Northwest Fisheries Science Center

Highlights 2008

January 2009

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Message from the 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 2008. I am proud of what Center scientists achieved and appreciate the hard work of our many collaborators. Among our accomplishments this past year, the Center advanced 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. The Center also provided scientific support to key regional initiatives, including the West Coast Governors' Agreement on Ocean Health and the Puget Sound Partnership. 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 2009.

Sincerely,

Usha Varanasi

Usha Varanasi

Who We Are and What We Do

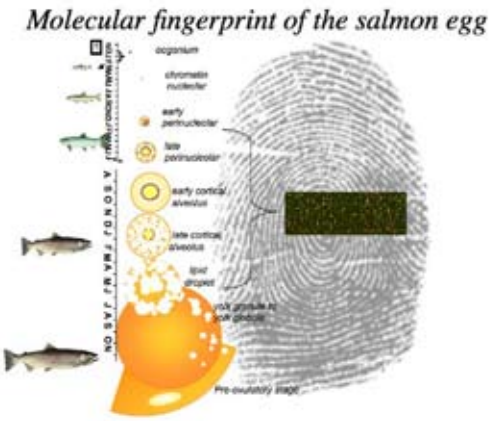
The Northwest Fisheries Science Center (NWFSC or Center) conducts research to support the conservation and management of living marine resources (e.g., marine fish, salmon, and killer whales) and their habitats in the Northeast Pacific Ocean—primarily off the coasts of Washington and Oregon and in rivers and streams in Washington, Oregon, and Idaho used by anadromous fish, like salmon. 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 2008 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 ocean. The CCLME is home to an abundance of marine life, sustains many active fisheries, modulates 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.



In 2008 we:

Started Development of an Integrated Ecosystem Assessment for Puget Sound

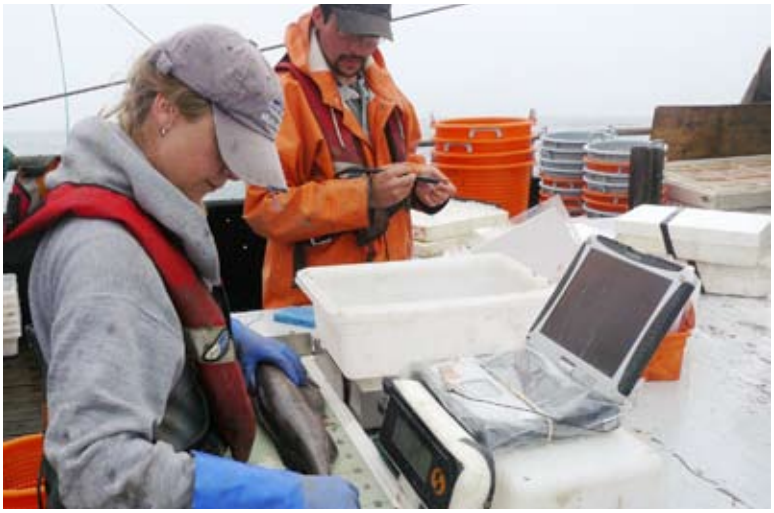
While the concept of ecosystem-based management has been adopted by many policy makers, implementation of such an approach has been challenging due to the complexity of information needed. Integrated Ecosystem Assessments (IEAs) are a proposed solution to organizing scientific information and effectively informing management decisions. An IEA is a management tool that synthesizes and analyzes all available information related to organisms and processes; identifies ecosystem goals, indicators, and risks; evaluates the effects of alternative management strategies on key ecosystem processes; and ensures adequate monitoring and assessment to evaluate the efficacy of management actions. The CCLME does not currently have such an assessment. This past year, the Center, in collaboration with the Puget Sound Partnership, led a team of scientists in conducting a preliminary IEA for Puget Sound. These efforts in Puget Sound will provide a solid basis for recovery and management efforts in the region and will help guide the development of an IEA for the CCLME and other areas throughout the nation.

