

Oregon Sea Grant Program Summary Report

Introduction

Oregon Sea Grant (OSG) is a statewide program headquartered at Oregon State University (OSU). The program was established in 1968, and in 1971 was designated one of the first four Sea Grant programs in the nation under NOAA. Our mission employs an integrated program of research, education, and engagement that helps people understand, rationally use, and conserve marine and coastal resources. Our activities respond to the needs of ocean stakeholders and act to stimulate the Oregon economy.

OSG engages partners and seeks a broad funding base to ensure program vitality as a leading national and regional creator of knowledge and a trusted provider of information. All actions are guided by program-wide goals: (1) improve human health and safety related to ocean and coastal use; (2) promote social progress and economic vitality; and (3) enhance the sustainability of coastal ecosystems. An Advisory Council of marine industry and coastal community leaders provides continued external review of and advice to the program.

We support competitive, peer-reviewed research that allows top ocean and coastal scientists to apply their skills to issues of critical importance to the state, the region, and the nation. The biennial process is rigorous. The research we fund, integrated with strong education and public engagement programs, fosters science-informed decisions. Funded proposals must have scientific excellence *and* societal relevance and are expected to include outreach and engagement components to ensure that the results of cutting-edge science will be put to work on the ground—and at sea. Program development funds also provide rapid response to emerging problems and opportunities that arise outside the scope of the biennial competition.

Everything OSG does is driven by an ethic of public service, and the program uses various and unique approaches to engage our constituents as a trusted broker of scientific information. We take particular pride in engagement, which is supported by being housed at OSU, which has a Vice Provost for

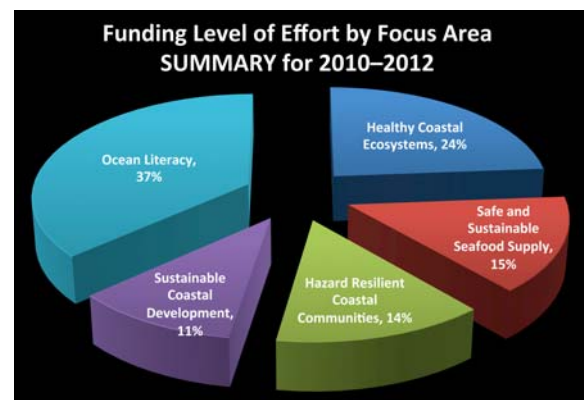
Outreach and Engagement and has Sea, Land, Space, and Sun Grant programs. Extension faculty reside in communities distributed throughout the coast.

OSG also runs the Visitor Center at the Hatfield Marine Science Center as a public-service learning facility and free-choice learning laboratory. Last year alone the Center had more than 162,000 visitors, 12,000 volunteer hours, 22,000 K–12 students, and developed 60-plus curricula.

Opportunities to develop a working knowledge of coastal and marine issues, management, and policy are afforded undergraduate and graduate students through our Sea Grant Scholars Program, which includes fellowships, internships, and scholarship programs, placing students with state and federal resource policy agencies, the state Legislature's Coastal Caucus, coastal science labs—and within OSG itself.

OSG leadership is prevalent at OSU (the director chairs the OSU Marine Council, representing 17 colleges, departments, and centers, with \$100M of research), the state (OSG chairs the Legislature's Scientific and Technical Advisory Committee for policies), and the region (e.g., recent programs on invasives, regional research priorities, West Coast Governors Fellows, and tsunami marine debris).

The OSG program is balanced across all five National Sea Grant focus areas. This report summarizes some of our major impacts and accomplishments during the 2008–2011 funding period by providing two extended examples and a brief synopsis of selected other activities for each of the focus areas. In all cases we are looking at a four-year window that has a rich history and a planned future.



OREGON SEA GRANT**Healthy Coastal Ecosystems**

Research and Outreach

Hypoxia

Fisheries Management

Stakeholder and Public Engagement

Ecosystem Restoration

Invasive Species

Stewardship Education

Habitat Restoration

Salmon Disease

Ocean Acidification

Ocean Observing

Water Quality

Sustainability

Economic Vitality

Ecosystem Management and Decision Making

Public Science Communication

Healthy Coastal Ecosystems**Oregon Sea Grant enlists science, communities, schools, and the public in combating invasive species**

Invasive, nonnative species cause at least \$143 billion in ecological, economic, and human health damage in the U.S. each year. In Oregon, the costs of such invasions amount to nearly \$500 million annually. Controlling existing invaders, and limiting the introduction of new ones, is certainly important to the state's economy and environment.

Oregon Sea Grant (OSG) is a leader in invasive species science, education, and public engagement, working with agency partners, school districts, communities, and others to develop strategies and deliver programs to identify, track, prevent, and limit the spread of ocean and coastal invaders. Dr. Sam Chan serves on—and has chaired—the Oregon Invasive Species Council (OISC), dedicated to a coordinated and comprehensive effort to keep invasive species out of Oregon and to eliminate, reduce or mitigate the impacts of those already found in the state. Dr. Chan conducts research into public attitudes and behaviors around invasives—in Oregon, the West, and across the nation—and integrates results into outreach and education programming for, and with, resource managers, boaters, campers, schoolteachers and their students, and the public at large.

OSG's leadership on invasives has led to a regional program to apply what we have learned to the entire West Coast, and has given us a leadership role in a five-state effort to deal with potential invasives arriving on U.S. shores with debris from the 2011 Japanese earthquake and tsunami.

At the state and national level, OSG has worked with the OISC and The Nature Conservancy to coordinate funding and data collection for a streamlined, statewide, all-taxa invasive species database, iMapInvasives. This online tool, which is connected to and communicates with other databases around the country, allows resource managers and others to share records of invasive species sightings, map the spread and extent of invasions, and better understand and manage this challenging and costly problem.

Budgets for invasive species detection and management tend to be low compared to the potential economic and environmental threats. Recognizing this, policymakers in the Pacific Northwest expressed a need for research to support their investments. In response, OSG funded research that led to a new risk-assessment model that lets managers analyze the most cost-effective control points for a given invasion, thus helping reduce mitigation costs. Current research is looking at ways to predict the likelihood of new invasions, weigh the economic and environmental risks, and use that information to determine where best to target prevention efforts.

Public education and involvement are critical to detecting, preventing, and controlling the spread of invasive species. OSG addresses this challenge with multiple approaches, including:

- **Rapid response:** When highly invasive marine tunicates were identified on Coos Bay construction barges being used to build the new NOAA Pacific Marine Operations Center in Newport, OSG quickly informed agency and commercial parties about the infestation. OSG led development of a treatment plan that successfully decontaminated the hulls, saving more than \$300,000 and averting a potential ecological disaster in Yaquina Bay.
- **Informing decisions:** Firewood brought into campgrounds from elsewhere often carries insects and other pests that can threaten local ecosystems. Working with partners in Washington and Idaho under a USDA grant, OSG surveyed coastal campers in 2011 and found that while 40 percent of campers regularly brought firewood with them, two-thirds said they'd change their practice after learning about the problem. OSG makes that easier with "Firewood Buddy," a new mobile phone application that lets campers learn where they can buy local firewood near campgrounds.
- **Stewardship education:** WISE, the Watershed Invasive Species Education program, enlists, trains, and mentors teachers in STEM (Science, Technology, Engineering, and Mathematics)-qualified invasive species education. In 2011 alone, WISE teachers reached 3,996 students—many of whom engaged in hands-on stewardship projects in their communities alongside local watershed councils and other groups. Among other results, WISE teachers discovered that some marine animals they were buying for classroom use can be invasive, and OSG helped them find sources for native replacements.

