
Oregon State University Hatfield Marine Science Center 2006 - 2007 Annual Report



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Director's Message

Dr. George W. Boehlert, Director

This has been a strong and positive year in HMSC's development. The HMSC Strategic Plan was finally approved and our Master Plan has been completed; together, these two documents help guide the organization's future. Several activities this year demonstrate how HMSC is able to address important scientific and social issues in marine and coastal science by taking advantage of the diversity of scientific talent and institutions.

Three active projects were highlighted in our first strategic plan annual report. Project CROOS (Collaborative Research on Oregon Ocean Salmon), one of the largest interdisciplinary collaborative industry-scientists fishery projects ever conducted on the West coast, was led at HMSC by the COMES program. The Research Experience for Undergraduates (REU) program provides undergraduates with hands-on research experience under the mentorship of OSU and agency scientists, resource managers and educators at the HMSC, and its success is evident in the program expansion as the National Science Foundation renewed the award. Finally, the Free Choice Learning Initiative has developed the HMSC Visitor Center into a social laboratory to conduct research on how people learn. Each of these programs demonstrates some of the unique attributes of HMSC and its many partners.

HMSC's many accomplishments for 2007 are described in this report. In our educational programs the hiring of two key positions, the Academic Program Coordinator for HMSC and Director of Education for Sea Grant, brought new energy to our educational enterprise. The challenge of increasing access to instructional and experiential learning opportunities for underrepresented groups in the sciences has been addressed through both the Ocean Learning Activities in Spanish program A(Las OLAS) and as one of the key objectives for HMSC's REU program and other internships. Highlights from HMSC research programs include geophysical surveys in Antarctic deep waters and the Mariana Arc in the western Pacific. The Marine Mammal Program was elevated to Institute status and the addition of two new faculty highlight its ambitious growth plans and future collaborations. HMSC has played an important role in fostering development of a comprehensive OSU program in wave energy, helping meet the Governor's objectives for Oregon leadership in this area.



Hatfield Marine Science Center Director George Boehlert welcomes visitors to SeaFest 2007

In the coming year, the HMSC will pursue several new initiatives. Working with several community and state partners, we hope to solidify Yaquina Bay as a national resource in marine science with an emphasis on creating an infrastructure support base for the ocean observing system. Parallel efforts in the HMSC Visitor Center will create exhibits to improve public awareness of these issues. For college-level education, we will create opportunities in experiential marine science for lower division OSU students to maintain interest in marine science. We will continue to work to aid the development of the National Wave Energy Demonstration Center and hope to see increased activity by the College of Engineering at HMSC. Finally, we will work to secure funding to move forward with development of the HMSC Master Plan.

HMSC's accomplishments and plans for the future are all dependent upon the cooperation of our many partners and stakeholders, from the students and scientists to our many donors. The work of each and every one is sincerely appreciated.

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 by 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 13 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 its 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 seven primary areas: Aquaculture (Chris Langdon), Fish Disease (Paul Reno), 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 2006-2007 was successful and marked continued growth of the Station. COMES helped facilitate one of its subunits, the Marine Mammal Endowed Program, in transitioning to Institute status and becoming the Marine Mammal Institute (MMI). This unit will now answer directly to the Dean in the College of Agriculture. COMES, however, will continue to coordinate with MMI including administration of joint faculty

(Scott Baker and Markus Horning). Michael Morrissey, Director of the Astoria Seafood laboratory took a new position as Superintendent of the Food Innovation Center in Portland while continuing to act as Astoria laboratory director. Paul Reno, a microbiologist and fish disease specialist retired in June 2007.

Based on the Oregon Invests database, in 2006-2007 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 18 students including 9 MS and 8 Ph.D's. COMES faculty also gave over 75 presentations and organized 10 workshops and conferences. For 2006-2007 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 2006-2007 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. Today, Pacific whiting is Oregon's largest (by volume) and most sophisticated fishery and generates between \$20-30 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 40 fishermen and seafood processors in business and market planning, provided over \$1.6 million in investments and loans to coastal seafood companies, developed five new value added seafood products, delivered 55 seafood demonstrations, and is assisting the Oregon Dungeness Crab Commission in certification by the Marine Stewardship Council (MSC).

Molluskan Broodstock Program (MBP) MBP conducts research and outreach with industry partners to improve oyster broodstock and associated economic benefits. Billions of juvenile oyster 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 110 international and domestic students in 2006-2007 and the Astoria Surimi School alone generated over \$120,000 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. With the recent hire of Jesssica Miller, this is expected to be one of the fastest growing COMES program.

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.

Research activities over the past year have included:

Value-added products. Research continues in the area of value-added products from albacore tuna and shellfish. The SRL has teamed with the Seafood Consumer Center to develop a Stage-gate Process" for developing new products through the Community Seafood Initiative (CSI). Currently there are six new products in the pipeline working directly with small and mid-size seafood companies in the Pacific Northwest.

Seafood Safety. The use of electrolyzed water was studied for the reduction of *Vibrio parahaemolyticus* in Pacific oysters has shown the efficacy of this process in reducing Vp by 2 log no. Investigation on the levels of mercury in albacore tuna have shown that local troll-caught tuna has lower levels that reported for albcore by the FDA due to their smaller size. A research grant was awarded to the SRL to study the levels of cadmium in oysters and is ongoing.

Seafood Processing/Quality. New processing methods for the recovery and utilization of fish proteins through manipulation of pH have shown the potential of this method. This method also proved valuable for the extraction of high omega-3 fatty acids from sardines. Lipase was used to further concentrate the omega-3 fatty acids. New research has been initiated using protein identification through ELISA methods and DNA identification through PCR techniques to determine species identification and prevent possible fraud in fish utilization.

Surimi Research. Various researches covering surimi and surimi seafood have been conducted. As a part of Sea Grant projects, sarcoplasmic proteins from sardine have been isolated at various pH conditions. Their interaction with myofibrillar proteins from Alaska Pollock has been studied. To find out a way to assess the quality of surimi quickly, a multidisciplinary approach was used:

Ca²⁺ ATPase activities and storage modulus showed a great correlation with breaking force and deformation of surimi gels. Ingredient studies also conducted to determine the interaction between egg whites and fish proteins. Various modified starches were also reviewed for possible stabilization at higher temperature.

Outreach. The 15th Annual Surimi School was held in May. It was co-sponsored by 25 companies and had over 100 attendees from all over the world. The 6th annual Surimi Forum was held the day before and focused on changing fishery regulations and market opportunities for the industry. The SRL in partnership with five other universities and CSI was recently awarded a USDA grant to provide information and training for Health Professionals regarding risks and benefits in seafood consumption.

Cooperative Institute for Marine Resources Studies

Michael Banks, Director

Now in its twenty-fourth 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 vHatfield 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. Besides the core NOAA funded research projects detailed below, CIMRS research faculty generated over \$850K in FY 2006 alone for independent research projects funded from a variety of funding sources.

<i>Principal investigator</i>	<i>Funding Agency</i>	<i>Grant Title</i>	<i>Funded Amount</i>
William Chadwick	NSF	Intrusion and Eruption Dynamics on Active Galapagos Volcanoes	\$11,813
R. Dziak/H. Matsumoto	NSF	Real-Time Volcanic Event Detection	\$127,367
Robert Dziak	KOPRI	Submarine Volcanic Activity and Associated Extreme Ecosystems of the Drake Passage and Antarctic Peninsula	\$29,912
D. Mellinger/R. Dziak	NOAA Ocean Exploration	Earthquakes and Endangered Whales: Passive Acoustic Exploration off Greenland and Iceland	\$231,000
David Mellinger	NPS	Datasets of Odontocete Sounds Annotated for Developing Automated Detection Methods	\$175,000
David Mellinger	IAGC/IAOGP	Passive Acoustic Monitoring System Development for Ishmael, 3-D Sperm Whale tracking and Directional Cardioid Sensor Processing	\$263,786
David Mellinger	ONR	Marine Bioacoustic Signal Analysis	\$31,383
		Total Amount:	\$870,261

Additionally, Vladlena Gertseva, Asst. Professor, Sr. Research, was granted an L.L. Stewart Faculty Development Award to develop a new course in fisheries stock assessment, contributing to the improvement of teaching at Oregon State University.

For Collaborative Research with National Marine Fisheries Service/Northwest Fisheries Science Center see section on National Oceanic and Atmospheric Administration, page 25.

For Collaborative Research with NOAA's Oceanic and Atmospheric Research Division see section on Pacific Marine Environmental Laboratory, Vents Program, page 37.

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.

A growing number of graduate student projects are being supported with contributed funds through grants from the Northwest Fisheries Science Center. 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 (/Sardinops sagax/) Population Structure along the west coast of North America Co-Major Professors: Michael Banks, Kym Jacobson NOAA Fisheries Rep: Kym Jacobson, NWFSC
Ph.D.	Claudia Bravo *	Environmental Molecular & Toxicology	Toxicology of Polycyclic Aromatic Hydrocarbons: Dibenzo [a,l] pyrene (DB[a,l]P) in Rainbow Trout, Oncorhynchus mykiss Major Professor: Larry Curtis, E&MT NOAA Fisheries Rep: Mary Arkoosh, NWFSC
M.S.	Maria Juan Jorda *	Marine Resource Management	Development of a Physical Database and GIS Coordination at Heceta Bank, Oregon Major Professor: Jack Barth, COAS NOAA Fisheries Rep: Waldo Wakefield, NWFSC
M.S.	Natalie Reed *	Marine Resource Management	Cold-water Corals and Sponges: Habitat Preferences on Oregon's Continental Margin Major Professor: Clare Reimers, COAS NOAA Fisheries Rep: Waldo Wakefield, NWFSC
M.S.	Kate Boersma	Fisheries and Wildlife	Divergent anti-predator strategies and risk allocation in juveniles of three north Pacific flatfishes Co-Major Professors: Selina Heppell, Cliff Ryer NOAA Fisheries Rep: Cliff Ryer, AFSC
* = Degrees Completed			

Degree	Student	Dept	Thesis
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	Brooke Martin *	Fisheries and Wildlife	Purification and Characterization of Vitellogenin, and use for Enzyme Linked Immuno-absorbent Assay (ELISA) for gender and maturity status in Black rockfish (<i>Sebastes melanops</i>) Major Professor: Selina Heppell Minor Rep: Scott Heppell NOAA Fisheries Rep: Grant Thompson, AFSC
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
* = Degrees Completed			

Marine Mammal Institute (MMI)

Bruce Mate, Director

The longstanding Marine Mammal Program was granted Institute status by the University in November 2006. One of seven research programs within COMES, the Marine Mammal Program was formed to conduct original research to better understand marine mammal conservation and management issues such as population numbers, critical habitats, migrations, behavior, and interactions with human activities (e.g. fishing, oil and gas development, and shipping). 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 21 faculty, staff, and students. In the past year, two new labs were created in addition to the existing Whale Telemetry Group, headed by Bruce Mate, and the Oregon Coast Marine Mammal Stranding Network, coordinated by Jim Rice. In late May, Markus Horning brought his expertise in pinniped ecology from Texas A&M to Newport, and his Pinniped Ecology and Applied Research Laboratory (PEARL) was formed. July brought the addition of internationally recognized whale geneticist Scott Baker, and his Cetacean Conservation and Genetics Laboratory (CCGL). 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. At its full capacity, the Institute will also add dozens of living wage jobs to the local coastal economy.

The Marine Mammal Institute will be 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. Finally, the MMI will develop curricula to foster the interest of youth in math and science. In addition to K-12 education, the MMI is committed to a highly visible public education program, which will include public participation projects (Oregon Marine Mammal Stranding Network, Whale Watch Spoken Here, and limited research opportunities) as well as media/web-based information delivery systems. 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, information, and will be used by public policy makers, scientists, media, educators, and the general public.

With the expanded awareness of the research being conducted at the Institute, funding opportunities continue to grow. FY2007

brought in \$1.3 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 our approval for growth is the creation of a new building to house the Marine Mammal Institute (and the expanding program in marine genomics, of which Scott Baker is also a part). The 28,000-square-foot building is estimated to cost \$12 million, and will provide the space to support the dynamic growth we envision in the near future. OSU is looking to donors for half of the building costs.

Oregon Sea Grant

Bob Malouf, Director

Jay Rasmussen, Associate Director

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

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

Oregon Sea Grant, for nearly 40 years, since its origins as one of the original four Sea Grant programs, 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 become one of the first four Sea Grant Colleges in the nation by 1971. 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.

Over \$342,650 of Oregon Sea Grant-funded competitive projects took place at the Hatfield Marine Science Center during the 2006-2007 fiscal year. Research and projects included studying how iPods change group learning dynamics at exhibits; developing methods for reducing the mortality in oyster production; retaining native oysters; understanding mortality of wild-caught marine ornamental 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 2006/07 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. David also worked with several graduate students to develop simulation software to assist ODFW in exploring systems for monitoring and managing nearshore groundfish resources. In addition, David was the lead author of a new stock assessment for black rockfish. Data compilation and analysis were the focus of his activities during winter 2007 and developing and evaluating the stock assessment model were his focus during the spring.

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 continued his involvement in a collaborative research project that is attempting to develop survey methods for canary rockfish, with the aim of supplementing the information provided by the standard bottom trawl surveys. The Canary Rockfish project continued field-testing a video-trawl system, which aims to provide a non-lethal quantitative method for counting canary rockfish and other large bottom dwelling fish species. The video-trawl device consists of a lighted, backward-facing color video camera that monitors fish as they are forced up and out of the trawl by a rigid fish-excluder grate. Field trials, which began in spring 2006, continued during late summer 2006 off the northern Washington coast using a chartered commercial trawler.

During the year 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.

Teaching: During autumn 2006 David taught his course "Dynamics of Marine Biological Resources" and was the lead instructor for the team-taught course "Coastal Ecology and Resource Management". As in past years, lectures for the

Dynamics course were given in the HMSC studio classroom and televised to the main campus, with about half the students at either location. The Coastal Ecology course was taught at the HMSC and included an intensive series of lectures, field trips and laboratory exercises during the first week of the term.

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 2006-2007 included: AFS Eugene, January 2007 "Wild Coho Salmon Do Use Estuaries" J. Chapman, J. Spangler H. Stout;- Spring Marine Ecology - Zool. 451/551, Fall - Coastal Ecology and Research Management, the Oregon Coast Aquarium and Oregon Coast Community College Aquarium Science Program, the HMSC summer intern and adult volunteer program, OIMB Biological Invasions Seminar.

A reanalysis of the origins of the introduced periwinkle *Littorina littorea*, performed in cooperation with the Michael Banks lab, Maritime Studies Program; Williams College - Mystic Seaport, CT; and University of New Hampshire, Durham, NH, resolved what may be the earliest record of a marine introduction to North America (via the Vikings). The main paper appeared in the July 2007 issue of *Biological Invasions* and was reported in "Nature" news "The mystery of the wandering wrinkle" <http://www.bioedonline.org/news/news.cfm?art=3499> an also is reported on a Chinese website with a photo:<http://www.sci-china.com/shownews.asp?id=114>

John's "Light and Smith" amphipod chapter - Chapman, J. W. (2007) Amphipoda, pp. 545-618, In J. T. Carlton (ed.) The Light and Smith Manual: Intertidal Invertebrates from Central California to Oregon, 4th edition, University of California Press - is a synthesis of eastern Pacific marine gammaridean amphipod taxonomy that includes 51 plates, 900 + illustrations 347 species. This chapter is the first comprehensive treatment of shallow-water eastern Pacific marine gammaridean amphipods ever published and includes 10% of all species in the 1000+ page tome.

Smith, A. E., **J. W. Chapman**, B. R. Dumbauld (In press 2007). Energetics of the bopyrid isopod parasite *Orthione griffenis* in mud shrimp *Upogebia pugettensis*, Journal of Crustacean Biology, 25 pp.: This is the first of a series of papers on the biology, ecology and impacts of native and introduced parasitic isopods on burrowing shrimp is in press.

The paper: Chapman, JW (2007) The Mysterious Periwinkle (*Littorina littorea*): Norse or Later Introduction from Europe? Arctic Studies Center Newsletter, Smithsonian Institution, National Museum of Natural History 14:2. (http://www.mnh.si.edu/arctic/html/pub_news.html), appeared previous to John's May-June 2007 trip to Newfoundland to gather data necessary to test whether the first aquatic introduction to North America was brought by the Vikings. Probably it was.

John and daughter Katie, seem to have located the 1000 year old fossils at L'Anse aux Meadows, Newfoundland, where the Viking

land fall occurred. John will apply for funding to radio-carbon date the shells and reported these preliminary results in the July HMSC seminar series “Were the earliest marine introductions to North America before Columbus?”. Additionally, John Darling, USEPA, Cincinnati reports, as John predicted, the genetic diversity of *L. littorina*, that Katie and John collected at the site, include nearly all of the diversity found so far in eastern North America.

An additional *L. littorina* paper: Chapman, J. W., A. M. H. Blakeslee, J. T. Carlton, and M. R. Bellinger (In Press 2007) Parsimony dictates a human introduction: On the use of genetic and other data to distinguish between the natural and human-mediated invasion of the European snail *Littorina littorea* in North America, Biological Invasions 7 pp. should appear in the September issue of Biological Invasions.

Returning from Newfoundland in June, John trained, organized and partially funded two Lincoln County “Summer Natural Resources” (SNR) student crews to assist with collecting and transplanting thousands of burrowing shrimp and their parasites in Alsea and Yaquina Bay. The SNR crews performed the majority of labor required to isolate the settling life stages and critical experiments that demonstrate induced chemical signaling by these parasites to attract mates and their efforts were critical to support the projects of HMSC (NSF-REU) Craig Brauer and Judy Miller, (2007, 2008, M. J. Murdock Charitable Trust, Partners in Science visiting summer high school teacher).

Judy Miller worked this summer with John on a method lure bopyrid cryptoniscans to receptive females, in situ, for quantitative measures of their abundances. This new method allows analyses of marine invertebrate immigration and emigration in entire estuaries, has great potential to study larval recruitment and provided REU student, Craig Brauer positively identified cryptoniscans for his project.

Craig’s project “Soliciting Sex for Cryptoniscan Taxonomy” Species specific chemical attraction to unmated females, in situ, as well as experimental transplants were used to positively identify and describe the cryptoniscan larval stages of the eastern Pacific bopyridean isopods, *Ione cornuta* Bate, 1864, and *Orthonione griffenis* Markham, 2004. Recognition of these first bopyrid cryptoniscans to be identified in the region allow greatly expanded opportunities to measure critical species in estuary ecosystem dynamics.

Manuscripts in draft form or accepted:

Chapman, J. W., J. R. Cordell, M. Sytsma and R. D. Draheim-Waldeck. Vectors of *Nematostella vectensis* Stephensen, 1935 dispersal to Europe and western North America.

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 remains on the committee of Ph.D. student, Michael, Chi-Chang Liu, Dept Fisheries and Wildlife (thesis topic, the

introduced New Zealand Mudsnaill), continues as a member of the Western Regional Panel, (of the National Invasive Species Panel) but no longer on the executive committee where he previously organized international meetings. John organized the May 2007 Newport Sprint Triathlon – fund raiser for the Newport Swim Team and Newport High School National honors society for the fourth year.

Marine Fish Ecology

Selina Heppell, Associate Professor

Scott Heppell, Assistant Professor

This year, the Heppell Lab has focused on maternal effects on offspring quality in rockfishes, along with continued research on nearshore fish ecology. Brooke Martin (MSc) completed her thesis research on the endocrine cycle of black rockfish from the Newport Depoe Bay area. She found that younger black rockfish females begin their reproductive cycle later than many older fish. Brooke was supported through the Alaska Fisheries Science Center and the Cooperative Institute for Marine Resource Studies (CIMRS).

