

**Washington Ocean Acidification Center:
Focused on Ocean Acidification Impacts and Adaptation in Washington**

WHY IT IS NEEDED:

The growing level of carbon dioxide in the atmosphere is causing the acidity of sea water to increase, threatening Washington's marine species and ecosystems and our economy. Small changes in acidity are already affecting marine animals and plants, as evidenced by the significant mortalities among oyster larvae at Pacific Northwest hatcheries between 2005 and 2009. For more information, see "Six things we know about ocean acidification in Pacific Northwest coastal waters" at <http://coenv.washington.edu/research/major-initiatives/ocean-acidification/>, prepared by the Washington Ocean Acidification Center co-directors with input from six leading ocean acidification scientists.

Washington's shellfish industry – the nation's top provider of farmed oysters, clams and mussels – generates \$270 million annually, and directly and indirectly supports 3,200 jobs. Impacts to marine food webs could affect Washington's seafood industry, which generates over 42,000 jobs and contributes at least \$1.7 billion to gross state product. Tribes in Washington depend upon shellfish for food, income and connection to their cultural heritage. Recreational harvests of oysters and clams contribute more than \$27 million annually to coastal economies.

Ensuring the continued viability of Washington's native and commercial shellfish species requires advances in understanding of the threat that ocean acidification poses to our marine resources, our economy, and jobs that depend on these resources. It requires better information about local seawater conditions around the state. And it requires linking this knowledge with the needs and concerns of local decision makers, businesses and communities. The Center was established by the Washington Legislature in 2013 and funded for the biennium to fulfill this requirement, to coordinate regional ocean acidification response activities, synthesize and evaluate resulting scientific knowledge, and communicate the information to a wide diversity of audiences.

WHAT IT IS DOING:

The primary purpose of the Center is to serve Washington state through coordination of research and monitoring activities and integration of outputs to guide response and adaptation in Washington state. Following direction set by the Washington State Legislature, the Center is implementing the following key research and monitoring actions:

- Ensure continued water quality monitoring at the six existing shellfish hatcheries and rearing areas to enable real-time management of hatcheries under changing pH conditions. The monitoring data have enabled hatchery operators to avoid drawing acidic water into the hatcheries and rearing areas.
- Establish an expanded and sustained ocean acidification monitoring network to measure trends in local acidification conditions and related biological responses. This monitoring will allow

detection of local acidification conditions and increase our scientific understanding of local species responses.

- Establish the ability to make short-term forecasts of corrosive conditions for application to shellfish hatcheries, growing areas, and other areas of concern. A real-time online tool will be developed and accessible to shellfish growers and managers to track acidification on a scale of days to weeks, giving them time to change or adjust hatchery operations.
- Conduct laboratory studies to assess the direct causes and effects of ocean acidification, alone and in combination with other stressors, on Washington's species and ecosystems. The action will focus on determining the biological responses of species of ecological, economic, and cultural significance, to multiple stressors to which they are exposed, and will help estimate the potential of these species to adapt to ocean acidification.
- Investigate and develop commercial-scale water treatment methods or hatchery designs to protect larvae from corrosive seawater. Scientists from the UW will help shellfish growers assess the effectiveness of the adaptation measures.

HOW IT OPERATES:

The Center is located within the UW's College of the Environment, a national leader in environmental research. The Center is modeled after and integrated with the UW's Climate Impacts Group (CIG), regionally known for developing and delivering decision-relevant science. The Center uses a distributed network model of organization to join the expertise of UW scientists with that of other regional academic institutions, agencies, and organizations. The Center engages with industry representatives, state, local, federal, and tribal policy makers, and public opinion makers. The Center will be entering into a dialog with the Marine Resources Advisory Council (MRAC), appointed by the Governor, to bridge science and policy needs. To guide its scientific work, the Center is establishing a science advisory team.

Principal activities of the Center are to:

- **coordinate scientific research and monitoring** on ocean acidification in Washington state **to promote scientific collaboration and coordination**, as well as data sharing, across academic institutions, agencies, and organizations to fill critical knowledge gaps, identify research priorities, **reduce redundancies, and leverage distributed resources** in response to the challenges of ocean acidification;
- **connect decision-relevant ocean acidification science with managers and policy-makers**. The Center, working with the MRAC, will assure that research and monitoring outputs reach the hands of decision makers representing diverse entities and the public;
- **identify education and outreach opportunities and needs and work to link specific groups that can fill these needs**. The Center co-directors have working professional relationships with Washington Sea Grant, Western Washington University, Northwest

Indian College, Seattle Aquarium, Pacific Science Center and other regional groups with education and outreach capacities. We will be working with these groups over the biennium to identify needs, collaborations, and opportunities; and

- **leverage existing assets and seeking new sources of funding**, including grants from federal agencies and foundations.

