Northwest Fisheries Science Center

Highlights 2010

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Message from the Acting Science Director

As we welcome a new year, I would like to share with you some of the activities and accomplishments of NOAA's Northwest Fisheries Science Center in 2010. I am proud of what Center staff achieved and appreciate the contributions of our collaborators, both within and outside the NOAA family. Among our accomplishments this past year, Center staff received national recognition for their efforts in addressing seafood safety concerns in response to the *Deepwater Horizon* oil spill, provided critical scientific advice to our West Coast stakeholders for salmon recovery, and strengthened NOAA's role in regional governance efforts such as the Puget Sound Partnership and the West Coast Governors' Agreement on Ocean Health. The Center also continued advancing its strategic science and research planning efforts to ensure that our activities remain of the highest quality, meet current and long-range societal needs, and are completed in an efficient and cost-effective manner. Moreover, this year represented a time of transition for many of our leadership staff, among them our distinguished former Center Director Usha Varanasi who retired with over 35 years of service. While we continue to face critical challenges in protecting and conserving Pacific Northwest ecosystems, we have made many important strides and I look forward to continuing our efforts in 2011.

Sincerely,

John E. Stein

Who We Are and What We Do

The Northwest Fisheries Science Center (NWFSC or Center) conducts research to help conserve and manage living marine resources (e.g., marine fish, salmon, and killer whales) and their habitats in the Northeast Pacific Ocean—primarily off the coasts of Washington and Oregon and in rivers and streams in Washington, Oregon, and Idaho where anadromous fish, like salmon, exist. Our research assists resource managers in making sound decisions that build sustainable fisheries, recover endangered and threatened species, sustain healthy ecosystems, and reduce risks to human health. The Center conducts research in four primary areas:

- Ecosystem Approach to Management for the California Current Large Marine Ecosystem
- Habitats to Support Sustainable Fisheries and Recovered Populations
- Recovery, Rebuilding and Sustainability of Marine and Anadromous Species
- Oceans and Human Health

What follows are some of the Center's 2010 accomplishments in each of these areas.

Ecosystem Approach to Management for the California Current Large Marine Ecosystem

The Pacific Northwest's waters are part of the California Current Large Marine Ecosystem (CCLME), which stretches from British Columbia to Baja California and is one of the most productive coastal ecosystems in the world. The CCLME is home to an abundance of marine life, sustains many active fisheries, influences weather patterns, and plays a vital role in the region's economy. Center scientists work to support an ecosystem approach to management of the CCLME, which requires an understanding of the processes, functions, and interactions among organisms, including humans, and their environment. This approach is especially timely and relevant with recent development of new initiatives such as NOAA's Next Generation Strategic Plan and the Ocean Policy Task Force's guidance on Coastal and Marine Spatial Planning.

In 2010 we:

Completed Preliminary Integrated Ecosystem Assessments for Puget Sound and the California Current Large Marine Ecosystem

An Integrated Ecosystem Assessment (IEA) is a scientific synthesis and management tool that integrates economic and social science data with all available ecosystem data related to organisms, processes and habitat; identifies the social and ecological benefits and risks of different management actions; and evaluates performance. This past year, a team of Center scientists, in collaboration with the Puget Sound Partnership, completed the first iteration for an IEA to support a large-scale ecosystem effort in Puget Sound. This team completed the critical IEA steps of scoping, identifying indicators, estimating risk, and evaluating alternative management strategies and economic consequences. These efforts in Puget Sound will provide a solid basis for recovery and management efforts in the region. In addition, the Center helped complete the agency's pilot IEA for the California Current in collaboration with the Southwest Fisheries Science Center and other NOAA line offices. In this first iteration, scientists focused on a series of ecosystem components and pressures that are of keen interest to resource managers, policy makers, and the public: ecosystem health, groundfish, salmon, and green sturgeon. The California Current IEA is being developed to help regional ocean governance groups, such as the West Coast Governors' Agreement, with their efforts to promote ocean health and coastal and marine spatial planning.