Decades of Oregon Sea Grant research and outreach pays off for salmon and their habitats, but new challenges loom

Native salmon are iconic to the Pacific Northwest, and the decline of wild salmon stocks since the 1950s has had crushing consequences for the region's economy, its ecosystems, and its cultural identity. OSG's leadership in salmonid research, in engaging coastal communities in watershed and habitat restoration, and in studying salmon disease has contributed to the slow rebound of some species, but challenges remain to full restoration of these economically and culturally important fish. In more than four decades of studying native salmon and their habitats, Oregon Sea Grant (OSG) has amassed a vast body of knowledge, and built trust-based working relationships with a stakeholder base that includes commercial and sport fishers, local communities, conservationists, watershed owners, and state and federal resource managers. From this diverse and comprehensive base of research, education, and public engagement, OSG is now looking more closely at what makes habitat restoration successful, and how factors such as climate change could affect the future of salmon in the Northwest.

The Salmon River Estuary is a large restored estuary on the central Oregon coast, and is the site of multiple research projects since 1998 through which OSG has

- created an unprecedented picture of the web of flora and fauna that contribute to an estuary's resilience
- pioneered concepts and techniques for evaluating how salmon respond to restored wetlands
- demonstrated that restoration yields measurable benefits to salmon populations.

These findings are being used today in habitat restoration activities throughout the Northwest. In 2011, building on the Salmon River work, OSG published *Pathways to Resilience: Sustaining Salmon Ecosystems in a Changing World*, a groundbreaking book of essays by scientists at the leading edge of ecosystem resilience studies.

Habitat restoration protocols developed under the leadership of Dr. Giannico, OSG fisheries specialist and researcher—based in part on his research into the effects of dikes and tide gates on salmon and trout migration and habitat quality—are being incorporated by Northwest watershed councils, which are themselves established with the help of OSG’s coastal Extension faculty, into their own restoration action plans. Farmers and ranchers, meanwhile, are beginning to use Giannico’s research findings to change grazing and farming practices to improve salmonid habitats.

OSG-funded research by Jerri Bartholomew that identified the lifecycle of the virulent salmon parasite *Ceratomyxa shasta* has led to a water assay tool that agencies are using to help manage migrating salmon in the Klamath and other river systems to minimize their exposure to the parasitic disease. Now Bartholomew is looking at how rising water temperatures caused by a warming climate might affect the parasite’s spread, and whether restoring and protecting coldwater refugia in key salmon migration rivers can provide the fish with some degree of protection from the disease. This Klamath River research also played a vital role in an expert panel’s recommendation concerning hydroelectric dam removal to restore salmon habitat and migration routes, which informs pending legislation for \$1.4 billion in remediation.

Additional examples of impacts and accomplishments 2008–2011

OSG’s work also aims to advance the **science of watershed and water resource health** with regard to the roles of natural hydrology, aquatic invasive species, riparian area ecology, harmful algal blooms, land use, and development. Examples of OSG-led practices that assist regional managers in prioritizing invasive species management, as well as prevent and respond to invasions, include development of more than 20 new management and prediction tools and documents and the 2nd edition of *GardenSmart Oregon: A guide to Non-Invasive Plants*. Nearly 50 percent of Oregon coastal communities now use OSG watershed health and water resource planning tools to improve

invasive species management and prevention protocols, with more than 100 presentations delivered to resource managers by OSG faculty.

Watershed education takes a number of forms, with invested individuals, watershed councils, academic institutions, and related groups making informed decisions based on expanded knowledge and perspectives, thanks to OSG classes and training workshops. A newly developed online curriculum has already trained nearly 150 individuals as Master Naturalists and Watershed Stewards. Citizen scientists can now take leadership roles in Oregon community watershed and water resource education, with nearly 750 individuals receiving “train the trainer” instruction in topics ranging from Low Impact Development and Best Management Practices to watershed management. Further, OSG communications reports a record 200,000 downloads of our *Oregon Rain Garden Guide*. Finally, program evaluation is a primary goal for OSG faculty and their more than 20 stakeholder partners when delivering water resource and watershed education. All surveyed respondents demonstrated increased knowledge and awareness on six key points following participation in OSG training.

OSG supports research to **increase knowledge of deep-sea vent organisms, bioactive compounds, pharmacology molecular tools, and cell biology**. The marine environment has emerged as one of the key sources of natural-product drug leads, and screening organisms from rare or extreme ecosystems is a novel approach to discover new products with important biological activities. Deep-sea hydrothermal vents are an excellent example of this type of ecosystem and are among the most dynamic and extreme environments on Earth. The unique and diverse invertebrate and microbial organisms that inhabit vent regions may lead to the discovery of new bioactive natural products, given that chemical diversity is directly proportional to biological diversity. OSG-supported researchers are using already collected samples of deep-sea vent specimens to search for natural products beneficial to human health and new drug leads. These promising new lines of useful pharmacological tools add to a burgeoning research field. Moderate antibacterial activity

and growth inhibition are already noted for some strains, revealing their potential as new drugs. A series of cholesterol analogs has been isolated for characterization and purification of active fractions that potentially contain new chemicals. One sample revealed 12 natural-product gene clusters with predictable structures, a further indication of their possible pharmaceutical use. A peer-reviewed publication and several scientific and public outreach presentations have already resulted from this work.

Several of the 2010–2012 OSG-funded research and associated ongoing projects related to Healthy Coastal Ecosystems will result in data that can be used as **baseline or to develop indicators for use in ecosystem-based management (EBM)**. Existing projects include hypoxia impact on fish and invertebrates, nearshore wave dynamics, ecosystem connectivity, and invasive species dynamics. Newly funded projects incorporate the effects of ocean acidification on ecologically sensitive coastal habitats and commercially important organisms, as well as continue work on coastal circulation processes. Research results will ultimately inform EBM across the region and include activities to build and strengthen communication among scientists, fishing communities, fisheries managers, and the general public. One example of increased communication on the topic is the hypoxia pre- and post-season research exchanges organized by PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans, www.piscoweb.org/hypoxia). Attendees include representatives from Oregon's research community and management agencies.

OSG researchers and personnel organize meetings with fishermen to share research results, including a new fish-community database comparable to one already available for invertebrates. New ways of fostering information exchange were identified through discussions with fishers who agreed to participate in developing communications networks with input from OSG Extension faculty. Mechanisms include VHF radio broadcasts and posters at docks and in vessels, as well as continued efforts through the long-standing Scientists and Fishermen Exchange (SAFE).

Oregon Fishermen in Ocean Observing Research (OrFIOOR) is another cooperative research program between ocean scientists and fishers in the Pacific Northwest, in which Dungeness crab fishers attach sensor packages (temperature and dissolved oxygen) to crab pots, which serve as platforms of opportunity for ocean observing. A master's thesis and recently published paper used multiple criteria decision analysis (MCDA) framework to incorporate quantitative and qualitative elements of six ocean observing platforms into a measurement of user satisfaction. Results from this research indicate that the OrFIOOR program has the support of many fishermen and ocean-scientists, can provide data of comparable quality to existing ocean observing platforms, and compares favorably to more-traditional methods for alongshore monitoring of temperature and dissolved oxygen variables.

Hypoxia data are currently being incorporated into a public exhibit at OSG's popular HMSC Visitor Center in Newport, Oregon, and ROV video footage of organisms in hypoxic areas is available on the Oregon Department of Fish and Wildlife (ODFW) website (www.dfw.state.or.us/MRP/habitat).

Several OSG communication products highlight the research and information exchange engendered by ongoing hypoxia-related projects, including articles in the latest issue of *Confluence*, Oregon Sea Grant's periodical (www.seagrants.oregonstate.edu/confluence), and a special publication focused on hypoxia research in the Pacific Northwest and in the Gulf of Mexico.

Novel research techniques developed include a beam trawl to sample nearshore benthic communities and to gather in-situ behavioral observations of fish movement via a computer vision algorithm that can be used to automatically detect, track, and analyze fish targets from in-situ video observations. A remotely operated vehicle (ROV) is also used to survey offshore populations in hypoxic areas, along with high-frequency rockfish catch data and long-term monitoring for fish and invertebrate populations. A model for predicting oyster physiological stress related to ocean acidification is also in development.