Emily Waschak (MSc student) has been collecting Pacific ocean perch and their larvae in the Gulf of Alaska, near Kodiak. So far, she has found little evidence of the positive correlation between mother’s age and larval condition in this species, contrary to results for black rockfish. The project is funded by the Alaska Fisheries Science Center and the North Pacific Research Board.

Brett Gallagher (MSc student) is completing his research on settlement timing and growth of juvenile rockfishes in nearshore and estuarine habitats near Newport. Contrary to popular belief, Brett has found large numbers of black rockfish juveniles growing well in Yaquina Bay, but no black rockfish juveniles in nearshore rocky reef habitat. This suggests that bays and estuaries are primary, rather than secondary, habitats for this species. Marine Team undergraduate students completed a project on English sole juveniles from Yaquina Bay that show signs of tumor-like growths caused by a papilloma virus. The students found reduced growth rates in infected fish and won the best poster contest at the Oregon Chapter of the American Fisheries Society meeting. A new group of Marine Team students will be conducting a radio-tracking project on Dungeness crab this fall. Funding for student projects and Heppell Lab boat maintenance comes through CIMRS.

Abby McCarthy (MSc) completed her thesis on analysis of oceanographic parameters and sea turtle bycatch and satellite tracks in the North Atlantic. Abby was a recipient of the Reynolds award in 2004, a Mastin award in 2005, and a Marine Technology Fellowship in 2005, and is now working for the Acoustics Program Lab at the Alaska Fisheries Science Center in Seattle.

On-going student projects based at HMSC include:

- Field work and experiments on the spread and impact of the invasive New Zealand mud snail by Markham award-winner Michael Liu, who is also an Aquarist for the Visitor’s Center
- Diet analysis and surveys of lingcod on the central and

southern Oregon Coasts by Markham award-winner Craig Tinus, who is working with the Port Liaison Project and local fishermen in a cooperative research project to investigate the potential impacts of recovering lingcod populations on local rockfish populations.

- Lab experiments in the AFSC lab on behavior of juvenile flatfish in response to predation risk and light intensity by Kate Boersma, a student working with Cliff Ryer and Tom Hurst and our lab.
- Analysis of distribution, diet and reproduction of Northern anchovy by Marisa Litz, a student working with Robert Emmett in the NWFSC lab. Marisa received a Markham award this year to run a series of lipid composition analyses in forage fish.

Marine Fisheries Ecology

Jessica Miller, Assistant Professor

It was the first full year for the Marine Fisheries Ecology program. The major research objective of the program is to provide information on life history variation in marine and anadromous fishes that will improve not only population-level assessments but also our understanding of how individuals interact with their environment and other species. A major component of our research relies on information embedded in the “ear bones”, or otoliths, of fishes. These small, calcium carbonate structures provide a permanent, chronological record that we can use to determine the age, rate of growth, and, in some cases, the origin of individual fish.

Research efforts include:

The Elk River Ocean Test Fishery (w/M. Banks, co-PI, funded by ODFW) - We successfully combined genetic and otolith chemical methods to provide information on stock composition of the Port Orford Chinook bubble fishery, a small terminal fishery in southern Oregon. This project applied state-of-the-art techniques to provide previously inaccessible information on the composition of this fishery and the information will be useful for local management efforts.

Reconstructing early ocean residence of juvenile steelhead of the coast of Oregon and Washington (w/NOAA NWFSC) - Although it is now recognized that the environmental conditions when salmon and steelhead first enter the ocean affects their survival, there is relatively little information available on early ocean residence, especially for steelhead. Furthermore, there is no information on whether hatchery and wild fish behave similarly during this period. This effort will quantify variation in the early ocean residence of steelhead by determining the timing and size of ocean entry and duration of nearshore residence of wild and hatchery juvenile steelhead in Oregon and Washington.

Project CROOS - We are participating in the Collaborative Research on Oregon Ocean Salmon Project, also known as Project CROOS, by determining if information stored within the otoliths, such as elemental and isotopic ratios, can provide insight into the migratory history of individuals within and among different stocks. This will provide information on whether we can

use otolith chemistry to learn more about stock-specific ocean migration and mixing in Chinook salmon.

Juvenile salmon & the Columbia River Plume: the importance of early ocean residence (w/NOAA NWFSC) - Although ocean conditions are recognized as important in the early survival of salmon, the mechanisms regulating survival have not been identified. Here, we are working to provide empirical data to test two hypotheses, i.e., top-down, predator-driven control vs. bottom-up, growth-regulated survival, for early ocean survival of spring Chinook from the mid-upper Columbia River. This project will use otolith microstructure and chemistry to determine the size and timing of ocean entrance for juvenile spring Chinook, examine interannual variation in growth, and examine how variation in early ocean growth relates to freshwater and ocean conditions and overall survival.

Mixing & Migration in Black & Canary Rockfish - The extent marine populations are open, i.e., well-mixed groups with genetic exchange, versus closed, i.e., spatially isolated groups, is a critical question in population ecology, fisheries management, and conservation. Given that most species likely fall along a continuum of exchange ranging from wholly open to fully closed, it will remain a challenge to provide empirical information on specific species that provides new knowledge and is useful for management and conservation efforts. This Oregon Sea Grant funded project examined mixing and exchange among coastal populations of these two rockfish species using otoliths as natural tags.

Re-establishment of the native oyster in Netarts Bay, Oregon - An OSU MRM MS student, Pamela Archer, is working on a project to evaluate the effects of efforts to re-establish the native oyster (*Ostrea conchaphila*) on native eelgrass (*Zostera japonica*) in Netarts Bay. Eelgrass is considered essential fish habitat and is important in the early life history of juvenile English sole and chum salmon in Netarts Bay. There is little known regarding the ecological role of the reef-building native oyster which co-evolved with salmon in Oregon's coastal watersheds. The project, funded by NOAA and The Nature Conservancy, will document the impact of the restoration efforts on eelgrass beds and determine the effects of oyster and eelgrass density on subsequent growth and survival of both oysters and eelgrass.

Presentations:

2007. Miller, J. A., Gera, S. M., Nickels, A. Re-constructing migratory history in Pacific salmonids. Salmon Ocean Ecology Meeting, Newport, OR.

2007. Archer, P. A., Miller, J. A., Vander Schaff, D. V. Re-establishment of the native oyster (*Ostrea conchaphila*) in Netarts Bay, Oregon. Pacific Estuarine Research Society Annual Meeting, Victoria, BC. (Best Student Paper, honorable mention for P. Archer)

2007. Miller, J. A., Gera, S. M., Nickels, A. Re-constructing migratory history in Pacific salmonids. Pacific Estuarine Research Society Annual Meetings, Victoria, BC.

2007. Miller, J. A. Elucidating life history variation in Pacific salmonids. American Fisheries Society, Oregon Chapter. Eugene,

2006. Miller, J. A. Otolith chemistry and population connectivity: assumptions and applications. Larval Biology Meeting, Charleston, OR.

2006. Miller, J. A. Larval dispersal and connectivity in marine populations: Introduction to the symposium. Larval Biology Meeting, Charleston, OR.

Other Activities:

Co-organized symposium on "Dispersal and Connectivity in Marine Populations in Marine Populations," at the 7th Larval Biology Meeting at University of Oregon Institute of Marine Biology, August 2006.

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.

The pilot study named ProjectCROOS (Collaborative Research on Oregon Ocean Salmon), developed in response to the recent fall Klamath Chinook salmon crisis, resulted in a lot of new activity that continues to grow as we expand this project to include collaborators in Washington and California. We determined the river basin of origin with high accuracy for more than 2,000 ocean caught samples from the 2006 season. By studying salmon that had tags identifying their home basin we verified that genetic ID agreed with coded-wire tags in all but one case. Now that we can identify where the salmon originated from, the next step is to learn how the distribution of fish is related to oceanographic data. Given greater understanding of these processes we hope that fishery managers might develop methods to avoid shutting down the entire region to protect a single run of fish like those from the Klamath River.

Other research focused on the genetic basis of run timing, homing and straying in salmon, along with mate choice and population structure in rockfish, has continued to provide exciting discoveries. Seven manuscripts recently published or in press include two on Chinook run timing, one on Chinook database development, one on coho population structure, one on the relative fitness of coho wild and hatchery stocks and two on rockfish population genetics. New students and staff include two PhD students, two post docs, a visiting scientist, two research assistants and the exciting recruitment for an assistant professor that will help develop our program further.

MMI - Cetacean Conservation and Genetic Laboratory (CCGL)

C. Scott Baker, Associate Professor; Jennifer Jackson, Postdoctoral Fellow; Debbie Steel, Faculty Research Assistant

Scott Baker joined the Marine Mammal Institute in July 2006, as Associate Director and Associate Professor in the Department of Fisheries and Wildlife. Debbie Steel joined the Institute in September 2006 as a Faculty Research Assistant and was instrumental in directing the renovation of space for the new Cetacean Conservation and Genetic Laboratory (CCGL). 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.

The CCGL is committed to a greater understanding of the molecular ecology and systematics of whales, dolphins and porpoises around the world. Our work on large whales is pursuing three inter-related themes: reconstructing the past; assessing the present and conserving the future. Postdoctoral Fellow 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 Program of the Pew Foundation. The objectives of this program are to better estimate the impact of hunting on the abundance of whales and to improve our understanding of the ecological role of whales before human exploitation. 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. Preliminary results of this approach were presented in February, at the International Summit on evolutionary change in a human modified environment, held at the University of California, Los Angeles. In August 2006, Scott and Jennifer participated in a workshop on estimating the history of whale and dolphin abundance in New Zealand, sponsored by the History of Marine Animal Populations (HMAP) and New Zealand National Institute of Atmosphere and Water (NIWA), Wellington, New Zealand.

To assess the current 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 1,000 individuals representing nine feeding grounds and eight breeding grounds. Analysis of another 1,000 samples collected is underway and will provide the first comprehensive description of population structure of humpback whales in the North Pacific.

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. At a recent meeting of the Consortium (January

2007), Debbie and Scott presented results providing the most comprehensive picture, to date, of the fidelity and interchange among the islands of Oceania. Although whales generally show fidelity to regional wintering grounds, individual are capable of 'voyaging' between different regions in alternate years. Results of this work have also been presented to the annual meeting of the Scientific Committee of the International Whaling Commission as part of the Comprehensive Assessment of humpback whales in the Southern Hemisphere.

A 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.

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 November 2006, to conduct genetic analysis of whale and dolphin products sold in Japan through the Internet (a recent change from the traditional markets) and participate in a documentary on the threat of exploitation to whales and dolphins around Japan. The work is part of a long-term study of trade in protected whales and dolphins using a portable PCR (Polymerase Chain Reaction) laboratory to identify the species origins of the products. The results of a five-year survey of whale products in Korea were used to estimate the growing threat of unregulated exploitation of minke whales by fisheries entanglement ('net whaling'). Using a novel capture-recapture method developed for the analysis of market products by Dr. Justin Cooke, we estimated that more than 800 minke whales have been killed and sold on markets during the last five years. 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 future of whaling and the recent expansion of scientific whaling remain thorny issues for international conservation. In April 2007, Scott participated in a PEW Foundation and UNEP sponsored symposium on the 'State of the Conservation of Whales in the 21st Century' held at the United Nations, New York. The symposium considered a number of 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/whalesymposium/index.php>.

MMI - Pinniped Ecology Applied Research Laboratory (PEARL)

Markus Horning, Assistant Professor

Markus Horning arrived at the Hatfield Marine Science Center in June 2006 to establish the Pinniped Ecology Applied Research Laboratory (PEARL) within the Marine Mammal Institute. He was joined by Faculty Research Assistant Lisa Petrauskas, who moved to HMSC from the Alaska Sea Life Center at Seward, AK. Erin Kunisch and Jamie Womble will join the PEARL in the Fall

of 2007 as graduate students through the Dept. of Fisheries & Wildlife.

The PEARL is dedicated to the study of ecology, behavioral physiology and conservation biology of pinnipeds in polar, temperate and sub-tropical regions. Our investigations of the physiological ecology of aging in pinnipeds will take Markus and a team of five researchers to McMurdo Sound, Antarctica from late September through early December of this year, for the second 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) and carried out in collaboration with Dr. Jo-Ann Mellish (Alaska Sea Life Center) and Dr. John Lawler (Texas A&M University). Other participants include graduate students Allyson Hindle (Texas A&M University) and Jeanette Nienaber (University of Alaska Fairbanks), as well as Drs. Sue and Roger Hill from Wildlife Computers (Redmond, WA). Allyson will defend her dissertation in August and will continue to work with PEARL as a postdoctoral researcher through 2008. In 2006, our team worked with 20 adult Weddell seals of various ages. Using animal-borne telemetry devices, we recorded dive depths, swim speeds, flipper stroking, feeding activity and electro-cardiograms. Blood samples and small muscle biopsies are being analyzed for indicators of oxidative stress implicated in aging processes, and for effectiveness of protective antioxidant mechanisms. This year we are hoping to work with an additional 30 animals.

Also funded by the NSF is a project on "Development and Calibration of Remote Infrared Thermography of Homeotherm Animals." This project is an enhancement of the recently completed development (under NSF 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, the SLiDAP system will allow us to monitor body mass, health, condition and reproductive status of pinnipeds in many coastal areas.

Markus is continuing a project funded by the Steller Sea Lion Research Initiative (NOAA / DOC): "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 Jo-Ann Mellish, Tom Gelatt (National Marine Mammal Laboratory), and Lorrie Rea (Alaska Dept. Fish & Game). Under this and a related project, four rehabilitated California sea lions and six juvenile Steller sea lions have been released with recently developed, implanted Life History Transmitters. These devices allow remote monitoring of pinnipeds throughout their entire lives, a first for any marine mammal. In September 2007, Markus will join Lisa in Seward, AK, for the next round of transmitter implant procedures at the ASLC.

In a collaborative effort with Anne York (York Consulting, Seattle, WA) 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 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.

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 1100 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. 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. The F1 generation of both the newly acquired Pacific and Kumamoto oyster broodstock will be maintained in quarantine. If these F1 generations are certified disease-free, they will be spawned and their progeny planted in coastal waters. This time-consuming quarantine procedure is necessary to avoid introduction of unwanted oyster diseases and parasites. The establishment of the USDA-ARS shellfish genetics program, under Dr. Mark Camara, has resulted in an expansion of oyster research opportunities at HMSC. This joint research currently focuses on 1) identification of molecular and physiological responses of juvenile oysters to heat stress that may be useful in predicting summer oyster mortality at grow-out sites, 2) evaluation of mixed-family versus single-family plantings in determining family performance at grow-out sites and 3) identification of appropriate broodstock for restocking depleted populations of native oysters (*Ostrea lurida*) on the West coast.

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 Oregon Sea Grant to continue work on the development of microparticulate diets for marine fish larvae. In addition, Chris Langdon spent 5 months on sabbatical in Norway developing lipid spray beads for delivering micronutrients to enrich rotifers and other prey species used in rearing cod larvae. It is anticipated that there will be further collaboration with Norwegian aquaculture nutritionists in the future.

Seabird Ecology

Robert Suryan, Assistant Professor-Senior Research
Karen Fischer, Graduate Research Assistant (M.S.)

August 2006 marked the inauguration of 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 \$118,000 in funding, authored/co-authored four papers, and gave fourteen presentations at scientific meetings, seminars, and public forums. One particularly memorable, invited presentation was for a special symposium on the endangered short-tailed albatross in Tokyo and was attended by Prince Akishino. Research projects during the past year included: 1) Foraging patterns and marine habitat use of short-tailed albatrosses nesting on Torishima, Japan; 2) Albatross habitat use and fishery interactions off Alaska; 3) California Current chlorophyll hot spots, seabirds, and marine protected areas; 4) Seabird surveys along the Newport hydrographic line; and 5) Common murre reproductive biology and foraging ecology at Yaquina Head. 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 fifth 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.

Albatrosses off Alaska

2006 was the final year of capturing albatrosses at-sea in the

Aleutian Islands for satellite tracking and tissue collections for stable isotope and contaminants analysis. 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. These data were used within three months of collection by the North Pacific Fisheries Management Council to modify proposed changes to seabird deterrent regulations for Alaskan longline fisheries.

California Current Seabird Hot Spots and MPAs

This is a collaborative study with PRBO Conservation Science. The initial stages of this research is a 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. The next stage will be to incorporate other environmental variables and long-term seabird survey data from focal study areas to allow prediction of the at-sea distribution of seabirds. A third stage will include predictive modeling of seabird distribution in the California Current System, an assessment of knowledge gaps, and, ultimately, to provide recommendations for marine protected area (MPA) networks along the U.S. West Coast.

Seabird Surveys Along The Newport Hydrographic Line

This year, SOL began conducting monthly 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 ride along 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 murre colonies on the west coast. The Bureau of Land Management manages the Yaquina Head Outstanding Natural Area, located in Newport. SOL initiated research and monitoring at this colony during the 2007 breeding season in collaboration with Amanda Gladics (U.S. Fish and Wildlife Service) and Michelle Schuiteman (Oregon Sea Grant fellow). 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 beginning of the Newport Hydrographic Line and a popular public attraction viewed by thousands of visitors annually

Department of Agricultural and Resource Economics

Marine Fisheries Management and Policy

Susan Hanna, Professor

Fishery management is in a state of change in Oregon and the Pacific Northwest, nationally and internationally. In Oregon, the Governor has requested the Ocean Policy Advisory Council (OPAC) to develop a proposal for a system of marine reserves. Nationally, the Magnuson-Stevens Fishery Conservation and Management Act was reauthorized at the end of 2006 with elements encouraging the adoption of limited access privilege programs (LAPPs) and other tools to promote reductions in fishing capacity, minimization of bycatch, and the achievement of sustainable fisheries. The ecosystem management recommendations of the U.S. Commission on Ocean Policy and Pew Oceans Commission continue to be promoted through the Joint Ocean Commission Initiative (JOCI). At all levels, there is growing interest in strengthening the role of fishing communities in fishery management. Susan Hanna is involved in a number of issues related to trends in fishery management and ocean policy, incentive-based tools, fishing communities and ecosystems.

Trends in Fishery Management and Ocean Policy

- **Oregon Ocean Policy:** invited presentation “Social Science Needs for Oregon’s Ocean” at “The 2006 Oregon Ocean Conference” (the “Heceta Head Conference”), Florence, Oregon.
- **Coastal Oregon Decisionmakers:** Steering Committee of the OCZMA Economic Demographic Study and gave advice on project design and data needs.
- **Fishery Management History:** Invited seminar “Fishery Management under the Magnuson Act: Where are we now and how did we get here?” to Marine Resource Management Program graduate students, Oregon State University.
- **Integrating Fishery Management and Markets:** Appointment to the Board of Directors of the Oregon State University Seafood Consumer Center.
- **Extension Education:** With Chris Dewees, U.C. Davis, designed and conducted a two-day training workshop for Sea Grant Extension personnel in the California and Oregon programs. The workshop covered a range of fishery management tools and policy subjects, supplemented with background readings prepared by Hanna and DeWees. Many of the workshop materials are being developed into a series of Oregon Sea Grant outreach education briefs on fishery management tools and policy.
- **National Policy:** NOAA Science Advisory Board (SAB), providing general scientific advice to NOAA and specific social science advice to the NOAA Research Council on implementation of the report of the Social Science Review Panel (SSRP) “Social Science Research Within NOAA: Review and Recommendations.” The Board has formed a panel of external experts to do a “check-in” on progress toward implementing recommendations of the SSRP report. Hanna will chair the panel.
- **National Policy:** Science Advisory Panel to the Joint Ocean Commission Initiative (JOCI), the combined

implementation effort of the US Commission on Ocean Policy and the Pew Ocean Commission.

