An Investigation of the Tissue Distribution of Lead in Steelhead Trout

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ABSTRACT

Lead is a metal that interferes with a variety of body processes and is toxic to many organs in humans and other animals. There is a legacy of lead pollution in the waterways of Western New York (WNY). Fish consumption advisories in WNY are partially based on the danger of lead contamination. However, it is not always clear if tissues of the fish that are commonly consumed are as highly contaminated as less commonly consumed tissues. In collaboration with a research team from D'Youville College, we investigated the lead concentration in different tissues of nine steelhead trout caught in the Lower Niagara River. The fish were dissected, and samples of each of the following tissue types were collected: muscle (fillet), liver, gonad, and spleen. Samples were dissolved in nitric acid to release the lead into solution. An Atomic Absorption Spectrometer (AAS) with a graphite furnace module was used to measure lead in the samples to part per million levels. The lead concentrations in each tissue were averaged. Our results show a near to no detection for lead concentrations using our method. While it is encouraging that the fish appear to have very low levels of lead in their tissue, we were not able to conclude that any tissues are less contaminated than others. Future work will focus on contaminants that are expected to be at detectable concentrations based on fish consumption advisory data.

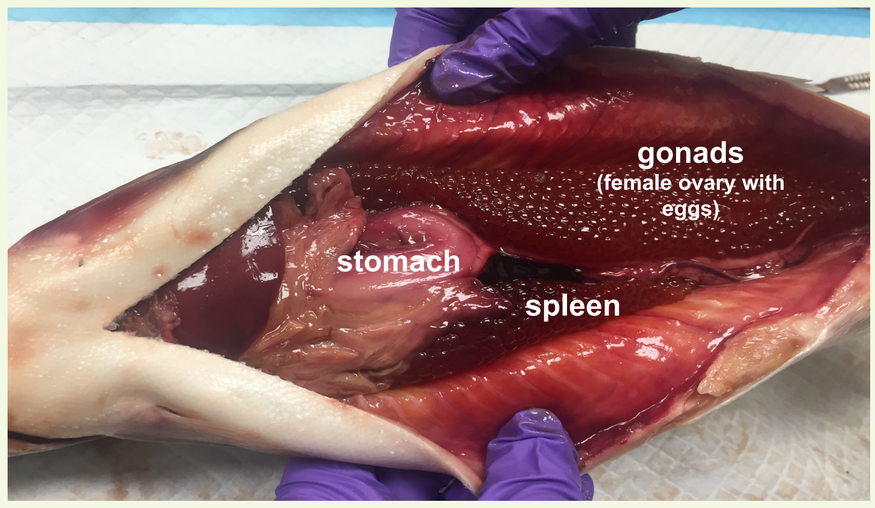
INTRODUCTION

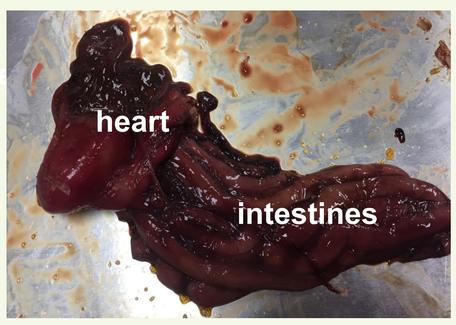
Heavy metals like lead are found naturally in small amounts in the earth. However, industrialization along the Niagara River has emitted higher concentrations of lead into our waterways. Lead can be toxic to humans, causing a variety of health problems. Humans can be exposed to lead through their diet, such as when eating animals that have been exposed to lead. The New York State Department of Health has therefore provided recommendations for fish consumption based on levels of legacy contaminants.

Each body organ has its own set of functions, and thus each organ processes contaminants differently. As a result, different tissues within an animal may contain higher or lower concentrations of heavy metals than other tissues. It is currently unclear whether all tissues of contaminant-exposed fish are equally contaminated with heavy metals, or if certain tissues contain higher heavy metal concentrations than others. For example, one of the roles of the liver is to detoxify chemicals, and so it is plausible that the liver may have higher heavy metal concentrations than other organs.

It has been established that WNY has contaminant lead in the environment. We aimed to study fish caught in the lower Niagara River, and determine whether tissues from different fish organs, some consumed more commonly than others, had differing levels of lead concentrations.

SAMPLE COLLECTION





Figures: A, One female steelhead trout prior to dissection. **B,** Dissected female steelhead trout. Samples of organ tissue were collected from: gonads, spleen, stomach, intestines, liver, heart, muscle, and gills. **C**, Gills removed from fish. **D**, Heart and intestines removed from fish.

