.D. 2008*, a doctoral student in Science and Mathematics Education, completed her research on the use of iPods as supplementary learning materials in the Visitors Center and was awarded her degree. Abby Nickels – *M.S. 2008*, and Eleanor Hodak – *M.S. 2008*, both M.S. students in Marine Resource Management, carried out comparative research at the HMSC as well as the Oregon Coast Aquarium and Marine Discovery Tours, and both were awarded degrees. Finally, MRM M.S. student Sarah Mikulak was awarded a Holt Marine Education Fund Award in spring 2008 in order to carry out her work designing and researching effective tools for FCL through work with near-real time data. In addition, Celeste Barthel, a doctoral student in Science and Math Education, was supported by the Free-Choice Learning Initiative to travel to Baltimore, MD, to work with the Maryland Science Center on professional development of staff and research on spherical data display systems.

Additionally, 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 disseminated 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. Specifically, Celeste Barthel, Heidi Schmoock – *M.S. 2007* (Oregon Sea Grant), Molly Phipps – *Ph.D. 2008*, and Bronwen Rice – *M.S. 2007* (NOAA Office of Education) were supported by the FCLI to travel to Baltimore for the National Association of Research in Science Teaching conference to present their research work. Molly Phipps also presented at the American Educational Research Association national meeting in New York. Shawn Rowe, Coral Gehrke -- *M.S. 2007*, Bronwen Rice – *M.S. 2007*, and Alicia Christensen – *M.S. 2007*, presented ongoing FCL research at the Northwest Aquatic and Marine Educators network meeting in summer 2007. Shawn Rowe also presented at the Outreach and Scholarship Conference held in Madison, WI, and was an invited keynote speaker at the International Conference for Science for the Next Society in Seoul, South Korea in November.

Evaluation and education opportunities were also expanded significantly over 2007-2008 thanks to several competitive grants. Most prominently, Dr. Rowe became the Co-Director and Co-PI on the newly established NSF-funded Center for Ocean Science Education Excellence, Pacific Partnerships. This five-year effort partners 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. Dr. Rowe's ongoing collaboration with Lawrence Hall of Science at the University of California, Berkeley to create communications and learning theory training opportunities for informal educators also continued this year. Based on work carried out by Celeste Barthel in Spring 2007, Heidi Schmooch and Shawn Rowe designed and taught a five-week class for educators, aquarists, and other staff from the HMSC and Oregon Coast Aquarium in Communicating Ocean Sciences to Informal Audiences. This work will become part of a national curriculum funded by NSF. Shawn Rowe also collaborated with Nancee Hunter on a competitive grant to NOAA for the installation and evaluation of a Magic Planet spherical display system for the Visitors Center. The evaluation component partners OSG's FCLI with University of Washington researchers to use state-of-the-art video capture and annotation technologies with audiences as part of real-time evaluation of the Magic Planet as a learning environment and tool. Results of this one-year effort will be distributed in summer 2009 to NOAA's Science on a Sphere Network.

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

**Expressing the Importance of our Ocean and Coastal Ecosystems Through Art -- 2007/08 Ocean Literacy Poster (Art) Contest:** The Hatfield Marine Science Center and the Oregon Coast Aquarium, as a joint Coastal Ecosystem Learning Center (CELC), helped to initiate and support a national poster/art contest. This contest was held in collaboration with Coastal America and the Smithsonian Institution Ocean Hall to promote ocean literacy -- an understanding of the ocean's influence on you and your influence on the ocean.

The national contest had over 1900 students from Kindergarten thru college participate and helped to promote ocean literacy more broadly. The posters were focused on one of the seven essential principles of ocean literacy:

1. The Earth has one big ocean with many features.
2. The ocean and life in the ocean shape the features of Earth.
3. The ocean is a major influence on weather and climate.
4. The ocean makes the Earth habitable.
5. The ocean supports a great diversity of life and ecosystems.
6. The ocean and humans are inextricably interconnected.
7. The ocean is largely unexplored.

