WHAT WE KNOW ABOUT OCEAN ACIDIFICATION

Ocean acidification is affecting Washington waters in ways that threaten key biological resources. Its intensity varies regionally, seasonally, and by water depth. Building on leadership and investments in knowledge regarding the status and trends of ocean acidification in Washington is critical to understanding risks and fostering resilience.

What We Have Learned

The Washington Ocean Acidification Center (WOAC), several Washington state agencies, and NOAA regional centers continue to advance scientific research regarding ocean acidification and how it is uniquely manifesting within Washington waters. We know that:

- **Carbon dioxide is the cause.** Atmospheric increases in carbon dioxide from emissions and other human activity affect seawater by changing its temperature, pH, and aragonite saturation state. The decrease in seawater pH and aragonite saturation is known as ocean acidification.

What is aragonite saturation state?

Aragonite is a form of calcium carbonate that many organisms produce and use to build their skeletons and shells. The saturation state is a measure of how easily aragonite can dissolve in the water.

- **The rate of ocean acidification is increasing.** Ocean acidification is increasing in the open ocean at the same rate that carbon dioxide is increasing in the atmosphere. Off the Washington coast and in Puget Sound, the rate of ocean acidification is faster than in other regions because of lower buffering capacity in our waters. Rivers in our region add freshwater with lower alkalinity, which reduces the local buffering capacity (ability to resist changes to pH and aragonite saturation).

- **Conditions vary by location, season, and water depth**. In the Salish Sea, salty ocean waters mix with fresher estuarine waters. The ability of seawater to resist changes in pH from increased carbon dioxide varies regionally, due to freshwater input. Off the coast, seasonal upwelling brings up deeper waters with higher carbon dioxide content. These variables mean that pH and aragonite saturation are not constant over a season or across locations, and monitoring continues to be important.

Why This is Important

Ocean acidification threatens biological and human communities in ways we need to better understand. For instance:

- **Ocean acidification adds physiological stress to organisms**: Seawater chemistry is causing shell corrosion for some plankton, including crab larvae. While natural processes can have this effect, the additional stress from ocean acidification makes it even worse. This is an example of how the addition of carbon dioxide from human activities influences how quickly ocean acidification conditions approach physiological thresholds that affect marine species, many of which support our coastal communities and economy.

- **Multiple climate stressors can exacerbate impacts**: In addition to ocean acidification, other climate-driven factors can severely impact ocean conditions and the health of marine species. Warming temperatures during heat waves and those associated with long-term global heating are known to increase stress among organisms. Warming seawater temperatures can also decrease ocean mixing and increase the likelihood of deoxygenation and hypoxia. Interactions between these compounding stressors are currently difficult to predict.

- **Viable habitats can shift or shrink**: As ocean conditions change, and as stressors intensify, suitable habitat for marine organisms can move or compress. Human interactions with marine species, for example through fisheries, are also likely to change.

This work supports Washington's strategy to invest in Washington's ability to monitor and investigate the effects of ocean acidification

Visit **www.oainwa.org** to learn more about Washington's strategic response and the Marine Resources Advisory Council

Contact **mrac@oainwa.org** for more information

What Still Needs to Happen

Rapidly changing seawater conditions and their effects on marine species calls for swift action and tighter coordination among managers, scientists, and policymakers to foster human adaptation. Resource management approaches that have worked in the past will need to be modified to successfully navigate future conditions.

Key priorities include:

- Continued monitoring of ocean acidification conditions, co-located with sampling plankton species.

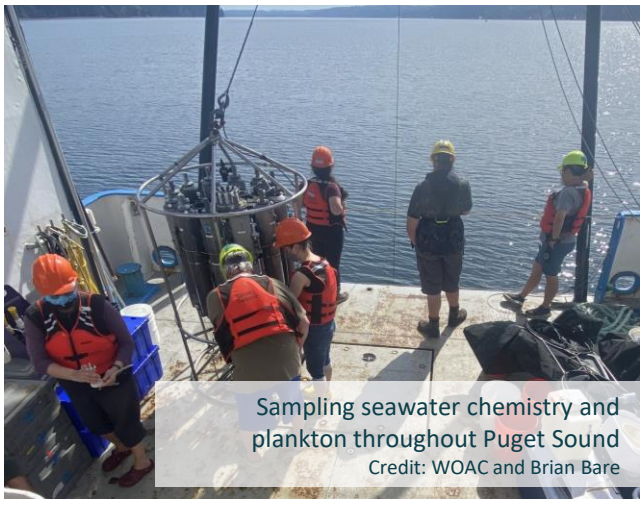
- Conducting continued and new laboratory studies and field experiments on key Washington species.

- Improving forecasting and modeling abilities to examine conditions over broader space and time scales.

- Enhancements to maintain highest-quality timeseries data.

- Adaptation and mitigation.

- Communications to distribute ocean acidification information to a wider audience, including Tribal partners, resource managers, and others.



Sampling seawater chemistry and plankton throughout Puget Sound
Credit: WOAC and Brian Bare