Provided Science to Support Implementation of New West Coast Catch Share Program

Catch shares refer to management programs that allocate a specific portion of the total allowable fishery catch to individuals, cooperatives, or communities. Following the agency's policy encouraging the use of catch shares nationwide, the West Coast will serve as the testing grounds for a new groundfish rationalization program. In 2010, Center scientists collaborated with the Northwest Regional Office, Pacific Fishery Management Council, and constituents to complete the design of scientific monitoring and data collection programs for economics and bycatch information, two of the basic components that will be needed to implement and assess the performance of the West Coast groundfish trawl rationalization program. The Center also conducted outreach and designed new training related to this important agency initiative.

Investigated Biological Effects of Ocean Acidification

Ocean acidification is caused by human-derived and natural increases in atmospheric carbon dioxide that is then absorbed by the oceans, increasing its acidity and decreasing the levels of carbonate that are crucial to species that use calcium carbonate to form their shells. The West Coast and North Pacific are susceptible to ocean acidification, and the level of corrosive ocean waters is accelerating faster than models have predicted. This increasing acidity can disrupt the calcification process of shell-producing organisms at the base of the food chain, such as krill, and can lead to a ripple of negative effects on other species of commercial and conservation concern. In 2010, Center scientists initiated studies on the biological effects of ocean acidification on shellfish using a state-of-the-art acidification experimental facility, which provides seawater with controlled pH, carbon dioxide, and dissolved oxygen levels for multiple, simultaneous

Above left: Integrated Ecosystem Assessments provide the science needed to improve management of shared resources.

experiments on diverse marine organisms. These studies will help researchers better understand the susceptibility of key species such as oyster, geoduck and abalone to an acidified ocean environment under realistic scenarios of future levels of carbon dioxide in the atmosphere, assess the ecosystem impacts on food web dynamics, and determine where ocean acidification has already had impacts on marine species.

Completed Ecosystem Models for Three Major Ecosystems

Implementing ecosystem-based management requires an understanding of the complex dynamics of marine ecosystems and how humans fit into the system. In 2010, Center scientists completed a multi-year effort to develop ecosystem models of Puget Sound, the California Current and the Gulf of California. Using an ecosystem simulator called *Atlantis*, scientists integrated physical, chemical, ecological, and anthropogenic processes to produce three-dimensional, spatial models. The three models have been central to management efforts in each of these regions, allowing decision-makers to explore the potential effects of natural and human-induced change over a range of spatial and temporal scales.

Above left: Scientists collect baseline data on fish abundance and habitat quality in the Elwha River.

Above right: Habitat restoration efforts can benefit salmon populations.

Habitats to Support Sustainable Fisheries and Recovered Populations

Living marine resources in the Pacific Northwest use and depend on a variety of habitats, from freshwater streams and rivers to estuaries and the ocean. Center scientists conduct research to better understand these habitats and how they impact species and ecosystem structure and function.

In 2010 we:

Developed Critical Freshwater Habitat Restoration Principles

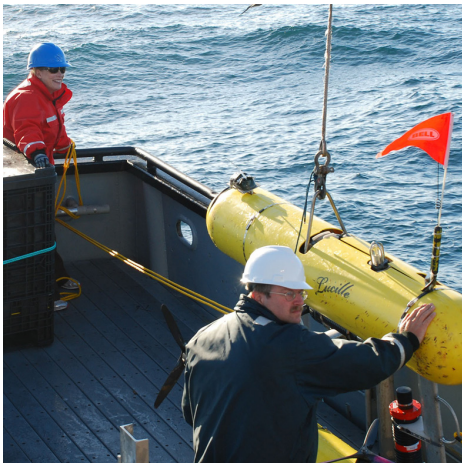
Successful recovery and management of listed fishes in the Pacific Northwest depends in part on our understanding of how habitat restoration can improve the health of riverine ecosystems and salmon populations. This year, Center scientists published a key paper in the journal Bioscience summarizing four process-based principles needed to ensure that watershed restoration will lead to ecosystem recovery: 1) restoration actions should address the root causes of degradation, 2) actions must be consistent with the physical and biological potential of the site, 3) actions should be scaled to environmental problems, and 4) actions should have clearly described outcomes for ecosystem dynamics. This key paper applies the latest science developed by NOAA to help guide sustainable actions for ecosystem restoration as well as the recovery of salmon species that depend on these ecosystems.