- *International Policy*: Board of Directors of the Institute of Fishery Management and Coastal Community Development, North Sea Centre, Hirtshals, Denmark. The Institute has now joined with Aalborg University to promote mutual interests in coastal community development in Denmark and abroad.

Incentive-Based Tools

- *Recreational Fisheries*: Invited presentation “Evolution of Property Rights: Lessons of Process and Potential for Pacific Northwest Recreational Fisheries,” to the Political Economy Forum “Evolving Approaches to Managing Marine Recreational Fisheries,” sponsored by Environmental Defense and the Property and Environment research Center, Montana State University. Bozeman, MT (October 06).
- *Regulatory Design*: Invited presentation “Matching Property Rights With Fishery Context: Avoiding Excessive Mongrelization,” at the workshop “Property Rights and Fisheries,” sponsored by the National Center for Ecological Analysis and Synthesis and Environmental Defense, Santa Barbara California. .
- *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.
- *Management Costs*: Review of the management costs associated with implementing Limited Access Privilege Programs (LAPPs).
- *Graduate Student Supervision*: Ph.D. student Branka Turcin finished and successfully defended her PhD dissertation in February. Her research involved modeling spatial distribution of Oregon groundfish effort as part of a project to develop incentives-based approaches to best management practices in fisheries. Branka is an Assistant Professor at the University of Alaska Fairbanks and is actively engaged in North Pacific fisheries research.

Fishing Communities

- *Collaborative Management*: Invited presentation “Sustaining Salmon Fisheries: the Challenge of Collaborative Management” to the “Symposium on the Sustainability of Arctic-Yukon-Kuskokwim (AYK) Salmon Fisheries” in Anchorage, Alaska.
- *Fishery Co-Management*: Invited seminar “Fishery Co-Management in Theory and Application” to Marine Resource Management Program graduate students, Oregon State University.
- *Community Property Rights*: Invited chapter “Community Fisheries” for the Economics of Fisheries and Aquaculture section of the Encyclopedia of Life Support System (EOLSS) published by UNESCO.
- *Fishing Communities and Fishery Management*: Presentation: “Integrating Fishing Communities into Fishery Management: The Influential Economics of Organization,” at the 2006 conference of the International Institute of Fisheries Economics and Trade (IIFET), Portsmouth, U.K.
- *International Issues*: Organized and chaired a special session and presented an overview paper at the 2006

Conference of the International Institute of Fishery Economics and Trade (IIFET), Portsmouth, England (July.) “Fishing Communities and Fishery Management: Economics and Property Rights.” Also chaired the plenary “Policy Day” session and presented a review paper on an EU stock recovery project “UNCOVER.”

- *Legal Status of Fishing Communities in Management*: Review Panel for the National Sea Grant Law Center research project on the legal status of fishing communities in regulating local fisheries.
- *Fishing Communities and Fishery Change*: Continued writing book manuscript Sustaining Fishing Communities in an Environment of Change. The book is targeted at fishery managers and highlights research and outreach conducted under the Oregon Sea Grant “Adapting to Change” project, summarizing the “so what?” of social science and fisheries management.

Ecosystems

- *Oregon Ocean Policy*: Scientific and Technical Advisory Committee (STAC), Oregon Ocean Policy Advisory Council (OPAC). The primary advisory role concerns the economic dimensions of marine reserves and process aspects of marine reserve development.
- *Oregon Ocean Policy*: 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*: Steering Committee of the Oregon Sea Grant 2007 conference on resilience in salmon ecosystems. “Pathways to Resilience: Preserving Pacific Salmon in a Changing World”
- *Ecosystem-Based Fishery Management*: Invited presentation summarizing social science issues for ecosystem-based fishery management at the “Policy Workshop on Ecosystem Management, Western Pacific Fishery Management Council.

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 and the Oregon Watershed Enhancement Board (OWEB). 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 hope to develop a larger and more comprehensive three year project that can collaborate with other West Coast agencies and industries.

These research projects have generated over \$2.0 million in extramural funding and are supporting six graduate students (Six Masters' candidates) from the Departments of Agricultural and Resource Economics and Marine Resource Management.

College of Forestry

Department of Forest Science

Bryan Black, Associate 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
- Disturbance history of a mixed conifer stand in central Idaho. Collaborators: Karen Arabas, Willamette University and The 15th North American Dendroecology Fieldweek disturbance ecology group
- 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.
- Spatial variability of growth in yelloweye rockfish. Collaborators: George Boehlert, HMSC and Mary Yoklavich, NOAA SWFSC Santa Cruz, CA.

- 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

Funded projects for the coming year 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

The lab has also hosted summer interns through the National Science Foundation-funded Research Experience for Undergraduates (REU) program. Rose Kormanyos, an undergraduate at Whitman College worked in the lab during the summer of 2006 and Matt Stuckey, an undergraduate at the University of California, Berkeley, completed an REU internship during the Summer of 2007.

College of Oceanic and Atmospheric Sciences

Estuarine and Coastal Ecology

Anthony F. D'Andrea, Assistant Professor

Research in the Estuarine Ecology Lab focuses on the benthic ecology of estuarine ecosystems with a special focus on the linkage between benthic communities and the physical and biogeochemical properties of the sediments that they inhabit.

During 2006-2007, much of the research in the lab focused on the life history and population genetics of the burrowing ghost shrimp, *Neotrypaea californiensis*. This project represents a collaboration among Oregon State University, USDA (Dr. Brett Dumbauld), US EPA (Dr. Ted DeWitt), and San Jose State University (SJSU; Dr. Leslee Parr) researchers to understand the role of larval dispersal in structuring adult shrimp populations and the genetic structure of adult populations of ghost shrimp in

Oregon, Washington, and California. The larval component of this project was spearheaded by the D'Andrea lab and included larval rearing experiments, daily sampling of ghost shrimp larvae in Yaquina Bay using a pump plankton sampler, collection of zooplankton samples in the coastal ocean off OR and WA during the Bonneville Power Authority (BPA) and NOAA-Fisheries "Ocean Survival of Salmonids" project for genetic analysis of ghost shrimp larvae, and examination of BPA long-term data sets for spatial and temporal patterns of shrimp larvae in the coastal ocean. The success of this project has greatly benefited from student involvement including a summer REU intern (Patrick Luke) in 2006, an OSU Fish and Wildlife graduate student (Katelyn Cassidy) and SJSU graduate students (Kenji Kozuka & Michael Doan).

Recently, the lab received a grant from the US EPA to study the impacts of river flood sedimentation events on tideflat macrobenthic communities in Pacific Northwest estuaries. The field study, based in Netarts Bay, OR, will simulate flood sedimentation events and track the initial mortality and recovery of the benthic community from these events. The study will be used to quantify the resilience of intertidal benthic communities and identify important structural changes (e.g., biodiversity, native vs. non-indigenous species) that may indicate a threshold or shift in the benthic ecosystem in response to flood sedimentation events. Precipitation frequency and intensity is increasing in the United States and the risk of extreme flood events is likely to increase with modest climate shifts. PNW coastal systems are particularly at risk of such events due to the magnitude and strongly seasonal rainfall patterns in these systems. PNW estuarine ecosystems are thus at increased risk of flood deposition events with unknown impacts on the biodiversity and function of estuarine ecosystems. Two new OSU graduate students (Anna Pakenham, Marine Resource management & Cassidy Thomas, Biological Oceanography) will be conducting student research within the framework of this project. For more information: <http://cfpub.epa.gov/ncer/abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/8565/report/0>

Marine Geochemistry

Clare Reimers, Professor

Research in the Clare Reimers' lab focuses on investigations of how the chemistry of sediments in marine environments is shaped by physical and biological processes with a specific focus on oxidation and reduction reactions, where the oxidant and/or the reductant may be organic or inorganic compounds. Two over-riding objectives are to understand benthic responses to a changing ocean carbon cycle and to develop new electrochemical tools for seafloor observations.

During 2006-2007 two projects focused on developing and evaluating prototypes for revolutionary microbial fuel cells designed as self-refueling power sources for fixed seafloor sensors (the benthic microbial fuel cell). A laboratory experiment was continued into its second year in a refrigerated lab at HMSC that is designed to evaluate the impacts of seafloor microbial

fuel cell reactions on sedimentary organic matter. Meanwhile field experiments with chambered benthic microbial fuel cells were conducted in Yaquina Bay and Monterey Canyon. These latter studies were led by Oceanography graduate student, Mark Nielsen, who also received a Markham fellowship to conduct a project aimed at relating sediment permeability measurements to electrical resistance measurements.

In the fall of 2006, C. Reimers served as an invited lecturer in Advanced Training Workshop on Southeast Asia Regional Carbon and Water Issues that was held in Taiwan, and she was appointed to the ORION Ocean Observing Steering Committee. In May 2007 she presented an invited talk at the Joint Assembly of AGU, Acapulco, Mexico, Biogeophysics session.

College of Science

Department of Botany and Plant Pathology

Gayle Hansen, Associate Professor

Mission and objectives: During the 2006-2007 academic year, Gayle Hansen, our marine botanist, continued with her research and teaching on the taxonomy, phylogeny, and distribution of west coast seaweeds. In addition to completing her research papers, her ultimate goal is to provide comprehensive floristic accounts of the seaweeds of her two primary focus areas: (1) Oregon and (2) Alaska.

Taxonomic and phylogenetic research: In order to verify the taxonomy of Northeast Pacific seaweed species using molecular biological techniques, Gayle has collaborated with scientists and students from a number of countries around the world. This past year she worked with experts from: Russia and Alaska (on the seaweed order Laminariales), Japan (on the Ulvales), Portugal and Ireland (on the Fucales), the Netherlands (on the Cladophorales), and Mexico (on the crustose Corallinales). Papers on species in the Laminariales and Fucales were completed and are due to be published this fall. The rest of these studies will continue through next year.

Floristic and distribution studies: Gayle's Catalog of the Occurrence and Distribution of Oregon Seaweeds and Seagrasses was put on hold this year so that she could devote her time to projects on the seaweeds of Alaska and southwestern Washington. For Alaska, she joined John Uscian in the preparation of a book entitled Alaska SeaLife Center Guide to Marine Life. Gayle's contribution of 3 chapters on the seagrasses and seaweeds of Alaska added substantially to this 600 page volume that is due to be published sometime during the coming year. For southwestern Washington, Gayle began a year-long floristic study of the seaweeds of Willapa Bay. Well-known for its introduced invertebrates, the seaweeds of the Bay had never before been studied. Her research to date has revealed that more than 50% of the seaweed species of this Bay are either introduced or cryptogenic (meaning widespread and of unknown origin). Her study of the seaweeds of Willapa Bay was made possible through collaboration with another HMSC scientist, Brett Dumbauld (USDA), an expert on the burrowing shrimp of the Bay.

Educational activities: During the spring of 2007, Gayle co-taught a course on the Ecology of Marine Plants at the University of Oregon's marine lab in Charleston with Cynthia Trowbridge (OSU Zoology). Gayle's part of the course was on the evolution, systematics, and life histories of marine plants.

Outreach activities: Due to her long-standing status as one of the only seaweed experts in Oregon, Gayle was interviewed by both Oregon Coast Magazine and by Jefferson Public Radio. These interviews (cited below) concentrated on her studies and on the status of seaweed research and utilization in Oregon.

1. Damian Fagen. 2007. "Coastal Personality: Dr. Gayle Hansen, the seaweed lady". Oregon Coast Magazine, Jan/Feb 2007: pp 20-21.

2. Bob Binnewies. 2007. "Seaweed lady catalogs Oregon's marine plant life". An interview for Jefferson Public Radio. www.ijpr.org/OnlineAudio.asp

Department of Science & Math Education

Shawn Rowe, Assistant Professor

Shawn Rowe, Ph.D., represents the College of Science's Department of Science and Mathematics Education at the HMSC. In addition to his own research, which focuses on how people learn science in informal settings like museums, Rowe oversees or coordinates research and evaluation work by students from the College of Science that involves HMSC visitors. The HMSC's Visitor Center is a prime laboratory for this research. Between July 2006 and June 2007, Rowe and/or students presented research findings from their work at the HMSC to attendees at the National Marine Educators' Conference, the Northwest Aquatic and Marine Educators Conference, the National Association of Research in Science Teaching Annual Meeting, The EarthScope National Meeting, and the Visitors Studies Association Annual Meeting.

Studies underway this year at the HMSC's Visitor Center looked at how math can be introduced into exhibits and group activities; how families learn from bilingual family science nights; how concept maps and other tools can be used for evaluating learning activities and programs; how iPods change group learning dynamics at exhibits; how individuals and groups learn science from visual representations of data; and how scientists can learn to be better communicators. Over the course of the year, at least one Science and Mathematics Education student has been in residence at the HMSC every quarter.

Two students working with Dr. Rowe also completed Evaluation and Research Internships at Oregon Coast Aquarium this year. Coral Gehrke, a Marine Resource Management student, prepared critical baseline data on visitor use of physical spaces within the Aquarium. Christine Smith, a Science and Math Education graduate student, carried out an evaluation of the Aquarium's K-5 outreach program.

As part of an NSF funded project with Lawrence Hall of Science, Melissa Feldberg and Shawn Rowe of Sea Grant 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 carried hands-on activities on marine biology and physical oceanography to audiences at the HMSC and Oregon Coast Aquarium, high-school students at OSU's Salmon Bowl, middle-school students at SMILE's Middle School Challenge and Saturday Academy's Winter Wonderings, Lincoln Elementary 3rd graders, and engineering undergraduates at Wilson Hall. As a spin-off of this class, two groups of oceanography undergraduates from Jim Richman's OC 321 class prepared HMSC auditorium presentations, including demonstrations on dead zones.

Department of Zoology

Marine Ecology

Bruce Menge, Professor; Jane Lubchenco, Distinguished Professor; and Sally Hacker, Associate Professor

1. 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 and NOAA. A new NSF grant was just awarded to Menge and Hacker with colleagues Francis Chan (Assistant Professor, Senior Research in Zoology) and Karina Nielsen (Assistant Professor in Biology at Sonoma State University).

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.

2. Activities: PI research: PISCO uses HMSC laboratory sea water space to stage field work, using space in April-June each year. Personnel involved besides the PIs include Erin Richmond, Mae Noble, 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 and Postdocs:

Francis Chan (PISCO, Assistant Professor, Senior Research): focuses on coastal biogeochemistry 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 interaction 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 larval condition in relation to phytoplankton concentration, temperature and acidity in the inner shelf waters off Cape Perpetua and Cape Arago. Her activities at HMSC include sample processing, microscope work, maintenance of cultures of larvae and larval food, and lab experiments.

Margot Hession-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, 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

National Health and Environmental Effects Laboratory - Office of Research and Development 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 high rate of human population growth in the Pacific Northwest is subjecting estuaries and coastal watersheds to many anthropogenic stresses. The amount of this stress will continue to increase as population growth continues and the Northwest further develops economically. Stressors which jeopardize the ecological sustainability of estuarine and coastal watershed resources include watershed alterations (e.g., urbanization, land use alteration, road construction, agriculture and forestry practices) such as increased nutrient and sedimentation loads, habitat loss and alteration (e.g., landfill and dredging), planned and unplanned biotic introductions, pollution, anthropogenic-caused algal blooms, and extreme natural events such as floods, droughts, and disease outbreaks. Determining the effect of stressors is complicated by the fact that they have different ecological effects and act at various, often overlapping, spatial and temporal scales.

The specific 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. The research seeks to evaluate how specific estuarine habitats, and particularly seagrasses and burrowing shrimp, respond to a range of potential stressors which may lead to habitat alteration. Additionally, the research effort seeks to understand the influences of these stress factors at spatial scales from local to regional, and seeks to develop indicators of ecological condition which may be used to evaluate estuarine status across multiple spatial scales. 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 the Western Coastal Environmental Monitoring and Assessment Program, which is part of the National Coastal Assessment (NCA) being conducted by EPA. The program is designed 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 2006, Western Coastal EMAP carried out an assessment of coastal ecological condition for the estuaries of Washington, Oregon, and California, and began the first year of a two year assessment of the Aleutian Islands of Alaska. PCEB scientists contributed chapters on western region coastal conditions to two major EPA reports during 2006, the National Coastal Condition Report III, and the National Estuary Program Coastal Condition Report (<http://www.epa.gov/owow/oceans/nepccr/index.html>).

During 2006, a major effort for PCEB scientists led by Dr. Cheryl Brown, 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. This research is an example 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.

Associated with the nutrient criteria effort, PCEB scientists Dr. Peter Eldridge and Dr. Jim Kaldy, together with EPA and academic collaborators, have developed models to predict how two important species of seagrass will respond to changes in coastal conditions caused by excess nutrients, suspension and deposition of sediments, and temperature changes. In particular, the models will assist coastal managers in determining appropriate levels for nutrients in estuarine waters that will help protect these important coastal resources. Models have been developed for eelgrass (*Zostera marina*), which is found along the Northeast and West Coasts, and for turtlegrass (*Thalassia testudinum*), which is found along the Gulf Coast, thus providing management tools for much of the US coast line.

PCEB scientist Dr. Henry Lee II participated as a technical advisor in the negotiation of the ballast water treaty under the International Maritime Organization (IMO) of the United Nations. Dr. Lee's assistance was requested by EPA's Office of Water/Office of Wetlands, Oceans and Watersheds in addressing the section of the treaty that allows a risk assessment approach for ships traveling between designated ports as an exemption to the biologically-based standards for ballast water discharges. These guidelines are being considered as part of the ballast

water treaty being formulated by the IMO, in particular the development of risk assessment guidelines for invasive species introduced through ballast water.

Support to the EPA Region 10 Office in Seattle was provided by Dr. Ted DeWitt with research on mapping seagrass habitats in turbid estuarine waters. Studies were conducted to determine the efficacy of several mapping approaches for use in shallow, turbid estuaries. The best method was side scan sonar coupled with underwater video. The video data were used to 'train' a computer-based mapping and classification system, and to test the accuracy of the resulting seagrass maps. These maps are highly accurate (80-90% accuracy) and turbidity effects are inconsequential. Costs for producing maps with this method compared favorably to costs of other remote sensing techniques.

Dr. Henry Lee II (U.S. EPA) and Deborah Reusser (USGS) collaborated to produce the *Pacific Coast Ecosystem Information System (PCEIS Version 1.0)* is an integrated database of information on distributions of native and non-native species at spatial scales ranging from tributaries to the entire Northeast Pacific, and that can also be coupled to landscape data. It provides a powerful tool for researchers and managers to use to extract information at the appropriate spatial scale when evaluating the effects of invasive species, nutrient enrichment, habitat alterations, and other environmental problems in the coastal zone. PCEIS unique and is the first tool of this type to be developed.

PCEB scientist Dr. Steve Ferraro completed and published results of a 3 year study in the estuaries of the Pacific Northwest which allows identification of which areas, among all the different types within an estuary, are most important for survival of swimming organisms such as fish, crabs, and shrimp. This knowledge will allow us to designate particular estuaries (or portions therein) as critical habitat for certain species, to prioritize areas for environmental protection (e.g., those areas that are used by the most species), to map potential species distributions up and down the Pacific Northwest coast, and to determine the risks of human activities on estuarine species.