Used Larval Fish as Indicators of Climate Variability & Change in Fisheries Recruitment

Variations in physical (e.g., water temperature) and biological (e.g., food biomass) conditions lead to variations in the health and abundance of important fishery resources. Sound resource management decisions require an understanding of how ecosystem changes, such as climate variation, impact current and future fishery resources. Center scientists examined the abundance patterns of larval fish from the 1970s to present day in the northern California Current in relation to ocean conditions. During cool years (1999-2002), they found that the larval fish assemblage was dominated by northern or coastal taxa (e.g., sand lance, sanddabs, and smelts), whereas in warm years (1997-98 and 2003-05) southern or offshore taxa (e.g., English sole, northern anchovy, and rockfishes) were important. Center scientists found that these changes were related to concurrent shifts in copepod composition–a crucial link in the marine food chain–and biomass off Oregon, while variations in peak spawning correlated with temperature and outflow regimes from the Columbia River. This work will assist managers in their assessment of the recruitment and distribution of important fishery resources, including groundfish and pelagic stocks.

Began Development of a Tool to Monitor Impacts of Environmental Conditions on Salmon Reproductive Health

Analysis of messenger ribonucleic acid (mRNA), which is a copy of the information carried by a gene on DNA, can provide important information about genetic differences among individuals and species that was previously impossible to determine. By analyzing mRNA, Center scientists have identified several hundred salmon ovarian genes that are differentially expressed when salmon are initiating maturation and when cell death occurs. This information will be used to develop tools that can help monitor the impacts of ecosystem conditions on the reproductive health of salmon, such as how changes in climate (e.g., water temperature) impact the quality of salmon eggs.



Observers collect biological data from catch on a West Coast groundfish trawler.

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. The NWFSC conducts research to improve understanding of these habitats and how they influence species and ecosystem structure and function.

In 2008 we:

Examined Use of Reconnected Wetland Habitats by Salmon

Wetlands that are no longer hydrologically connected to rivers or estuaries cannot fully support salmon. Reconnecting these systems restores the exchange of water and material between these important environments. Through measurements of hydrological changes and salmon use of previously diked pastureland, researchers found that tidal fluctuations immediately returned and juvenile salmon quickly expanded into this newly available habitat. Center scientists determined that reversing the habitat fragmentation and hydrologic isolation that exists in most tidal freshwater reaches of the Columbia River could help improve the status of salmon populations and their resilience to human-induced and environmental perturbations.

Showed that Salmon Recovery Requires Restoration of Shallow, Intertidal Estuarine Habitats

To date, the principal focus of salmon recovery efforts in the Columbia River basin has been on habitat changes and passage problems caused by large dams. Recent studies by Center scientists and University of Washington collaborators, however, have shown that salmon recovery will require restoration of shallow, intertidal estuarine habitats that support juvenile salmon. Scientists also found that many juvenile salmon reside, feed, and grow for days or weeks within the same wetland channel and that young salmon feed heavily on insect species produced in wetland habitats. Despite its importance, nearly 60% of wetland habitat in the Columbia River basin has been destroyed or degraded. The Center's research will inform restoration strategies that best support recovery of Columbia River salmon.

Provided Scientific Support for National Consultation on Pesticides and Pacific Salmon

Rivers and estuaries that provide critical habitat for threatened and endangered salmon are often contaminated with complex mixtures of pesticides. The NWFSC conducted novel research on common-use pesticides to improve understanding of the adverse effects of chemical mixtures on salmon health. Researchers found that some mixtures behaved as commonly thought, producing additive inhibition of brain enzyme activity. However, most of the mixtures produced synergistic toxicity, and even caused unexpected mortality. These results were used by NOAA in a biological opinion that concluded that these chemicals are likely to jeopardize 27 populations of salmon on the West Coast. The assessment also calls for expanded vegetation buffers and other measures to protect salmon and their habitats from the harmful effects of these pesticides.

Above: Researchers set a trap-net to sample juvenile Chinook salmon in a tidal channel of the lower Columbia River estuary.

Below: Pre- and post-breaching of diked pastureland.

Recovery, Rebuilding and Sustainability of Marine and Anadromous Species

In the Pacific Northwest, approximately 39 marine and anadromous 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. While important progress has been made, such as taking one marine fish stock off the "overfished" list, much more work needs to be done.