Completed Baseline Monitoring Report for Elwha River

The removal of the Elwha River dams to restore Washington State's Elwha River ecosystem and its native fisheries is one of the largest and most important dam removal projects in the nation. Over the last decade, scientists have been collecting baseline data on juvenile and adult fish abundance and habitat condition. This data will help explain how the dams have altered present-day conditions in the river and will provide a "before" dataset to compare with data collected after dam removal. The Center's baseline monitoring report, completed earlier this year, summarizes the ongoing data collection effort, synthesizes historical data, and outlines new methods for identifying fish and habitat. This report will be used to analyze potential environmental impacts following the removal of the Elwha River dams.

Explored Underwater Habitats and Marine Life Associated with the Submerged San Andreas Fault

Using advanced technology and a "green" research vessel powered by a combination of wind and diesel, Center scientists teamed up with collaborators to map the submerged Northern San Andreas fault, which has remained largely unexplored for over a century. During the expedition, the team used multibeam sonar and seismic reflection data to create three-dimensional maps of the seafloor and underlying strata. These maps were then used to prioritize a series of dive sites for the autonomous underwater vehicle (AUV) *Lucille*, which returned tens of thousands of photos of the seafloor. Scientists now have a high-resolution map of the submerged fault. Moreover, the digital images taken from cameras aboard the AUV *Lucille* provided the first views of the composition of the seafloor and its associated fish and invertebrate communities, including Dover sole, English sole, skates, sculpins and giant anemone.



Above left: Scientists deploy the Autonomous Underwater Vehicle to help map an underwater fault and its associated marine life.

Above right: Juvenile Chinook salmon.

Recovery, Rebuilding and Sustainability of Marine and Anadromous Species

Over the last several decades some living marine resources have become depleted and, in some cases, are in danger of extinction. In the Pacific Northwest, approximately 39 marine species are listed as endangered or threatened under the Endangered Species Act and seven marine fish stocks are classified as "overfished" under the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act. Recovering and rebuilding these populations and sustaining all marine and anadromous populations are important for ecological, economic, social, and cultural reasons.

In 2010 we:

Completed Pacific Salmon Status Review Updates

Center scientists conducted five-year status reviews for all Pacific salmon listed as endangered or threatened under the Endangered Species Act, a major effort that involved compiling updated population information such as abundance and productivity, as well as information on threats such as trends in hatchery production, harvest, and habitat quality. In addition to producing the status report, Center scientists and database developers designed and implemented a new web-based Salmon Population Summary database to make salmon abundance information publicly available.

Created Life Cycle Model to Inform Recovery Efforts in Columbia River Basin

The Columbia and Snake Rivers are used and valued for ecological, economic, social, and cultural reasons. These rivers are home to endangered and threatened Pacific salmon, provide irrigation for millions of acres of farmland, transport goods, support commercial, recreational, and tribal fisheries, and generate electric power via a series of dams. Due to these multiple and varied uses, Center scientists have modeled the cumulative effects of harvest, hatchery, habitat, and hydropower management on listed salmon species in this region. The model is being expanded to incorporate freshwater climate change impacts, the effects of hatchery supplementation, and the changes in habitat due to human activities. Results helped inform the 2010 harvest guidance for Lower Columbia River Chinook salmon, and will provide information necessary to explore the potential consequences of alternative climate and management scenarios.

