Ocean water and blue mussel (*Mytilus edulis*; yaak*) samples create baseline for climate change and pollution indicators and strengthen data sovereignty for the Tlingit community of Kake, Alaska

Talia Davis[1], Curry Cunningham[1], Elizabeth Figus[2]

1. University of Alaska Fairbanks, College of Fisheries and Ocean Sciences
2. University of Alaska Fairbanks, Alaska Center for Climate Assessment and Policy

Introduction

The Organized Village of Kake (OVK), Kake Tribal Corporation (KTC), and the City of Kake partnered with the Alaska Center for Climate Assessment and Policy at UAF to undertake investigation of climate change and environmental effects of pollution in and around Kake, Alaska between 2020 and 2022. From June to October 2020 the partnership focused on the implementation of a community-led ocean monitoring program, with Kake residents leading ocean water sampling and mussel (*Mytilus edulis*; yaak*) collection. Ocean water samples were collected and analyzed for: temperature; salinity; pH; Dissolved Metals; Total Mercury; Nitrogen; Ammonia; and Fecal coliform. Blue mussel tissues were also collected and analyzed for Total Metals; Total Mercury; PST (Paralytic Shellfish Toxins, specifically saxitoxin); and Nitrogen. This data will be added to OVK's climate and ecological archive and further strengthens the tribe's data sovereignty. It will form a baseline for future data collection and analysis of this data will provide insight into the condition of the ocean around Kake and potential impacts on subsistence species and Kake community members.

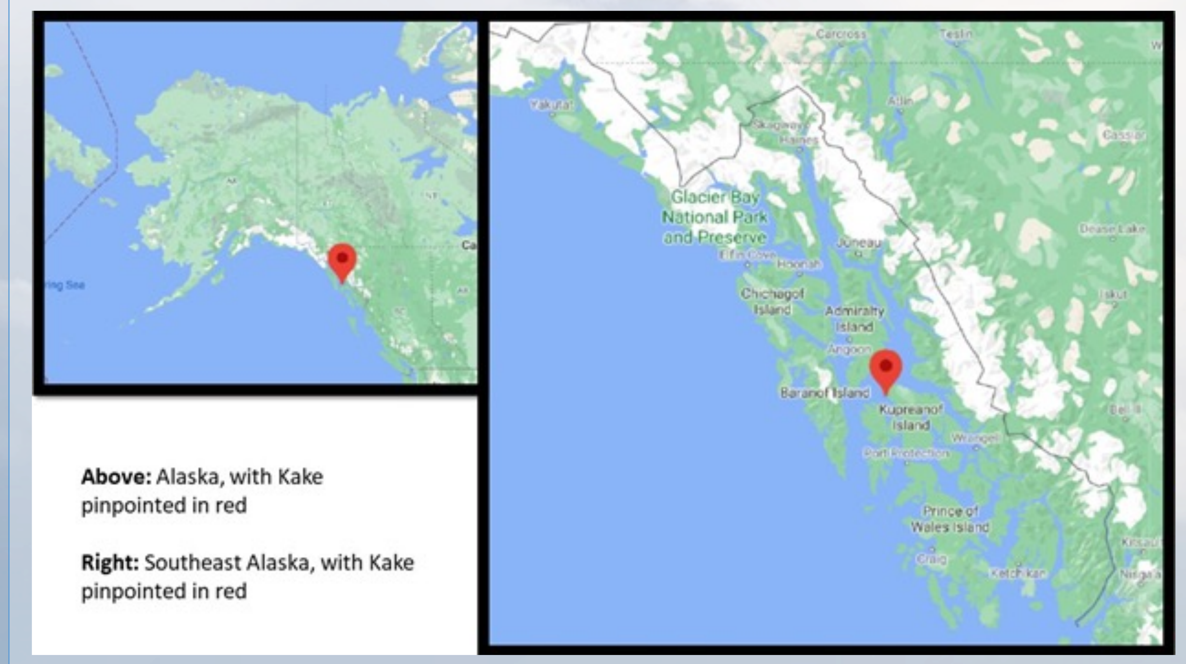

Figure 1. Maps displaying the location of Kake, Alaska.

Research Questions

Primary research questions:
What are the baseline levels of heavy metals, fecal coliform, PST and mercury in the waters and mussels around Kake?

Analysis Questions:
Do heavy metal, fecal coliform, PST and mercury concentrations differ among sampling locations or across the 2020 sampling period (June-October)?

Discussion questions:
What do these levels tell us about potential pollution and the impacts on community members and subsistence species?
What do these data tell us about possible climate change effects?

Materials and Methods

Materials

- Primary sampling equipment included:

Figure 2. Primary sampling equipment: A) Fieldmaster Basic Water Bottle, B) Dr. Meter pH meter PH-100V, and C) YSI Pro 30.

Steps for water sampling

- There were two types of water sampling events: S1, shore (Pt. MaCartney) and S2, approximately 13 miles from Kake (Pilot boat location)

Materials and Methods cont.

Figure 3. A map displaying the ocean water sampling sites S1 and S2 and the mussel collection sites Pt. White Jr. and Town Flats.