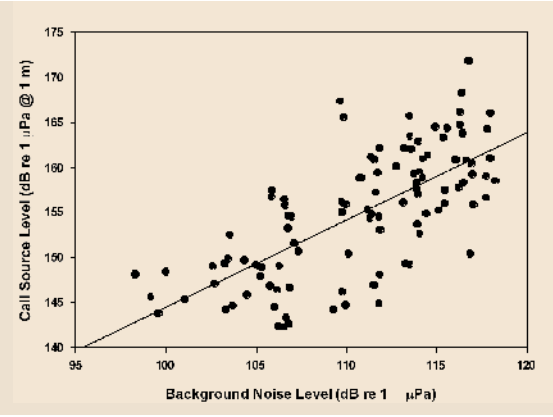
In 2008 we:

Developed a Method for Aging Killer Whales Based on Fatty Acids

Knowing the age distributions of killer whale populations is critical to assessing the status and long-term viability of these top-level predators. Currently, there is no reliable method to determine the specific age of live whales, particularly for remote populations that have not been continuously observed and therefore lack a complete photographic record. Using fatty acid ratios in blubber of killer whales, scientists developed a model that predicts the age of individual whales within four years of the actual age. This model has been applied to several killer whale populations and is providing critical information that will help inform the conservation and management of these populations. In addition, the fatty acid method is also being tested on other marine mammal species.

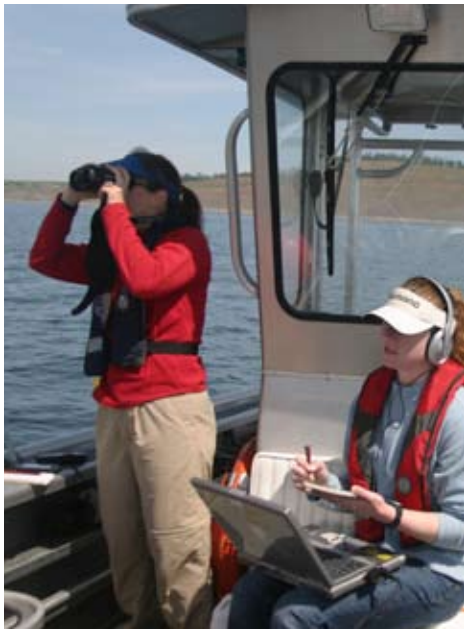
Found that Killer Whales Compensate for Vessel Noise

In Puget Sound, Southern Resident killer whales (SRKWs) are listed as endangered. Given their dependence on sound for communication and the many anthropogenic sources of noise in Puget Sound, it is critical to understand acoustic impacts on SRKWs. In a groundbreaking study, Center scientists and collaborators at Colorado College and Beam Reach, reportedly found that these whales compensate for the masking effects of vessel noise by calling louder; whales increase their call level by one decibel for every decibel increase in ambient noise levels. Researchers also found that noise levels increase as the number of motorized vessels around the whales increase. With more vessels nearby, vessel noise could completely mask their calls or significantly decrease the range over which whales can communicate with one another, which may limit the extent to which they are able to disperse to find food. This research will help managers identify actions that would protect both whales and maritime commerce in Puget Sound.



Developed a Model to Predict Salmon Survival in the Columbia and Snake Rivers

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, support commercial and tribal fisheries, and generate electric power via a series of dams. Due to these multiple and varied uses, Center scientists and collaborators throughout the Pacific Northwest developed a model to describe juvenile salmon passage through the Columbia and Snake rivers. The Comprehensive Passage (COMPASS) model predicts the effects of alternative dam and reservoir operations on salmon survival rates. This model received positive reviews from a panel of independent scientists and serves as a valuable analytic tool to assess the costs and benefits of alternative management actions.

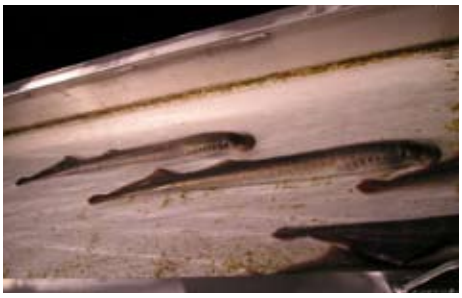


Above: Researchers measuring sound levels of killer whale calls near San Juan Island.

Left: Graph showing that as background noise levels from vessels increased so did the whales' call level.