EPA research staff at HMSC currently 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. In 2006, PCEB hosted two high school summer interns, Alexandria Williams and Matthew Parrish, through the Saturday Academy Program, an intern, Caitlin Wilson, through the CWEST program with OSU, and hosted an EPA intern, Carolyn Hammer, during a rotational assignment from Washington, D.C.

National Oceanic and Atmospheric Administration (NOAA)

National Marine Fisheries Service

Alaska Fisheries Science Center

Fisheries Behavioral Ecology Program

Allan W. Stoner, Program Manager

The Fisheries Behavioral Ecology Program conducts experimental research directed toward 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 goal of the Program is to provide the critical information needed to improve survey techniques, to improve predictions of population abundance and survival, 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:

- 1) The Behavior Program continues to evaluate the mechanisms which control mortality in fish when they are discarded from fishing operations (bycatch mortality). Simple behavioral indices (e.g., reflex responses) have been developed to predict capture-related delayed mortality, and these new predictors are being incorporated into field experiments in the United States and Canada. Extending this line of research, members of the Program initiated new efforts with Alaska king, tanner, and snow crabs in 2007, and mortality predictors are being tested in the Bering Sea.
- 2) The Program has an increasing interest in how climate change, especially changing seawater temperatures, affect growth and recruitment of larval and juvenile fish in Alaska. Efforts continue with Alaska flatfishes, and laboratory studies have been expanded substantially with Pacific cod. The North Pacific Research Board is supporting collaboration with researchers at Oregon State University to project the effects of climate change on cod recruitment in the Bering Sea. This project is combining laboratory, field and modeling components.
- 3) 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. Laboratory experiments in Newport and field trials in Kodiak are being conducted 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.
- 4) 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, understanding bias in visual surveys conducted with underwater vehicles, and reducing shark capture on longlines.

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 and conducts critical research on groundfish and salmon and their ecosystems throughout the West Coast.

Administration (NOAA)

Hollis Lundeen, Newport Research Station Facilities Manager

NWFSC staff conducts critical West Coast salmon and groundfish research in the Captain R. Barry Fisher building (BFB), Newport Aquaculture Lab (NAL), and Research Support Facility (RSF) building.

Center staff continued to make improvements in the areas of environmental compliance and safety. Recent additions to the facility included improvements to the aquaculture laboratory's raceway and greenhouse, replacement of seawater effluent grid covers, and installation of credential key card access with security requirements in all buildings. Center staff also completed modifications resulting in installed research fume hoods, lab reconfigurations, and a HAZMAT shower and eyewash installation. Staff also coordinated SeaFest 2007 activities, where over 4,000 attendees participated in tours and talks focused on climate change, educational booths, and displays of ships and vessels. In addition, Hollis Lundeen hosted several site tours for Foreign National visitors, researchers, and members of the public.

Environmental Conservation Division (EC):

Dr. Mary Arkoosh, Supervisor, Immunology and Disease

Dr. Mary Arkoosh, Dr. Frank Loge, 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 an 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. Claudia Bravo, Dr. Joe Groff, Erik Loboschfsky, and Don Thompson, University California Davis, Dina Spangenberg, 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 transcripts number with real time 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 (IHNV) 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. Conversely, in-river outmigrants that arrived at the estuary earlier were found to experience less delayed mortality than later in-river outmigrants.

Barged and in-river fish that died during estuary holding had a statistically significant smaller condition factor than fish that survived. The condition factor is commonly viewed as a qualitative measure of health, and hence, fish that died in the net pens were not as healthy as fish that survived holding. A complete histopathological analysis is underway to ascertain putative causes of death.

We found that barged fish from the Dworshak National Fish Hatchery were found to be 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. 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 will be performed on PIT-tagged juvenile spring Chinook salmon from both Dworshak and Rapid River Hatcheries. Sixty fish have been collected from each hatchery as well as from Lower Granite, McNary and Bonneville Dams three times throughout the migration period. Finally, barged fish will be collected upon arrival at Bonneville Dam at times concurrent with the collection of fish from the other locations. Sixty animals from each hatchery will be 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. DNA 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. 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 contaminate 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 as Sentinels in the Development of Mathematical Models of Disease Transmission

The impact of human activities on our own and other populations on the planet is making news at an alarming pace. Global warming, ocean and freshwater contamination and acidification, deforestation, habitat destruction and incursion, and a burgeoning human population are associated with a complete spectrum of shifts in population dynamics. Scientists have linked effects of human activity to major shifts in populations of songbirds, insects, coral reefs, ocean mammals, and anadromous fish (just to name a few). The linkage, however, often remains tenuous due to the difficulty in quantitatively combining ecological processes with environmental fate and transport processes. This difficulty is avoided (and the linkage cloaked) via the often-used assumptions of complete mixing in populations that treat as noise the variations that are in reality due to measurable factors. To reveal and manage the cause-effect linkages, we are currently using fish as sentinels to establish quantitative tools, that is, models, for combining population dynamics and environmental chemical/thermal factors. We are currently in the process of using these new models to demonstrate how environmental stress can influence the dynamics of infectious disease transmission in natural populations.

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, Jennifer Menkel, Carrie Johnson, Jason Phillips, Heather Soulen, Jesse Lamb; Karen Hunter, and Mary Bhuthimethee; Research Associates: Drs. Hongsheng Bi, Andrey Suntsov, Jay Peterson, Jim Ruzicka, Jim Colbert, Doug Reese, Linda O'Higgins and Todd Miller; and Graduate Students: Marisa Litz, Julie Keister, Todd Sandell, and Rebecca Baldwin; Contractors: Paul Peterson.

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 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, 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 Rafael 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. The year 2007 marks the beginning of the 12th year of these efforts. At each station, Leah Feinberg, Tracy Shaw and Jennifer 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, Jennifer Menkel and Leah Feinberg. Jennifer 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 Catton, 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 sub arctic 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 four to six 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, and Heather Soulen 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 particular, 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.

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 2004-2006 (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 three 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. Andre Suntssov also initiated a study of the trophic ecology of juvenile rockfishes, 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 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 continued to evaluate the ecology of parasites and the importance of disease processes that affect salmon populations in the estuary and ocean environments. The potential effects of salmon pathogens (viruses, bacteria and macroparasites) on 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 prevalence 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 to be published by the American Fisheries Society in 2007 that will look at regional comparisons of salmon distribution and ecology. Studies were made on regional comparisons in distribution (Fisher, Brodeur), condition (Fisher), feeding (Brodeur, Daly, Miller), parasites (Jacobson, Baldwin) and associated nekton (Pool, Brodeur, Emmett), as well as regional variations in zooplankton species composition and community structure, in samples collected from southeast Alaska to northern California (Morgan and Peterson).

Harmful Algal Blooms

Dr. Bill Peterson was recently funded by the NOAA/OHHI program to begin work on Harmful Algal Blooms (HABs) 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 Northwest Fisheries Science Center in Seattle, and with HAB scientists from Oregon State University (P. Strutton) and University of Oregon (M. Woods). Strutton, Woods, O'Higgins and Peterson recently received a five-year award from the NOAA MERHAB program to continue work on ecology of HABS and to develop forecasting capability for HABs in Oregon's coastal waters.

Coastal Pelagic Species

Drs. Jacobson and Emmett began a program in 2005 to investigate the migration and stock distribution of small coastal pelagic fishes, initially focusing on Pacific sardines off of Oregon

and Washington. This program includes the use of parasites as potential biological markers and is being conducted by Rebecca Baldwin. In June 2007, 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. In June 2007 we collaborated with the SWFSC to conduct a spawning biomass estimate of northern anchovy and Pacific sardine off Oregon.

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 Mary Bhuthimethee have also examined 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 and Stacey Miller 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 Miranda Petersen;
- 3) Oregon State University (OSU) graduate student LCDR Todd Bridgeman;
- 4) Pacific States Marine Fisheries Commission (PSMFC) staff Patrick McDonald, Nikki Atkins, Susan Coccetti, Jennifer Cramer, Betty Kamikawa, and Omar Rodriguez;
- 5) IAP World Services, Inc. staff Allen Cramer; and
- 6) The Data Entry Company (TDEC) staff Carol Ksycinski.

Stock Assessments and Stock Assessment Research

During 2006 and 2007 FRAM Stock Assessment members produced two full assessments, one on sablefish (*Anoplopoma fimbria*) prepared by Dr. Michael Schirripa, and one on longnose skate (*Raja rhina*), prepared by Drs. Vladlena Gertseva (CIMRS) and Michael Schirripa. Details on these assessments (and other west coast groundfish assessments conducted in 2007) can be obtained from the Pacific Fisheries Management Council's web site (www.pccouncil.org). The sablefish and longnose skate assessments form the basis for Council recommendations for Allowable Biological Catches and Optimum Yields for these species for 2009-10, which will be finalized at the September 2007 Council meeting.

In September 2006 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 October 2006, Dr. Schirripa assisted with assembling a scientific session of the North Pacific Marine Science Organization (PICES), an inter-governmental scientific organization that was established in 1992 to promote and coordinate marine research in the northern North Pacific. The session, entitled "Linking climate to trends in productivity of key commercial species in the sub arctic Pacific", included nine oral presentations given by scientists from Canada, China, Japan, Korea, Russia, and the United States. Details of these presentations can be found at the PICES web site (www.pices.int). An objective of this workshop was to achieve consensus on a list of 12 to 15 of the most important commercial species that will help to identify the specific linkages between climate and trends in production. After this agreement was achieved and there was further clarification of the effects of climate variability, the key species then became an index of climate-related impacts. With time, this could become an important forecasting tool for industry and governments. This workshop was well received and spawned another workshop entitled "Forecasting Climate Impacts on Future Production of Commercially Exploited Fish and Shellfish". The ongoing project is being referred to, for the interim, as the PICES Panel on Fisheries and Climate Change (PPFCC).

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 2006 through June 2007, the species and number of associated otoliths aged to support ongoing and future assessments were; sablefish (7,326), darkblotched rockfish (9,975), Pacific Ocean perch (1,471), canary rockfish (5,356), Pacific hake (4,538), English sole (4,720), arrowtooth flounder (4,276) and Dover sole (1,016). The total number of structures

aged for this reporting period includes; production (33,168), cross training (3,562), double reads (1,535) and research (413). The maintenance of the Ageing Lab inventory for this reporting period included the following; structures (57,266), samples from state and federal sources (1,277), and species (60).

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.

ASTWG (Advanced Sampling Technology Working Group) Workshop: Advanced Sampling Technologies to Improve the Classification and Monitoring of Marine Habitats for NOAA Strategic Goals - The FRAM division hosted a workshop in August 2006 to identify the most effective and promising approaches and technologies for identifying, mapping, and monitoring essential offshore habitat for demersal fish species. Waldo Wakefield acted as the moderator of the workshop and Julia Clemons as rapporteur. The workshop co-organizers and steering committee included: Waldo Wakefield, Dave Demer (NMFS SWFSC), Chris Gledhill (NMFS SEFSC), Vince Guida (NMFS NEFSC), Bill Michaels (NMFS NEFSC), Frank Parrish (NMFS PIFSC), and Dave Somerton (NMFS AFSC). The goals of this workshop were to provide a forum for an exchange of information and ideas between the Fisheries Science Centers on technology and mapping seafloor habitats to identify the most effective and promising approaches/technologies to identifying, mapping, and monitoring essential habitat for demersal fish species and to develop draft recommendations to the ASTWG for research themes that could be included in a future ASTWG Request For Proposals. Representatives from each of the science centers, over 40 participants, had the opportunity to hear an overview of the current research activities and research needs related to mapping offshore habitats, and also the technologies that are currently being used at each center.

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 (ATSMML) 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 2007 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). This project is funded, in part, by the Integrated Ocean Observation Program of NOAA. The data portal can be accessed via the Internet at: <http://nwioos.coas.oregonstate.edu/>.

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 ultrasonic imaging sonar (Dual-frequency IDentification SONar) to document and categorize fish behavior in response to interaction with a selective flatfish bottom trawl.

Summer 2006 marked the second field season for this research project. This 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 2006 field season 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 2006 cruises are currently being analyzed and preparations are underway for field work in 2007.

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 2006 survey season began with the annual "At Sea Safety" training and survey orientation session at the HMSC for participating students, scientists from other agencies and volunteers. The chartered fishing vessels Ms. Julie, Noah's Ark, Excalibur and Raven conducted the 2006 West Coast Bottom Trawl Groundfish Survey from May 2006 through October 2006. 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 10th annual groundfish survey began in May 2007 with the annual "At Sea Safety" training and Survey Orientation sessions held at the HMSC 2-3 May. The contracted fishing vessels Noah's Ark and Ms. Julie embarked upon the actual survey in late May and return in late July. The second pass departs in mid August aboard the fishing vessels Excalibur and Raven and is expected to conclude in late October. In addition to FRAM survey members, participants in the 10th annual bottom trawl survey included graduate students from Oregon State University and Moss Landing Marine Laboratories (Moss Landing, Calif.), scientists from the Oregon Department of Fish and Wildlife, as well as two unaffiliated volunteers.

Acoustics

In addition to coast-wide bottom trawl surveys for groundfish, FRAM scientists conduct surveys and fisheries research employing underwater acoustics. The FRAM Acoustics group conducts both survey and analysis efforts involving acoustic fisheries surveys, 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 2006-2007 included:

In August 2006 the group participated with Canadian scientists on a joint research cruise onboard the CCG vessels W.E. Ricker and J.P. Tully. One of the major objectives of this cruise was to evaluate the use of the Simrad EK60 echosounder for

performing multi-species discrimination. Plankton, nutrient, and physical oceanographic data were also gathered. Biological data for groundtruthing the acoustic data was obtained on the J.P. Tully using plankton tows (bongo), BIONESS nets plus a Video Plankton Recorder (VPR); fish data was collected using trawls from the W.E. Ricker. Results of this cruise showed that the new Simrad EK60 performed well and gave new insight for discrimination between different species while using five frequencies. The areas of primary interest during this survey were the drop-off points where bottom depth changed from 100-200 m. These areas showed high scattering on the 120 and 200 kHz sounders while BIONESS trawls through these areas noted concentrations of euphausiids and copepods to collaborate with the observations. The addition of the VPR allowed observations of animals too fragile to be captured in the BIONESS net and the escape responses of animals (particularly euphausiids and chaetognaths) in front of the BIONESS. Plankton tows (bongo) and CTD casts will be analyzed and linked with biomass estimates made from echosounder recordings.

Throughout the year the Acoustics group has been planning for the 2007 US-Canada Joint Hake integrated acoustic and trawl survey. In this survey, acoustic data is collected while mid-water and bottom trawls are deployed to verify size, species composition and gather biological information (i.e., age composition, sex). This biennial survey, which will take place onboard the NOAA Ship Miller Freeman started in June 2007 and continues through August 2007. Scientific crews are composed of both U.S. and Canadian scientists. The U.S. scientific crew includes Lisa Bonacci (FRAM acoustician stationed in Newport), Steve Pierce (OSU Oceanographer), and Irene Watts (OSU Graduate Student). The survey spans the continental slope and shelf areas along the West Coast from south of Monterey California (35.7° N) to the Dixon Entrance area (54.8° N).

After completing the U.S. portion of the hake survey the acoustics group will conduct an inter-vessel comparison of hake acoustic backscatter measurements. These measurements will be recorded primarily by the NOAA ships Miller Freeman and Oscar Dyson. The results from the cruise will provide vital information for a smooth transition from the NOAA Ship Miller Freeman to the NOAA Ship Oscar Dyson for future hake acoustic surveys.

West Coast Groundfish Observer Program

In its sixth year, the West Coast Groundfish Observer Program continues to successfully deploy observers aboard commercial fishing vessels along the West Coast. Observers are responsible for collecting catch and discard estimates, species composition data, and biological specimens in West Coast groundfish fisheries. This year witnessed an increased effort on collecting biological specimens from discarded catch to aid in stock assessments. Specimens were also provided to a number of scientific and educational organizations. Additionally, observers were redeployed on pink shrimp vessels beginning in March 2007 after a one-year hiatus. The Observer Program also conducts observer training (sampling, species identification, and at-sea safety) twice annually at Hatfield. The observer safety training group has continued to work in cooperation with the West Coast bottom trawl survey to provide cold-water safety training. Observer

group members have also worked in outreach, providing fish identification training to high school students through the Oregon Coast Aquarium and in assisting with SeaFest 2007. Through a cooperative agreement between NOAA Fisheries and the Pacific States Marine Fisheries Commission, Observer Program staff is 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.

Conservation Biology Division (CB):

Dr. Peter Lawson

Dr. Laurie Weitkamp

Heather Stout

Dr. Peter Lawson and 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 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 and 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.

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/cbd/trt/>). The first step in this process is developing biological goals for the recovery of salmonid species, a task that is 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 considers listed coho salmon along the coast from the Columbia River to Punta Gorda, California. This process involves 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 is 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.

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.

Oceanic and Atmospheric Research Division

Pacific Marine Environmental Laboratory (PMEL)

Vents Program

Steve Hammond, Director

John Lupton, Acting Program Manager

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

The Vents Program has a long-term commitment to investigating volcanic activity in the northeast Pacific and on the Juan de Fuca Ridge in particular. An important part of this involves acoustic monitoring by Bob Dziak's group using the U.S. Navy's SOSUS hydrophone array. In the past, this acoustic monitoring has led to the detection of submarine eruptive events and to sampling of the impressive "megaplumes", which are postulated to be the result of sudden catastrophic release of huge reservoirs of hydrothermal fluid. In addition to the acoustic monitoring which covers a broad area of the north Pacific, the Vents Program is also has a research project called NeMO (New Millennium Observatory), which is a long-term study focusing on Axial Volcano on the Juan de Fuca Ridge. NeMO, which is in its ninth year, involves arrays of seafloor and water-column instruments and sample collection systems for chemical, biological, hydrographic, and geological studies. Axial Volcano last erupted in 1998, and monitoring data have shown that it has been re-inflating ever since. In addition to the continuous monitoring at Axial using moored and seafloor instruments, NeMO also involves repeat expeditions to the volcano to collect time-series samples using manned and unmanned submersibles. The most recent of these expeditions was just completed in August of 2007 with Bill Chadwick as chief scientist.

A significant portion of the research conducted by the Vents Program is supported by NOAA's Ocean Exploration Program. One such research effort is the Submarine Ring of Fire Program (SRoF), a multi-disciplinary and international project concentrating on the active volcanoes on the Mariana and Kermadec volcanic arcs in the western Pacific. In April 2006, as part of the SRoF project, an expedition led by Bob Embley completed a series of dives on the Mariana Arc using a remotely operated vehicle (ROV). This expedition made several exciting discoveries, including the observation of spectacular eruptive activity at NW Rota-1 volcano. Other highlights of this cruise included the discovery of molten sulfur ponds and new insights into the chemosynthetic ecosystems at Mariana submarine volcanoes.

As another part of the SRoF project, a recent expedition to the southwest Pacific focused on Brothers Volcano, an active volcano on the southern Kermadec Arc north of New Zealand. During this expedition, a detailed bathymetric survey of Brothers was completed using the ABE autonomous underwater vehicle (AUV). As part of this overall project, Bob Dziak's group had previously deployed 4 ocean-bottom hydrophones (OBHs) on the caldera floor of Brothers in September of 2004. The OBHs were recovered 7 months later, and when the data were downloaded a total of 110 earthquakes had been recorded. Analysis of these results indicated the likely presence of a hydrothermal fluid or magma reservoir in one section of the Brothers Volcano caldera.

