Alaska Ocean Acidification Network

Alaska Salmon and Ocean Acidification

Scientists estimate the ocean is 30% more acidic today than it was 300 years ago. When humans burn fossil fuels, the carbon dioxide (CO_2) that is emitted dissolves into the surface water of oceans, lowering the pH and increasing the acidity. **More acidic water can affect marine life, including the growth and behavior of fish.**

Research on salmon response to ocean acidification (OA) is still in the early stages. Salmon are difficult to study in the lab, and wild salmon populations are challenging to research because of the immense distance they travel over their lifetime and the multitude of factors that can influence their health throughout different life stages and geographies. However, salmon's critical importance to Alaska's commercial fleet, subsistence culture, and coastal communities makes salmon a high priority. If OA is impacting Alaska salmon, we want to know.

As research efforts focused on Alaskan salmon increase, we are learning more about how certain species react to acidic waters. **Some studies have uncovered unexpected resiliency while other studies have detected changes in salmon physiology that may be of concern**. Here's what we know so far:

Coho Salmon

Initial studies on coho salmon found that when juvenile marine phase coho salmon were exposed to elevated CO_2 for two weeks, they no longer avoided the scent of predators. This change in behavior was likely driven by changes in how they processed important odor signaling in their brains, resulting in a changed perception of what they were smelling and how to respond. The scientific consensus is that this altered perception is the physiological result of the salmon's need to actively buffer their blood to the changing external pH of the seawater.

Fortunately, this research also showed that even though coho salmon experienced significant and negative effects in acidic waters, **they were able to fully recover in less acidic water as soon as six hours after an exposure. This tells us that salmon are highly adaptable.**

Chris Miller

Pink Salmon

Recent experiments on pink salmon found **OA decreases the maximum metabolic rate, growth and overall health of juvenile pink salmon**. This may negatively affect pink salmon during their transition from freshwater to saltwater as juveniles, making them more vulnerable to predation during that time. However, there is also the potential for certain populations to acclimate to an acidifying ocean. Evidence suggests that **certain populations of pink salmon may be able to adjust their physiology to cope with acidic conditions over many generations.** To gain a better understanding of this likelihood, researchers need to explore how long it would take salmon to build a tolerance to elevated CO_2 in later generations. It remains to be seen if other species of salmon could possibly develop similar resistance.

Recent studies

- In 2020, researchers in British Columbia found that juvenile pink salmon that naturally migrate through low pH waters showed no significant changes in blood chemistry when exposed to low pH waters. Looking at a specific current population of juvenile pink salmon that experienced corrosive conditions within their natural range during early development, researchers found this population had an increased capacity for acclimatization under OA conditions. **These results suggest that salmon that have had exposure to low pH conditions over many generations could develop a resistance to elevated CO_2 conditions.** While this study is relatively limited in its ability to make broad assumptions about the response of pink salmon to OA, it does suggest that certain populations of pink salmon may be better suited to an acidified ocean in the future.

- In 2022, researchers in Alaska conducted the longest lab study of juvenile pink salmon under experimental conditions to date. Their study focused on the response of juvenile pink salmon to OA paired with reduced food availability as future OA conditions are predicted to cause a decline in certain zooplankton species that pink salmon eat. **Preliminary results show that exposure to higher acidity water has a negative effect on the overall health of juvenile salmon, and higher acidity water in combination with reduced food limits growth rates for juveniles.**

Chris Miller

Are we seeing impacts on salmon from OA in Alaska waters?

Although Alaska is expected to experience OA faster and more intensely than any other coastal waters in the United States, research investigating salmon response to OA in Alaskan waters has just begun. So far, data and modeling efforts in Prince William Sound show that OA has not yet played a statistically significant role in pink salmon population numbers, but this could change in the future as ocean chemistry continues to change and fish are faced with multiple stressors. More research efforts are getting started across the state as OA's potential impact on our salmon species becomes a top priority.

Implications

For Alaskans dependent on salmon, understanding how species may fare in a higher-acidity environment is critical. The cultural and economic implications of the future of salmon depend on our ability to make well-informed decisions and to adapt to changing conditions.

Research efforts that formally evaluate the risks of OA and other thresholds to salmon fisheries allow policy-makers to assess the benefits of pre-emptive human responses. This is particularly important in Alaska, as the state's constitution mandates that salmon populations must be managed according to maximum sustainable yield. This approach provides less room for adaptive ecosystem-based management that include response to major shifts in ocean conditions. With this in mind, researchers are prioritizing closing the gaps in our knowledge of salmon response to OA and multiple stressors in the future.

UNIVERSITY of WASHINGTON

UAF UNIVERSITY OF ALASKA FAIRBANKS

OAP NOAA OCEAN ACIDIFICATION PROGRAM

AOOS Alaska Ocean Observing System