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 had 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 new fish passage designs that take advantage of lamprey's unique climbing ability, to assist in their successful passage of the dams and facilitate rebuilding of their populations.



Above: Pacific lamprey climbing a lamprey-friendly fishway at Bonneville Dam.

Below: Researchers installing a new lamprey passage structure at a Bonneville Dam fishway.

Collected Critical Data on West Coast Groundfish

The West Coast Groundfish fishery includes some 80 commercially fished stocks and supports millions of dollars in economic activity. Center scientists conducted two 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 and a joint Canadian-U.S. Pacific hake acoustic survey from south of Monterey, 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 to support stock assessments of managed species. This year, an international panel and the Pacific Fishery Management Council approved the Center's stock assessment models for the Pacific hake fishery and are using its specifications to set harvest levels. In addition, to ensure sound, high quality data, the Center conducted an inter-vessel calibration for the hake survey.

Assisted in Recovery of Redfish Lake Sockeye Salmon

Redfish Lake sockeye salmon travel over 900 miles from the Pacific Ocean up the Columbia River to their natal stream and spawning grounds in Idaho's Redfish Lake. With 8 large dams along the river, however, these salmon have a difficult journey and their populations have dwindled. With less than six fish returning, in 1991 Redfish Lake sockeye salmon were listed as endangered under the ESA. As part of a multi-agency captive broodstock program to protect the genetic structure and prevent further decline of Redfish Lake sockeye salmon, NWFSC researchers helped develop techniques to successfully culture sockeye salmon to adulthood and rear and release juveniles. These efforts contributed to a record return in 2008 of 636 adult sockeye salmon to Redfish Lake--a level that has not been seen in over 30 years. This increase in returns will help stabilize the population until factors leading to their decline can be more fully addressed.

Developed Technology to Create Valuable Products out of Fish Waste

For every 4 billion pounds of fish that the Alaska Seafood Industry processes each year, 1 billion pounds of "waste" is produced and discharged into the ocean. This "waste" is an enormous untapped resource. Using technologies already in use by other industries, Center scientists, in collaboration with the processing industry, developed technology to convert 50% of this "waste" into valuable products, including high quality fishmeal and fish oil, in an economically-efficient manner. The use of this technology not only diminishes "waste" produced, it also minimizes the need to harvest additional fish for the production of these types of products.

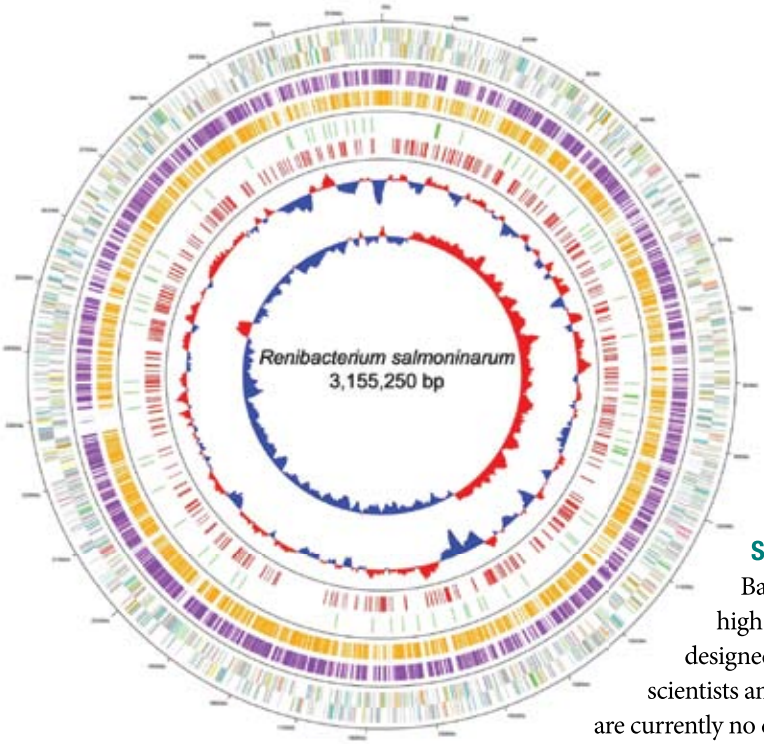
Developed Tools & Techniques to Improve Hatchery Practices

Hatcheries are fish breeding and raising facilities designed to enhance harvest and reduce the impacts of development that destroy or degrade salmon habitat and block migratory routes. While hatcheries have the potential to assist in the conservation of wild stocks, they also pose some risks. Center scientists developed a tool to help minimize straying of hatchery fish, which occurs when salmon do not return as adults to their hatchery of birth, and also developed techniques to reduce early maturation of juvenile hatchery spring Chinook salmon. Early maturation reduces hatchery production and has potential negative ecological consequences.