US Department of Agriculture (USDA)

Agricultural Research Service (ARS)

Mark Camara, Research Geneticist

Bett 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 the 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 shellfish genetics program has focused on four areas:

- 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) Surveying genetic differentiation among extant remnant populations of the native Olympia oyster, *Ostrea conchaphila*.
- 3) Analyzing quantitative genetic variation and covariation in economically important characters in Pacific oysters to develop better selection procedures.
- 4) Identifying patterns of gene expression in selected oyster strains that are associated with enhanced tolerance to heat stress using DNA microarray technology. At present, summer mortality 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.

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 three coastal estuaries and results suggest that ghost shrimp recruitment continues to be relatively low while mud shrimp recruited extensively to Oregon but not Washington coastal estuaries in 2006 and 2007. 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. Tests were initiated on the susceptibility of small recruited shrimp to KCL (a less toxic salt) in 2007. A collaborative project with Dr. John Chapman at HMSC also indicates that a parasitic bopyrid isopod is influencing mud shrimp populations and that another species of bopyrid isopod can be attracted to ghost shrimp.
- 2) Studying the effects of shellfish aquaculture on estuarine habitats utilized by juvenile salmonids 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. An extensive mapping effort was completed in Willapa Bay this year to map

burrowing shrimp populations and ground-truth eelgrass cover from aerial photography taken in 2005.

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 (Service) 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 2006-07, the Oregon Coast National Wildlife Refuge Complex had seven permanent employees, one 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. At Siletz Bay NWR two parcels totaling 7.64 acres were acquired from Meriwether Northwest Oregon Land & Timber LLC. The parcels were inholdings consisting of riparian forest and tidal marsh located along Millport Slough Road. Acquisition of two additional parcels of land at Siletz Bay NWR is nearing completion and should close by the end of the calendar year. At Nestucca Bay NWR a landowner has approached the Refuge Complex and is interested in selling his land. An appraisal is being done and an offer will be made for the property.

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. The monitoring is being done in cooperation with the Confederated Tribes of the Siletz Indians. Preliminary information suggests that juvenile salmonid use of the restoration site is significantly higher than adjacent natural tidal marsh. Planning for an 82-acre tidal marsh restoration project on the Little Nestucca Unit of Nestucca Bay NWR was completed this year and the project is now under construction with an expected completion date of September 30, 2007. Planning for a 400-acre tidal marsh restoration project on Bandon Marsh NWR was initiated this year. 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 construction and planning was initiated this year with expected construction in 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, baseline data continues to be collected on plant communities and amphibians on refuge lands.

Research and monitoring of Steller sea lions continued in summer 2007 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.

The Environmental Education program continues to reach out to new schools and more students. Over 800 students from across Oregon submitted artwork for the annual Junior Duck Stamp Art Competition. The 2007 Oregon "Best of Show" winner was Joy Breneman, a home schooled senior from Tigard who drew a Trumpeter Swan entitled, "Hope is the thing with Feathers..." Continuing work under a grant from the National Fish and Wildlife Foundation, AmeriCorps volunteers brought the Shorebird Sister Schools Program to more than 650 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. Students from the Jane Goodall Environmental Middle School in Salem received a grant to help remove invasive species from Nestucca Bay National Wildlife Refuge. All 100 students and their parents showed up for a day of pulling English Ivy, Scotch Broom and American Holly, after the removal students monitored the growth of native vegetation in the area. In partnership with many other organizations the Service completed the much anticipated Oregon Coast Birding Trail Guide and website.

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 three permanent employees, one detailee from Bureau of Land Management, 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 2005-2006, the Newport Field Office celebrated a number of

accomplishments:

- Completed 10 restoration or habitat assessment projects under the Coastal Program which enhanced or restored 140 wetland acres and 215 upland acres, restored or opened passage on 2.3 miles of stream, and provided a number of other benefits to threatened species, coastal ecosystems, and local communities. Anticipate funding a similar number of projects in FY08.
- Completed a strategic plan 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.
- 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. We anticipate that the document and a Draft Environmental Impact Statement will be available for public review in September 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 the Oregon silverspot butterfly and western lily.

Oregon Department of Fish and Wildlife

Marine Resources Program

Patricia M. Burke, 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.

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 which 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.

Working With Crabbers to Limit Pots

In June of 2006 the Oregon Fish and Wildlife Commission put in place rules that limited the number of crab pots that commercial crabbers could use effectively reducing the amount of gear by about one quarter. The plan has three tiers of limits - 200, 300, and 500 pots per vessel, depending on the vessel's landings during the six seasons between 1995 and 2001. It reduces the total number of pots in the fishery from approximately 200,000 pots to around 150,200. The decision came after more than two years of meetings with the public and members of the crab industry. The 2006-2007 commercial Dungeness crab season was the first that had crab pot limits in place.

Working With Fisheries Councils

Recent developments point out the importance of representing Oregon's groundfish resource and fishery interests at the Pacific Fishery Management Council (PFMC), which advises the federal government on regulations marine fisheries on the West Coast. Implementation of new two-year management cycle began in January, 2007, and includes a special framework for regional

management of key species in sport fisheries. Oregon also has a seat on the North Pacific Council, dealing with Alaska fishery issues.

Fisheries Monitoring

Around 40 percent of the MRP's budget is devoted to a fishery harvest sampling program that monitors both commercial and sport fisheries along the Oregon coast. Port biologist and seasonal samplers survey sport and commercial fishers to determine the amount and kinds of fish landed, area of catch and information about the execution of the fishery. They also gather biological information from the landed catch – lengths, weights, age samples, etc.

The information is used both on an in-season basis to track fish landings for catch quotas and to ensure regulatory controls of fisheries. On a long-term basis, the information collected provides state and federal managers with data needed for assessing stocks and managing fisheries. The data became part of a West Coast data system to inform West Coast regional fisheries management.

Expanded Shellfish Sampling

In the spring of 2006 the MRP expanded the recreational shellfish sampling along the coast. In the previous year, the Astoria field office conducted recreational catch and effort surveys for razor clams along the Clatsop beaches and recreational crabbing in the Columbia River estuary. In May 2006 MRP staff began catch and effort surveys in Yaquina Bay. The Alsea Bay was added in August 2006. In addition, three beaches in the Newport area are regularly surveyed for recreational razor clam catch and effort as well as wastage surveys.

Marine Mammal Surveys

Recent conflicts between sea lions and endangered salmon populations highlight the importance of the three decades of population and distribution research done by the MRP marine mammal staff. Annually, they take thousands of aerial photographs of seals and sea lions to document their distribution and abundance in Oregon. Data from these surveys are used to determine population status and trends which in turn can be used to guide management decisions.

2006-7 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.

Investigating Hypoxia Events

The MRP's Habitat Project worked collaboratively with the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) in conducting investigations into nearshore hypoxia.

Underwater video surveys were conducted at Perpetua Reef monthly since May using ODFW's remotely operated vehicle (ROV), to look at species assemblages and fish and invertebrate behaviors on the reef during various periods of dissolved oxygen readings.

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 black and quillback rockfish are also tagged.

Black Rockfish Research

MRP researchers are in the sixth year of a black rockfish mark-and-recapture project off Newport, Ore. 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.

For more information visit:

<http://www.dfw.state.or.us/MRP/MrpOverview.pdf>

HMSC Visiting Scientists

Ken Hall, Program Manager

The Hatfield Center welcomed scientists from institutions near and far this past year – most coming for short visits to conduct experiments or collaborate with researchers at HMSC, often in conjunction with delivering a seminar during their visit.

Efforts to increase awareness of opportunities for visiting scientists took a big leap forward with the announcement of the Lavern Weber Visiting Scientist Fellowship, an endowed program that aims to bring at least one distinguished scientist per year at the Center. The program was launched in 2006 with the announcement of available funding to support a researcher in residence for a period of several months. 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 funding from the OSU Research Office.

Nominations were solicited through HMSC faculty and reviewed by a committee of faculty and students. The recipient for the first year's award was announced in January 2007: Gordon Kruse, Professor of Fisheries and Ocean Sciences at the University of Alaska, Fairbanks, whose research on spawning and juvenile recruitment of English sole will involve collaboration with NOAA Fisheries, ODFW, and OSU researchers. Kruse will be at HMSC from July through December 2007. It is hoped the program will allow examination of new specialties and expertise at the HMSC, stimulate cooperative research with different institutions, and provide new opportunities for OSU students.

A number of visiting scientists were hosted by individual faculty members, research groups or agency units at the Center during 2006-07, including:

Dr. Vladimir Gertsev, Professor of Mathematics at Rybinsk State Academy of Aviation Technology (Russia)

John LaFargue, Fishery Biologist with NOAA Northwest Fisheries Science Center

Won Sang Lee, Korean Polar Research Institute

Jeannette Yen, Biology Professor and Director, Center for Biologically-Inspired Design at Georgia Tech.

II. FACILITIES

HMSC Facilities

Randy Walker, Facilities Manager

Facilities was busy this year with the general upkeep and expansion of HMSC. Late last summer, Facilities constructed two laboratories for the Marine Mammal Institute at HMSC. These extensive remodels brought the existing spaces into state of the art laboratories for Dr. Scott Baker, and Dr. Marcus Horning. Facilities was a part of a workshop to discover the best way to pump seawater and build a docking system for the future. Facilities has developed a beginning plan that will be studied and enhanced to bring the best possible dock and pumping station to HMSC in the future.

Working in concert with Oregon Department of Minerals and Geology's Jonathan Allen, Ken Hall, Program Manager for HMSC, and the Oregon National Guard, facilities was among the team players that saw the completion of the Dynamic revetment. The purpose of the revetment is to stop wave action from eroding more land from the HMSC Campus.

During the course of the last year, Facilities applied for and awarded the contract to do the maintenance and facility work for the National Marine Fisheries Service, at the Hatfield Campus. We look forward to providing great service to them for the next five years.

Late last summer, Facilities constructed two laboratories for newly hired research faculty of the Marine Mammal Institute. These extensive remodels transformed the existing spaces into state of the art laboratories for Dr. Scott Baker, Dr. Marcus Horning, and their research staff.

In March of 2007, a shoreline stabilization project was completed to address an erosion problem near the north end of the HMSC estuary trail. Working in concert with Jonathan Allen of the Oregon Department of Geology and Mineral Industries, HMSC Program Manager Ken Hall, and the Oregon National Guard's Innovative Readiness Training program, Facilities was among the team players that helped install a cobble beach along the northeast edge of the HMSC campus. The dynamic revetment was designed to provide resistance to wave action and prevent further erosion of land which was beginning to threaten critical infrastructure at HMSC.

In May, the Facilities department participated in a planning workshop focused on improving the aging seawater pumping system and associated dock infrastructure at HMSC. Facilities has developed a preliminary plan that will be studied and revised to bring the best possible seawater pumping technology and to improve dock facilities for small boats and research activities at HMSC in the future.

During the course of the last year, Facilities applied for and was awarded the contract to do the maintenance and facility work for NOAA's National Marine Fisheries Service and Pacific Marine

Environmental Laboratory facilities at the Hatfield Campus. We look forward to providing great service to them for the next five years.

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 2007 her 196 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, Massachusetts Institute of Technology, 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, 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/

III. EDUCATION

Student Enrollment Statistics

Itchung Cheung, Academic Program Coordinator

Summer 2006	Credit	Course Title	2006-2007
ANT407/507/808	1	Making a Living on the Estuary Workshop (R. Hall)	5
FW 421/521 BI499	4	Aquatic Biological Invasions (J. Chapman)	2
FW/BI 302	4	Biology of Marine Mammals (J. Sumich)	5
FW 499/808 PHL499	1	Integral Ecology (B. Tissot)	1
SED 431/531	4	Understanding Free Choice Learning for Education and Outreach (S. Rowe)	5
WR 199	1	Writing about the Sea and Shore (D. Mack)	3
Z 461/561	4	Marine and Estuarine Invertebrate Zoology (C. Trowbridge)	5
Fall 2006	Credit	Course Title	2006-2007
AqS 100 (OCCC)	3	Intro to Aquarium Science (M. Mann)	16
AqS 215 (OCCC)	4	Biology of Captive Fishes (M. Mann)	15
AqS 220 (OCCC)	4	Biology of Captive Invertebrates (M. Mann)	16
AqS 240 (OCCC)	4	Life Support Systems and Design (M. Mann)	16
FW 407/507	1	Marine Science Seminar	9
FW 426x/526x	5	Coastal Ecology and Resource Management (Sampson)	13
FW 431/531	4	Dynamics of Marine Biological Resources (Sampson)	10
FW 441	1	Introduction to Group problem solving (Langdon)	4
FW 442	2	Problem Definition and Analysis in Fisheries and Wildlife (Langdon)	5
FW 454/554	5	Fishery Biology (Heppell)	15
FW 497/597	3	Aquaculture (Langdon)	3
FW 498/598	3	Aquaculture lab (Langdon)	1
FW 499	3	West Coast Groundfish Crisis (Shields)	6
FW 599	2	Special Topics in Fisheries and Wildlife (Hal Weeks)	14
Winter 2007	Credit	Course Title	2006-2007
AqS 232 (OCCC)	4	Nutrition and Reproduction of Captive Fishes and Invertebrates (B. Koike)	15
AqS 270 (OCCC)	4	Fish and Invertebrate Health Management (T. Miller-Morgan)	16
BI 234 (OCCC)	4	Microbiology	24
Spring 2007	Credit	Course Title	2006-2007
BI 450/451	16	Marine Biology (S. Hacker)	20

HMSC Education

Fisheries Classes

Selina Heppell, Associate Professor

Scott Heppell, Assistant Professor

Scott and Selina Heppell continue to participate in the Fisheries and Wildlife Fall teaching program. This year, they taught Fishery Biology and Marine Conservation Biology, and participated in the Coastal Ecology and Resource Management course. Scott taught two weeks of the Marine Biology course in Spring term. The Heppells also developed a summer course, Scientific Methods in Conservation Biology.

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 2006-07, fifteen 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 NSF-funded "Research Experience for Undergraduates" (REU) program. Twelve 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 2006. While all of the interns demonstrated a significant level of accomplishment with their research projects, several of the students developed projects that have a life beyond the 10-week summer program. In addition, three undergraduate students participated in the HMSC Visitor Center Internship in marine science education.

Two of the REU student interns from the Summer 2006 program presented research posters at the February 2007 American Society of Limnology and Oceanography, Aquatic Sciences Meeting, Santa Fe, New Mexico:

Andresen, C. G.*; Banks, M.: Molecular Genetic Tools For Discrimination Among Runs of the California's Endangered Central Valley Chinook Salmon. Presentation.

Kormanyos, R. E.*; Black, B. A.: Fine-Scale Reconstructions of Ocean Variability Using Growth Increments of Long-Lived Geoduck Clams in the Northeast Pacific. Poster Educ-18.

During the summer at HMSC some students gained research experience at sea, in some cases before or after the REU project. For example, Kate Ruck (working on mathematical modeling of *euphausiid* dynamics) and Alexandra Cwalina (working on glider deployment and physical oceanography) arrived early and participated in cruises on the RV Wecoma. Joel Scheingross accompanied his mentor, Tom Hurst, on a trip to Alaska immediately following the REU program to evaluate fish behavior in the field relative to his research conducted in the laboratory. Students also conducted laboratory-based REU projects to gain field experience on the 54-ft coastal research vessel Elakha. To gain training and experience relevant to her project, Rose Kormanyos participated in the North American Dendroecology Field week workshop held at HMSC one week prior to the start of the REU program.

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, and they attended weekly summer seminar series.



REU student interns, Summer 2007

REU Interns

REU Intern	Home Institution	Faculty Mentor	Project Title
Christian Andresen	Univ. of Texas El Paso- El Paso, Texas	Michael Banks	Researching the genetic basis of adult run timing differences for fall and spring Chinook from the same watershed.
Alexandra Cwalina	Stony Brook University - Stony Brook, New York	Kipp Shearman	Analysis of the effects of surface heating, winds, and shelf circulation on temperature in the coastal ocean off Oregon
Stefanie Gera	College of William and Mary - Williamsburg, Virginia	Jessica Miller	Determining migratory history of juvenile steelhead (<i>Oncorhynchus mykiss</i>) along the Oregon coast using otolith increment and microchemical analysis as an indicator of life history patterns and growth rate
Ethan Herget	Portland State University- Portland, Oregon	Shawn Rowe	A comparative analysis of visitor experiences and expectations at 4 informal learning sites: Yaquina Head Outstanding Natural Area tide pools, Seal Rock State Park tide pools, Oregon Coast Aquarium touch pool and Hatfield Marine Science Center Visitors Center
Rose Kormonyos	Whitman College- Walla Walla, Washington	Bryan Black	Researching how annual growth increments in long-lived geoduck clam shells provide a record of ocean climate, much the same way that tree rings provide a record of terrestrial climate
Patrick Luke	Oregon State University - Corvallis, Oregon	Anthony D'Andrea, Brett Dumbauld, Theodore H. DeWitt	Temporal patterns of larval ghost shrimp in Yaquina estuary
Alexandra Penny	Brown University - Providence, Rhode Island	Steve Parker, Bob Hannah	The effects of rapid decompression of rock fishes during capture using hook and line
Kate Ruck	James Madison Univ. - Harrisonburg, Virginia	Bill Peterson	Growth rates and distributions of <i>Euphausia pacifica</i> off the Newport Line
Joel Scheingross	Univ. of California - Berkeley, California	Tom Hurst,	Studying how physical factors such as light level, availability of food, temperature and turbulence affect the vertical position of larval Pacific Cod (a commercially important fish found throughout the Bering Sea and Gulf of Alaska).
Angie Sremba	Kalamazoo College - Kalamazoo, Michigan	Bill Peterson	Comparison of <i>Euphausia pacifica</i> ingestion rate's on five different micro algae
Lillian Tuttle	Centre Collete - Danville, Kentucky	Kym Jacobson	Early ocean ecology of juvenile steelhead salmon (<i>Oncorhynchus mykiss</i>) as indicated by parasite communities
Lauren Woods	Ohio Wesleyan Univ. - Delaware, Ohio	John Chapman	Shrimp sex and blood sucker sex: Testing how bopyrid isopod infestations alter growth and sexual development in the ghost shrimp <i>Neotrypaea californiensis</i> and mud shrimp <i>Upogebia pugettensis</i>

HMSC Education Interns

Trista Baxter	Oregon State University – Corvallis, OR..	Bill Hanshumaker	Using Media Presenter software, Trista developed an interactive kiosk based on the auditorium program “OceanQuest’06”
Betsy Brewer	Davidson College – North Carolina	Bill Hanshumaker	ROV Usage in Place-Based Education
Alyssa Harris	Oregon State University, Corvallis, OR	Bill Hanshumaker	Formative evaluation of educational outcomes from a surge-type aquarium

STUDENT AWARDS and SCHOLARSHIPS

Ichung 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 2007 Markham Symposium (named for the Mamie L. Markham Endowment, which annually awards two years of financial support for eight students pursuing research at HMSC) was held on June 13. Students who had made significant progress towards completion of their research gave brief presentations. Those students being awarded new monies for 2007-08 year displayed posters explaining their proposed research. Their awards are listed below:

Award	Recipients
Mamie L. Markham First Year Student Award - <i>provides financial assistance to an incoming, first year graduate student who plans to be resident at the HMSC after completing first academic year in Corvallis.</i>	Erin Kunisch, Fisheries & Wildlife (\$10,000) Advisor: Markus Horning
Joan Crebbin Memorial Fellowship - <i>to foster education in the marine sciences by providing financial support to undergraduate or graduate students pursuing marine science related fields at OSU.</i>	Jessica Johnson, OSU senior in the Dept of Fisheries and Wildlife PI: Bill Hanshumaker Charlotte Alvord, OSU senior in the College of Science (Zoology) PI: Shawn Rowe Kirsten Heesacker, OSU junior in Dept of Fisheries and Wildlife PI: Rob Suryan
Lillian Brucefield Reynolds Scholarship Fund - <i>for graduate students engaged in study of marine science at Hatfield Marine Science Center.</i>	Mattias Johansson, Fisheries & Wildlife (\$1,000) Advisor: Michael Banks
Cecil and Martha MacGregor Scholarship in Marine Science - <i>awards to cover housing expenses for undergraduate OSU students in residence at the HMSC and taking coursework during the summer.</i>	Tricia Ratliff, Fisheries & Wildlife (\$250) Rebecca Roush, Fisheries & Wildlife (\$250) Dottie Passmore, Zoology (\$250)
Curtis and Isabella Holt Education Fund - <i>intended to foster education in the marine sciences by providing financial support to undergraduate or graduate students pursuing marine science studies.</i>	Christine Smith, Science and Mathematics Education (\$6,000) Advisor: Shawn Rowe
Walter G. Jones Fisheries Development Award - <i>intended to support an academically qualified graduate student pursuing research which contributes to fisheries development.</i>	Joo Dong Park, Food Science & Technology (\$1,300) Advisor: Jae W. Park
William Q. Wick Marine Fisheries Award - <i>intended to encourage graduate student research in the area of marine fisheries ecology and ocean related research.</i>	Mattias Johansson, Fisheries & Wildlife (\$3,500) Advisor: Michael Banks Amanda Kaltenberg, COAS (\$3,500) Advisors: Kelly Benoit-Bird, Doug Biggs
Mamie L. Markham Endowment Award - <i>intended to assist graduate or student research utilizing OSU's Hatfield Marine Science Center.</i>	
Pamela Archer, MRM (\$7,685) Advisors: Jessica Miller, Tony D'Andrea	Marisa Litz, Fisheries & Wildlife (\$8,574) Advisor: Selina Heppell
Katelyn Cassidy, Fisheries & Wildlife (\$4,206) Advisors: Chris Langdon, Brett Dumbauld	Alena Pribyl, Fisheries & Wildlife (\$8,000) Advisors: Carl Schreck, Steve Parker
Dafne Eerkes-Medrano, Zoology (\$9,732), Advisors: Bruce Menge, Jane Lubchenco	Wade Smith, Fisheries & Wildlife (\$10,000) Advisor: Selina Heppell
D. Matthew Hawkyard, Fisheries & Wildlife (\$2,988) Advisor: Chris Langdon	Phoebe Zarnetski, Zoology (\$10,000) Advisors: Sally Hacker, Eric Seabloom
Paul Lang, Fisheries & Wildlife (\$7,005) Advisors: Chris Langdon, Mark Camara	

Course Descriptions

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, Writing and Zoology. The courses are open to upper division 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.

