Salmon on the Beamlines

V. Bajaj, I. Chan, I. De Lazzari, A. Iacob, S. Mar, E. Paulo, C. Rizzo, D. Sawyer, R. Shuai, D. Ting, H. Yan, J. Yonathan, P. Yu,
J. Muise - St. Thomas More Collegiate
G. Korbas, D. Pelly, M. Buye, T. Walker - Canadian Light Source Inc.

1. Introduction

The health of the salmon population is a reflection of us as stewards of the environment. The Indigenous Peoples of the Pacific Northwest, including the Coast Salish Peoples of the Qayqayt and Kwikwetlem First Nations on whose traditional and unceded territories St. Thomas More Collegiate is located, have maintained a connection with salmon for thousands of years. Fishing industries add hundreds of millions of dollars to the B.C. economy, and salmon serves as an integral part of the ecological system of B.C. by transporting nutrients from the river to sea as well as fertilizing much of B.C.'s old-growth forest.

We chose to research salmon as they are at the heart of British Columbia's culture, economy and environment. Salmon are culturally important for BC's First Nations peoples. Due to their migration, the health of a salmon population can be used to determine the overall health of an ecosystem. We chose to specifically dive into their concentrations of minerals as a way to observe whether or not fish are being negatively affected by industrial runoff from the agricultural and mining industries. Our goal was to examine the fish eye lenses, observe the buildup of elements, draw meaningful conclusions, and of course have fun!

2. Big Questions about Our Project

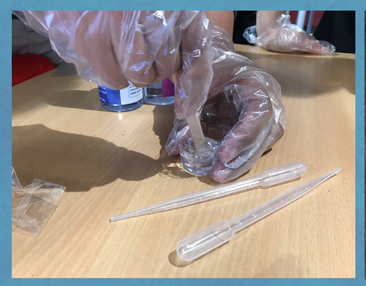
- **What are our major concerns? (why we chose this + who this affects)**
- **How will we prepare for this experiment? (research, resources, sample prep, and technical skills)**
- **What will we find and what will we learn from this project?**

Hypothesis:

The BioXAS-Imaging beamline is capable of detecting chemical differences in eye lenses

3. Process and Samples

- **The goal of analyzing the lenses was to detect traces of metal contaminants in the fish. We chose eye lenses since they are highly concentrated with minerals and contain no moisture, making them less prone to beam damage. Also, by using salmon heads, we minimize our environmental and ethical impact, as fish heads are often an unused byproduct of fishing activities.**
- **Our group consulted with scientist, Dr Gosia Korbas, from the CLS, as well as Professor Karin Limburg from SUNY-ESF. Alumni and teachers provided samples of Chinook and Coho salmon, and water samples from various rivers. Our use of the salmon was deemed as ethical as the fish were caught for the purpose of food, and the heads were simply an unused byproduct.**
- **We first dissected the fish to remove the eye lenses. Then, in order to process the lenses to an optimal thickness for the BioXAS-Imaging beamline, we embedded them in epoxy and then used sandpaper to sand them down to a thickness of ~1mm.**



Preparing samples in epoxy

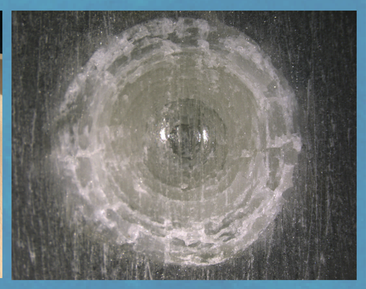
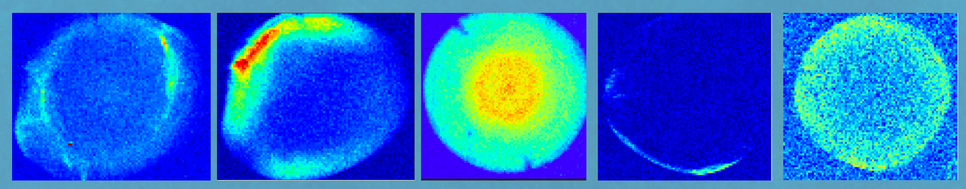
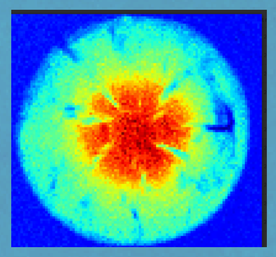