Above: Potentially valuable products can be developed from salmon waste.

Below left: Complete genome map of *Renibacterium salmoninarum*.

Below: Hatchery-reared salmon eggs and alevin.



Sequenced a Deadly Salmon Pathogen

Bacterial Kidney Disease (BKD) is a chronic, debilitating disease with high mortality in salmon raised in hatcheries, fish farms, and programs designed to help maintain endangered and threatened salmon stocks. While scientists and managers have long been aware of the threats that BKD poses, there are currently no completely effective vaccines or antibiotic treatments to treat infections by *Renibacterium salmoninarum*, the bacterium that causes BKD. To develop better tools to treat BKD, Center scientists and collaborators completely sequenced and published the genome of *R. salmoninarum*. This genetic map of the bacterium will help develop more effective vaccines and therapeutic measures. In fact, examination of the genome sequence has already revealed the presence of a key component of bacterial protein secretion that can be targeted with anti-infective compounds to potentially prevent infections.

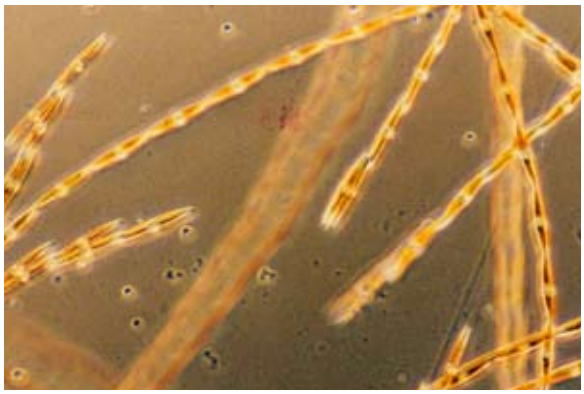
Oceans and Human Health

We 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 can impact our health and well-being. Center scientists work to understand, predict, and develop early warning systems for negative impacts of viruses, bacteria, biotoxins, and chemical contaminants on humans and other organisms. This research has direct relevance to U.S. seafood safety and security.

In 2008 we:

Discovered a Hotspot for Harmful Algal Blooms

Harmful algal blooms (HABs) occur when a particular species of toxic algae proliferates, and can be transferred through the food web through accumulation in shellfish, crabs and some fish. One of the toxins heavily impacting the Pacific Northwest is domoic acid, which is produced by the algae *Pseudo-nitzchia.* Beach and shellfish closures resulting from these blooms have had severe social and economic impacts on both coastal and tribal communities. As a result of data collected during six research cruises, Center scientists and collaborators discovered that the Juan de Fuca eddy, an ocean gyre about 50km off the northern coast of Washington, is a "hotspot" for *Pseudo-nitzchia.* Analysis of samples at sea revealed that domoic acid seemed to be related to water within a specific range of temperatures and salinities, which suggests that domoic acid is associated with "aged" water, like that found in an eddy, and rarely found in recently upwelled bottom water, like that associated with waters near the coastline. Understanding where and how these blooms originate and move is critical for accurate forecasts that could provide early warning to protect human and ecosystem health.



Algae in the genus *Pseudo-nitzschia* produce domoic acid.