Advanced Wildlife Forensic Science

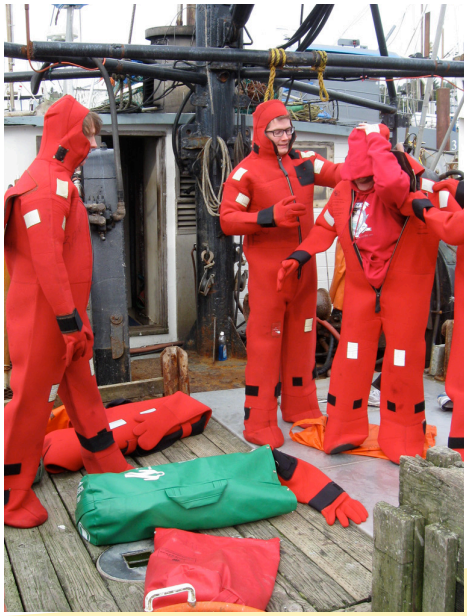
As part of a national effort to re-evaluate forensic science standards for federal laboratories, Center scientists served on several working groups for the National Science and Technology Council and joined colleagues to form the Society for Wildlife Forensic Science. The Center's participation will help further develop standards and testing protocols appropriate for the accreditation of laboratories performing non-human forensic analyses. Also in 2010, the Center continued to provide genetic analysis of evidence in 8 new cases for NOAA Fisheries law enforcement agents, one of which resulted in a guilty plea in the first federal criminal case involving the take of endangered steelhead via blocked access to upstream habitat.

Collected Critical Data on West Coast Groundfish

The West Coast groundfish fishery includes some 90 commercially fished stocks and supports millions of dollars in economic activity. Center scientists conducted several coast-wide groundfish surveys using state-of-the-art sampling technology and techniques: a bottom trawl survey from Cape Flattery, Washington to the U.S.-Mexican border; a hook and line survey in rocky habitat; and a Pacific hake acoustic survey (conducted jointly with Canada) from central California to the Alaska-Canadian boundary. These surveys are a key source of fishery-independent information about the distribution, abundance, and age structure of groundfish that is needed for stock assessments. This year the Center completed a stock assessment for hake which will be used by the Pacific Fishery Management Council to set harvest levels, and collaborated with the Southwest Fisheries Science Center to plan over a dozen more stock assessments for 2011, including the first West Coast assessments for spiny dogfish and green-spotted rockfish.

Assisted in Record-breaking Recovery of Redfish Lake Sockeye Salmon

Redfish Lake sockeye salmon travel over 900 miles from the Pacific Ocean up the Columbia and Snake Rivers to their natal stream and spawning grounds in Idaho's Redfish Lake Creek. With 8 large dams along the river, these salmon have a difficult journey and their populations have dwindled. In 1991, with less than six fish returning, Redfish Lake sockeye salmon were listed under the Endangered Species Act. As part of a multi-agency captive broodstock program to protect the genetic structure and prevent the further decline of Redfish Lake sockeye salmon, Center scientists in collaboration with others developed techniques to successfully culture sockeye salmon to adulthood and rear and release juveniles. As a result of these efforts, in 2010, a record number of 1,800 adult sockeye salmon returned to Redfish Lake--a level that has not been seen in over 40 years. For the third year in a row, captive broodstock production has resulted in over 150,000 outmigrating smolts. This increase in returns should help stabilize the population until factors leading to their decline, such as loss of downstream rearing habitats, can be more fully addressed. The innovative captive broodstock program exemplifies the science-based tools NOAA is using to recover ESA-listed stocks of Pacific salmon.



Advanced Fish Tagging and Detection Technology

The passive integrated transponder tag (PIT tag) is a small communications device, about the size of a grain of rice, with a computer chip that is inserted into the body cavity of juvenile salmon. Electronic systems at dams detect PIT tags in juvenile salmon as they move downstream and send information to a database so that scientists can learn more about fish passage and survival. This year, Center scientists conducted research to advance PIT tag capabilities, including deploying a prototype mobile PIT tag research vessel and completing the design of a new tagging system for dam spillways to reduce the standard errors in current salmon survival estimates. Scientists also recovered approximately 1 million PIT tags from large terns and cormorants colonies in the Columbia River basin and estuary to identify fish consumed by avian predators. These PIT tag studies will help provide critical information regarding salmon migration, behavior, passage and survival of ESA-listed stocks.