**Washington Ocean Acidification Center
Work Plan 2013-2015**

The work plan for the Washington Ocean Acidification Center for the biennium 2013-2015 is summarized below. Accomplishments to date are indicated in italics.

1. Implement the actions called for by Washington State Legislature.

Action 1: Ensure continued water quality monitoring at the six existing shellfish hatcheries and rearing areas to enable real-time management of hatcheries under changing pH conditions. The monitoring data have enabled hatchery operators to avoid drawing acidic water into the hatcheries and rearing areas. *We facilitated an open process via conference calls with representatives of the shellfish industry (Taylor Shellfish, Whiskey Creek Shellfish Hatchery, Coast Seafoods, Pacific Shellfish Institute (PSI), Pacific Coast Shellfish Growers Association (PCSGA)) and ocean acidification scientists (UW, NOAA) to scope the best use of the year one funds. Consensus was reached on a budget that extends and enhances the PCSGA monitoring program currently in place. This includes partial funding for a PSI technician to continue monitoring in Willapa Bay and Lummi Bay; part-time support through the UW Joint Institute for the Study of Atmosphere and Ocean (JISAO) for a chemical oceanographer to provide expert assistance to Washington regional shellfish growers (including Taylor Shellfish, PSI, and the Lummi Shellfish Operations) regarding operation and maintenance of their monitoring equipment; support for equipment to enhance ocean acidification monitoring in South Sound; and funds for calibration samples and maintenance supplies for the monitoring conducted by Taylor Shellfish and PSI. The Center is in process of establishing a contract for this work with PCSGA.*

Action 2. Establish an expanded and sustained ocean acidification monitoring network to measure trends in local acidification conditions and related biological responses. This monitoring will allow detection of local acidification conditions and increase our scientific understanding of the response of local species. *This task is in the scoping phase. Our intent is to include support for regional cruises, moorings, and nearshore monitoring in all of Washington's marine waters to measure physical, chemical, and biological variables. We are assessing existing assets and efforts, and possibilities for leveraging existing assets and programs, in order to make the most effective investment of the new funds. Existing joint operations by UW (through US IOOS-NANOOS funds) and NOAA Pacific Marine Environmental Laboratory (through NOAA Ocean Acidification Program funds) for cruise sampling and mooring support are being maintained during this scoping phase. We envision enhancing these efforts to include plankton monitoring and a wider regional scope. We are coordinating activities with regional entities including the Olympic Coast National Marine Sanctuary, the Intergovernmental Policy Council, the Puget Sound Partnership, the Center for Coastal Margin Observation and Prediction, Washington state agencies, tribes, and others.*

Action 3. Establish the ability to make short-term forecasts of corrosive conditions for application to shellfish hatcheries, growing areas, and other areas of concern. A real-time online tool will be developed and made accessible to shellfish growers and managers to track acidification on a scale of days to weeks, giving them time to change or adjust hatchery operations. *We used a competitive Request for Proposals (RFP) process to initiate this task. We advertised the RFP nationally, secured external scientific reviews, evaluated reviews and awarded the project to Dr. Parker MacCready's UW Coastal Modeling Group. Their model will be used to produce forecasts of corrosive conditions for Washington's marine waters, including the offshore coastal waters, the major estuaries (e.g., Willapa Bay, Grays Harbor, and Puget Sound) and the Columbia River plume. Deliverables consist of the following: Year 1: System-wide forecasting of physics; coastal forecasting of pH and aragonite saturation; Year 2: Demonstrated progress toward full system forecasting of pH and aragonite saturation. The modeling team proposed to use their model to assess the contributions of various drivers of ocean acidification in Washington waters, and to assess the relative contribution of various anthropogenic and natural forcings.*

