

Ocean Acidification

Q: What is ocean acidification?

A: The world's oceans absorb carbon dioxide (CO₂) from the atmosphere. As the oceans soak up excess carbon emissions, the chemistry of the seawater changes — both locally and globally. This absorption process pushes the ocean's natural acid-base balance toward acidity. This move toward a lower pH value is called ocean acidification.

Over the past 250 years, surface oceans have absorbed about 550 billion tons of CO₂ emissions from the atmosphere, or about 30 percent of total carbon emissions created by human activity (Feely et al, 2010). The absorption of carbon dioxide in the ocean impacts the chemistry and biology of the oceans.

Q: Why does ocean acidification matter and what are the impacts?

A: Although ocean acidification research is an emerging field, there is already growing evidence of biological harm from ocean chemistry changes. Water that is more acidic may be harmful to marine organisms, particularly those that form shells. Ocean acidification reduces the ability of marine organisms to make shells or skeletons built from calcium. This could affect species important to the food web such as shellfish, corals, and pteropods (a food source for salmon, herring, and whales). Increased ocean acidification poses a risk to economically important shellfish such as oysters. It may weaken their shells and harm their ability to reproduce.

“For the last few years it [ocean acidification] has become probably the most dominant issue for the West Coast Shellfish industry. If you don't have seed you don't have an industry.

We've had a major problem producing it and research suggests increasingly corrosive seawater may be the cause.

Even if we change carbon emission policies today, we'll still have 50 more years of problems coming our way.”

~ Bill Dewey, Taylor Shellfish Farms based in Shelton, Washington

The speed of the changes is of concern. Studies indicate that ocean acidity has increased about 25 percent since the start of the industrial age. The fast change outweighs historically natural influences. If fossil fuel use and deforestation continue at current rates, ocean acidity could increase by as much as 100 to 150 percent above pre-industrial levels by the end of the century (Intergovernmental Panel on Climate Change, Fourth Assessment, 2007).

Q: How do we know that acidity levels are increasing?

A: Scientists have collected relevant data from the Pacific and Atlantic Oceans for the past 20-30 years. The time-series records for Hawaii, Bermuda, and the Canary Islands show that CO₂ absorption in the ocean mirrors the global increase in atmospheric CO₂ emissions (Ocean, Carbon and Biogeochemistry, European Project on Ocean Acidification, 2010).

Dr. Richard Feely of the U.S. National Oceanic and Atmospheric Agency (NOAA) reports that these changes are evident by dropping pH levels that indicate oceans are becoming more acidic. “Scientists have estimated that the pH of our ocean surface waters has already fallen by about 0.1 pH units from an average of about 8.2 to 8.1 since the beginning of the industrial revolution.” This is about a 25 percent decrease, which is considered significant.

Q: What is happening in Washington?

A: Washington is likely to see the impacts of ocean acidification on marine organisms earlier than other coastal areas due to the presence of low oxygen zones that contribute to low pH levels. Coastal waters receive excess nitrogen that can stimulate algae blooms. As these blooms die and sink, bacteria decompose them, depleting oxygen from the surrounding water. This biological process increases CO₂ which lowers pH even more. Research suggests that acidification may already affect estuaries such as Willapa Bay, Hood Canal, and Grays Harbor.

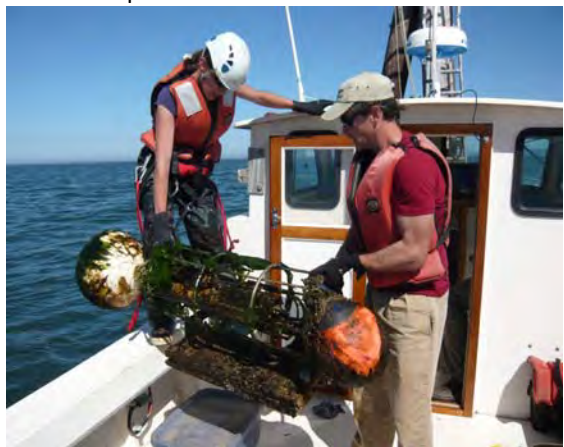
A team of scientists led by Dr. Feely recently reported that subsurface waters in Washington’s Hood Canal were 200 percent more acidic than the ocean surface waters.

Impacts on marine species and food supplies could affect local economies – especially communities that rely on seafood as an important food source. Washington shellfish growers are part of a \$111 million dollar per year industry on the West Coast that supplies more than 15 percent of the nation’s oysters. Washington is the leading producer of farmed bivalve shellfish in the United States.

Oyster farmers started to worry in 2005 when oysters failed to reproduce in Willapa Bay. New sets of oyster seed in Willapa Bay failed again in 2006, 2007, 2008, and 2009. During this same time, two of the West Coast’s larger shellfish hatcheries experienced major problems producing Pacific oyster seed. Although the cause has not been determined, corrosive waters may have contributed to the declines in oyster survival.



Department of Ecology employee collects a water sample in Hood Canal.