These principles were developed by scientists and science educators as a framework for incorporating ocean sciences into K-12 classrooms. An ocean literate person, as defined by these developers, understands these essential principles and can communicate about the ocean in a meaningful way. In turn, they are able to make informed decisions regarding the ocean and its resources.

The ability to interpret the ocean principles through artistic renderings translates into some base-level understanding of the principle identified. The general public audience viewing

the poster throughout the process also gains an understanding of these important principles through the various artistic translations.

HMSC and the Oregon Coast Aquarium provided in-kind support through staff-time and use of other internal resources. In addition, each participating CELC was responsible for issuing a call, for judging the entries and selecting first, second, and third place winners in each grade category, and for submitting all winners to Coastal America for a national judging competition. National judges include: Vice Admiral Conrad C. Lautenbacher, Jr. -- Under Secretary of Commerce for Oceans and Atmosphere, Department of Commerce (NOAA Administrator), Wyland -- Painter and Sculptor, Jean-Michel Cousteau -- President, Ocean Futures Society, and Dr. Sylvia Earle -- Oceanographer and "Ocean Ambassador" National Geographic Society Explorer-in-Residence, to name a few.

The national winners will be highlighted at the Smithsonian's Museum of Natural History as part of the new Ocean Hall exhibit. In addition, a poster series will be developed and distributed to marine education centers across the country.

***Civic Activities***  
**Ken Hall, HMSC Program Manager**

The HMSC is strongly represented in the community by virtue of its employees' being actively engaged 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.

As a visible and respected institution, the HMSC is also seen as a place for civic engagement. It serves as a gathering spot for various community-oriented meetings throughout the year. Public meetings on various 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.

Recognizing the importance of public understanding of research activities with local, state and national policy implications, HMSC sought to expand opportunities for citizen engagement through more frequent public forums over the past year. The Hatfield Forum on Marine and Coastal Issues was introduced as a mechanism to promote greater public awareness of research initiatives involving HMSC faculty. From ocean observation to wave energy to marine reserves, the HMSC is filling a key role in encouraging greater public understanding of these issues. Advertised and promoted to the local community, the forums are recorded for broadcast on local cable television, in a partnership with the Lincoln County School District.



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

- July 25 Oregon Watershed Enhancement Board Meeting
- July 27 Oregon State Bar Meeting regarding Environmental & Natural Resources Law
- Aug 13 Lincoln County Teacher Summer Symposium sponsored by Oregon Sea Grant
- Aug 14 Umpqua Radiotelemetry meeting by ODFW
- Aug 16 REU Program Intern Symposium (public invited)
- Aug 16 Salmon & Albacore Commission meeting
- Aug 17 Marine Reserves meeting by ODFW
- Aug 24 South Slough Reserve meeting
- Sept 9 National Estuaries Day (public event)
- Sept 20 Governor Irwandi Yusuf delegation visit (of Indonesia)
- Oct 06 Coast Hills Running Club
- Oct 11-12 Wave Energy Workshop
- Oct 13 Oregon Shores Conservation Coalition
- Oct 13 Nye Beach Writers' Series
- Oct 18 Climate Change Advisory committee meeting
- Oct 19 Salmon Saturday (public event)
- Oct 19-21 Photography Workshop
- Oct 20 FESRI (Fisherman Extending Salmon Recovery Information) meeting
- Oct 27 National Wildlife Refuge Assoc. meeting by USFWS
- Nov 10 Shark Watch (public event)
- Nov 11 Lecture by Dr. Gordon Kruse (public event)
- Nov 13 Oregon Salmon Commission -Review Board meeting
- Nov 14 Wetland Monitoring & Assessment Workshop by EPA
- Nov 17-18 Whale Observation Training
- Dec 8 Hypoxia Lecture (public event)
- Dec 20 South Beach Community Planning Group
- Dec 26-Jan 1 Whale Watch Week (public event)
- Jan 1 Yaquina Bay Heron Meeting by ODFW
- Jan 9 Oregon Watershed Enhancement Board
- Jan 26 National Wildlife Refuge Association, Partner's Meeting by ODFW
- Jan 31 Focus the Nation - community forum on global warming solutions
- Feb 9 Fossil Fest (public event)
- Mar 5 Dune Restoration Workshop
- Mar 13 HMSC Forum on Ocean Observation