Summer 2006 Courses

ANT407/507/808. MAKING A LIVING ON THE ESTUARY (R. Hall) (1)

Weekend course/workshop exploring how native people use the richness of the estuary in their technology and foods. It will include discussions of plants and animals with specific focus on sea mammals (notably, the sea otter) and on plants used in basketry.

FW 421/521 BI499. AQUATIC BIOLOGICAL INVASIONS (J. Chapman) (4)

An overview of the background, theory, evolution, ecology, politics and conservation of invasions by introduced species in aquatic environments. PREREQ: One year of university-level biology.

FW/BI 302. BIOLOGY OF MARINE MAMMALS (J. 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. PREREQS: One year of introductory biology is mandatory.

FW 499/808 PHL499. INTEGRAL ECOLOGY (B. Tissot) (1)
Examination of the work of a philosopher or of a specific problem; e.g., Wittgenstein, determinism, perception. PREREQS: 6 credits of upper-division philosophy, sophomore standing.

SED 431/531. UNDERSTANDING FREE CHOICE LEARNING FOR EDUCATION AND OUTREACH (S. Rowe) (4)
Current issues, trends, and topics in science education.

WR 199. WRITING ABOUT THE SEA AND SHORE (D. Mack) (1)

Weekend course/workshop exploring the possibilities of creative nonfiction and poetry to capture the majesty, complexity, and fragility of the confluence of sea and shore.

Z 461/561. MARINE AND ESTUARINE INVERTEBRATE ZOOLOGY (C. Trowbridge) (2)

Comparative survey of eight major invertebrate phyla and many lesser-known phyla. Areas of emphasis will be 1) invertebrate

identification, 2) natural history (diversity, habitat, feeding, behavior), and 3) comparative anatomy (adaptive significance of morphological structures). Laboratories and field trips will strongly supplement lecture material. Lec/lab. PREREQ: One year of university-level biology.

Fall 2006 Courses

AqS 100 (OCCC). INTRO TO AQUARIUM SCIENCE (M. 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 (M. 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. PREREQS: BIO 103 or consent of instructor.

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

Reviews the life history and captive care requirements of invertebrates commonly cultured in the aquatic animal industry/profession. PREREQS: BIO 103 or consent of instructor.

AqS 240 (OCCC). LIFE SUPPORT SYSTEMS AND DESIGN (M. 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. PREREQS: Completion or concurrent enrollment in AQS 215 and AQS 220, or consent of instructor.

FW 407/507. MARINE SCIENCE SEMINAR (G. Boehlert) (1)
See list of seminar series speakers. Pages XX-XX

FW 426x/526x. COASTAL ECOLOGY AND RESOURCE MANAGEMENT (D. Sampson) (5)

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

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

Strategies of marine fishery management. A synthesis of the principles of population dynamics for single- and multi-species systems from the viewpoint of a marine resource manager. Offered alternate years. PREREQS: BI 370 or BI 371

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

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

a fisheries and/or wildlife topic. PREREQS: FW 441, FW 442, and FW 443 must be taken in sequence.

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

Student groups working with mentors will define the problem selected in FW 441, collect and review relevant information, and develop a problem analysis plan on a fisheries and/or wildlife topic. Finalized plans will be presented at an open forum at the end of the term. PREREQS: FW 441.

FW 454/554. FISHERY BIOLOGY (S. 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. PREREQS: FW 320 and FW 315

FW 497/597. AQUACULTURE (C. Langdon) (3)

Principles and practices for the aquaculture of fish, shellfish, and algae. (Writing Intensive Course.) PREREQS: 9 credits of upper-division biology.

FW 498/598. AQUACULTURE LAB (C. Langdon) (3)

Biology and culture requirements of fish, shellfish, and algae. Emphasis on laboratory culture techniques and practical experience in handling organisms. PREREQS: 9 credits of upper-division biology.

FW 499. WEST COAST GROUND FISH CRISIS (B. Shields) (3)

A lecture and discussion course that covers the history of the current crisis and the effects of over fishing on fish and fishermen. Highlights for discussion include plans for rebuilding stocks and future management.

FW 599. SPECIAL TOPICS IN FISHERIES AND WILDLIFE (H. Weeks) (2)

Winter 2007 Courses

AqS 232 (OCCC). NUTRITION AND REPRODUCTION OF CAPTIVE FISHES AND INVERTEBRATES (B. 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 (T. 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. PREREQS: AQS 215 and AQS 220, or consent of instructor.

BI 234 (OCCC). MICROBIOLOGY (4)

Presents a survey of bacteria and other micro-organisms, em-

phasizing their impact upon human health. Includes discussion of infection, immunity, common pathogens, and methods and mechanisms of control. PREREQS: BI 231 with a grade of C or better within the last seven years or consent of instructor.

Spring 2007 Courses

BI 450. MARINE BIOLOGY (S. 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. PREREQS: One year of college biology or equivalent. Departmental approval required. Admission to BI 450/BI 451 and BI 550/BI 551 is by application only. Must be taken concurrently with BI 451.

BI 451. MARINE BIOLOGY LABORATORY (S. 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. PREREQS: Departmental approval required. Must be taken concurrently with BI 450/BI 550.

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-principal investigators on the National Science Foundation implementation grant and works 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. In addition, Miller-Morgan lectures in VM 709, Introduction to Veterinary Medicine, where he presents an overview of the subspecialty of aquatic medicine. He also teaches 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 and he is a co-instructor for VM 738, Animal Handling and Husbandry and Introduction to Fish Husbandry and Handling. He also 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

The Aquarium Science Program at Oregon Coast Community College continues to attract individuals from around Oregon as well as from other states. This past year's cohort of 14 students comprised of Oregonians from Astoria, Corvallis, Irrigon, Madras, Salem, Yamhill, as well as individuals from Alaska, California, Minnesota, Oklahoma, Idaho, Texas, and Washington. A common thread that each program participants experienced is gaining access to learning opportunities and resources available through the Mark O. Hatfield Marine Science Center (HMSC).

As the Aquarium Science Program prepares individuals for careers in the aquatic animal husbandry profession, real work place experiences as well as the involvement of research scientists are two essential elements that lead to student success. In response to this need, numerous agencies and organizations stationed at the HMSC have allowed students to work/volunteer alongside their staff, resulting in skill building, increased knowledge, and greater confidence. Oregon Sea Grant, the Molluscan Broodstock Program, the NOAA Fish Behavior Laboratory, and Oregon Department of Fish and Wildlife have interacted with students in this manner. Likewise, associated facilities such as the Oregon Coast Aquarium, the Microbiology Department at Oregon State University, the Oregon Hatchery Research Center, and other state fish hatcheries have contributed to learning activities that benefit students.

The Ornamental Fish Program through Oregon Extension Sea Grant became the first organization at the HMSC to hire a program graduate full time. Dennis Glaze was hired as an aquatic animal health and husbandry specialist and curator of husbandry at the HMSC. Dennis, a 2006 graduate, will continue to assist in the development of aspiring professionals through his role at the HMSC.

The placement rate of graduates is 100% with individuals

are working at such facilities as Henry Doorly Zoo (Omaha, NE), Georgia Aquarium (Atlanta, GA), Riverbanks Zoo and Garden (Columbia, SC), New York Aquarium (Brooklyn, NY), Moody Gardens (Galveston, TX), and Oregon Coast Aquarium. Additional graduates are working in ornamental fish specialty stores, veterinary clinics and marine research/educational facilities. With these individuals excelling in the workplace, additional opportunities will develop for future cohorts of Aquarium Science students.

Exciting times are ahead as the Aquarium Science Program continues to mature. Likely in 2009, the Aquarium Science building at the Hatfield Marine Science Center will become operational. This new complex will allow for the instruction of this discipline within a spaces designed to support its instruction and be able to contribute to the overall master plan for this world class research and educational facility known as the Mark O. Hatfield Marine Science Center.

Guin Library

Janet Webster, Librarian

The Marilyn Potts Guin Library continues to be one of best marine and estuarine libraries in North America. It is intriguing to consider what that means in this day and age of digital information. As part of the OSU Libraries, the staff members of the Guin Library tackle that question daily as we move our journal collection from the display shelves to the computer monitor and as library users access more and more of our resources at their desktop. Best to us means facilitating users' access to the information they need to learn and conduct research. It means providing a welcoming physical environment for those looking for place to study, collaborate and meet. It also implies maintaining and preserving a unique collection of resources that contributes to the collective wealth of information.

Our projects and resulting accomplishments for the Fiscal Year 2007 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.

- Digitization of materials – Oregon's estuaries are unique environments and the information on them equally so. Our long term goal is to compile bibliographies on each of the estuaries and then provide digital access to material not copyrighted or where we have secured the authors' permissions. This will give students and researchers access to older material as well as hard to find current report literature. We are currently working on the Umpqua, Netarts, Salmon and Alsea.

- Creating context – Digitizing material is not enough; it must be accessible and put into some form of context for the user. The OSU Libraries in cooperation with the Institute for Natural Resources produces the OregonExplorer with its related Explorer portals as a means to provide context for information. The Guin Library staff takes a leadership role in maintaining and enhancing the NorthCoastExplorer (<http://northcoastexplorer.info/>).

• Archiving unique OSU materials – The College of Oceanic and Atmospheric Sciences has a long history at OSU and close ties to HMSC. Janet Webster serves as the COAS subject librarian and as such is working to ensure the publications legacy of the College is better preserved. We are currently digitizing the data and reference series that provide a window on the science conducted by the College since the 1950s. Also, the student reports from the Marine Resource Management Program are now becoming available digitally, enhancing access to these non-thesis papers that cover a broad range of important topics.

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, we developed a display titled Defenders of Free Expression that focused on people who have stood up against censorship.
- The Oregon Coast Community College Aquarium Science program students use the library regularly. So, one of the instructors put together a display showcasing the projects from the Exhibit Design Course.
- In mid-March, an exhibit, The Power of Observation, featured the photography of Douglas Engel, an OCCC Aquarium Science student.
- Two of our high school student workers created an exciting display on the science and fun of Surfing.

Staff activities:

Janet Webster, the librarian, continues to serve on the University of Washington iSchool MLIS Advisory Board. She chairs the Oregon Library Association's Legislation Committee and in that capacity, helped organize the OLA/OEMA Legislative Day as well as orchestrate testimony at various hearings on issues of interest to the library community. Janet was appointed to the Standing Committee of International Federation of Library Association's Science and Technology Libraries Section as one of the American Library Association members.

Susan Gilmont was elected as the archivist for the OLA's Support Staff Division.

Judy Mullen joined the HMSC Sustainability Committee and prompted the Guin Library's migration to 100% recycled paper in all of its copiers and printers.

Guin Library General Statistics	2004 - 2005	2005 - 2006	2006- 2007
Number of items check out & renewed	4,088	3,505	3,033
Number of items loaned to other libraries	1,742	1,522	1,725
Number of books, etc. added to the collection	611	962	687
Journal issues physically checked in	1,421	610	553
Number of copies on photocopiers & printers	138,095	135,935	122,794

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 Visitor Center (HMSVC) 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 also provides opportunities for conducting research on devices, methods, and concepts for informal science education that will advance the art of public education.

Exhibit Development

Working with the Oregon Coast Community College's Aquarium Science program, a new aquarium focusing on marine research has been installed. With a surge mechanism, the aquarium is ideally suited to display intertidal organisms. The Partnership for Interdisciplinary Studies of Coastal Studies (PISCO), readily agreed to assist with crafting exhibit copy that reflects their research and to provide additional developmental funds. After completing the formative evaluation of the signage, these funds will be used to out-source the fabrication of new graphic panels.

Graphic displays on the Oregon Hatchery Research Center and ODFW's Salmon and Trout Enhancement Program (STEP) were installed. ODFW also provided an aquarium with living salmon eggs, mimicking the materials of their Salmon Trout Enhancement Program school program.

Though the efforts of Dr. Annette von Jouanne and the OSU Engineering Department, an interactive exhibit featuring Wave Energy was installed. This Oregon Sea Grant-funded exhibit demonstrates a working prototype of the proposed design that was created to capture the energy from ocean waves, and convert it into usable electrical energy. Exhibit copy and a video loop explain the potential (and challenges) of creating an offshore energy facility.

An interactive exhibit on historic changes in sea otter range was designed, developed, and fabricated. The participant presses buttons to fiber optics that illuminate the historic and current range of sea otters.

Building on the successful exhibition from last year, 13 "Pattern Puzzles" were rented and installed from March 15 through

June 7. Not only are these extremely popular “hands-on” exhibits, but they also help alleviate some of the stress on the touch tank animals caused by the handling by this season’s large school groups. Attempting to reach out to our Hispanic audience, directions for each puzzle were translated into Spanish.

Public Programming

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

Giant Squid Dissection is a popular event for the public. This year, a six-foot long hooked-club squid, *Moroteuthis robusta*, was dissected. A professional videographer recorded the dissection for eventual screening on the television show *Animal Planet*.

The ninth annual *Fossil Fest* was a huge success. Presentations included Uncovering Oregon’s Beach Fossil by The Fossil Guy: Guy DiTorrice. Attendance topped 145 (standing room only) and was very well received. Dr. William Orr, State Paleontologist from the University of Oregon, presented Fossil Forms and Function, with approximately 107 people in attendance. Exhibits and displays included fossil displays and Oregon’s newly declared state fossil, *Metasequoia*, with fossil identification by Dr. Orr. Children’s activities included screening for fossil shark teeth that they could keep.

National Estuary Day events included talks by Drs. Ted DeWitt and Brett Dumbauld, an interactive erosion table (Lincoln County Soil and Water) and a guided Yaquina estuary walk.

We developed and produced a 40-minute auditorium presentation titled *OceanQuest’06*. This multimedia program compares the biology, geology, and research instruments employed by the HMSC off the Oregon coast, in the Marianas, and in the Southern Ocean between South America and Antarctica. Daily logs and pictures from our 2006 research voyage to Antarctica can be viewed at: <http://hmscblog.blogspot.com>.

NOAA’s *OceanExplorer* site includes a slide show of some of the best images that we captured from Antarctica. <http://oceanexplorer.noaa.gov/explorations/06sounds/welcome.html> Look for *Sounds of the Southern Ocean*.

A new marine mammal presentation based on acoustics and research was developed and delivered to the general public during *Whale Watch Week*. Over 100 small children and their parents were “edu-tained” by *Whale Tales* during the same time period.

Bookstore

Oregon Sea Grant’s Bookstore provides the visiting public, students, and staff with quality books, clothing, and other science-related items. The bookstore is managed by Oregon Sea Grant and is presently staffed by one part-time permanent staff member and one part-time student. Three volunteers also work each week in the store to assist the staff.

The bookstore promotes the HMSC through lectures, book

signings, and other special events, including the Lincoln County Glass Float Drawing and promotion, which is held each year from November through January. This drawing attracts a large annual group of visitors and locals who use a map featuring more than 75 locations where they can enter the drawing to win one of two free glass floats available at each location. This year, one of the winners for the bookstore location was a long-time volunteer and the other was a 12-year-old child from the Portland area.

In January, the bookstore manager attended an American Booksellers Association national Winter Institute in Portland. This three-day workshop covered the financial and media aspects of running a store and also provided an opportunity to meet authors and publishers. There was an immense binder of information generated, which was brought back and shared with the bookstore staff and continues to be an important reference for the store. A second event was the Annual Museum Store Association Conference held in Denver in early April. This is a national six-day gathering that includes museum store tours, workshops, and a large vendor show, offering one-time special purchases for museums. This was a unique opportunity to meet other museum store managers, make new connections, share ideas, and be involved in some great conversations.

The bookstore is also responsible for print media and advertising for the Visitor Center, including the mailing of visitor center rack cards and other promotional materials as requested by community members, the general public, and the tourism industry.

HMSC Visitor Center Volunteers

Katherine Fuller, Sea Grant Volunteer Coordinator

Volunteer Program

During FY06/07, the HMSVC had 68 volunteers who contributed 6,462 hours of service to Visitor Center operations. We had 91 volunteers on record this year, but some were in an inactive state. New volunteers were recruited throughout the year, mostly through word of mouth. This recruitment method enabled us to add 18 individuals to the volunteer corps.

Volunteers are critical to the success of the visitor center. They greet many of the 140,000-plus annual visitors, orient them to the center, and provide educational information related to live animals and exhibits in addition to general marine science. Their enthusiasm for learning and desire to share information makes 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): hypoxia, touch tank interpretation, fish dissection, and *Sounds from the Southern Ocean*. Volunteers also participated in tours of the Hinsdale Wave Laboratory and the R/V *Wecoma*. Ten volunteers attended the Pacific Northwest Docent and Volunteer Association’s annual conference. Volunteers’ efforts were recognized on a daily basis and were also celebrated at a summer picnic and again at a banquet during National Volunteer Appreciation Week.

