Contact Darcy Dugan, dugan@aoos.org

Alaska Ocean Acidification Network

Working to Understand Ocean Acidification to Help Alaskans Adapt

Ocean Acidification in Southeast Alaska

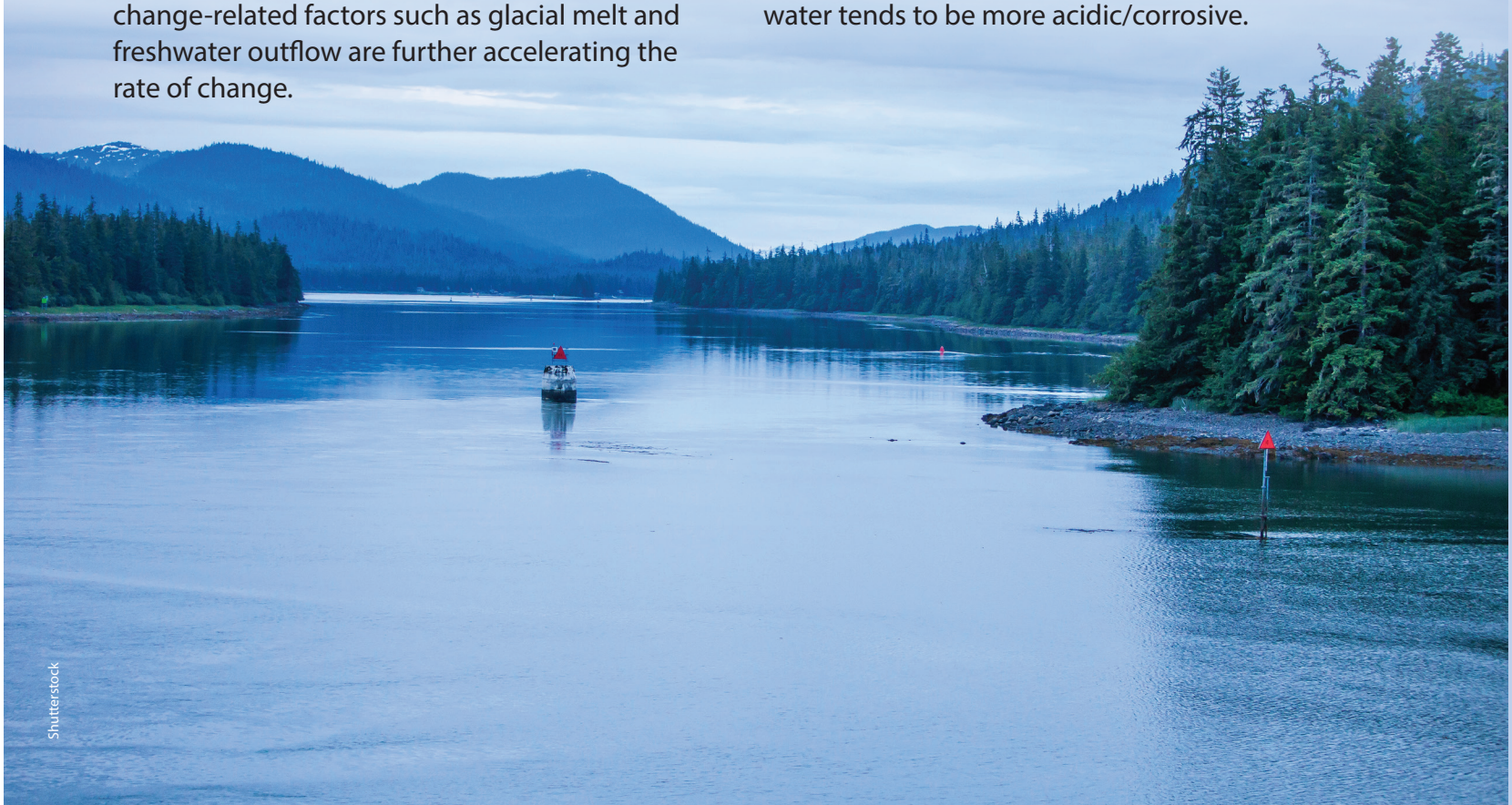
Ocean acidification occurs as human-emitted carbon dioxide is released into the atmosphere and absorbed by the ocean. This excess carbon dioxide causes a chemical reaction, increasing the acidity of seawater. This phenomenon is accelerating on a global scale and scientists estimate that acidity in the surface ocean is 30% higher today than 300 years ago. Increases in acidity can affect marine life, including the growth and behavior of fish and shellfish, and is expected to impact ecosystems and fisheries worldwide.