- Mar 15 Birds & Plants Monitoring Group - University of Washington
- Mar 15 Sea Turtle Saturday (public event)
- Mar 15 Nye Beach Writers' Series
- Mar 22-29 Whale Week (public events)
- Mar 25 Yaquina Bay Ocean Observation Stakeholders meeting
- Mar 26 OR Dungeness Crab Commission public meeting
- Apr 16 "Solving the Klamath Crisis" film screening
- Apr 17 OPB "Silent Invasion" film screening (public event)
- Apr 28 Coastal Caucus meeting
- Apr 30 Pinniped Forum
- Apr 30 Chinook Regulations meeting by ODFW
- May 16-17 OSU SMILE program - teacher training workshops
- May 21 Flying Farmers meeting
- May 28 Oregon Trawl Commission meeting
- May 31 Coast Range Association meeting
- Jun 17 Markham Symposium (public invited)
- Jun 24 South Beach Urban Renewal Plan Update Process
- Jun 25 Our Ocean Coalition meeting
- Jun 30 Deep-Sea Biodiscovery workshop
- Monthly meetings of Yaquina Birders and Naturalists

***SeaFest 2008 draws record attendance***

**Ken Hall, HMSC Program Manager**

**Lisa Mulcahy, SeaFest 2008 Coordinator**

What a fabulous day SeaFest 2008 turned out to be! Turnout for this year's open house and marine-themed festival, held on Saturday, June 28, 2008 was estimated at 4,500 visitors. Many of the comments we received suggested this was perhaps the biggest and best SeaFest ever. The weather was spectacular, and probably played a large part in our record attendance.

Credit and thanks go to all who participated, including the scientists who worked tirelessly to bring great new exhibits and ideas to the event, members of the SeaFest planning committee and our incredible army of volunteers, Ship Operations staff for their wonderful 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.



SeaFest could not happen without the financial contributions of OSU our state and federal agency partners at the Hatfield Center (EPA, ODFW, NOAA, USDA, USFWS) and of course, our key community sponsors – Confederated Tribes of Siletz Indians, Georgia Pacific, Marine Discovery Tours, TLC Federal Credit Union, and Oregon Coast Aquarium.

This year's event saw a record-high participation of 34 community exhibitors (not including Kids Zone) and a full house in the Barry Fisher Building, with 30 Science Zone exhibitors. The Visitor Center was jam-packed throughout the day, with special exhibits on robotics and wave energy drawing adding to the mix of stimulating displays.

The Kids Zone booth exhausted their "ocean passport" supply, but had plenty of other activities inside and out to keep younger visitors enthralled. The lawn was a great spot to enjoy the music, and we had a fabulous line-up with Sons of the Beaches, Clean Slate, and Ladyz n the Barley.

Radio station KNPT operated a live remote from SeaFest, doing on-the-air interviews with visitors and exhibitors about all the things to see and do at SeaFest. Afternoon crowd-pleasers included the U.S. Coast Guard Search and Rescue exercise on Yaquina Bay and David Specht's demonstration of the EPA hovercraft careening around the parking lot.

Out at the dock, visitors enjoyed tours on OSU's research vessels *Wecoma* and *Elakha*, rides on the Oregon Rocket (courtesy of Marine Discovery Tours), and interactive exhibits put together by ODFW's Marine Resources Program staff. These included a full-size ROV on deck and an underwater camera mounted on a mini ROV in the bay, offering visitors a glimpse of the rich invertebrate life on the Research Dock's pilings.