Department of Ecology employees service an ocean monitoring device in Willapa Bay.

Q: What is Washington doing about ocean acidification?

A: Ocean acidification is a large-scale issue with international, national, regional, and local aspects. The Washington Department of Ecology (Ecology) will be one of many entities with an important role in contributing to an improved understanding of the issue. Key roles for Ecology to address impacts of climate change and ocean acidification include:

- Research.
- Monitoring pH and related ocean chemistry.
- Public education.
- Leadership.

A recent collaboration between Ecology, NOAA, the University of Washington, and the U.S. Environmental Protection Agency (EPA) resulted in a published paper titled, “The combined effects of ocean acidification, mixing, and respiration on pH and carbonate saturation in an urbanized estuary.” (See link under More Information.) This and similar efforts will improve our local understanding of ocean acidification from human sources and can lead to measures that will address its affects.

“Ecology is concerned about the effects of increasing acidification of ocean water in our inshore water bodies.

Ecology continues to assess nutrients that enter Puget Sound from rivers, stormwater runoff and wastewater treatment plants because nutrients can contribute to ocean acidification.

Hood Canal, due to its shape and extensive low oxygen zones, is particularly vulnerable to ocean acidification.”

~Dr. Christopher Krembs, Senior Oceanographer, Washington Department of Ecology

In December 2011, Ecology listed, subject to EPA approval, Puget Sound waters as waters of concern (Category 2) due to the anomalies observed by shellfish growers. The listing in the 2010 marine Water Quality Assessment recognizes the increasing risks to fish and shellfish habitat from climate change, urbanization, and ocean acidification. The Assessment, required by the Clean Water Act, is the state’s latest list of polluted waters plus a status of water quality. The new Puget Sound “waters of concern” listing helps the state and the public be aware of, track, and study these water quality concerns.

Ecology and others are currently pursuing opportunities to foster additional monitoring and research on climate change and ocean acidification impacts to assess the size of problem and generate corrective actions. To get more information on Ecology’s efforts to address climate change and ocean acidification, go to <http://www.ecy.wa.gov/climatechange/index.htm>.

Q: Why do we need more research?

A: Policy makers, industry, and citizens need this information to make decisions on how to slow ocean acidification and develop adaptation strategies. Scientists are stepping up research about ocean acidification. Ecology's long-term marine monitoring program measures Washington's marine waters for pH, dissolved oxygen, and nutrients to look at trends. But we need to do more to link trends to effects on species and ecosystem functioning.

Collaboration is important to effectively use data and share results. Transparency and good communication are essential when citizens, scientists, and community leaders come together to discuss complex problems like acidification.

Q: What would the recently created Blue Ribbon Panel do regarding this problem?

A: To demonstrate the state's commitment to advance knowledge about ocean acidification Governor Gregoire created a Blue Ribbon Panel to summarize current scientific findings and develop actionable recommendations on understanding, monitoring, adapting, and mitigating ocean acidification in Puget Sound and Washington coastal waters. Members of the Panel will include leading scientists, opinion leaders, tribes, shellfish growers, relevant agencies and other stakeholders. The Panel report is due September 2012.

Q: Who in Washington is working on this problem?

A: A number of groups are working collaboratively on ocean acidification in Washington, including:

- Washington Department of Ecology
- Puget Sound Partnership
- Washington Department of Fish and Wildlife
- University of Washington
- National Oceanic and Atmospheric Association's (NOAA) Pacific Marine Environmental Laboratory (PMEL) in Seattle
- Northwest Association of Networked Ocean Observing Systems (NANOOS)
- Olympic Coast National Marine Sanctuary
- Marine Resources Committees in Grays Harbor County, Jefferson County, and Whatcom County
- Shellfish industry

More information

- NOAA's Pacific Marine Environmental Laboratories ocean acidification web site at <http://www.pmel.noaa.gov/co2/story/Ocean+Acidification>
- Feely, R.A., S.R. Alin, J. Newton, C. L. Sabine, M. Warner, A. Devol, C. Krembs, and C. Maloy, 2010. *The combined effects of ocean acidification, mixing, and respiration on pH and carbonate saturation in an urbanized estuary*. Estuarine, Coastal and Shelf Science, Volume 88, Issue 4, 10 August 2010, Pages 442-449. <http://www.sciencedirect.com/science/article/pii/S027277141000185X>
- IPCC Fourth Assessment Report: Climate Change 2007. *Section 10.4.2 Ocean Acidification Due to Increasing Atmospheric Carbon Dioxide*. Working Group I: The Physical Science Basis. http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch10s10-4-2.html
- Ocean Carbon and Biogeochemistry – USA and the European Project on Ocean Acidification, 2010. *Frequently Asked Questions on Ocean Acidification*. www.whoi.edu/fileserver.do?id=58683&pt=2&p=69346

Visit Ecology's Climate Change website for additional information on ocean acidification. http://www.ecy.wa.gov/climatechange/ipa_resources.htm

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