OCEAN ACIDIFICATION AND ALASKA PINK SALMON

WHAT WE KNOW FROM THE LAB

Background

The increase in carbon dioxide in the atmosphere from human activities is driving a long-term increase in ocean acidity, a process known as ocean acidification (OA). Lab research has shown that OA can have direct, negative impacts on marine organisms by affecting growth, calcification, reproduction, and survival. Ocean acidification can also affect marine food webs as many prey species are sensitive to changes in ocean chemistry. Alaska is naturally predisposed to ocean acidification because of its cold water and other factors. Understanding how species of economic and cultural importance may respond is vital to help inform future fisheries management.

Quick chemistry fact
The more CO_2 generated or injected into seawater, the lower its pH level will be. This is caused by the interaction between CO_2 and H_2O, which results in a release of carbonic acid. Lower pH corresponds to higher acidity.

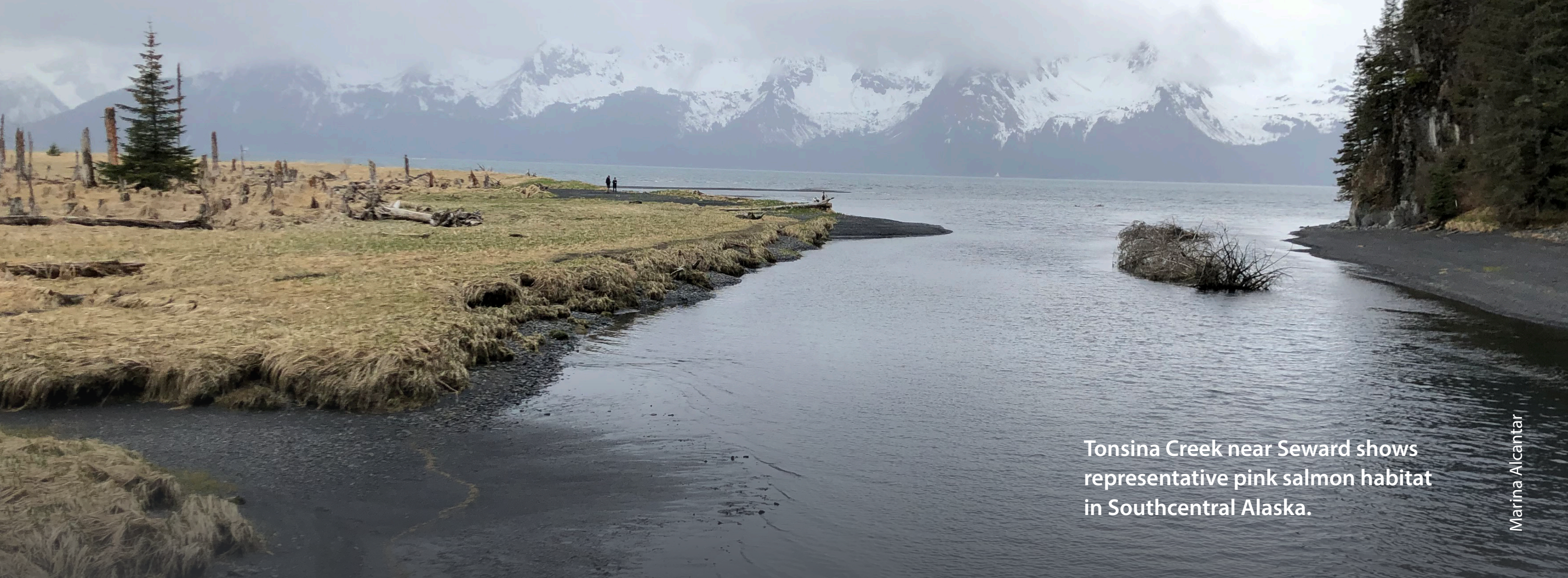
Treatment
Ambient pCO_2 = 400 uatm
Elevated pCO_2 = 1,100 uatm
Reduced food = 1.5% body mass

The research question

The Kelley Lab at the University of Alaska Fairbanks looked at how juvenile pink salmon respond to the direct effect of future ocean acidification conditions and the indirect effect of reduced food availability in the lab setting.

What we did

Juvenile pink salmon were exposed to treatments with increased pCO_2 (which increases acidity) and reduced food availability at the Alutiiq Pride Marine Institute in Seward, Alaska. Researchers from the University of Alaska Fairbanks measured developmental, physiological, and otolith mineral characteristics over the course of a 6-week period in 2021. The pCO_2 were consistent with conditions expected by the year 2100 under a "behavior as usual" scenario.



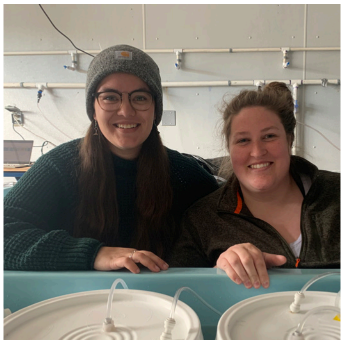
Tonsina Creek near Seward shows representative pink salmon habitat in Southcentral Alaska.

Marina Alcantar

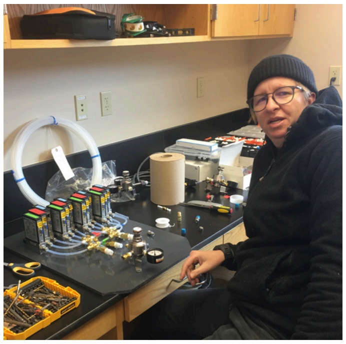
USFWS-Katrina-Mueller

How did the salmon respond?

- Weight and weight-to-length ratios were significantly smaller in fish exposed to future OA conditions.
- Stress hormone levels (cortisol) were significantly higher in fish exposed to future OA conditions and reduced food.
- The routine metabolic rate was significantly higher in fish exposed to future OA conditions and reduced food.
- The otoliths (inner ear bones) of juvenile pink salmon reared under future OA conditions were significantly smaller than the otoliths of fish reared in current day conditions.



UAF Kelley Lab team members at Alutiiq Pride Marine Institute.



Dr. Amanda Kelley builds out an ocean acidification exposure system in the wet lab.

Why it matters

- **Sublethal impacts to salmon from OA can affect fisheries.** While there was no significant effect of direct exposure to future OA conditions on juvenile pink salmon survival, the sublethal (not deadly) effects related to growth, stress, and metabolic rate were significant and could create population-level implications. These potential physiological changes should be incorporated into climate change mitigation and adaptation planning.
- **Subsistence, commercial, and recreational resource users may be impacted by OA.** Juvenile pink salmon lost weight under future OA conditions which could influence the total number of fish needed to meet the needs of harvesters. The increased metabolism of salmon in these conditions may also displace other target species through direct competition for prey.
- **Measurable effects require time.** Previous studies on juvenile pink salmon did not detect any impacts of OA on growth or physiology. However, the previous studies were short (~2 weeks). Our work demonstrated that the impacts of OA began to appear after two weeks of exposure, highlighting the need for laboratory studies to be carried out for longer periods.

UAF University of Alaska Fairbanks
OAP Ocean Acidification Program
Alaska Ocean Acidification Network
Alutiiq Pride Marine Institute