OREGON SEA GRANT**Hazard Resilience in Coastal Communities**

Research and Outreach

Coastal Hazards

Tsunami Readiness

Wave Prediction

Climate Change

Risk Prediction,
Adaptation, Mitigation
PlanningCommunity Risk
Response and Reduction

Inundation Mapping

Beach Closures

Bacterial Contamination

Zoonotic Diseases
and BiosecurityStakeholder Engagement
in Planning, Policy,
and Decision-MakingClimate Change—Social
Barriers and Strategies**Hazard Resilience in Coastal Communities****Oregon Sea Grant helps coastal residents prepare for “the Big One”**

Images of massive tsunamis striking Indonesia and Japan in recent years are especially chilling to residents of the Pacific Northwest coast, who have become familiar with warnings that a similar tsunami, released by an earthquake in the undersea Cascadia Subduction Zone (CSZ) just off the Oregon coast, could be equally disastrous and even more costly. And a big one is due. Current research estimates a one-in-three chance of a CSZ earthquake as great as Richter magnitude 9 within the next 50 years. And less devastating tsunami waves—the kind generated by distant earthquakes across the Pacific—can still ripple across the ocean to wreak damage on coastal ports and property. A recent Oregon Sea Grant (OSG) survey found that coastal managers were more concerned about earthquakes/tsunamis than other potential stressors on their communities, including a weak economy or extreme weather. OSG has a long history of leading the state’s responsiveness to these pending threats. OSG brings its integrated resources of research, education, and public engagement to bear on the challenges of seismic vulnerability, just as it has on coastal erosion and storms.

With recent funding, OSG researchers have corrected years of false theoretical assumptions by showing that tsunami run-up heights often deviate significantly from one area to the next, with local variability closely related to tsunamis’ reflective and refractive behaviors. Researchers have also worked closely with Seaside, Oregon, to model local tsunami effects at the Hinsdale Wave Center and to help community leaders determine whether some sort of engineered refuge structure might help save lives in a town whose critical services all sit near sea level.

Meanwhile, OSG social science research has revealed important considerations for protecting the most vulnerable. Dr. Lori Cramer’s work uncovered real preparedness issues: Nursing homes where staff felt torn between protecting their charges and their own families, non-English speakers who mistook drill sirens for the real thing, homeless and low-income people without resources to stockpile food and emergency supplies, and more.

While research results help coastal communities prepare for a shaky future, OSG considers public engagement *now* as vital—and potentially life saving. Extension faculty have conducted tsunami workshops for coastal cities, businesses, and neighborhoods; by 2010, 40 percent of all Oregon coast communities had formal received tsunami risk training. Integrated with Extension’s efforts is a series of widely distributed preparedness publications and videos (*Three Things You Need to Know about Tsunamis*, *Tsunami Guide for Mariners*, *Reaching Higher Ground*), all freely available on the Web. OSG’s Extension Coastal Hazards Specialist, Patrick Corcoran, has made it his mission to help Oregon coast

communities and residents not be victims, using both in-person meetings and the news media to spread fundamental, life-saving messages about coastal seismic preparedness throughout the Cascadia region. Corcoran's work has been featured in such diverse media outlets as *Outside* magazine, *Popular Mechanics*, *Northwest Yachting*, Radio Netherlands, and KING-5 TV (Seattle), as well as in-state media such as *The Oregonian*, Oregon Public Broadcasting, *Oregon Business*, OSU's research magazine *Terra*, and OSG's *Confluence*. The audience reach is in the millions.

In the town of Manzanita, Oregon, for instance, Corcoran's workshops sparked new collaboration between local and state officials to update evacuation, emergency response, and communications plans and put together a local preparedness guide. A cadre of citizen volunteers mapped neighborhood resources, organized retired medical professionals into response teams, and boosted the number of local HAM radio operators for emergency communications. Similar stories are repeated up and down the coast, where most communities now have emergency response and "Map Your Neighborhood" coordinators.

As a result of all this preparation, all seven of Oregon's coastal counties earned the "Tsunami Ready" designation from the National Weather Service—but more importantly, the effort should save lives and quicken emergency response when a tsunami does strike. These efforts, in turn, grew out of OSG's long history of catalyzing Oregon coastal responses to hazards ranging from erosion to major storms, a history that has made it a trusted and respected partner of communities and agencies for decades. One example: The 128-page OSG publication *Improving Natural Hazards Management on the Oregon Coast*, which grew out of a working group we convened almost 20 years ago, continues to inform hazards policy and practice on the coast today.

Climate change: some Oregon differences

Oregonians may feel that their coast is pretty special—but scientists *know* how that's true. Apart from being less populated than most others in the U.S., Oregon's coast is generally

less susceptible to one potential effect of coastal climate change: sea-level rise. Instead, increased wave heights associated with winter storms are generally a more significant concern for Oregon coastal erosion, as Oregon Sea Grant (OSG) researcher Peter Ruggiero has helped to show—and also to reveal in local maps, developed with a new methodology for probabilistic coastal vulnerability assessments. Over the longer term of centuries, incremental erosion will be dwarfed by the magnitude of a single Cascadia Subduction Zone earthquake and tsunami. Accordingly, Oregon coastal managers recognize that climate change poses a suite of risks but, generally, they have yet to consider those risks priorities, or so they told OSG researchers who surveyed them in 2008 and again in 2012. Therefore, OSG has adopted a targeted strategy in its climate change efforts.

Since 2006 we have led two national projects involving eight other Sea Grant states (funded in part by the NOAA Climate Program Office), preparing interested coastal communities for climate change while developing and testing a risk-assessment, communication, and engagement approach. For example, in Oregon we collaborated with a community nonprofit organization that convened a working group of citizens in Port Orford, who developed a community climate model, which in turn influenced the city Planning Commission to establish a policy of considering future climate change in reviewing city ordinances, comprehensive plans, and land development proposals.

Program integration takes a number of forms in OSG. With this climate work, the communication director, Joe Cone, leads integrated projects that involve other research, Extension, and free-choice learning faculty and result in peer-reviewed publications and training of graduate students.

Additional examples of impacts and accomplishments 2008–2011

OSG faculty and researchers work together with coastal opinion leaders and decision-makers toward a goal of helping coastal communities effectively respond to coastal catastrophes, such as climate change, extreme storm events, natural

disasters, or contaminant loading. Individuals and agencies change behavior and become more resilient in the face of climate change and coastal hazards. Within communities, there is increased capacity to prepare and adapt, along with proactive measures to ensure that hazards, risks, and vulnerabilities are communicated to property owners and other stakeholders. Among the many results of OSG's efforts in this area:

- Nearly 25 percent of Oregon coastal residents know what to do in case of an earthquake and/or tsunami with the addition of "Tsunami Ready" designation by NOAA Weather Service to all seven counties.
- Three Oregon coastal communities have instituted policies and procedures to enhance the natural ability of coastal ecosystems to buffer extreme events, based on several OSG peer-reviewed publications, technical documents, and articles that expand understanding and capacity of managers and coastal communities to predict the effects of climate change on coastal ecosystems.
- Coastal communities also address social and environmental barriers to improving the community's ability to mitigate and respond to natural hazards, and more than 10 Oregon state agencies incorporate recent research that expands knowledge of the key factors and social and economic barriers to preparing for hazards and adapting to change into planning and/or decision making.
- Oregon communities are more resilient to the effects of coastal hazards and climate change and experience minimal interruption of economic activity after an event; all seven coastal counties now have plans to adapt to hazards and/or climate change.