Above: Prototype for new mobile PIT tag research vessel.

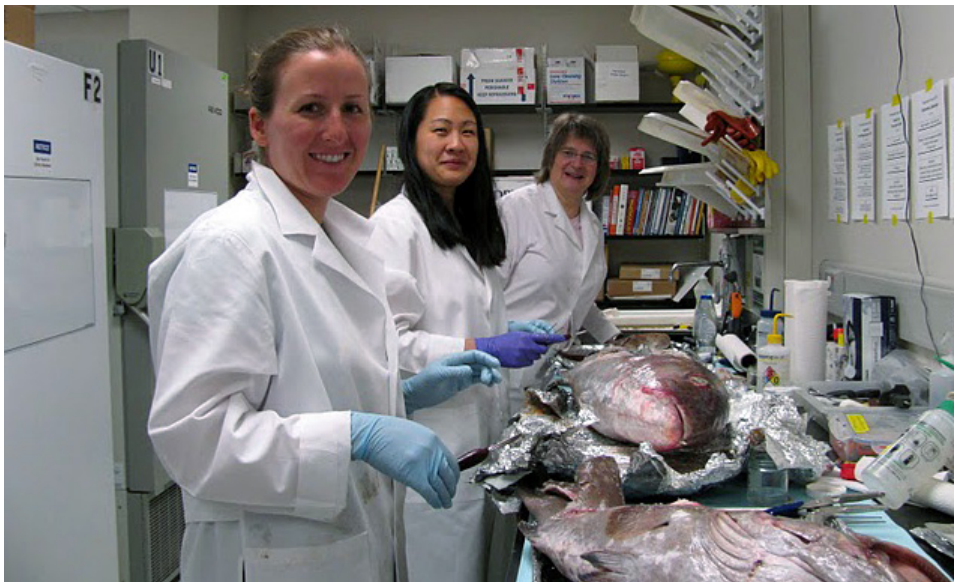
Left: Staff participate in safety training in Newport, Oregon.

Continued Successful Hatchery Production of Sablefish (Black Cod)

Hatcheries are fish breeding and raising centers that have been built primarily to enhance harvest or reduce the impacts of human development that could destroy or degrade salmon habitat and block migratory routes. The Center continued to significantly improve the survival of juvenile sablefish in captivity. By applying their advanced understanding of each stage in the sablefish's life history, a team of scientists successfully produced over 15,000 juveniles from approximately 250,000 larvae (up from only 24 juvenile sablefish produced in captivity in 2009). This dramatic success rate is primarily due to improvements in broodstock management and larval fish nutrition and husbandry. Scientists will continue improving this procedure will help meet the agency's goal of developing technologies to support sustainable marine aquaculture and increase sources of healthy protein.

Developed Lamprey-friendly Fish Passage Alternatives

Pacific lamprey are anadromous like salmon. They are born in freshwater, reach adulthood in the ocean, and return to freshwater to spawn. Lamprey have difficulty traversing fish ladders that were designed for salmon in the Columbia River. In recent years, lamprey populations have declined significantly due, in part, to their inability to traverse fish ladders and reach their spawning areas. Center scientists developed and tested innovative fish passage designs in the Umatilla River that take advantage of lamprey's unique climbing ability and worked with tribal fisheries biologists to evaluate the effectiveness of these new structures. These efforts are expected to assist the lamprey's successful passage of the dams and facilitate the rebuilding of their populations.