Action 4. Conduct laboratory studies to assess the direct causes and effects of ocean acidification, alone and in combination with other stressors, on Washington's species and ecosystems. The action will focus on determining the biological responses of species of ecological, economic, and cultural significance, to multiple stressors to which they are exposed, and will help estimate the potential of these species to adapt to ocean acidification. *We are in the process of releasing a competitive RFP for this task. The RFP stipulates research on the effects of ocean acidification, alone and in combination with other stressors such as temperature, on species of importance in Washington. These species include native shellfish of economic value. Highest priority will be given to proposals that focus on geoduck (*Panopea generosa*), Pacific razor clams (*Siliqua patula*), and Dungeness crab (*Cancer magister*), or a combination thereof. A second priority is a focus on zooplankton species that support species of commercial interest in Washington. Studies of euphausiids and copepods will be prioritized for funding. For both shellfish and zooplankton species, information on the response of vulnerable life-history stages is especially valued. We anticipate that the experimental research will begin in February 2014.*

Action 5. Investigate and develop commercial-scale water treatment methods or hatchery designs to protect larvae from corrosive seawater. Scientists from the UW will help shellfish growers assess the effectiveness of the adaptation measures. *In September, 2013, we met with several commercial shellfish industry members of the PCSGA at their annual meeting in Bend, OR, to obtain their input regarding the most effective means of accomplishing this action. The consensus opinion was to allocate the available funding evenly across two regional hatchery operators (Taylor Shellfish and Whiskey Creek Shellfish Hatchery) to develop hatchery methods that mitigate corrosive conditions. A Statement of Work and budget are currently being developed. Work on this action will involve a combination of testing new monitoring equipment and further developing water treatment methods. We will fund this work via our contractual arrangement established with PCSGA for Action 1.*

2. Coordinate scientific research and monitoring on ocean acidification in Washington state to promote scientific collaboration and coordination, as well as data sharing, across academic institutions, agencies, and organizations to fill critical knowledge gaps, identify research priorities, reduce redundancies, and leverage distributed resources in response to the challenges of ocean acidification. *The Center is working to establish itself as a regional node for ocean acidification knowledge and coordination. Efforts to date span a variety of themes:*

- *Information source: We have begun to establish a web presence for the Center which will grow with time, see <http://coenv.washington.edu/research/major-initiatives/ocean-acidification/>. At this site we posted a synopsis of the latest published science explaining “Six things we know about ocean acidification in Pacific Northwest coastal waters” prepared by the Center co-directors with input from six leading ocean acidification scientists.*
- *Regional Coordination: We are establishing a Science Advisory Team for the Center, drawing on expertise from the regions tribes, agencies, and universities. Letters of invitation have been drafted and will be sent following the first MRAC meeting.*
- *Data hub: We are working with NANOOS to host data streams from the shellfish grower monitoring (Action 1) and regional ocean acidification monitoring (Action 2).*
- *Community workshops: We are, with colleagues from British Columbia and NOAA, chairing a science session on ocean acidification in the Salish Sea at the 2014 Salish Sea Ecosystem Conference. We also are working with the Puget Sound Institute to scope interest and need in a focused workshop envisioned in 2014 on regional ocean acidification and its effects.*
- *Connection to larger-scale programs: Both Center co-directors serve as regional points of contact for ocean acidification. This includes serving on the West Coast Ocean Acidification and Hypoxia Panel and as liaison to the California Current Acidification Network, Global Ocean Acidification Observing Network, etc.*

3. Connect decision-relevant ocean acidification science with managers and policy-makers. The Center, working with the Marine Resources Advisory Council, will assure that research and monitoring outputs reach the hands of decision makers representing diverse entities and the public. *We are establishing a working relationship with the MRAC. The Center co-directors will attend the first meeting of the MRAC and will provide an initial briefing on the status of ocean acidification in Washington waters and Center activities to date. We will consistently brief this body and work to assure the efforts of the Center align with the information needs of the MRAC. Each of the RFPs the Center has used (Actions 3 and 4) require a Communication Plan for translating the scientific results to meet the needs of policy and management.*

4. Identify education and outreach opportunities and needs and work to link specific groups that can fill these needs. *The Center co-directors have working professional relationships with Washington Sea Grant, Western Washington University, Northwest Indian College, Seattle Aquarium, Pacific Science Center and other regional groups with education and outreach capacities. We will be working with these groups over the biennium to identify needs, collaborations, and opportunities.*

5. Leverage existing assets and seeking new sources of funding, including grants from federal agencies and foundations. *The Center co-directors are involved with responses to foundation sponsored projects, such as the Allen Challenge and X-prize, and to federal funding opportunities, such as the NOAA Marine Sensor Innovation and Biological Observing Network. We will continue to seek new opportunities and to foster regional responses.*