OSG also works with communities to reduce unnecessary beach closures. Residents and visitors can enjoy beach recreation without health concerns, and coastal ecosystems have improved water quality. Decision makers use recommendations and institute policies or regulations that improve water quality, with

overall improved capacity of communities to use information to reduce risks to human health and safety. For example:

- Awareness of human contribution to beach bacterial contamination has resulted in the use and codifying of Best Management Practices (BMPs) to deal with stormwater runoff in coastal communities. More frequent sampling has resulted in shorter advisories and a reduction in the prevalence of bacteria in beach water samples.
- Historically, beaches have been under a beach-bacteria advisory for an aggregate sum of 25 days per year in Oregon. In the most recent years, beaches were under advisory for only 11 days, representing a more than 50 percent improvement in water quality.
- During an advisory on one of the state's historically contaminated beaches, OSG reports 94 percent of samples met EPA standards for bacterial contamination entering waterways from known sources.
- Through OSG efforts in conjunction with coastal community leaders, 71 percent of beach counties have reduced contamination through new practices such as rain gardens, new stormwater ordinances, and higher stormwater quality standards.

Other specific examples of OSG integrated research and outreach on **Hazard Resilience in Coastal Communities:**

- Changing trends in wave heights are as important as sea-level rise—if not more so—in terms of increasing vulnerability to coastal hazards ranging from ship safety to enhanced coastal erosion and in the engineering design of ocean and coastal structures. The discovery is supported by wave buoy data dating to the mid 1970s that show wave height (and period) increases have been more responsible for increasingly frequent coastal flooding and erosion than has sea-level rise. This discovery has been incorporated into regional hazard

adaptation plans, including Tillamook County's Coastal Erosion Hazards Plan, that otherwise would have significantly underestimated the impact of climate variability on coastal hazards.

- Other research resulted in a prediction model for coastal wave activity. Researchers developed a nearshore wave forecast system for the Oregon coast that is already in use by agencies to help with sea safety. Routine, 72-hour forecasts began in spring 2011, and daily forecasts are available on the NANOOS Visualization System (www.nanoos.org/nvs).
- Beachside habitats also play a role in hazard resilience for coastal communities. OSG funded work on the first quantitative comparison of ecological (grass invasion) and physical (wave energy, sand supply) forces to determine their roles in controlling dune geomorphology, and ultimately, coastal habitats' ecosystem function and services. Results showed that species-specific attributes play a large role in their ability to provide ecosystem protective services, such as protection from coastal hazards. Out of collaborations developed with the National Center for Ecological Analysis and Synthesis (NCEAS) working group on Land-sea Interfaces and Conservation, a high-profile article on coastal ecosystem services was recently published.
- The West Coast Sea Grant programs, NOAA West, and the University of Washington Climate Impacts Group held a workshop May 25–26, 2011, in Seattle, Washington, to engage recreational fishers, resource managers, scientists, and environmentalists in assessing and planning for climate-change impacts on west coast fisheries. At the workshop, participants reviewed background materials and identified adaptive capacity and vulnerability. In addition to addressing workshop goals, this regional collaboration strengthened

partnerships among the West Coast Sea Grant programs and NOAA West.

- Sea Grant demonstrates a region-wide commitment to advancing research into socioeconomic science questions with high relevance to west coast stakeholders. This past year, the four West Coast Sea Grant programs collectively invested \$700,000 to fund high-priority regional projects over the next two years targeting socioeconomic science questions aligned with the national Sea Grant goals. One project focused on adaptation to climate change supports a series of workshops with community managers and adaptation practitioners. Stated goals include reaching a common understanding of desirable adaptation outcomes, and to explicitly address some of the persistent challenges of coastal zone management: public vs. private rights and responsibilities; ecological vs. human needs; and near- vs. longer-term objectives.
- The Sea Grant Visitors Center continues to provide a wide range of educational and free-choice learning exhibits on tsunami preparedness, beach safety erosion and other hazards.
- OSG leadership in safety training for commercial fishers has led directly to saving the lives of fishers. Since 1991 over 500 people have taken drill conductor training in Oregon. In 2010 the fishing vessel Michelle Ann caught fire. Six persons were onboard and they had recently been through drill conductor training and responded calmly. As a result, the vessel was able to make it back to port without any serious injuries to crew. The captain and crew of the fishing vessel Michelle Ann stated that it was the training offered by OSG and the USCG that saved their lives and the vessel.

OREGON SEA GRANT**Safe and Sustainable Seafood Supply**

Research and Outreach

Aquaculture Capacity Building and Efficiency

Mitigating Risk to Oyster Seed Stock

New Seafood Product Development and Distribution

Harvesting Practices

Seafood Safety

Nontraditional Fishing Collaborations (Fishers and Scientists)

Public Education on Fisheries

Fisheries Management, Allocation, Decision Making

Public Education on Seafood

At-Sea Genetic Stock Identification

Ornamental Fish Health

Fishers' Safety at Sea

Safe and Sustainable Seafood Supply**Oregon Sea Grant brings fishermen and scientists together for mutual—and public—benefit**

Commercial fishing is a tough and dangerous way to earn a living. Still, enough people choose that livelihood to make fish and other seafood Oregon's number 1 "crop," with annual landings valued at more than \$1.7 billion. Since the establishment of Oregon Sea Grant (OSG) 44 years ago, the program has worked to help fishermen work smarter and safer, improve their return on investment, and supply consumers with a growing variety of safe, healthy, sustainably harvested seafood products.

One way OSG does that is by bridging the gaps—between fishermen and science, fishermen and resource managers, and fishermen and consumers. In an increasingly difficult regulatory and economic environment, OSG works to help fishermen communicate with—and be understood by—resource managers, scientists, and the seafood-buying public.

One forum for that communication is the Scientist and Fisherman Exchange (SAFE). Launched by OSG a decade ago as a series of informal meetings designed to help fishermen and scientists get to know each other, exchange information on topics of mutual interest, and build communication and trust, SAFE has become an important collaborative tool for both groups. SAFE discussions of hypoxia along the Oregon coast revealed that ocean-bottom temperature monitoring was lagging because the cost of conventional monitoring platforms had become prohibitively high. Commercial crabbers responded by suggesting that their crab pots might be able to carry monitoring devices. By 2010, 15 vessels were participating in the long-term monitoring project, and one boat owner had bought a second vessel just for research.

It's not a one-way conversation, either; scientists say they, too, benefit from the experience-based knowledge of the fishing community, and from the questions they raise about what they see happening in the ocean.

"I think it's really built some goodwill between researchers and fishing communities," says Oregon State University oceanographer Jack Barth, whose participation in SAFE led him to change when and where he conducted research to avoid conflicting with commercial crabbers. (Fishermen, meanwhile, learned where scientists were placing monitoring equipment—and what it looked like—so they could avoid fouling it with their fishing gear.)

A concrete example of practical ocean knowledge being applied to science and fisheries management is Project CROOS (Collaborative Research on Oregon Ocean Salmon), a collaborative effort between fishermen and scientists to sustain Chinook salmon populations and the commercial salmon industry. Salmon fisheries are now managed to protect "weak" stocks. If a single river has numbers too low to harvest, ocean fishing can be closed for all stocks until the weak population rebounds.

The OSG-initiated project trains fishing crews in Oregon and California in data-collection methods, equipment, and protocols; equip their vessels with onboard data-collection equipment; and provide them with compensation for their efforts. During the 2011 season, more than 400 commercial fishermen recorded the exact time, location, and conditions of salmon as they caught them; data is entered into a Website where it is available to scientists and fisheries managers. Preliminary analysis suggests that such real-time data could help managers decide when and where to open fishing seasons, and fishermen hope it will help them focus their efforts more efficiently—and make the resource more sustainable.

OSG is also working to teach coastal visitors—and some longtime residents—what goes on behind the scenes at ports and harbors up and down the Oregon coast. In Newport, OSG has installed a series of weatherproof signs along the boardwalk that parallels the town's commercial fishing port, with pictures and text describing the vessels and gear visitors might see, and what they catch. In 2010, OSG made “working waterfronts” the theme of its annual Heceta Head conference, attended by 150 lawmakers, local government and port officials, and others, and the relationships begun there are helping the program shape a regional working waterfronts conference for 2012.