- All water sampling events consisted of individuals devoted to the following positions: logbook, clean hands, dirty hands, and YSI and pH
- At shore events, samples were collected at a depth of one meter
- At offshore events, samples were collected from a depth of one meter and 6.1 meters
- Once samples were collected, they were stored in a fridge (at between 2 and 6 degrees Celsius) until they could be sent to the lab for processing

Figure 4. Left: A sampler holding the grab sampler at the S1 site. Right: Samplers collecting an ocean water sample at the S2 site.

Steps for mussel collection

- Mussel samples were collected from two sites, one near the shore site for water (Pt. White Jr.) and one located in town (Flats)
- Mussels were selected based on collecting a consistent size throughout the season
- Approximately 30 mussels were collected during each sample event
- Once collected, mussels were soaked in sea water from the collection site for approximately 30 minutes and then the water was drained
- Mussels were shucked with nonmetallic tools and frozen prior to sending to labs for processing

Figure 5. Left: Mussels before shucking. Right: Mussels after shucking.

Data Analysis

Data was analyzed using Microsoft Excel during the fall of 2020. A review of relevant literature and local and regional data is ongoing to compare our data with relevant thresholds.

Results

- Ocean water and mussel tissue samples were tested for heavy metals, including: Cadmium, Chromium, Copper, Lead, Nickel, Silver, Zinc, in addition to Mercury, Fecal Coliform, and PST
- **RL:** Reporting Limit, the lowest concentration of analyte reportable by lab considering dilution or other factors
- **MDL:** Minimum Detection Limit, the lowest concentration an analyte can be detected in a sample as determined by method or study
- **ND:** Not Detected at the reporting limit
- **CMC:** Criterion Maximum Concentration, the EPA's recommended highest amount before posing significant risk to aquatic species

Tissue

- All heavy metals, along with mercury and PST, were detected at least once in tissue samples
- Mercury was detected in one mussel sample but was less than the RL but greater than or equal to the MDL
- Mussels showed average/low levels of PST compared to local and regional data collected by SEATOR

Water

- NDs were common and were observed multiple times in every analyte
- Heavy metals that exceeded the EPA's CMC at least once in ocean water samples: Copper and Zinc
- Mercury was observed in one water sample but was less than the RL but greater than or equal to the MDL
- Fecal coliform was observed in two unique sample events (out of 15 total events), both of which were collected at S1

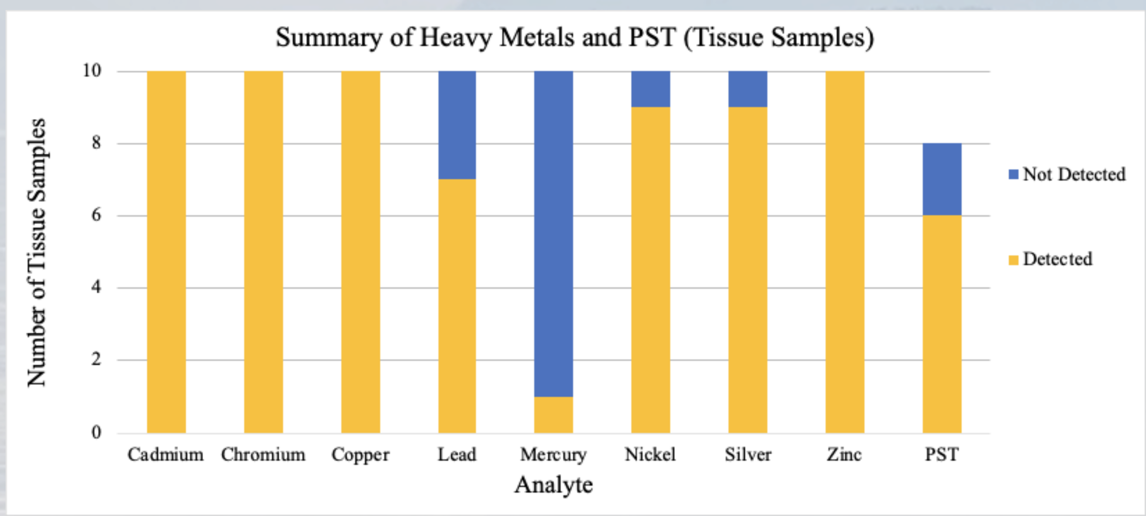

Figure 6. A graph summarizing heavy metals and PST within mussel tissue samples. All analytes were either detected or not detected.