Is ocean acidification happening in Southeast Alaska?

Yes. Alaska waters in general are more susceptible to ocean acidification than other parts of the world because of natural factors - they are cold and naturally rich in carbon dioxide, so the absorption of additional carbon dioxide from the atmosphere has a bigger impact. Conditions in Alaska are likely to approach species' sensitivity thresholds sooner than elsewhere. In Southeast Alaska, climate change-related factors such as glacial melt and freshwater outflow are further accelerating the rate of change.

Do conditions vary around Southeast Alaska?

Yes, local oceanography and geography influence seawater chemistry and can create hotspots with unfavorable conditions and "refugia" (areas with more favorable ocean conditions for organisms). Areas exposed to the open-ocean influences of Gulf of Alaska experience different conditions than narrow inside passages because of factors such as mixing, temperature, and freshwater outflow. Deep water tends to be more acidic/corrosive.



Shutterstock

Where are the hotspots?

Higher acidity water has been documented in all regions that lack a direct connection to the open continental shelf, which is much of the Alexander Archipelago (the 1,100 islands that comprise most of Southeast Alaska). Higher acidity and corrosive conditions are seen all year in zones where the tides regularly mix confined waters, such as Wrangell Narrows. Corrosive conditions are also seen in areas that receive significant glacial melt in the summer, with Lynn Canal exhibiting the most severe conditions.