Staff was on hand to help kids dissect sardines and anchovies and answer questions about several interesting specimens on display, including marine mammal skulls, deep-water viper fish and a brown cat shark. ODFW counted more than 560 SeaFest visitor interactions, counting only those contacts where one of their biologists answered a question or otherwise interacted with the public.

More than a few people were surprised at the variety of shellfish available in and around Yaquina Bay. Many kids and adults learned first-hand how to properly measure and sex a crab. And amazingly, only one little finger was pinched by the Dungeness and rock crabs in the water table.

Lisa Mulcahy served as the SeaFest 2008 Outreach / Event Coordinator, a position created through the AmeriCorps LINKS program of the Northwest Service Academy (NWSA). The HMSC has been fortunate to work with such highly qualified people through AmeriCorps/NWSA over the years, providing a pathway to various other positions based at HMSC, including for Oregon Sea Grant and the US Fish and Wildlife Service, Oregon Coastal Field Office.

HMSC and the entire Newport community really has an event to be proud of in 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 2007-08 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 a generous contribution from John Sherman, the Las OLAS program (Ocean Learning Activities in Spanish) was 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 \$90,000 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, and scholarships for three college-bound local high school students from fishing families in the community. (See *EDUCATION* section of this report for full list of Student Awards and Scholarships.)

Other activities sponsored by the Friends of HMSC during 2007-08 included the launch of "Science on Tap", an alternative format public lecture series inaugurated on February 15th at the Rogue Ales brewery in Newport. Senior Researcher Bill Chadwick of the OSU-NOAA Cooperative Institute for Marine Resources Studies presented his research on undersea volcanoes in the western Pacific, drawing some 70 attendees to the family-friendly event. It was great to see Friends of HMSC at this event and others throughout the year, including the Markham Symposium and at the hospitality tent at SeaFest.