Image of prepared sample

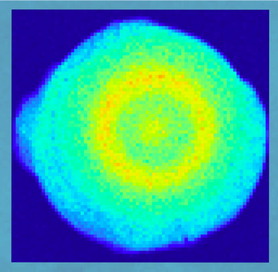
- **The technique used was X-Ray Fluorescence Spectroscopy (XRF), where X-rays are used to excite an electron that is then expelled from the atom. An electron from a higher energy orbital drops down to replace it, emitting energy in the form of a photon. Each element has a unique emission value and we are able to identify each element present from the energy of the photon emitted.**

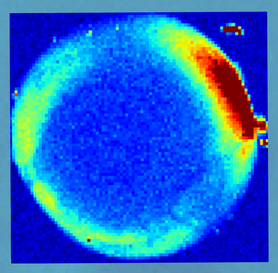
4. Results



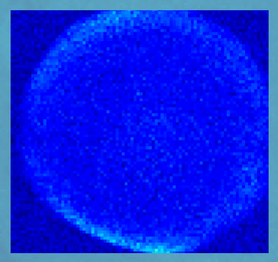


These are scans for selenium (plotted on the colour scale with the same min and max values for comparison) of samples from a Chinook salmon (left) and a Coho salmon (right). The Chinook eye lens tends to have higher selenium concentrations than the Coho. This difference is consistent across all of our samples, leading us to conclude that this trend is consistent between the species.





There is a similar trend in the bromine concentrations compared between Ocean Salmon samples (left) and samples from the Chilliwack River (right). This was also consistent across our samples leading us to conclude that it's consistent across biomes. We hypothesized that this difference in concentration was due to the presence of bromine salts in ocean water.



5. Conclusions

A. Concentrations of Selenium:

- The evidence showed differences in the concentration of selenium in the lenses between Chinook and Coho salmon. In the Chinook samples, there were higher accumulations of selenium in the lenses than those of Coho. A possible reason for this difference is due to their difference in habitat (Ocean vs River).

B. Concentration of Bromine:

- A higher concentration of Bromine was observed in ocean samples compared to those of river water. We hypothesised this could be a result of the time the different fish have spent in salt water as opposed to fresh water throughout their lifespans

3. Presence of Heavy Metals:

- Minimal amounts of heavy metals and elements linked with dangerous pollution were detected in the eye lenses of the fish. Despite the metals being undetected in the lenses, it does not rule out the possibility of harmful chemicals being present in other areas of the fish. It is also possible that the concentration of metals in the lenses were below the detection limit of the BioXAS-Imaging beamline.

4. Future Research Applications

- In the future, other researchers could investigate the elements found in fish that have lived in one location their entire life as well as water samples to paint a more accurate picture of the elements present in the fish's environments.
- This research could possibly be a new option for checking the health of farmed fish when compared to wild fish.

6. Acknowledgements

We would like to acknowledge that the CLS is located in Saskatoon on Treaty 6 Territory in the traditional territories of the Nêhiyawak, Anishinabek, Lakota, Dakota, and Nakota Nations, and the traditional homeland of the Métis. We would also like to acknowledge that St. Thomas More Collegiate is located on the traditional and unceded territories of the Coast Salish Peoples of the Qayqayt and Kwikwetlem First Nations. Our samples originated from the Tsleil-Waututh Consultation Area.

We would like to thank Dr. Gosia Korbas, Dallas Pelly, Mercedes Buye, Tracy Walker, and Dr. David Muir from the Canadian Light Source for helping us with learning to use the CLS. We also want to thank Phillip Lemp, Madie Bouvier, and Dr. Karin Limburg for providing support in the setup of our experiment. From STMC, we would like to thank Brandon De Lazzari for mentoring the group, Arxen Recalde (Grad of 2024) and Philp Lemp (Grad of 2016) for providing the samples, the STMC Parents Association for funding, and Mr. Muise and Mrs. Cameron for chaperoning and guidance.