Oregon Sea Grant helps seafood producers innovate and diversify to survive in tough economic times

A Coos Bay company called Oregon Seafoods is bringing new jobs to the local economy, and it's doing so in an innovative way: by packaging and selling west coast salmon and tuna in “retortable pouches.” The pouch, which resembles a slim envelope, is considered a type of canning—a state-of-the-art, high-tech version of canning. In its first year in business, the operation grew from 8 to 18 employees, won contracts with more than 150 vendors—including exclusive restaurants—and won a 2012 Product Innovation Award from the National Restaurant Association.

The technical know-how behind Oregon Seafoods and its new product line came from

Mark Whitham, an Oregon Sea Grant (OSG) food scientist who is revolutionizing Oregon's canning industry.

“Most store-bought tuna,” explains Whitham, “is twice cooked. That means they cook all the nutrients and flavor out.” Retortable pouches make it possible to cook the product only once, Whitham says, helping it retain all the good fats, juices, and nutrients.

To company owner Mike Babcock, a former lumber company owner, Whitham's advice and expertise meant the difference between failure and success. “We wouldn't be here today if it weren't for Mark,” he said.

From his food lab at Oregon State University Extension in Astoria, Whitham is in the vanguard of what's shaping up to be an Oregon-based canning coup. With over 30 years of experience in food processing, he is a sought-after expert by owners of small private and tribal canneries working to kick-start or upgrade their facilities.

Whitham's work is the latest example of how OSG has helped Oregon seafood processors stay ahead of the game—and often ahead of their times. From helping to launch micro-canneries in the 1970s to conducting research and training in safer processing techniques, to funding foundational research that led to the renowned, worldwide Surimi School processor training program, OSG has long been at the leading edge of seafood product development, sanitation, and marketing.

At the same time, OSG-sponsored research is helping unravel environmental and biological mysteries that threaten some of the region's most valuable seafood sectors—the puzzle of *Vibrio tubaishii*, for instance, and how oyster producers can protect their hatcheries from its effects.

Additional examples of impacts and accomplishments 2008–2011

OSG has a long-standing commitment to working toward a sustainable supply of safe seafood that meets public demand at affordable prices. Using OSG's research, extension, education, and communication capabilities to develop and disseminate essential knowledge about natural and human threats to the long-term

viability of wild and cultured fish populations, we work to identify ways to minimize these threats, and to use ecosystem-based fisheries management and other innovative approaches. New and continuing research efforts include rockfish conservation based on analysis of catch-and-release survival in the live fishery, and data-poor stock assessment tools. Other OSG-funded studies have identified shellfish pathogens in regional aquaculture facilities and provided genetic techniques to assess effects on shellfish. A recently funded related study is focused on the emerging threat of ocean acidification to coastal shellfish populations.

An area of historic strength for OSG is to ensure fishers are knowledgeable and employ efficient fishing techniques. Our recent efforts have evolved toward engagement of fishers in public process and collaborative research efforts. In addition to Scientist and Fisherman Exchange (SAFE), OSG works to improve decisions and support long-term sustainability of fishing by engaging fishers, researchers, and managers in collaborative research efforts. Through flagship efforts such as Project CROOS (Collaborative Research on Oregon Ocean Salmon), more than 300 fishers in the fleet receive training in at-sea genetic stock identification techniques. OSG efforts have also doubled the target number of management techniques adapted to utilize new knowledge. Currently, four techniques have been refined based on OSG-derived knowledge, ranging from fisheries release and genetic stock-identification techniques to reporting websites and expert reports.

OSG works to promote mutual respect between groups and increase accurate understanding of fisheries and seafood issues, including increased engagement of multiple stakeholder groups in fisheries planning and decision making. More than 20 fishing groups now effectively communicate and collaborate with non-fishing groups, such as through OSG work on a Towlane Agreement that introduces crabbers to tow boat operators, two groups both working near Coos Bay, Oregon, without historic communication.

OSG fisheries specialists educate residents and visitors on ecological, economic, social, and cultural aspects of regional fisheries. The number of locations that provide OSG-produced

materials about fishing industries has increased fourfold in the past two years, with signage and education materials statewide. OSG works to ensure that state and regional fisheries managers, including the Pacific Fisheries Management Council (PFMC), have access to sound, science-based information when making management and allocation decisions. Almost 30 presentations have been given to managers and fishermen over the past two years, and an OSG faculty member is currently serving as a member-at-large with the PFMC.

Another area of historic strength for OSG is a seafood processing industry that learns and understands techniques and processes to ensure the production and delivery of safe and healthy seafood. Current efforts have evolved toward marketing safe seafood products (see below) and improved safety related to commercial fishing, recreational fishing, and fisheries research. Increased knowledge on how to avoid risk at sea and practiced survival techniques were learned by more than 200 sea safety training students who successfully completed the course offered directly through both OSG training and Coast Guard efforts supported by OSG. OSG leadership in safety training for commercial fishers has led directly to saving the lives of fishers. In 2010 the fishing vessel Michelle Ann caught fire. Six persons were onboard and they had recently been through drill conductor training and responded calmly. As a result, the vessel was able to make it back to port without any serious injuries to crew. The captain and crew of the fishing vessel Michelle Ann stated that it was the training offered by OSG and the USCG that saved their lives and the vessel.

OSG specialists partner with the seafood industry to increase availability and profitability and improve fisheries management to match market demand for sustainability. Strategies include development of new products and innovative marketing approaches to support economically viable, efficient, and sustainable Oregon seafood industries. Related goals include increasing demand, value, and profits for Oregon-caught and -cultured seafood products, and improving the value and increasing product availability of Oregon and west coast safe, local, sustainable seafood products, particularly in urban markets. Since 2010, 17 new Oregon

seafood products have appeared in markets with 180 new distribution points for Oregon fish, including local grocery store chains New Seasons Market and Market of Choice, and REI stores. Over the past two years, there has been a 70 percent increase in economists and other social scientists working to improve regional fisheries management, with various efforts including workshops and other education and research approaches.

Our established efforts in fisheries and seafood include engendering informed consumers who understand the importance of ecosystem health and sustainable harvesting practices to the future of our domestic fisheries, who appreciate the health benefits of seafood consumption, and who understand how to evaluate the safety of the seafood products they buy. OSG engagement efforts strive to educate residents and visitors on ecological, economic, social, and cultural aspects of regional fisheries and broaden and improve the information base about the source, safety, and health benefits associated with Oregon and west coast seafood. Since 2010, five new OSG-led seafood marketing tools have been put in place, including innovative retail packaging and education on home canning and smoking techniques. This past year, the four West Coast Sea Grant programs have collectively invested \$700,000 over two years to fund high-priority regional projects targeting socioeconomic science questions aligned with the national Sea Grant goals. One west coast regional project

focused on identifying new seafood direct-marketing approaches to increase resilience and sustainability of community-supported fisheries, emphasizes helping fishers learn about direct marketing and identifying approaches appropriate to local fisheries and consumers.

OSG is a leader in the increased use of best health practices within the ornamental fish industry. More than 50 koi hobbyists and import/retail facilities in California, Oregon, New York, and Minnesota have implemented increased biosecurity and fish health management practices based on interactions with OSG's Aquatic Animal Health Program, with 64 total facilities initiating use of best health practices within the ornamental fish industry. Implementation of such practices has led to healthier and better-quality ornamental fish for sale to the customer. Over the past year of data collection, OSG observed a 21 percent decrease in morbidity and mortality among ornamental fish imported into Oregon from California. California is a major importer and the main resource of fish for Oregon retailers, and improved health/quality and increased survival and decreased disease among ornamental fish results in increased opportunities to market high-quality ornamental fish in Oregon. OSG works to improve value, quality, and sustainability of the ornamental fish trade in Oregon. A total of 10 new or improved sources provide healthy, sustainably produced/collected ornamental fish, including seven U.S. and three international suppliers.