Continued Development of the SoundToxins Monitoring Program

In the Pacific Northwest, several types of algae and bacteria can cause harm to humans and other species when their populations reach high enough levels. High concentrations of the bacterium *Vibrio parahaemolyticus* and toxins produced by certain algal species can accumulate in shellfish and be transferred up the food chain to humans. Due to increases in harmful algal blooms and *Vibrio* occurrences over the last decade, a partnership called SoundToxins was formed to develop an early warning system that protects human health by meeting current criteria, while minimizing effects

on shellfish harvesting. SoundToxins is a diverse group of shellfish and fish farmers, environmental learning centers, Native American Tribes, and volunteers that work with Center scientists to monitor 10 locations in Puget Sound for certain types of algae and bacteria. This past year, for example, a large bloom of harmful algae was detected by SoundToxins collaborators and a warning was sent to groups throughout Puget Sound. In addition, all SoundToxins data is now being entered into a database that is shared with other monitoring networks. This database will help scientists better understand the environmental conditions that foster harmful algal blooms, as well as increases in concentrations of harmful bacteria, and advance our ability to predict adverse events.

Our Staff, Facilities, & Operations

The quality of the Center's scientists and staff was reflected in the successes achieved in 2008. Coupled with improved facilities and a strong infrastructure, the Center's high-quality science was used effectively in conserving and managing living marine resources in the Pacific Northwest.

In 2008, we:

Supported Key Regional Collaboration Efforts

With NOAA's move towards regional coordination and communication, the Center engaged in multiple efforts that improved productivity and value to its customers. The Center had a significant role in advancing critical ecosystem research as part of the NOAA West Regional Collaboration Team, the Puget Sound Partnership, and the West Coast Governors Agreement to improve coastal and ocean health. In addition, the Center continued to foster important inter-agency/organization collaborations through a variety of mechanisms, such as two seminar series and an annual open house focused on watershed research.

Advanced Center Research Planning

In 2007, the Center developed a strategic research plan that identifies key research priorities for the Center in the near and long-term and are relevant to the resource management decisions being made by NOAA and others. In addition, the Center identified priorities as urgent or of critical management importance in the near-term and began work to implement these priorities. This past year, the Center created the infrastructure and processes necessary to successfully implement this research plan, to meet regional and national priorities, and to be adaptive to changes in marine ecosystems from climate change and future human population growth. These efforts were acknowledged by NOAA leadership and aligned well with Agency priorities.

Participated in International Science Efforts

The NWFSC continued to support international efforts on several fronts, including serving as advisors, educators, and chairs for several organizations. Center scientists provided technical expertise on fish dam passage to Swedish scientists, on aquaculture for a trilateral U.S.-Canada-Norway consortium, and on fish reproduction and growth to Japanese scientists. Several scientists also served as chairs and participants for international science organizations such as the North Pacific Marine Science Organization (PICES), International Whaling Commission, and the U.S.-Japan Cooperative Program in Natural Resources (UJNR).

Worked to Improve Environmental Literacy and Stewardship

Center staff participated in local education and outreach events, including the NOAA Science Camp, the Pacific Science Center's Marine Exploration Weekend, and the SMART Girls annual science workshop. As part of the NOAA West Regional Collaboration Team, Center staff led the coordination of the well-attended "NOAA and Our Planet Day" at the Oregon Coast Aquarium. Center staff also developed educational curricula on key topics, including oceans and human health. In addition, to help increase interest in careers that support NOAA's mission, the Center provided over 50 students with internship opportunities at the Center. In providing these internship opportunities, the Center continued to support the participation of students with disabilities through the Washington State DO-IT program.

Improved Safety and Operations

Safety is a high priority, and Center staff conducted a number of risk assessments to help minimize accidents and injuries in the workplace and in field work. In addition, a variety of training opportunities have been provided to staff, including CPR/first aid and ergonomics safety. By establishing the Green Team, the Center also began to develop an Environmental Management System, with the goal of becoming a more environmentally-responsible facility.

Received Recognition for Achievements

Many staff received awards this year in recognition of their accomplishments. The awards included a Department of Commerce Gold Medal, two group NOAA Bronze medals, and a NOAA Administrator's Award. In addition, a Center scientist received the prestigious William E. Ricker Resource Conservation Award.

Scientists interact with visitors at the Oregon Coast Aquarium during NOAA and Our Planet Day.

Learn More & Come See us in Action

Sharing our work with other scientists, with policymakers, and with the public is important to us. To learn more about what we do, please visit our website at www.nwfsc.noaa.gov. To arrange a visit or obtain additional information, please call 206-860-3200.