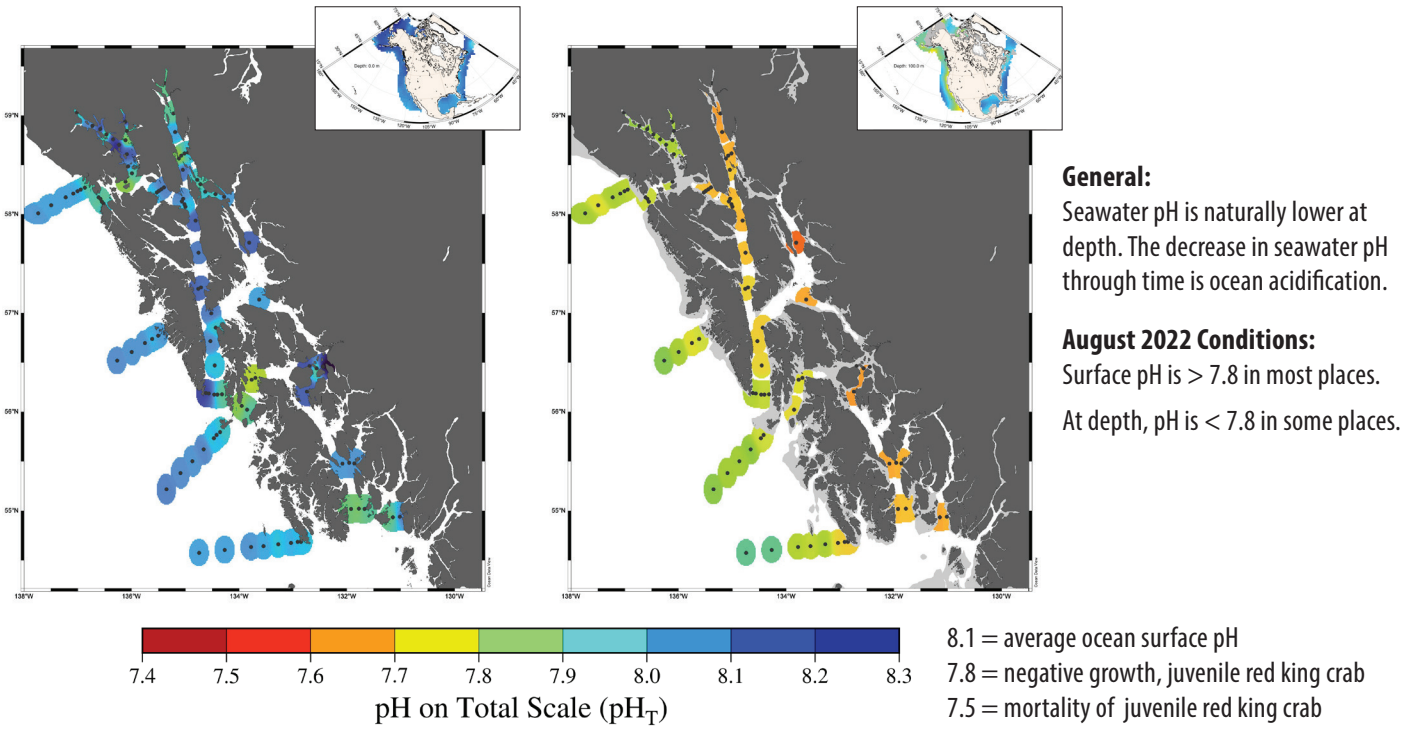


Fig. 1 The maps above show pH (acidity) in locations around southeast Alaska in August of 2022. Recall that lower pH values indicate higher acidity. The lefthand map shows conditions at the surface and the righthand map is at 100m depth. As can be seen by the warmer colors, locations in deeper water show higher acidity than the surface, and protected inside waters show higher acidity than outside waters. Source: UAF OARC.

Where is monitoring taking place in Southeast Alaska?

Monitoring ocean acidification has been a team effort and more samples have been collected in Southeast Alaska than any other part of the state. Tribes have taken a lead role, coordinated by the Sitka Tribe of Alaska (STA) and Southeast Alaska Tribal Ocean Research (SEATOR). Samplers across eight communities are taking samples, and University of Alaska Fairbanks, the National Park Service, and NOAA conduct ship-based surveys in the region. The Alaska Marine Highway ferry Columbia took samples along its weekly 1300km route from Bellingham to Skagway from 2017-2019. The STA also houses a carbon chemistry measurement device called a Burke-o-Lator that produces real-time data. Researchers at UC Santa Cruz have contributed data on carbonate chemistry dynamics of coastal rocky reefs as well.

Are there seasonal fluctuations in addition to long term changes?

Across Alaska we can see clear seasonal changes in ocean acidity and favorability for shell builders that occur in a predictable annual pattern. Phytoplankton blooms play a major role in the seasonal cycle of carbon dioxide in the Gulf of Alaska. In the summer, phytoplankton – small marine plants – consume carbon dioxide from the upper, sunlit portion of the ocean during photosynthesis, reducing acidity. When phytoplankton die and sink, they can be metabolized by bacteria, creating more carbon-rich water, with higher acidity, near the seafloor. This creates a clear annual cycle of surface seawater carbon dioxide levels, within the long term trend of increasing carbon dioxide overall.