OREGON SEA GRANT**Sustainable Coastal
Development**

Research and Outreach

Spatial Planning
and Management

Marine Reserves

Ocean Energy

Community
Decision Making

Policy Development

Working Waterfronts

Sustainable Communities

Low Impact Development

Science for Improved
ManagementReducing User Group
Conflict**Sustainable Coastal Development****Oregon Sea Grant brings together many interests
on critical, contentious issues**

Oregon's ocean and coastal resources face unprecedented competing pressures, from traditional sectors—commercial fishing, recreation, conservation—and new ones, such as marine reserves and renewable energy. With a reputation for unbiased science-based information built over 40 years of working with coastal communities and interests, Oregon Sea Grant (OSG) is uniquely positioned to take leadership in the emerging field of Coastal and Marine Spatial Planning (CMSP) and ecosystem-based management, bringing together multiple stakeholders to work toward mutually acceptable resolution of conflicts over ocean uses.

OSG has been instrumental in leading West Coast Sea Grant programs in regional initiatives, from development of a \$500,000 West Coast Regional Research and Information Plan to securing \$300,000 in national funding to support four fellows to work on the West Coast Governors Alliance on Ocean Health to Developing regional coordination on developing invasive species policies to more recent work to lead a workshop to develop a coordinated regional response to the Tsunami Debris.

The OSG director chairs the Scientific and Technical Advisory Committee to the governor's Ocean Policy Advisory Council (OPAC), the body charged with developing and administering the Oregon Ocean Resources Management Plan and Territorial Sea Plan. The committee—and thus Sea Grant—plays an essential partnership role in the state's territorial sea planning.

At a more fundamental level, Sea Grant is expert at getting competing interests to sit down, talk to each other, and, more often than not, come up with ways they can work together.

Six years into an attempt to identify a limited number of offshore marine reserves to test their effectiveness, OPAC—deluged by comments and criticism from coastal communities—asked OSG in 2007 to develop and run a coastal outreach effort to hear concerns, answer questions, and gather comments from coastal interests and individuals, to be included in the reserves siting process. OSG held a series of “listening and learning” forums in eight coastal towns, ultimately gathering thousands of written comments around a series of five key questions and publishing them in a 476-page report to the state. That document would become central to the state's ultimate decision to establish pilot reserve programs at Otter Rock, north of Newport; and Redfish Rocks, off Port Orford.

Those pilots became permanent reserves in 2009. Three more sites—off Cape Perpetua, Cascade Head, and Cape Falcon—have since been designated as reserves and are beginning the process of collecting human and ecological baseline data. The size and spacing criteria used as a central guide was developed by STAC and OSG. OSG Extension fisheries specialist Jeff Feldner serves on the state's

Marine Reserves Leadership Team, which evaluated the initial sites, held more than 30 coastal meetings to discuss the options in 2010, and ultimately crafted the compromises that helped them win public acceptance.

By explicitly inviting coastal stakeholders into the siting conversation and creating a non-confrontational process for citizens, governments, tribes, and businesses to influence the state's decisions, OSG not only helped the state focus its efforts, but defused what had become a volatile public issue. Support for marine reserves among coastal stakeholders has grown; in Port Orford, the siting process gave impetus to the Port Orford Ocean Resource Team (POORT), a community group with strong fishing industry involvement dedicated to "maintaining access to natural resources by people who are fishing selectively, while promoting sustainable fisheries and protecting marine biological diversity."

Team members worked with OSG to develop scientifically valid "long-form" profiles of fishing communities, which are now being used by resource managers to inform decision making, and which are serving as models for additional profiles being built by the Oregon Department of Fish and Wildlife to help assess potential future marine reserves and led to the creation of three additional sites.

Today, POORT collaborates with scientists on research in the Redfish Rocks reserve; for example, local fishermen and their vessels provide transport, muscle, and ideas to researcher Tom Calvanese, whose OSG-supported Fishtracker project studied the movement of rockfish in the reserve.

Science, too, benefits from OSG's efforts to foster collaborative discussion and decision making on ocean and coastal issues.

In 2009, the Oregon State Legislature established the Oregon Task Force on Nearshore Research, with representation from OSG as well as state and federal agencies, local government, commercial fishing, small business, nearshore recreation, conservation and coastal zone management. OSG Director Stephen Brandt chaired the Task Force through evaluating nearshore research and funding strategies for Oregon, and in 2010 the body (since sunsetted) presented the governor and Legislature with

recommendations on how to infuse science into the decision-making process. Those recommendations provide mechanisms for the state of Oregon to have the best scientific information to manage its diverse marine resources, and to support and coordinate planning, data management, science advice, funding, and public engagement. This process has given OSG regular, direct access to agency and statewide community stakeholders to discuss their major needs for science.

Dr. Brandt is currently co-PI (with the deputy science director of NOAA's Northwest Fisheries Science Center) on a NOAA-funded project to develop a framework for engaging West Coast stakeholders in coastal and marine spatial planning. And the university's Marine Council—also chaired by Brandt—has begun focusing on Coastal Marine Spatial Planning (CMSP), with a recent workshop bringing more than 70 scientists together to explore fundamental research questions and statewide coordination.

Oregon Sea Grant helps diverse interests make themselves heard in marine renewable energy siting decisions

Less than a decade ago, when Oregon Sea Grant (OSG) provided a modest "seed-money" grant to a team of Oregon State University engineers investigating whether the ocean's waves could be used to generate electricity, no one could have predicted how that modest investment would help Oregon become a national leader in the emerging field of marine renewable energy.

Today, with multiple companies vying to capitalize on marine renewable energy, OSG is working to ensure that coastal communities and their people don't get lost in the rush.

OSG is a partner in the Northwest National Marine Renewable Energy Center (NNMREC), a DoE-funded collaboration between Oregon State University and Washington State University. Sea Grant's expertise in community engagement powers the center's efforts to inform and engage an array of interests including the energy industry, regulators and decision makers, commercial and recreational ocean users, scientists, coastal communities, and the broader public.

With the Center's support, OSG Extension Community Outreach Coordinator Flaxen Conway, a sociologist, led a team that conducted research and produced a report, "Ocean Space, Ocean Place: The Human Dimensions of Wave Energy in Oregon." The report, published in 2010 in the journal *Oceanography*, warns that when energy permitting processes fail, it's rarely over technical merits; rather, it's because of "lack of attention to the human dimension."

The study pointed out what may be obvious to coastal residents: Commercial and recreational fisheries—both of which could be disrupted by poorly conceived or sited marine energy projects—underpin the state's economy; with annual landings valued at more than \$1.7 billion, commercial fishing amounts to Oregon's largest "crop," and the NMFS has estimated that recreational fishing directly and indirectly contributes more than \$250 million a year to the state's economy.

The article was informed by Conway's experience, along with that of OSG Extension Marine Fisheries Educator Kaety Hildenbrand, in bringing ocean and coastal stakeholders into the siting process for marine renewable energy projects proposed off the Oregon coast. OSG helps local stakeholders understand the pros and cons of energy development, navigate the regulatory and permitting maze, and empower themselves to serve as their own advocates.

OSG also helps the public understand the technical, ecological, and social ramifications of wave energy, through publications, videos, and exhibits at its public aquarium and visitor center at OSU's Hatfield Marine Science Center in Newport—not far from the offshore site that will soon become NNMREC's first open-ocean test site for marine renewable energy devices.

STAC has also recently completed a review of the entire special database that informs the Territorial Sea Plan which rates all sites as to their suitability for development of alternative energy based on existing uses.

Additional examples of impacts and accomplishments 2008–2011

OSG's role in Sustainable Coastal Development includes a commitment to coastal citizens, community leaders, and industries that recognize

the complex inter-relationships between social, economic, and environmental values in coastal areas and work together to balance multiple uses and optimize environmental sustainability. Through OSG's efforts with Oregon's Nearshore Task Force, the Ocean Policy Advisory Council (OPAC), and the Scientific and Technical Advisory Committee (STAC), as well as involvement in the Pacific Fisheries Management Council (PFMC), more than 60 scientific experts and experienced ocean users in Oregon are using science for improved resource management toward an overall goal of spatial planning that reduces (rather than exacerbates) ocean use conflicts, and spatial planning that improves the sustainability of coastal and ocean uses.