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## Seminars at HMSC

Seminars presented at HMSC from July 2007 to June 2008

DATE	NAME	AFFILIATION	TITLE
July 5, 2007	Marisa Litz	OSU Graduate Student	<i>Ecological considerations for northern anchovy / <i>Engraulis mordax</i> / abundance and distribution in the northern California Current</i>
July 12, 2007	Rob Suryan	Assistant Professor OSU/HMSC	<i>Environmental forcing of life history strategies: Multi-trophic level response at ocean basin scales</i>
July 19, 2007	John Chapman	Department of Fisheries and Wildlife, HMSC, OSU	<i>Were the earliest marine introductions to North America before Columbus?</i>
July 26, 2007	Sylvia Yamada	Zoology, OSU	<i>Will the European green crab persist in the Pacific Northwest?</i>
August 2, 2007	Shawn Rowe	Dept of Science & Math Education, OSU/HMSC	<i>Free-choice learning research in the HMSC Visitors Center: An Overview</i>
August 9, 2007	Ted Grosholz	University of California, Davis	<i>Consequences of biological invasions for estuarine food webs</i>
August 16, 2007	Research Experience for Undergraduates	Mini Symposium - Results of research REU's did during 10 week internship at HMSC	<i>REU interns: Carrie Antolik, Casey Benkwitt, Craig Brauer, Marley Jarvis, Jessie Martinez, Jamila Payton, Zahirah Salahuddin, Erin Seale, Matt Stuckey, Jenny Wollschlager, Diane Wu</i>
September 27, 2007	Micky Kruse	Senior Associate, Wostmann and Associates, Inc	<i>E-landings - commercial fisheries landings data reporting system</i>
October 4, 2007	Richard Brill	Virginia Institute of Marine Science	<i>From lab bench to pelagic longlining - What physiology can offer fisheries science</i>
October 11, 2007	Gordon Kruse	President's Professor of Fisheries, University of Alaska, Fairbanks and 2007 Lavern Weber Visiting Scientist	<i>Climate change and dynamics of Alaskan crab populations</i>
October 18, 2007	John W. Ferguson	Director Fish Ecology Division, NOAA Northwest Fisheries Science Center, Seattle	<i>Summit to the Sea: Research for salmon recovery in the Pacific Northwest</i>
October 25, 2007	Dan Cooper	Alaska Fisheries Science Center, Seattle	<i>Reproductive output of Atka mackerel: fat pets vs. wild skinny fish</i>
November 1, 2007	Won Sang Lee	Korean Polar Research Institute	<i>Sounds of the Southern ocean - Interpreting Antarctic Hydrophone Data</i>
November 8, 2007	Steve Johnson	Oregon Department of Fish & Wildlife	<i>Use of Acoustic Tags for tracking migration and survival of steelhead smolts</i>
November 15, 2007	Robert Francis	University of Washington	<i>Resilience Thinking and the California Current Ecosystem</i>
November 29, 2007	Randy Keller	OSU College of Oceanic & Atmospheric Sciences	<i>Gulf of Alaska Seamount Morphology</i>
December 6, 2007	Francis Chan	OSU College of Oceanic & Atmospheric Sciences	<i>Hypoxia on the Oregon shelf: historical context and an update on the 2007 season</i>
January 10, 2008	Alena Pribyl	HMSC Grad Student, Dept. of Fisheries & Wildlife	<i>Got gas? Try recompression!</i>
January 10, 2008	Marc Johnson	HMSC Grad Student, Marine Fisheries Genetics Laboratory	<i>Testing for a signal of selection at olfactory receptor gene-linked markers in coho salmon (<i>Oncorhynchus kisutch</i>)</i>
January 17, 2008	Jennifer Jackson	Post-doctoral Research Fellow, Marine Mammal Institute, HMSC	<i>Reconstructing the history of exploitation and recovery for humpback whales in the south Pacific</i>
January 24, 2008	Kirsten Grorud-Colvert	Marine Reserves Science Coordinator, PISCO / COMPASS	<i>The science of marine reserves: insights based on recent syntheses</i>