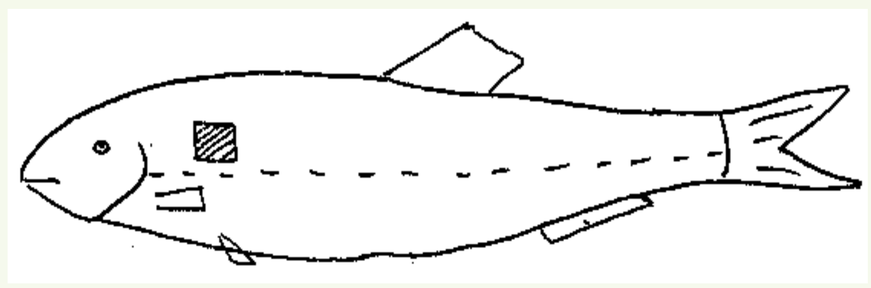
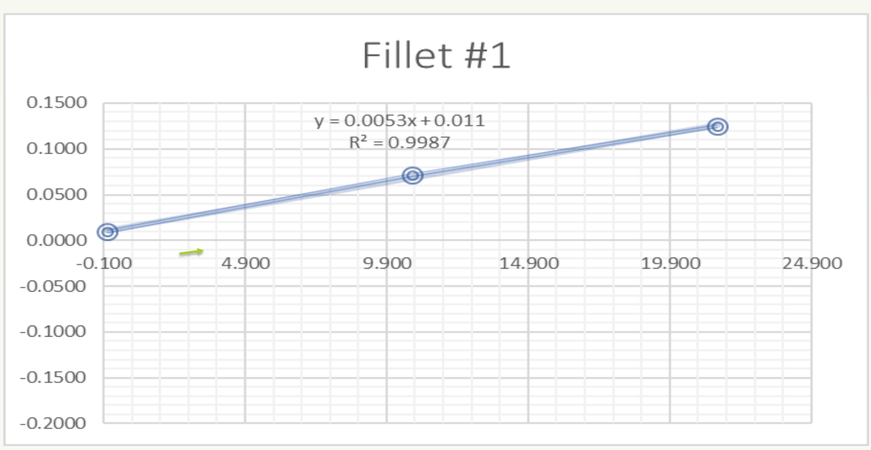


Figure 3: Fish dissection. *Dotted line* shows scalpel cut from 2nd anal fin towards head. Scales (*shaded box*) were collected from above the lateral line (*dashed line*) and between the head and dorsal fin as shown for age of the fish.

RESULTS



The data points on the graph show our standard addition calibration curve in addition to the lead present from the tissue samples. R^2 values indicated that we can be confident in our ability to test for lead ions, that we have a valid methodology, and that our data is reliable. When graphed, y= mx+ b yielded an "X" intersect very close to zero indicating a non-detection limit for our unknown lead concentrations. We had non-detection in almost every sample we tested.

DISCUSSION

The quantification of lead concentrations from fish tissue was obtained through analysis of 3 tissue samples from 3 organs (muscle/fillet, liver, gonads) of 9 fish. Data suggests that we are not reliably detecting lead in our tissue samples. This is not unexpected as lead is not the most important health concern for steelhead trout from the Lower Niagara River. Our AAS detection limit was determined to be 2.57 ng/ml of solution. Upon discussion of results, we realized that we were unsure if our detection level was higher or lower than the limit determined by the World Health Organization (WHO). We determined where our detection range compared to the WHO guideline of 1.75 mg/person/week by calculating the amount of fish per Kg that a person would have to consume per week. We determined that the average person would need to eat roughly 25 kg of fish (56 lbs) per week to meet the WHO threshold for lead.

Upon completion of our lead analysis, we believe we have a reliable methodology and are interested in examining other contaminants that may be potentially found in our tissue samples.

CONCLUSION

Data analysis, using our methodology, indicated that:

- Lead levels are nearly undetectable by our method in tissues of multiple organs of steelhead trout caught from the Lower Niagara River.
- Lead levels are not likely to be a concern for consumption of these fish.

FUTURE WORK

1. Examine other contaminants that are expected to be at detectable concentrations, such as PCB's, based on fish consumption advisory data.

2. Determine whether there are differences in contaminant concentrations in tissues of fish from various WNY waterways (e.g., Lake Erie vs. Lake Ontario).

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