OSG engages coastal communities toward goals of efficient use of land, energy, and water resources, and to protect the resources needed to sustain coastal ecosystems and quality of life. OSG takes a leadership role in designing and carrying out public-engagement processes related to coastal development, sharing of resources, and development of marine reserves. In particular, efforts on coastal ocean use have reached more than 17,000 participants through state and national workshops, presentations, and educational events aimed to improve access to and utilization of spatial planning and multiple use information, especially with regard to ocean energy and marine reserves. This increased knowledge improves functioning of existing community groups and leads to development of new groups. Indeed, stakeholders are currently engaged in decision-making processes related to allocation and use of ocean space in Oregon, with 14 new community groups representing all seven coastal counties involved in spatial planning and mapping ocean use and economic activities.

To improve understanding and collaboration among ocean energy researchers, developers, ocean users, coastal communities, and decision makers, and provide outreach and education to stakeholders about marine policy decision processes related to multiple uses and spatial planning, OSG leverages the best available natural and social science. OSG takes a state and regional leadership role on coastal and marine spatial planning (CMSP) through workshops and

focus groups targeting west coast regional academic and management communities. OSG, in partnership with Oregon State University, held a two-day workshop on The Science of CMSP in November 2011. The 70 workshop participants identified key research questions and discussed how Oregon is uniquely positioned to address them and serve as a west coast leader. OSG secured additional funding to assess NOAA's knowledge capacity and needs for engaging stakeholders on CMSP at five focus group locations, with nine separate focus groups, throughout the west coast region.

Oregon's past, present, and future economy relies heavily on ocean use activities, and OSG works to facilitate healthy coastal economies that include working waterfronts, an abundance of recreation and tourism opportunities, and coastal access for all citizens. Current knowledge about spatial planning and balancing multiple ocean uses is synthesized, and social and economic research priorities are identified and used by ocean user communities and decision makers. OSG efforts in research, engagement, and education to promote inclusion of social and economic sciences, alongside natural sciences, in spatial planning have resulted in up to 10 new economists and social scientists at various levels involved in state spatial planning processes.

Over the past five years, OSG has invested significant resources in wave energy technology development and sparked significant interest in the ocean energy industry. Now the biggest need in our state is conflict management and creating fair public engagement opportunities related to ocean energy. The social science dimension of ocean use related to wave energy development is highlighted in two recent articles by OSG faculty in the respected journal *Oceanography*: "The Human Dimensions of Wave Energy in Oregon" (F. Conway, F., J. Stevenson, D. Hunter, M. Stefanovich, H. Campbell, Z. Covell, and Y. Yin, 2010); and "Navigating the Public Process: Engaging Stakeholders in Ocean Energy Development" (K. Hildenbrand, 2010).

OSG supports local, regional, and national efforts to preserve and increase public access to

the nation's beaches and waterfronts through assessment of access needs, analysis of legal issues, and technical assistance. OSG's extension and education capabilities are employed to engage coastal communities in planning processes that support the efforts of community leaders to identify and pursue sustainable economic development policies and programs. Two ways that OSG accomplishes this are through participation in and coordination of state and regional meetings, such as a recent economic summit coordinated by Oregon's Coastal Caucus. To facilitate innovative and practical solutions for ocean use conflicts, OSG efforts focus on sharing nearshore resources without conflict to maximize social and economic vitality. OSG, along with Washington Sea Grant, is sponsoring the 3rd national working waterfronts symposium in Tacoma, Washington, in early 2013.

OSG also supports research and outreach activities that provide local communities with information and techniques to help them enhance their waterfront-related economic activities, such as commercial and recreational fishing, aquaculture, tourism, and energy and port development, without diminishing the long-term health of the natural coastal environment. One example is a recently funded OSG project to develop a community-based framework for identifying, estimating, and evaluating ecosystem services associated with Oregon's proposed marine reserves. This project applies an operational evaluation framework for two coastal communities using available quantitative and qualitative data. Over two years, four focus groups identified benefits associated with ecosystem services changes within the marine reserve and adjacent areas, and OSG, in conjunction with state resource management agencies (Oregon Department of Fish and Wildlife, Department of Land Conservation and Development), will develop a manual for managers and stakeholders titled *Manual for Community-Based Assessment of Marine Reserves*, to be delivered within the next year.

OREGON SEA GRANT**Ocean Literacy**

Marine Science Education

New Science Education
Tools

Teacher Training

Ocean Literacy

Diverse Audiences

Museum, Aquaria,
Interpretive Centers

Free-Choice Learning

Communication Science

Structured Decision Making

Researchers in
the ClassroomEvaluation and
Behavior ChangeTraining Young
Professionals

Sea Grant Scholars

Informed and Engaged
Society**Ocean Literacy****Oregon Sea Grant leads the nation in understanding and delivering free-choice learning**

Free-choice learning is all about deciding what, where, and how we want to learn over the course of our lifetimes. It's the learning that takes place all the time, outside of the classroom, no matter how young or old you are. Free-choice learning is a way of describing the learning that happens when choice and control in learning shifts from educators to learners. Such self-directed learning is typical of most of the learning that occurs across the lifespan. Oregon Sea Grant (OSG) leads Oregon State University (OSU), the national Sea Grant network, and indeed the nation in bringing current research and practices on free-choice learning to bear on marine education efforts for schools and public audiences alike. Starting in 2003 with the hiring of an Extension Free-Choice Learning Specialist and continuing three years later with our sponsorship of a dual Sea Grant Professorship in Free-Choice Learning with the OSU Department of Science and Mathematics Education, OSG's focus on free-choice learning has resulted in new graduate programs at OSU, the development of a robust research agenda, and revamped programming and exhibits at the OSG-operated Visitor Center at OSU's Hatfield Marine Science Center on the central Oregon coast. OSG is now building on these successes, reshaping its entire education and ocean literacy effort to focus on free-choice learning across the lifespan and in all learning contexts.

Starting in 2011, under a \$2.6 million National Science Foundation grant (the largest ever received by OSG), Dr. Shawn Rowe and his team began transforming the Visitor Center into a state-of-the-art laboratory for the study of how people interact with, and learn in, aquariums, museums, science centers, and similar facilities. Incorporating advanced technology (valued at \$3 million and provided to the program free of charge by Hewlett-Packard) to observe how visitors move among exhibits and interact with them, with each other, and with docents and educators, the new lab will allow scientists from around the world to study many aspects of informal learning.

What we are learning from this research is already allowing OSG to better focus, design, deliver, and evaluate educational programming for the public and K–12 audiences we already serve. Nearly 20,000 K–12 students each year participate in OSG's HMSC marine education programs; more than 150,000 people of all ages, and from all over the world, pass through the Visitor Center each year. And countless Internet users visit our popular "OctoCam" page, observing a live stream of our giant Pacific octopus—and taking part, virtually, in three-times-a-week feedings where they learn about octopus behavior, reproduction, and biology. The system is also used to stream shark and squid dissections and other special programming, free of charge, to

school classrooms, bringing marine science programming to students who may never have seen the ocean.

Promoting sustained, long-term learning about marine and aquatic sciences in the 21st century requires rethinking how universities, organizations, and educators traditionally engage professional and public audiences. New models for OSG Extension and education based on how learners deploy choice and control across different work, school, and leisure contexts can help us better serve existing audiences while reaching new and underserved audiences where and when they need it.

Many OSG Extension and communication activities are also, in essence, free-choice learning. What we learn about how others learn, and how the knowledge they acquire influences their decisions, is already reshaping our work—and that of our peers. OSG Communications Leader Joe Cone and colleagues have already produced a series of Public Science Communication and Practice publications, demonstrating how social science research techniques can help people better understand and use science information.