Sea Grant Youth and Family Marine Education

Nancee Hunter, Sea Grant Education Director

Sea Grant Youth and Family Marine Education

This year we reached out to new audiences through a variety of education programs and experiences, including summer camps, field trip programs, online education, workshops, and more.

Last summer we offered our ever-popular summer camps. Marine Biology I and Marine Biology II. Geared toward upper-level students, these camps offer students 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 students, Coastal Adventures I introduces them to the coastal environment, while Coastal II reinforces the information learned in Coastal Adventures I.

Fall marked the beginning of our school group programs. Coursework was fine-tuned to better meet the needs of our audience, based upon evaluations and surveys conducted throughout the year. And our home school program filled before the registration deadline, prompting us to offer our home school day program for two days in November. 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. An individual sponsorship of \$10,000 will allow the program to continue for another year.

The winter Career Day event for high school juniors and seniors was another success. Students were able to hear presentations from scientists, take an interactive tour, and learn about careers in marine science. In addition, we served approximately 300 boy and girl scouts from around Oregon and Washington.

Sponsored by Oregon Sea Grant, our educators were able to attend the Northwest Aquatic and Marine Educator Association Conference in Alaska, presenting on the Alien Invader Traveling Kit. This kit is being developed to educate students in both informal and formal settings. Oregon Sea Grant also sponsored an educator at the National Marine Education Association Conference in New York. Lead Educator Fawn Custer presented Home School in a Nutshell, providing information on our Home School programs to more than 30 participants. In addition, Oregon Sea Grant was represented at the Oregon Science Teachers Association Conference. Those who attended had the opportunity to apply for a grant from ACCESS STEM, through the University of Washington, that would enhance the learning of those with different abilities. As a result, Oregon Sea Grant received a grant of nearly \$4000 for classroom equipment.

Marine Extension

Jay Rasmussen, Oregon Sea Grant Associate Director and Sea Grant Extension Program Leader

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 10 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. And in 2006 we collaborated with the OSU Seafood Laboratory and the Community Seafood Initiative to hire a seafood product specialist, Mark Whitham, 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, forest resources, math and science education, oceanic and atmospheric science, political science, and sociology.

In mid-2007, the following HMSC faculty members have appointments, ranging from full time to quarter time, with Oregon State University: Fawn Custer, Kath Fuller, Dennis Glaze, Bill Hanshumaker, Nancee Hunter, Tim Miller-Morgan, Shawn Rowe, Jay Rasmussen, and Lynne Wright. Fuller 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 Assistant Director for Education. Nancee Hunter, former Director of Education Outreach at the National Geographic society, was selected for this new position in early 2007.

Ornamental Fish Health Program -- Dr. Tim Miller-Morgan, Extension Veterinarian – Aquatic Pets, Oregon Sea Grant and College of Veterinary Medicine

The Ornamental Fish Health Program (OFHP), supported by Oregon Sea Grant and the College of Veterinary Medicine, has completed a busy fourth 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 Indonesia, United Kingdom, Belgium and China have begun to give an international flavor to the program. Miller-Morgan is also a Founding Member and Director-at-Large of the World Aquatic Veterinary Medical Association. This international organization was founded to fulfill the need for a professional organization that represents and serves the needs of aquatic animal veterinarians. Miller-Morgan was one of six veterinarians from around the globe who worked to develop an organizational structure and bylaws and plan the inaugural annual general meeting, which took place last July in Washington D.C. Miller-Morgan works 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 fifth year of training selected koi hobbyists to become health and husbandry advisors to their fellow hobbyists. The program has trained approximately 180 Koi Health Advisors throughout the country (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) and was invited to speak at the 2007 AKCA annual seminar in Phoenix, AZ.

Dr. Miller-Morgan has coordinated or co-coordinated multiple industry and veterinary profession seminars and workshops throughout the year, including: Water Garden University at the HMSC; Pond School 2007 on the OSU campus; Koi Health Academy in Reno, Nevada; Basic Koi Health Management for Hobbyists at the Point Defiance Zoo and Aquarium in Tacoma, Washington. These workshops focused on the basic principles of fish health management for the pond fish retailer, pond contractor, and hobbyist.

Dr. Miller-Morgan also co-coordinated, developed, and instructed a number of seminars for practicing veterinarians. The Koi Herpes Virus Education Program – the Associated Koi Clubs of America -- funded a train-the-trainer program in order to provide timely and scientifically accurate information on the biology and management of Koi Herpes virus. The program was developed by a group of extension fish health professionals from OSU (Miller-Morgan), the University of Arkansas, and the University of Florida. The goals of the program are to train veterinarians to work with pond fish retailers to reduce the risks of introducing KHV to their facilities and subsequently their customers. Two train-the-trainer sessions have been conducted in Ruskin, Florida and one here at the HMSC. Miller-Morgan also co-coordinated and instructed in the 4.5-day Aquatic Medicine Program at the American Veterinary Medical Association annual meeting in Washington D.C. These sessions, which provided 26 hours of aquatic medicine training, focused on private practitioners with an interest in adding pet fish to their practices.

Dr. Miller-Morgan continues to make regular visits to ornamental

fish retailers and wholesalers in the Willamette Valley, where he provides professional consultation on fish health matters. Until July 1, 2007, Miller-Morgan also served as the curator of husbandry and staff veterinarian for the Visitor Center and Education Wing animal collections at the Hatfield Marine Science Center (HMSC). He has also been actively involved in the remodel of the HMSVC Hospital/Quarantine facility. This completely redesigned facility provides for state-of-the art care for our increasingly diverse fish and invertebrate collection, as well as a wonderful hands-on teaching space for our veterinary and aquarium science students. Further, Miller-Morgan has been involved in the ongoing redesign of the West Wing animal holding area and the development and implementation of new animal exhibits. Dennis Glaze, a graduate of the Aquarium Science Program, has been appointed Curator of Animal Husbandry programs in addition to his current title as Aquatic Animal Health & Husbandry Specialist. Diana Churchill, an Aquarium Science Program student, has been hired as a research Aquarist. She oversees the animals used in our marine ornamental fish research, assists with experiments, and assists Dennis with husbandry management of the Aquatic Health and Husbandry Teaching laboratory.

Free-Choice Learning-- Shawn Rowe, Marine Education Learning Specialist, Oregon Sea Grant and Science and Math Education Department, College of Science

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 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 Visitor Center and Marine Education programming to carry out a program of research, evaluation, and design in free-choice learning.

In the fall of 2006, John Falk and Lynn Dierking joined Sea Grant and the Department of Science and Mathematics Education as Free-Choice Learning professors. Falk and Dierking are credited with coining and championing the term "free-choice learning."

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 Alicia Christensen, an M.S. student in the Marine Resource Management Program, to complete her work

with the Oregon State Parks and Recreation Department to research evaluation tools that can be used effectively with their long-running Whale Watching Spoken Here program. Molly Phipps, a doctoral student in Science and Mathematics Education, was also supported by the Free-Choice Learning Initiative and Sea Grant Communications to carry out research on how iPods can be used in meaningful ways for general public understanding of ocean sciences as part of visiting HMSC. Heidi Schmoock, an M.S. student in Environmental Sciences, received a Holt Marine Education Fund award to research Spanish-speaking families' science learning through the Oregon Sea Grant Las OLAS bilingual marine education program. This work led to her Master's Thesis, defended in June 2007. Christine Smith, an M.S. student in Science and Math Education, received a Holt Marine Education Fund award to work with local oyster farming businesses, scientists with the Molluscan Broodstock Program (MBP), Sea Grant Marine Educators, and HMSC public audiences to redesign the MBP exhibit in the Visitors Center. This work is part of her master's degree project. 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.

Coastal Ecosystem Learning Center (CELC)

Ken Hall, HMSC Program Manager

Nancee Hunter, Sea Grant Education Director

AmeriCorps*NCCC - Coastal America 2006 Signature Project Summary

In May 2006, the Hatfield Marine Science Center (HMSC) welcomed a 12-member team from the AmeriCorps*National Civilian Community Corps for a five-week habitat restoration project on Oregon's central coast. The project's primary objectives included survey and removal of non-indigenous invasive weeds, revegetation of native plant species, and other habitat restoration activities, to be completed by AmeriCorps*NCCC team members under the guidance and direction of project partner personnel from the US Forest Service (USFS) and US Fish and Wildlife Service (USFWS). Education and outreach were also a component of the project, to increase public understanding of the invasive species problem and mitigation efforts.

AmeriCorps team members received training and instruction on invasive species removal revegetation techniques and learned how their work would contribute to natural resource management objectives at project sites in the Siuslaw National Forest and

Siletz Bay National Wildlife Refuge. The team spent five weeks performing invasive species removal and habitat restoration activities including manual removal of non-indigenous invasive plant species such as Scotch broom (*Cytisus scoparius*), English holly (*Ilex aquifolium*), English ivy (*Hedera helix*), and Yellow Flag iris (*Iris pseudacorus*), which threaten to crowd out native plants and alter the coastal habitat. Related habitat improvement tasks included removal of old fence posts and barbed wire from marshlands formerly diked for agriculture, which today are part of restored estuarine habitat.

AmeriCorps team members also planted early blue violets (*Viola adunca*) in a coastal meadow at Bray Point to enhance habitat for the Oregon Silverspot Butterfly (*Speyeria zerene hippolyta*), a federally endangered species. Along the Oregon coast, salt spray meadows filled with violets were once commonplace. Today, the fields of violets are few and far between, and so are the Silverspot butterflies, which are found at only six sites along the Pacific Coast of North America from northern California to southern Washington.

In addition, the AmeriCorps team members engaged in several education/outreach activities, where they communicated the value and benefits of their service project to the public. Team members participated in an Earth Day event at the Oregon Coast Aquarium, where they interacted with children and explained their service project to Aquarium visitors. Team members also developed a 10-foot high informational panel for display in the HMSC Visitor Center, to help communicate how their service project contributed to habitat restoration and invasive species management objectives of the project partners. Team members also visited local schools to speak to students about their project and about the AmeriCorps*NCCC program to future potential AmeriCorps members.

Summary of Quantifiable Accomplishments

506	Acres of wildlife habitat restored or protected
11730	Pounds of exotic invasive vegetation removed
200	Seedlings planted
150	Trees or shrubs cared for
40	Trees or shrubs removed
2	Environmental education programs conducted
17	informative signs built, painted, or installed

“Aquatic Invaders” project receives a Coastal America Partnership Award

Oregon Sea Grant was honored with a Coastal America Partnership Award. As a member of the science development team, Oregon Sea Grant contributed to the development of the “Aquatic Invaders” education package through a joint project sponsored by the NSGO and the Assn. of American Zoos and Aquariums (AZA). The project developed aquatic invasive species awareness and prevention resource materials, activities and messages for use in zoos and aquaria. A highlight of this project is a 20-minute long hosted program/performance that engages zoo and aquarium visitors to learn about aquatic invasive species, pathways for spread, and how to take personal actions to prevent their spread.

Participation in National Summit on Oceans and Coasts

In 2005, the Hatfield Marine Science Center and the Oregon Coast Aquarium signed a memorandum of understanding to collaborate on the Coastal Ecosystem Learning Center. The co-partnership combines the resources of the two facilities to better promote environmental literacy. In 2006, HMSC collaborated with the Oregon Coast Aquarium to send four youth volunteers to the National Summit on Oceans and Coasts in Washington D.C., December 5-8. Alice Anderson of Corvallis, Alexander Rose of Yachats, Lauren Dimock of Alsea and Jenna Browning-Kamins of Corvallis presented their project, titled Rockfish Bycatch; An In Depth Study, which tackles problems that include misidentification and barotrauma in rockfish.

Along with eighteen other student delegations from around the nation, the Oregon students researched the issues related to their topic, determined solutions and developed an action plan involving their community which they will implement locally. The action plans were then presented to senior Bush Administrative officials, including representatives from the White House, Federal Environmental agencies and leading ocean scientists.



Dr. Sylvia Earle (left), Ocean Explorer and National Geographic Society Explorer-in-Residence, met with Oregon students Lauren Dimock, Alexander Rose, Jenna Browning-Kamins and Alice Anderson, who presented their research on Rockfish Bycatch at the National Student Summit in Washington D.C.

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. Currently, two members of the Toledo City Council and one member of the Waldport City Council are HMSC employees.

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 hearings and forums on fisheries and other coastal resource management issues were hosted by Oregon Department of Fish and Wildlife, the US Fish and Wildlife Service and other governmental and non-governmental organizations. Briefings by state and federal elected officials this past year included town hall meetings hosted by Senator Gordon Smith, Senator Ron Wyden, and Representative Darlene Hooley. Numerous other meetings by public and private organizations made use of HMSC facilities for meetings this past year, including:

July 7 Senator Ron Wyden Meeting with representatives of Newport Fishing Fleet and Town Hall Meeting
 July 21 Environmental Natural Resources Section OSB: CLE & Exec Committee Meeting
 Aug 3 Tsunami Community Education Forum
 Aug 16 Oregon Dungeness Crab Commission - Public meeting
 Aug 17 REU Program Intern Symposium (public invited)
 Aug 24 Commercial Halibut Meeting hosted by ODFW
 Aug 24 Sport Halibut Meeting hosted by ODFW
 Aug 29 Property Acquisitions meeting
 Sept 01 OSU Residential Facilities & Maintenance Supervisors Retreat
 Sept 14 (and other dates) Small Farm Workshop sponsored by Oregon Sea Grant
 Sept 18 Oregon Watershed Enhancement Board workshop
 Sept 21 Listen Session - Oregon's 150th Birthday Bash
 Sept 23 Gilbert Ichthyological Society gathering



Sept 23 Coast Range Association Board Meeting
 Sept 24 CONNECT OSU group visit
 Sept 27 Public Forum on Port of Newport Proposed Bond Measure
 September 30 Watershed Weeks / National Estuaries Day (public event)
 October 04 (multiple days) Koi workshop sponsored by Oregon Sea Grant
 October 04 Oregon Department of Land Conservation meeting
 Oct 10 Day Care Issues with the State of Oregon
 Oct 12 Oregon Dept of Energy meeting
 October 21 Oregon Shores Conservation Coalition - Annual Meeting
 October 24 Distinguished Lecturer - Bob Pettit (Public Event)
 October 24 Sustainability Workshop by Duke Castle: The Natural Step
 November 6 Oregon Trawl Commission meeting
 Nov 8 Oregon Dept of Agric./Salmon Commission - Public Meeting on Appeals Process
 November 11, 2006 Marine Science Careers Day
 Nov 4 Student Summit - Bill Hanshumaker Oregon Sea Grant
 Nov 29 Siuslaw Nat'l Forest - work meeting
 Nov 30 Proposed Rule making hearing by Oregon Watershed Enhancement Board
 Dec 11 China Ocean University delegation to OSU
 Dec 14 Fishermen Extending Salmon Recovery Information Advisory Council Meeting
 January 9 Pacific Herring meeting sponsored by ODFW
 January 27 Coast Range Association Board meeting
 February 07 Public Meeting - Oregon Coast Dungeness Crab commission
 February 09 KHV trainer seminar sponsored by Oregon Sea Grant
 February 17 OSU Biology Graduate Student Symposium
 March 11 Lecture: Living on the Oregon Coast in a Century of Climate Change (public invited)
 March 13 President's Commission on Ocean Futures
 March 15 Ocean Salmon meeting sponsored by NOAA Fisheries
 March 16 Sea Grant Seafood Celebrity Cook-off Judge's Social
 March 17-18 2nd NAB the Aquatic Invasive Species Workshop
 March 22 National Offshore Aquaculture Act workshop Agenda
 March 23 Ocean Policy Advisory Council's Scientific and Technical Advisory Committee (STAC)
 March 24 OAPHCC's Journeyman plumber continuing education seminar
 March 26 Sea Grant Extension talk on Master Naturalist and Coastal Naturalist Program
 April 5 Univ. of Oregon Landscape Architecture studio class presentation on HMSC landscape design concepts
 April 11 Oregon State Archives workshop
 April 21 Earth Day - Speakers on Global Climate Change (public event)
 May 7-11 NOAA Fisheries Star Panel for sablefish and long nose skate
 May 12 International Migratory Bird Day (public event)
 May 14 Seawater Dock Workshop
 June 13 Markham Symposium (public invited)
 June 14 Columbia River Plume Project Meeting sponsored by NOAA Fisheries

June 18 International ZEW Club (Ornamental Fish Medicine) Workshop
June 23 – Seafest
June 28 Public hearing on Wave Energy
(Monthly) Yaquina Birders

Public welcomes return of SeaFest **Ken Hall, HMSC Program Manager**

They arrived by land and by sea. Undeterred by morning drizzle and a vehicle accident that stopped traffic across the Yaquina Bay Bridge for nearly an hour, an estimated 3,700 people made their way to the HMSC on Saturday, June 23rd to attend SeaFest. After a year's hiatus, the return of SeaFest in 2007 garnered an enthusiastic response from visitors and the local community. Hundreds took advantage of a water taxi service operated by Marine Discovery Tours by special arrangement with OSU's Ship Operations, allowing the public a first-ever direct connection between Newport's bayfront and the OSU dock.

In addition to the ever-popular touch tanks, aquaria, and permanent exhibits in the HMSC Visitor Center, there were dozens of exhibits created especially for SeaFest, where scientists engaged visitors with hands-on activities and demonstrations. White lab coats were hard to find, but researchers wearing jeans and t-shirts and "Ask me about my science" buttons were plentiful, inviting visitors to peer through microscopes, examine live specimens, and handle instruments used in the lab and field.

Responding to public interest on the subject of global warming, SeaFest organizers lined up several speakers to address the question of how the oceans are impacted by climate change.

Gail Achterman, Director of the Institute for Natural Resources at OSU, and Stephen Hammond, Director of NOAA's Pacific Marine Environmental Laboratory at HMSC, spoke at the SeaFest opening lecture on Friday evening. Hammond, who is also Acting Director of NOAA's Ocean Exploration Program, noted that coral reefs and other calcifying marine organisms may be the first victims of large scale changes in ocean chemistry driven by oceanic uptake of carbon dioxide.

Saturday afternoon featured a trio of experts explaining how climate is related to the dramatic variability in ocean conditions and productivity of plankton, salmon, and other fish stocks seen over the past decade and a half. Jack Barth and Michael Harte of OSU's College of Oceanic and Atmospheric Sciences and Bill Peterson of NOAA's Northwest Fisheries Science Center offered some predictions of how rising ocean temperatures and sea level could significantly affect fisheries and marine habitats.

Oregon Secretary of State Bill Bradbury delivered a presentation highlighting action being taken at the state level to reduce greenhouse gas emissions and transition to renewable energy sources. Many exhibitors also addressed sustainability themes in their displays, educating the public about ways that individuals and households can reduce their "carbon footprint".

As usual, a large segment of the attendance at SeaFest was families with children. "Knowing that a big part of our audience at SeaFest is school aged children, we design exhibits and activities to make the science fun and accessible," says Ken Hall, program manager at the Hatfield Center. "Of course, those kids are coming to SeaFest with their parents or grandparents, and it is equally important that the adult audience walk away feeling they have learned something about our research and why it is important."

So, in addition to "Whale Tales" storytelling, fish printing, and photo ops with the giant blue goose and Junior Ranger Beaver roaming the festival grounds, there were plenty of activities for older guests as well. Tours of the HMSC seawater system, oyster aquaculture lab, and aquatic animal husbandry area were offered throughout the day, and there were dozens of exhibits featuring cool gadgets and high-tech instruments being demonstrated and explained by the people who use them for research.