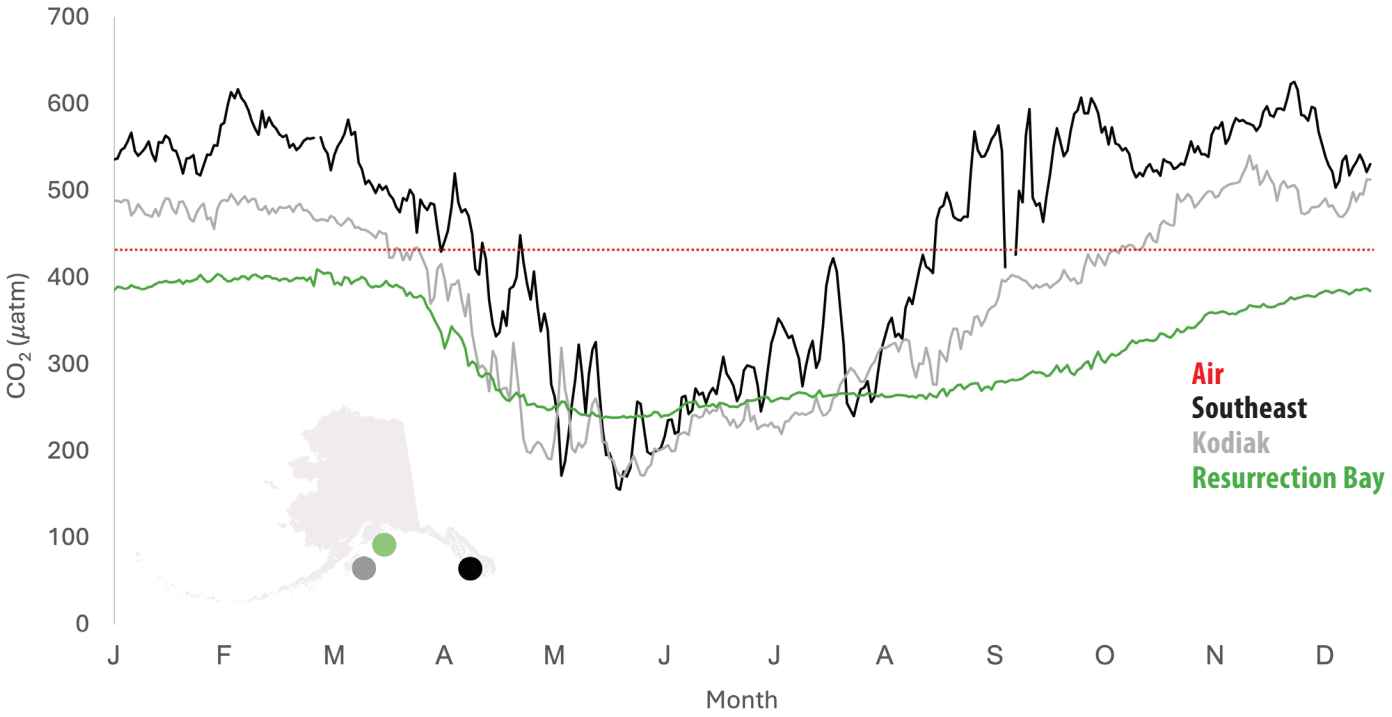


Fig 2. This figure shows the seasonal drop in carbon dioxide (CO2) concentration in seawater that occurs during the spring and summer as blooming phytoplankton remove CO2 from the surface of the water. Levels go back up in the fall when the blooms end and winter storms stir deep, higher acidity water from the bottom back up to the surface. Recall that increased CO2 corresponds to decreased pH (lower pH means higher acidity). Note that Southeast Alaska (black line) has a higher CO2 concentration than the other locations in the Gulf of Alaska. Source: UAF OARC.

How does OA affect species?

We are still learning about how species respond to changes in acidity through lab studies. The majority of marine species studied so far have shown some level of sensitivity that affects growth, calcification, reproduction or survival. For shell builders, ocean acidification reduces the calcium carbonate (building blocks) needed for shell building and maintenance. For finfish, higher acidity can affect growth, brain function and stress levels. For most species, results show variation by life stage. Because of the seasonal changes in conditions shown above, knowing the time of the most sensitive life stage is important.

Which species are we most worried about in Southeast Alaska?

Crab have been identified as a species of concern, and their response varies significantly by species. Lab studies show Red King Crab are sensitive during their juvenile stage. Dungeness crab have shown high sensitivity across all life stages, while snow crab appear to be resilient. Pacific oysters are sensitive as oyster seed (at the very beginning of their development). More research is needed on salmon response. Initial studies on pink salmon have shown sensitivity in juveniles with respect to growth, stress and metabolic regulation, however there is still much we don't know about salmon and many other fish. For species that prey on OA-sensitive species such as pteropods, food chain impacts could have the biggest consequences.

A NOAA research cruise collects samples in Glacier Bay in 2022.

Are those species currently being impacted?

The answer is likely yes, based on what we know from lab results. However, it's hard to attribute specific changes in the wild to a single factor. The marine ecosystem is complex and ocean acidification is one of many climate-change related factors affecting species. We do know that acidity levels are starting to reach values in some areas that trigger sensitivity for certain species. For most species, ocean acidification will be sublethal (a stressor, but doesn't kill them directly). However, the added stress will make it difficult to rebound from other stressors like warming and decreased food availability.

What can we do?

- **Support efforts to mitigate carbon emissions.** OA is driven by carbon dioxide emissions, and slowing down ocean acidification requires reducing emissions. Make changes in your own life and look for carbon policy-related initiatives at the community, state or national level to support. Voicing the need to address climate change to policy makers gives them confidence to take bold action.
- **Join or generate conversations around community adaptation.** Many communities around Alaska have started discussions about how our lifestyle, economy and infrastructure can adapt to a changing climate. Visioning how we want our communities to look in the future can bring us together as problem solvers.
- **Support young people on their path to become leaders.** Addressing complex issues like ocean acidification and climate is going to require new thinking and leadership. We need this next generation of thinkers and doers!

More information

Alaska Ocean Acidification Network: https://aoan.aoos.org/
Southeast Alaska Tribal Ocean Research: http://seator.org/

NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce

Alaska Ocean Acidification Network

UAF College of Fisheries and Ocean Sciences, University of Alaska Fairbanks