As part of the lead-up to this new direction, OSG partnered with the Centers for Ocean Science Education Excellence and the University of California, Berkeley, to create and teach the award-winning course, “Communicating Ocean Sciences to Informal Audiences (COSIA),” which has been adopted by universities and colleges nationwide. The course, co-taught by scientists and educators, places undergraduates, graduate students, and informal educators into museums, aquariums, and other educational sites to work with public audiences. Since the project began, OSG faculty have taught 149 scientists and educators to use learner-centered teaching techniques; together, they have reached more than 24,000 adults and children in Oregon and California alone.

Oregon Sea Grant expands opportunities for a record number of graduate and undergraduate students

Oregon Sea Grant (OSG) has long offered opportunities for graduate and undergraduate students to learn first-hand about marine science and public policy, and to undertake their own research projects, both through such national programs as the prestigious Knauss Fellowships and through internal fellowships, scholarships, and internships. But the students had few opportunities to meet and work with each other across programs, and little sense of “belonging” to Sea Grant.

That changed in 2010, when we launched a new Summer Scholars program for undergraduates and incorporated all our fellowship, internship, and scholarship programs under the Sea Grant Scholars umbrella.

Participants are now expected to share their experiences with each other, the program, and the world via occasional posts to our Sea Grant Scholars blog. A selected number of scholars work directly with the OSG program office on activities ranging from organizing conferences on ocean and coastal topics to science writing for our popular new magazine, *Confluence*, and engaging the public in hands-on marine science activities at summer festivals.

In 2011, the OSG-organized Heceta Head Conference included a poster session, which gave many students their first opportunity to present their research work in an academic setting to the scientists, resource managers, and organizational and community representatives in attendance. The activity drew such positive feedback that it is planned again for 2012. One result is that the number of Sea Grant Scholars is growing. In 2011 we placed a record number of students (202) in fellowships, internships, and other Sea Grant-related positions from Washington, D.C., and the

Oregon capital to coastal research labs and the Hatfield Marine Science Visitor Center. Less easy to enumerate, but readily observable, is a growing sense among these new students of “belonging” to the Sea Grant family. At least one Summer Scholar applied for, and won, a second year; several regularly read and comment on blog entries of their successors in the program.

Additional examples of impacts and accomplishments 2008–2011

OSG research, communication, extension, and education programs are at the forefront of Ocean Literacy efforts regionally. In addition to free-choice learning and OSG undergraduate and graduate scholars programs, OSG has a strong commitment to K–12 education through place-based and school-based activities. Some examples include increased K–12 student knowledge about marine sciences and careers through quarterly career days at Hatfield Marine Science Center, professional development for K–12 teachers that help improve in-school science education by teaching teachers to use free-choice learning venues to teach about the ocean and use the ocean to teach about science, engineering, and technology. Nearly 300 teachers have been trained in new science education tools developed by OSG in the past two years alone, reaching thousands of Oregon students.

For example, Oregon’s largest coastal school district might be surrounded by rich ocean resources, but until recently, teachers’ and students’ ocean literacy and understanding of the marine environment was judged as below standard. With OSG leadership, and in partnership with other marine education organizations, the Lincoln County School District (LCSD) implemented a district-wide effort to increase teachers’ knowledge of marine sciences, and is bringing this knowledge into the classroom to motivate and excite students. OSG designed and evaluated a model of professional development that improves teachers’ marine science content knowledge, increases their use of inquiry and field-based learning strategies, and increases ocean literacy and science achievement among their students via \$900,000

in U.S. Dept. of Education funding. This program was then expanded two additional years to enhance efforts and bring ocean literacy resources to other Oregon schools through NOAA B-WET funding, and to allow partners to incorporate distance-learning techniques through a grant from the Oregon Community Foundation. The program received a Presidential Coastal America Partnership Award in 2010, the highest level of national recognition for collaborative efforts that combine resources to accomplish coastal restoration, preservation, protection, and education projects. It also earned the 2011 Excellence in Curriculum Leadership Award (to LCSD) from the Oregon Association of School Executives, in recognition of curriculum leadership. This partnership has trained all LCSD teachers and created a rich, standards-based ocean literacy curriculum. Other schools throughout Oregon have used LCSD as a model for incorporating ocean literacy into their own curriculum. An example of the Guidance Document for Ocean Content that connects ocean literacy principles to Oregon state standards is available on the Web: www.sites.google.com/site/k12oceanliteracy/lincoln-county-school-district.

OSG’s commitment to Ocean Literacy extends to all facets of the program. For example, OSG’s Aquatic Animal Health Program partnered with Oregon Coast Community College (OCCC) to develop a professional technical program in aquarium science. This unique, hands-on training program is the only one of its kind in the country and is designed to train entry-level professional aquarists. The program offers two options: an Associate of Applied Science in Aquarium Science; and a Certificate in Aquarium Science, for individuals possessing an undergraduate degree in the biological sciences. Since the program’s first cohort in 2003, 55 students have graduated from the program. More than 50 percent of entering students already possess an undergraduate degree in the biological sciences. Ninety-eight percent of the program’s graduates have jobs in this profession within six months of graduation, and their employment contributes \$1.62 million annually to the state’s economy. The program has raised \$6.5 million from federal, state, local, and private funds, including

a local bond issue. In 2011 the program opened a standalone, state-of-the-art aquarium science teaching facility on the OCCC campus.

Other OSG goals include preparing youth and adults who are more ocean literate, and young professionals in marine science, policy, education, outreach, and engagement who are better equipped to become leaders in the field. OSG prides itself on increasing non-specialists' knowledge of science communication that effectively influences their behavioral choices, leading to residents who reduce their exposure to health and safety hazards related to ocean and coastal resource use. Almost 75 percent of participants in OSG health and safety education programs can identify risk-reduction strategies and engage in specific, intended risk-reduction behavior.

Stakeholders are engaged and influence planning, decision making, and policy changes. OSG outreach in 36 coastal communities led to resident engagement and implementation of planning, decision making, and policy changes related to such topics as ocean space planning, wave energy siting, low impact development (LID), and hazard response.

We know in part that our efforts are paying off because individuals participating in education and outreach programs can identify how their behaviors influence the environment and alter their behavior to enhance sustainability of the coastal ecosystems they are part of. Recently, OSG programs have refocused to effectively reach more diverse audiences by creating bilingual programs for Hispanic learners, working to create partnerships with tribal members, and increasing attention on international learners.

Additionally, communities and individuals are reporting that they are better trained to overcome barriers and are capable of adapting to the effects of climate change; all seven of Oregon's coastal counties now have adaptation strategies to overcome barriers to climate change adaptation related to language or ability. OSG faculty, students, and funded researchers continue inquiry-based study into increasing

knowledge on how to create and deliver education programs that effectively change behavior through improved impact of museums, aquaria, and coastal interpretive centers. A recent study conducted at OSG's Hatfield Marine Science Center Visitor Center identified significant differences in interactions at live animal exhibits, from surface encounters with animals to deeper engagement. The evidence suggests that deeper levels of engagement (more activities, more talk, etc.) may hinge on how much family members share their experiences with each other.

OSG also took the lead in collaborating with the West Coast Sea Grant programs to secure funding for two-year fellowship positions to advance regional priorities of the West Coast Governors Alliance (WCGA) and Sea Grant. Four recently graduated M.S. and Ph.D. students were placed in state and federal agencies in California, Oregon, and Washington, and are directly involved in the WCGA. One notable early success came in coastal ocean planning: Oregon's fellow led a workshop in December 2011 in Oakland, California (60 attendees), with a goal of developing a network of information managers and data providers to improve coastal ocean planning data management. The fellow subsequently led establishment of a WCGA Regional Data Framework Action Coordination Team focused on ocean and coastal data discoverability and access.

Finally, innovative research in the Salmon River estuary combines outreach and education efforts that provide opportunities for upper-division biology majors to serve as field and laboratory team leaders for undergraduate education majors; both student groups develop stronger scientific investigation skills and contribute to public and K-12 science education. This study is not only meeting the science goal of establishing a continuing monitoring program for macroinvertebrates and abiotic factors in the estuary, but also provides professional development for teachers and other stakeholders.