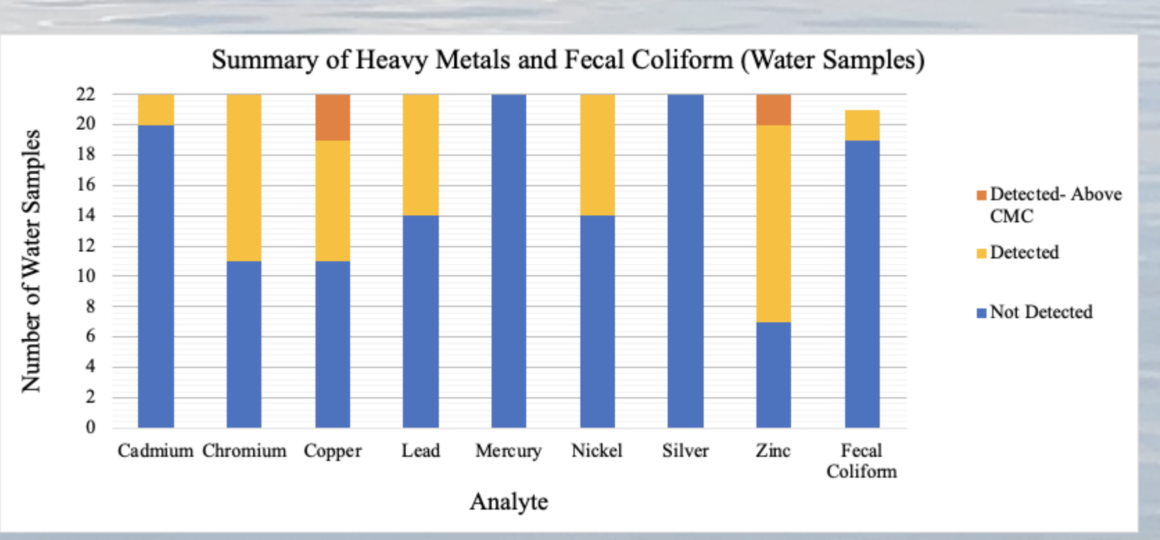

Figure 7. A graph summarizing heavy metals and fecal coliform within water samples. Heavy metals are characterized as being not detected, below their CMC, or above their CMC. Fecal coliform is either detected or not detected.

Conclusions

What are the standard levels of heavy metals, fecal coliform, PST and mercury in the waters and mussels around Kake?

- This dataset indicates relatively low concentrations of fecal coliform, heavy metals, and mercury in the ocean water surrounding Kake
- This dataset indicates the presence of heavy metals, PST, and mercury in mussels around Kake, but more samples are required to determine an accurate baseline
- The observation of many NDs is important when considering the impact of reduced ship traffic during the 2020 field season due to the Covid-19 pandemic

Do heavy metal, fecal coliform, PST and mercury concentrations differ among sampling locations or across the 2020 sampling period (June-October)?

- Additional samples are required to quantify seasonal changes
- Changes in analyte concentration at different locations and over time were dependent upon the analyte, time, and location
- More observations are required to answer the question of whether analyte concentrations differ across locations and time

What do these levels tell us about potential pollution and the impacts on community members and subsistence species?

- All heavy metals that were tested for have the potential to impact the biological species that live in the ocean water surrounding Kake
- High concentrations of Copper in water can impact salmon, an important subsistence species, and their olfactory senses[1]
- Increasing frequency and magnitude of PST levels in subsistence shellfish species pose a threat to community members
- Accumulation of heavy metals in seal, another important subsistence species, can impact both the animal and the people consuming it[2]

What do these data tell us about possible climate change effects?

- Ocean water and mussel samples, along with the analysis of salinity, temperature, and pH data are needed to determine any climate change effects
- Long-term data sets, paired with regional data, will be crucial in determining the effects of climate change around Kake

Future Research

- Logbook information and YSI results are currently being analyzed; this includes salinity, temperature, and pH readings from each sample event
- Third party data review is ongoing (checking for consistency, flags in the data, etc.)

References

SEATOR database: https://ahab.portal.aoos.org/#layer-data/3603595b-7c36-4df1-8641-e8aeffcbf130/location_id:town_flats

EPA table: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table - main-content

[1] Baldwin, D. H., Sandahl, J. F., Labenia, J. S., & Scholz, N. L. (2003). Sublethal effects of copper on coho salmon: impacts on nonoverlapping receptor pathways in the peripheral olfactory nervous system. *Environmental Toxicology and Chemistry: An International Journal*, *22*(10), 2266-2274.

[2] Jakimska, A., Konieczka, P., Skóra, K., & Namieśnik, J. (2011). Bioaccumulation of Metals in Tissues of Marine Animals, Part I: the Role and Impact of Heavy Metals on Organisms. *Polish Journal of Environmental Studies*, *20*(5).

Acknowledgements

This project is supported by funding from: The Alaska Center for Climate Assessment and Policy (ACCAP), a Regional Integrated Sciences and Assessments program of the National Oceanic and Atmospheric Administration, award NA16OAR4310162; The United States Department of Agriculture Hatch Grant, award 341261-63110; The Organized Village of Kake (OVK); The Kake Tribal Corporation; The City of Kake; the Indian General Assistance Program (IGAP; CFDA 66.926) at OVK; a Bureau of Indian Affairs Ocean and Coastal Management Planning Grant (held by OVK); the TRAYLS/YCC program (funded through the United States Forest Service, the Sustainable Southeast Partnership, and SEALASKA); and the International Arctic Research Center, at UAF; the University of Alaska is an AA/EO employer and educational institution and prohibits illegal discrimination against any individual: www.alaska.edu/nondiscrimination. We would also like to thank the 2020 ocean monitoring sampling team for their time and hard work.

*Yaak is the Tlingit word for mussel.