Out on the dock, visitors were able to board the OSU research vessel Elakha to learn how undersea gliders are used in oceanographic research. The R/V Pacific Storm, a converted fishing vessel now utilized by the OSU Marine Mammal Institute to track whales, was also on public display.

Organizers say the participation of local volunteers, exhibitors, food vendors, artists, and musicians at SeaFest contributes to the festival atmosphere and helps make it a true community event. Nearly 100 volunteers were in action on the day of the event, serving as greeters, information guides, parking attendants, and assistants for exhibitors and Kids Zone activities.

"We were also very fortunate to have community partners like the Confederated Tribes of Siletz Indians, Georgia Pacific, and Starbucks supporting SeaFest as co-sponsors," said George Boehlert, Director of the HMSC. "Their financial contributions enabled us to provide space for community exhibitors at no charge and to maintain SeaFest as a free event to the public."

The educational focus of SeaFest draws an audience that is naturally curious and interested in learning, which is one reason many community exhibitors say they enjoy participating in the event. Every year, the U.S. Coast Guard and Coast Guard



Auxiliary use SeaFest as an opportunity to teach and demonstrate boating safety.



Some visitors to this year's SeaFest got a better than usual view of the Coast Guard helicopter search and rescue demonstration on Yaquina Bay. Those who were being shuttled across the bay aboard Marine Discovery Tours' 27-foot rigid hull inflatable during the mid-afternoon exercise got a front row view of the action.

Rides on the "Oregon Rocket", offered for the price of a non-perishable food item or cash donation to benefit Lincoln County Food Share, were a highlight of SeaFest '07. The fundraiser netted over 235 pounds of food and \$550 in cash donations to the local food bank.

Hosting and primary sponsorship of SeaFest 2007 was provided by the following entities:

Oregon State University

Coastal Oregon Marine Experiment Station
Cooperative Institute for Marine Resources Studies
Hatfield Marine Science Center Director's Office
Marine Mammal Institute
Oregon Sea Grant

Cooperating State and Federal Agencies

NOAA Alaska Fisheries Science Center
NOAA Northwest Fisheries Science Center
NOAA Pacific Marine Environmental Laboratory
Oregon Department of Fish and Wildlife
USDA Agricultural Research Service
US Environmental Protection Agency
US Fish and Wildlife Service

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 2006-07 year, financial contributions from the Friends provided support for a wide range of programs, activities, and specific needs, including housing scholarships for Corvallis-based OSU students who wish to participate in the Fisheries and Wildlife intensive course at HMSC during the fall term and internships at the HMSC Visitor Center for students interested in science education. Support was also provided for continuation of Las OLAS (Ocean Learning Activities in Spanish), an innovative outreach program to Spanish-speaking families with school-aged children in Lincoln County.

Other activities promoted through the Friends of HMSC during 2006-07 included an open invitation to explore the Yaquina Bay estuary by canoe/kayak, bird-watching opportunities, and occasional guest speakers at the HMSC Visitor Center. On March 11th, a near-capacity crowd filled the Hennings Auditorium for a Friends-sponsored Sunday afternoon lecture and reception featuring OSU professor emeritus Paul Komar of the College of Oceanic and Atmospheric Sciences. His presentation entitled "Living on the Oregon Coast in a Century of Climate Change" explained the trend of increasing storm intensities and wave heights seen over the past 25 years, and highlighted the impacts on coastal erosion processes, which are expected to accelerate with rising sea levels in coming decades.

Donor Honor Roll

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Ms Joyce Signer
Siletz Tribe Charitable Donation Fund
Dr Randolph B Sleet and Ms Linda H Sleet
Mrs Ann Smart and Mr William H Smart
Mrs Meg Smith
Ms Frances G Spigai
Mr Stephen V Stehman
Mrs Barbara Bechmann Trent and Mr Bruce Everett Trent
Dr Jo Anne J Trow and The Honorable Clifford W Trow
Ms Estelle H Voeller
Dr Willard W Wakefield and Dr Clare E Reimers
Dr Lavern J Weber and Dr Pat Lewis
Ms Pamela Celeste Weber and Mr Ronald Dean Bonham
Dr Tim Weber and Mrs Lisa Cardamon Weber
Ms Janet Gray Webster and Mr Stephen A Webster
Mrs Peggy Russell Weems and Mr Gary L Weems
Mr John White and Ms Lori White
Mr Douglas M Whitmore and Ms Alessandra S Whitmore
Wiancko Family Charitable Fund
Ms Anna Wiancko-Chasman and Mr Paul Chasman
Ms Gail Willeke and Mr J L Willeke
Mr Eugene Williamson and Mrs Linda May Williamson
Mr Donald B Winn and Ms Marlene E Winn
Mrs Harriet M Winton
Mrs Susan D Zimmerman and Mr Jerry Zimmerman

Seminars at HMSC

Seminars presented at HMSC from July 2006 to June 2007

DATE	NAME	AFFILIATION	TITLE
July 13, 2006	Bryan Black	Assistant Professor/Senior Research Scientist, HMSC Assistant Adjunct Professor, Dept of Forest Science HMSC	Rockfish, tree rings and linkages between marine and terrestrial ecosystems
July 20, 2006	Courtney S. Campbell	Professor and Chair Department of Philosophy, OSU	Integrity and Responsibility: Pillars of Ethics in Scientific Research
July 27, 2006	Paul Lang	Department of Fisheries and Wildlife, HMSC, OSU	Hot steamy gene expression action (in <i>Crassostrea gigas</i>)
July 27, 2006	Rebecca Baldwin	NOAA & Department of fisheries and Wildlife, HMSC, OSU	Parasites as biological tags to examine foraging behavior and habitat use of pelagic fish
July 27, 2006	Mark Nielson	College of Oceanic and Atmospheric Sciences, HMSC, OSU	Benthic microbial fuel cells; enhanced power through pore water advection
August 3, 2006	Robert Allen	College of Oceanic and Atmospheric Sciences, Corvallis, OR	Graduate School - The College of Oceanic and Atmospheric Sciences and Beyond; An RUE's Guide to getting in
August 10, 2006	Robert T. Lackey	Environmental Protection Agency - Corvallis, OR	Ecological Policy: Defining Appropriate Roles for Science and Scientists
August 17, 2006	Research Experience for Undergraduates	Mini Symposium - Results of research REU's did during 10 week internship at HMSC	REU interns: Christian Andersen, Alexandra Cwalina, Stefanie Gera, Ethan Herget, Rose Kormanyos, Patrick Luke, Alexandra Penny, Kate Ruck, Angie Sremba, Lillian Tuttle, Sarah Walinski and Lauren Woods
October 5, 2006	Bill Chadwick	OSU, CIMRS and NOAA Vents Program	The Submarine Ring of Fire: Submarine eruptions and molten sulfur lakes in the Mariana volcanic arc
October 12, 2006	Kevin Lafferty	UCGS, Santa Barbara, CA	The ecology of parasites in a salt marsh ecosystem
October 19, 2006	Marc Johnson	COMES, Fisheries Science	Genetic structure, migration and patterns of allelic richness among coho salmon populations of the Oregon coast
October 19, 2006	Alena Pribyl	Graduate with Fish and Wildlife, OSU	Extreme Expansion: Rockfish who take it to the edge
October 19, 2006	Carrie Newell	Lane Community College Marine Biologist, Biology Department	TBA
October 24, 2006	Robert Pettit	Regents Professor Department of Chemistry and Biochemistry, Arizona State University	Distinguished Lecture Series: Discovery and clinical development of naturally occurring anti-cancer drugs
October 26, 2006	Joe Walder	US Geological Survey Cascades Volcano Observatory	Eruption at a glaciated volcano: some surprising results from Mount St. Helens, 2004-2006
November 2, 2006	Jane Lubchenco	OSU Distinguished Professor and Wayne and Gladys Valley Professor of Marine Biology	Oceanic Changes and Human Well-Being
November 9, 2006	Steve Parker	Oregon Department of Fish and Wildlife	Physiological ecology of catastrophic decompression in rockfishes
November 16, 2006	Julie Keister	Graduate Student, Faculty Research Assistant, OSU, CIMRS	Variability in mesoscale physical activity in the Northern California current
November 16, 2006	Emily Waschack	Graduate Research Assistant, OSU	Gonads, otoliths, and lipids: quantifying maternal effects for the deepwater rockfish Pacific Ocean perch, in the Gulf of Alaska
November 16, 2006	Mattias Johansson	Graduate Student, OSU, COMES	Effects of oceanographic barriers, habitat discontinuity, and geographic distance on population structure of copper rockfish along the Oregon Coast
November 30, 2006	Kristina McNyset	EPA, Western Ecology Division, Corvallis, OR	Predictive ecological niche modeling in aquatic systems

DATE	NAME	AFFILIATION	TITLE
December 7, 2006	Francis Chan	OSU Zoology Department, Corvallis OR	What do we know about the past present and future dynamics of hypoxia on the Oregon Coast?
December 14, 2006	Thomas P. Hurst	Fisheries Behavioral Ecology Program, Alaska Fisheries Science Center – NOAA – NMFS at HMSC Newport	Causes and consequences of winter mortality in fishes
January 19, 2007	Steven D. Gaines	Professor, University of California Santa Barbara	The emerging science of Marine reserve networks
January 19, 2007	Kipp Shearman	Assistant Professor, College of Oceanic & Atmospheric Sciences, OSU	Autonomous glider observations from the Newport hydro-line
January 25, 2007	Lyle Britt	Alaska Fisheries Science Center, Seattle, WA	An ecological perspective on spectral sensitivity of vision in northeast Pacific fishes
February 8, 2007	Hongsheng Bi	CIMRS, HMSC	Quantitative methods on copepod stage-specific mortality estimation and salmon ocean habitat analysis
February 15, 2007	Debra Finn	Postdoctoral fellow Dept. of Zoology, OSU	Dispersal and persistence of mountain headwater stream insects in a changing environment
February 22, 2007	Aaron Thode	Scripps Institution of Oceanography	Direct underwater visual and acoustic observations of echolocation behavior of sperm whales around a long line
March 1, 2007	Ann Shriver	International Institute of Fisheries Economics and Trade	Fisheries Economics: Where have we been, where are we going, and why should you care?
March 8, 2007	Ric Brodner	NOAA's Fish ecology (FE) Division at HMSC	Denizens of the deep: Mesopelagic and bathypelagic fauna off Oregon
March 15, 2007	Christine Weihoefer	US Environmental Protection Agency	Linkages between a large river and floodplain wetlands within Tualatin River Valley, OR
March 22, 2007	Peggy Krahn	NOAA/NWFSC	Use of chemical tracers in assessing the diet and foraging regions of killer whales
April 12, 2007	Melanie Frazier	University of Washington, Department of Biology	Thermodynamics vs biochemical adaptation in ectotherms: Is hotter Better?
April 19, 2007	Brian Tissot	Associate Professor, Washington State University, Vancouver	Marine protected areas and community-based fishery in management in Hawaii
April 26, 2007	Craig Young	Professor, University of Oregon	Can deep-sea larvae disperse across ocean basins?
May 3, 2007	Jeffrey Shaman	Assistant Professor College of Oceanic and Atmospheric Sciences	Hydrologic and meteorological drivers of mosquito borne disease transmission
May 10, 2007	Itchung Cheung	HMSC Academic Program Coordinator	Crab Butter! HAB Butter! No one eats it, so what is the matter? (Presence of Domoic Acid, a natural marine toxin in rock crabs in Monterey Bay)
May 17, 2007	Stephen Giovannoni	Professor, OSU Department of Microbiology	Lessons from oligotrophs: ecology, genomics and physiology of the SAR11 Bacterioplankton clade
May 24, 2007	Rob Witter	Oregon Department of Geology and Mineral Industries Coastal Field Office, Newport	Calibrating Tsunami inundation models with sand sheets deposited by prehistoric cascadia tsunamis, Cannon Beach, OR
May 31, 2007	Robbins Church & Joe Ebersole	US Environmental Protection Agency	Stable isotope studies of the use of marine-derived nutrients by coho salmon juveniles in the Oregon coast range
June 21, 2007	Scott Baker	Associate Director MMEP/COMES/MMP	Whale for Sale: Molecular ecology of whale-meat markets
June 28, 2007	Kimberly Catton	Georgia Tech	Quantitative analysis of tethered & free-swimming copepodid flow fields

V. PUBLICATIONS

KEY: * = Student, **Bold** = at HMSC ¹ = OSU,
² = NMFS, ³ = PMEL, ⁴ = EPA, ⁵ = ODFW

Allan, Jonathan C.¹; Hart, Roger, and Tranquili, J. V. The use of passive integrated transponder (PIT) tags to trace cobble transport in a mixed sand-and-gravel beach on the high-energy Oregon coast, USA. *Marine Geology*. 2006; 232(1-2):63-86

Almonacid-Merino, Sergio Felipe*. Monte Carlo Random Walk Simulation As a Complement to Experimental and Theoretical Approaches: Application to Mass Transfer in Fish Muscle Tissue. Thesis (Ph.D.)--Corvallis, OR: Oregon State University (Bioresource Engineering); 2006. 110 p.

Amogan, H. P.; Martinez, J. P.; Ciuffetti, L. M. ; Field, K. G., and **Reno, Paul W.¹** Karyotype and genome size of *Nadelspora canceri* determined by pulsed field gel electrophoresis. *Acta Protozoologica*. 2006; 45(3):249-254

Arkoosh, Mary R.²; Kagley, Anna N.²; Anulacion, B. F.; Boylen, Deborah A.²; Sandford, B. P.; Loge, Frank J.²; Johnson, L. L., and Collier, T. K. Disease susceptibility of hatchery Snake River spring-summer Chinook salmon with different juvenile migration histories in the Columbia River. *Journal of Aquatic Animal Health*. 2006; 18(4):223-231

Auth, Toby D.¹ and Brodeur, Richard D.² Distribution and community structure of ichthyoplankton off the coast of Oregon, USA, in 2000 and 2002. *Marine Ecology Progress Series*. 2006; 319: 199-213

Auth, Toby D.¹; Brodeur, Richard D.², and Fisher, K. M. Diel variation in vertical distribution of an offshore ichthyoplankton community off the Oregon coast. *Fishery Bulletin*. 2007; 105(3):313-326

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Bernier, Jeremiah C.¹ *. Neural Gene Expression Profiling in Chinook Salmon (*Oncorhynchus tshawytscha*) of Alternate Run Times. Thesis (M.S.)-- Corvallis, OR: Oregon State University (Fisheries Science); 2007; c2006. 45 p.

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Bi, Hongsheng*; Ruppell, Rachel E.¹, and Peterson, William T.² Modeling the pelagic habitat of salmon off the Pacific Northwest (USA) coast using logistic regression. *Marine Ecology Progress Series*. 2007; 336:249-265

Boin, Markus A.*. Identification of an Aerotaxis Transducer in *Vibrio cholerae*. Thesis (M.S.)-- Corvallis, OR: Oregon State University (Microbiology); 2007; 47 p.

Bottom, Daniel L.²; Simenstad, C. A.; Baptista, A. M.; Jay, D. A.; Burke, J.; Jones, K. K.; Casillas, E., and Schiewe, M. H. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. Seattle, WA: Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service; 2005. 246 p. (NOAA Technical Memorandum NMFS-NWFSC; 68).

Bottom, Daniel L.²; Riddell, B. E., and Lichatowich, J. A. The estuary, plume and marine environments. In: Williams, R. N., ed. Return to the river: restoring salmon to the Columbia River. San Diego, CA: Elsevier Inc.; 2006; pp. 367-412.

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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	3,622,500		20%
Oregon Department of Fish & Wildlife	4,500,000		25%
Vents Program - Federal	943,508		5%
Nat'l Marine Fisheries Service - NWFSC	5,249,739		29%
Nat'l Marine Fisheries Service - AFSC	1,433,000		8%
US Department of Agriculture - ARS	577,106		3%
US Fish & Wildlife Service	1,743,941		10%
Total State & Federal Agency Budgets		\$18,069,794	100%

FUNDING SOURCES

Direct State Funding

HMSC	1,367,568		
COMES	1,707,486		
CIMRS	174,008		
Guin Library	301,060		
Extension Sea Grant	710,842		
Ship Ops	47,346		
Total Direct State Funding		\$4,308,310	12%

Other State Funding

Matching Funds (Endowments)	203,777		
Student Fees (TRF)	28, 835		
Total Other State Funding		\$232,612	1%

Sponsored Research and Education Programs

Nat'l Oceanic & Atmospheric Admin. (NOAA)	4,923,750		
Nat'l Science Foundation (NSF)	1,614,609		
U.S. Dept. of Agriculture (USDA)	504,947		
Office of Naval Research (ONR)	1,392,671		
Department of Defense	0		
Department of Energy (DOE)	599,986		
Department of Interior (DI)	8,054		
Oregon Dept. of Fish & Wildlife (ODFW)	115,702		
Other Oregon Agencies	235,018		
California Dept of Water Resources	142,271		
Foundations & Other Organizations	2,273,096		
Sub-Contracts from other Universities	451,452		
Total Sponsored Research		\$12,261,557	34%

Other Funding

Self-Funding Units	1,163,810		
State & Federal Agency Budgets	18,069,794		
Total Other Funding		\$19,233,604	53%

<u>TOTAL FUNDING:</u>		\$36,036,084	100%
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BUDGETS

OSU at Hatfield Marine Science Center

<u>Research Administration</u>	<u>\$ Amount</u>	<u>Unit Sub- Total</u>	<u>Total</u>	<u>% of Total</u>
Administration	526,034			
Visitor Center Support	74,975			
Non-Sponsored Research	0			
Non-Sponsored Education	93,073			
Sponsored Education	84,198			
Sponsored Research	200,828			
Total Research Administration		\$979,109		5%
Physical Plant				
State Support	699,055			
Federal Support	499,608			
Other Sponsored Activity	28,835			
Total Physical Plant		\$1,227,499		7%
<u>Coastal Oregon Marine Experiment Station (COMES)</u>				
Administration	561,398			
Non-Sponsored Research	1,104,203			
Cost Shared to Sponsored Research	203,354			
Self-Funded Programs	585,776			
Extension	16,790			
Endowment	575,379			
Sponsored Research	3,299,002			
Total COMES		\$6,345,902		35%
<u>Cooperate Institute for Marine Resource Studies (CIMRS)</u>				
Administration	174,008			
Sponsored Research	4,215,073			
Total CIMRS		\$4,389,081		24%
<u>College of Oceanic & Atmospheric Sciences</u>				
Ship Support/Operations	2,552,040			
Ship Support & Communications	49,678			
Ship Scientific Equipment	415,913			
Total Ship Operations		\$3,017,631		17%
<u>Sponsored Research</u>	132,588	\$132,588		1%
<u>Education Programs</u>				
Extension	389,935			
Sea Grant	358,857			
Visitors Center (self-funded)	123,599			
Sponsored Programs	51,970			
Self-Funded Programs	58,275			
Total Education Programs		\$982,636		5%
<u>Housing</u>				
Self-Funded Operations	93,355	\$93,355		1%
<u>Bookshop</u>				
Self-Funded Operations	170,797	\$170,797		1%
<u>Other</u>				
Guin Library	301,060			
OSU Foundation & Gifts	123,434			
Network Service/Computer Support	179,256			
Federal Agencies (through OSU)	23,942			
Total Other		\$627,693		3%
<u>TOTAL HATFIELD MARINE SCIENCE CENTER:</u>			\$17,966,289	100%