## Seminars at HMSC - continued

DATE	NAME	AFFILIATION	TITLE
January 31, 2008	Laurence Padman	Senior Scientist, Earth and Space Research (ESR), Corvallis, OR	<i>Polar Ice and Global Sea Level Rise</i>
February 7, 2008	Chris Goldfinger	COAS, Oregon State University	<i>Holocene Great Earthquakes along the Cascadia subduction Zone: Riddle of the Sands</i>
February 14, 2008	John Chapman & Brett Dumbauld	OSU Dept. Fisheries & Wildlife USDA - ARS	<i>Doomed? Mud shrimp extinction faster than evolution?</i>
February 21, 2008	Kreg Lindberg	OSU Cascades	<i>Ecotourism: An opportunity for coastal development and marine conservation?</i>
February 28, 2008	Leslee Parr	San Jose State University	<i>Phylogeography, phylogeny and hybridization in trichechid sirenians: Implications for manatee conservation</i>
March 6, 2008	Jessica Miller	Assistant Professor, Marine Fisheries Ecology, OSU	<i>Understanding mixing and migration in marine and anadromous fishes: implications for conservation and management</i>
March 13, 2008	Rebecca Clausen	Department of Sociology, University of Oregon	<i>Economic Growth and Marine Biodiversity: Influence of Human Social Structure on Decline of Marine Trophic Levels</i>
March 20, 2008	Michael J. Behrenfeld	Department of Botany and Plant Pathology, OSU	<i>A satellite view of climate controls on global ocean phytoplankton</i>
April 3, 2008	Gregory C. Johnson	Oceanographer, NOAA/PMEL Seattle	<i>Argo: a contributor to the Global Climate and Ocean Observing Systems</i>
April 10, 2008	Michael Davis	Alaska Fisheries Science Center, Newport	<i>Rapid Field Assessment of Fish Morbidity and Delayed Mortality Using Reflex Impairment: Implications for Monitoring and Modifying Fishery Practices</i>
April 17, 2008	Paul Wade	National Marine Mammal Laboratory, NOAA, Seattle	<i>Killer effects: The role of killer whale predation on the population dynamics of Steller sea lions</i>
April 24, 2008	Deborah Kelly	University of Washington	<i>Life in One of the Most Extreme Environments on Earth: The Lost City Hydrothermal Field</i>
May 1, 2008	Doug Markle	OSU Department of Fisheries and Wildlife	<i>The influence of weather on year class formation in a long-lived freshwater fish in Upper Klamath Lake</i>
May 8, 2008	Richard Feely	Oceanographer, NOAA/PMEL, Seattle	<i>Ocean Acidification: The Other CO2 Problem</i>
May 15, 2008	Mattias Johansson	Marine Fisheries Genetics, COMES, HMSC	<i>Influence of habitat discontinuity, geographic distance, and oceanography on fine-scale population genetic structure of copper rockfish (<i>Sebastes caurinus</i>)</i>
May 22, 2008	Dan Nichol & Dave Sommerton	Alaska Fisheries Science Center, Seattle	<i>Flatfish Migration: Combining Archival Tag Data and Tidal Prediction Models</i>
May 29, 2008	Gayle Hansen	OSU at EPA, Pacific Coastal Ecology Branch	<i>Willapa Bay: a true hotspot for seaweed and seagrass introductions on the U.S. west coast</i>
June 5, 2008	Biology 450 Students	OSU undergraduate students	<i>OSU Marine Biology Student Symposium - Research Presentations</i>
June 12, 2008	Stephanie Moore	School of Oceanography, University of Washington	<i>Climate Variability and Paralytic Shellfish Toxins in Puget Sound Shellfish</i>
June 19, 2008	Holger Klinck	Postdoctoral Fellow, CIMRS	<i>From underwater soundscape to leopard seal ecology: developing a hydro-acoustic observatory for biological research</i>
June 26, 2008	Laurie Weitkamp	Research Fisheries Biologist, NOAA Fisheries/Northwest Fisheries Science Center	<i>Pacific salmon: biology and issues</i>

## V. PUBLICATIONS

**KEY:** \* = Student, **Bold** = at HMSC <sup>1</sup> = OSU,  
<sup>2</sup> = NMFS, <sup>3</sup> = PMEL, <sup>4</sup> = EPA, <sup>5</sup> = ODFW

Alexander, M.; Capotondi, A.; Miller, A.; Chai, F.; **Brodeur, Richard D.<sup>2</sup>** and Deser, C. Decadal variability in the northeast Pacific in a physical-ecosystem model: role of mixed layer depth and trophic interactions. *Journal of Geophysical Research - Oceans*. 2008; 113 (C2):C02017. doi: 10.1029/2007JC004359.

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## VI. BUDGETS

### State and Federal Agency Budgets at Hatfield Marine Science Center

	<u>\$ Amount</u>	<u>Total</u>	<u>% of Total</u>
Environmental Protection Agency	3,470,000		18%
Oregon Department of Fish & Wildlife	4,900,000		25%
Vents Program - Federal	1,072,361		5%
Nat'l Marine Fisheries Service - NWFSC	5,492,000		28%
Nat'l Marine Fisheries Service - AFSC	1,250,000		6%
US Department of Agriculture - ARS	658,099		3%
US Fish & Wildlife Service	2,813,600		14%
Total State & Federal Agency Budgets		\$19,656,060	100%

### FUNDING SOURCES

#### Direct State Funding

HMSC	1,413,176		
COMES	1,972,812		
MMI	-563		
CIMRS	181,317		
Guin Library	228,319		
Extension Sea Grant	650,321		
Ship Ops	3,108		
Total Direct State Funding		\$4,448,489	11%