Oceans and Human Health

The people of the United States are inextricably linked to the oceans: our activities on land, sea, and in the air impact the health of the oceans and the health of the oceans impacts us. As NOAA's West Coast Center of Excellence for Oceans and Human Health, Center scientists focus on advances in early warning systems, seafood benefits and risks, and improved assessments of ecosystem change and its effects on human health through studies of pathogens, toxin-producing algae, shellfish, fish and marine mammals, as well as climate variability.

In 2010 we:

Provided Seafood Safety Expertise in Response to the *Deepwater Horizon* Oil Spill

The *Deepwater Horizon* incident in the Gulf of Mexico was the first oil spill to be declared a spill of national significance in U.S. history, and immediately raised fear over seafood safety and the potential economic collapse of the Gulf fishing industry. The Center has a long history, dating back to the 1989 EXXON Valdez oil spill, of providing expert technical assistance during emergency responses that impact living marine resources. The Center served as the lead laboratory for conducting chemical analysis of Gulf seafood for the presence of polycyclic aromatic compounds from oil and are the compounds of public health concern. Another area of concern was the use of record amounts (i.e., nearly two million gallons) of dispersants to combat the flowing oil. Center scientists developed, in a short time, a new method to measure a key component found in dispersants. These efforts allowed the Center to provide a rapid assessment of toxic contaminants in thousands of finfish, oyster, and shrimp samples from the Gulf of Mexico for exposure to oil and dispersants, and helped inform the agency's decisions to first close and then re-open over 98% of Federal waters for fishing.

Left: Scientists insert PIT tags in Pacific lamprey.

Above: Scientists process fish samples after the *Deepwater Horizon* oil spill.

Improved Understanding of Toxic Effects of Copper on Salmon

Center scientists continued toxicological studies on the effects of heavy metals, such as copper, on aquatic life. They discovered that copper in stormwater runoff has direct toxic effects on coho salmon living in urban streams. Laboratory studies indicated that very low levels of dissolved copper interfered with juvenile coho salmon's sense of smell and its ability to avoid predators. Copper was also shown to affect invertebrates at the base of the food chain, which can limit food available to juvenile salmon. These studies added to existing data that ultimately prompted Washington State's 2010 decision to ban copper brake pads in automotive vehicles.

Developed New Model to Study an Important Bacterial Pathogen

Vibrio parahaemolyticus is responsible for nearly half of *Vibrio*-related infections in the United States and is contracted through the ingestion of raw shellfish, like oysters. Shellfish can be naturally colonized by hundreds of strains of this bacterium, although only a small percentage of the population is capable of causing infections in humans. Center scientists have developed a highly effective new animal model using the zebrafish to assess the virulence of various *V. parahaemolyticus* strains—which, up until now, has been difficult to determine given the lack of a relevant host model for infections. The zebrafish is an ideal host organism to study the mechanism of this infectious disease at the molecular level. Our results have shown that *V. parahaemolyticus* can establish a lethal infection in adult zebrafish. With this ongoing research, scientists hope to advance our understanding of the *V. parahaemolyticus* pathogen in shellfish and work towards eliminating a serious cause of seafood-borne illnesses.

Above: NOAA officials attend the commissioning of the NOAA Research Vessel *Bell M. Shimada*.

Our Facilities, Operations & Staff

Staff are the heart of the Center and its most important asset. Adequate facilities and a strong infrastructure are critical to supporting the high-quality work we strive to achieve.

In 2010, we:

Supported Key National Initiatives and Regional Collaboration Efforts

The Center's senior staff were actively involved in advancing the agency's national priorities, including proposals to establish a new NOAA Climate Service and to further develop NOAA's Next Generation Strategic Plan (NGSP). Center staff also continued their valuable support in regional activities to improve coastal and ocean health, as part of ocean governance (i.e., PSP, WCGA) and NOAA's regional collaboration initiatives. In the past year, several staff served on key committees and panels for the WCGA and PSP, providing critical science advice and guidance for key state partners. For NOAA's Western Region Collaboration Team (NOAA West), the regional team leader, a Center senior manager, and the Team coordinator and members from other NOAA line offices, conducted several key activities including support of NOAA's national priority objectives such as coastal and marine spatial planning and ecosystem-based management. These efforts demonstrated leadership in collaborating with federal and state entities and proved the value of NOAA's science and expertise to our regional constituents.

Advanced Center's Research and Strategic Planning

The NWFSC continued to implement several of the near-term priorities (NTPs) addressing the critical research needed in the next year or two, as outlined in the Center's *Strategic Science and Research Plan*. The NTPs include an integrated ecosystem assessment for Puget Sound; identification of biological and economic tradeoffs in freshwater use under climate change; surveys in untrawlable, unsurveyed or protected areas; expansion of our knowledge of the ocean ecology of adult salmon; development of a web accessible system for algal toxin detection protocols for West Coast marine mammal and fish species; and initiation of an ecosystem-based aquaculture program with sablefish in Puget Sound. In addition, NOAA Fisheries completed a *Northwest Science Facilities Plan* to identify the infrastructure needed to support our science today and into the future as well as a *Human Capital Investment Plan* to make improvements in the work life of our employees. Also in 2010, the NWFSC worked closely with the

Southwest Fisheries Science Center to develop the agency's first coast-wide operating agreement, which clarifies responsibilities and streamlines NOAA Fisheries science efforts in the California Current.

Worked to Improve Environmental Literacy and Stewardship

Center staff participated in local education and outreach events, including NOAA Science Camp, NWFSC's Kids Day, NOAA's Teacher in the Lab Program, the Seattle Aquarium's Family Science Weekend, and career fairs at the University of Washington and the Northwest Indian College. The Center also partnered with the Oregon Coast Aquarium and Poulsbo Marine Science Center for a year-long photographic exhibit attended by over 100,000 visitors, featuring marine life images taken with the NWFSC's scanning electron microscope. Together with the Quinault Indian Nation and the University of Maryland, Center scientists offered a unique summer camp program for 15 middle school students to study harmful algal blooms and human health impacts. In addition, Center staff participated in the Pacific Science Center's "Get to Know NOAA" public lecture series and the Seattle Times/Newspapers in Education climate and ocean literacy series for Pacific Northwest educators and students. Finally, to help increase interest in careers that support NOAA's mission, the Center provided over 50 students with internship opportunities at the Center and supported the participation of 7 students with disabilities through the Washington State DO-IT program.

Improved Safety and Operations

Center staff provided training opportunities to over 250 staff and colleagues occupying NOAA buildings, including CPR/first aid, laboratory safety, radiation safety, and hazardous materials shipping. The Center worked with the Nuclear Regulatory Commission and other specialists to obtain approval for land transport of isotope materials, which will help the Center develop a state-of-the-art microbiology field research lab that uses isotopes to analyze samples. The Green Team expanded the Center's recycling and reuse program to include styrofoam, which diverted the equivalent of 1,380 gallons of styro-waste from going to the landfill. Several facility upgrades to the Montlake Laboratory were also completed in 2010, including improved security lighting, new energy-efficient lighting that uses 45% less energy, new accommodations for people with disabilities, and freezer installation for seafood storage and sampling needs in response to the *Deepwater Horizon* oil spill.

Received Recognition for Achievements

Many staff received awards this year in recognition of their accomplishments. The awards included one Department of Commerce Gold Medal, one Department of Commerce Bronze Medal, one NOAA Technology Transfer Award, a NOAA Administrator's Award, a Columbia River Hero Award, and the Dr. S.Y. Hong Award for Outstanding Article in the journal *Marine Resource Economics*. In addition, Center staff who supported seafood safety and security efforts as part of the *Deepwater Horizon* oil spill or who served on regional ocean governance committees, panels and collaboration teams have received thanks and acknowledgments from their external partners and NOAA leadership for their dedication and teamwork on these important activities.

Right: Quinalt Junior Science Camp students perform a rapid toxin test for domoic acid in shellfish.