#### Other State Funding

Matching Funds (Endowments)	288,847		
Student Fees (TRF)	24,999		
Total Other State Funding		\$313,846	1%

#### Sponsored Research and Education Programs

Nat'l Oceanic & Atmospheric Admin. (NOAA)	3,896,111		
Nat'l Science Foundation (NSF)	4,662,092		
U.S. Dept. of Agriculture (USDA)	528,668		
Office of Naval Research (ONR)	403,142		
Department of Defense	0		
Department of Energy (DOE)	639,391		
Department of Interior (DI)	4,986		
Oregon Dept. of Fish & Wildlife (ODFW)	70,525		
Other Oregon Agencies	259,731		
California Dept of Water Resources	86,525		
Foundations & Other Organizations	2,769,352		
Sub-Contracts from other Universities	353,270		
Total Sponsored Research		\$13,673,793	35%

#### Other Funding

Self-Funding Units	1,096,429		
State & Federal Agency Budgets	19,656,060		
Total Other Funding		\$20,752,489	53%
<b><u>TOTAL FUNDING:</u></b>		<b>\$39,188,617</b>	<b>100%</b>

# BUDGETS

OSU at Hatfield Marine Science Center

	\$ Amount	Unit Sub-Total	% of Total		\$ Amount	Unit Sub-Total	% of Total
<b><u>Research Administration</u></b>				<b><u>College of Oceanic &amp; Atmospheric Sciences</u></b>			
Administration	552,605			Ship Support/Operations	2,899,831		
Visitor Center Support	73,427			Ship Support & Communications	41,411		
Non-Sponsored Research	0			Ship Scientific Equipment	1,127,495		
Non-Sponsored Education	156,031			Total Ship Operations:	\$4,068,737		21%
Sponsored Education	0						
Sponsored Research	336,539			<u>Sponsored Research:</u>			
Total Research Administration		\$1,118,602	6%	Sponsored Research	218,256		
<b><u>Physical Plant</u></b>				Total Sponsored Research:	\$218,256		1%
State Support	699,757			<b><u>Education Programs</u></b>			
Federal Support	669,325			Extension	562,961		
Other Sponsored Activity	24,999			Sea Grant	282,137		
Total Physical Plant:		\$1,394,081	7%	Visitors Center (self-funded)	76,838		
<b><u>Coastal Oregon Marine Experiment Station (COMES)</u></b>				Sponsored Programs	145,292		
Administration	468,389			Self-Funded Programs	72,852		
Non-Sponsored Research	1,346,723			Total Education Programs:	\$1,140,080		6%
Cost Shared to Sponsored Research	157,640			<b><u>Housing</u></b>			
Self-Funded Programs	72,257			Self-Funded Operations	85,230		
Extension	0			Total Housing:	\$85,230		0.44%
Endowment	0			<b><u>Bookshop</u></b>			
Sponsored Research	1,400,199			Self-Funded Operations	176,934		
Total COMES:		\$3,445,208	18%	Total Bookshop:	\$176,934		1%
<b><u>Cooperative Institute for Marine Resource Studies (CIMRS)</u></b>				<b><u>Other</u></b>			
Administration	175,238			Guin Library	228,319		
Sponsored Research	3,919,549			OSU Foundation & Gifts	97,777		
Total CIMRS		\$4,094,787	21%	Network Service/Computer Support	170,783		
<b><u>Marine Mammal Institute</u></b>				Federal Agencies (through OSU)	27,938		
Administration	36,676			Total Other:	\$524,817		3%
Non-Sponsored Research	35,030			<b><u>TOTAL HATFIELD MARINE SCIENCE CENTER:</u></b>			
Cost Shared to Sponsored Research	125,391				\$19,532,556		100%
Self-Funded Programs	517,976						
Extension	0						
Endowment	927,536						
Sponsored Research	1,623,214						
Total MMI:		\$3,265,823	17%				