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Title: "Wild: Determining Natal Origins of Juvenile Steelhead Using Otolith Chemical Analysis"

Laurentian Great Lakes steelhead are a complex stock of fish. The population is a mixture of hatchery-released and wild, naturally reproduced fish originating from many different streams. Knowing the natal streams of the fish is important to best managing this species, as it allows for targeted conservation and management to the areas that are the major contributors to the total lake population. Fortunately, we may be able to determine the natal stream of a fish by looking at its otolith.



Figure 1: Juvenile Steelhead (Rainbow Trout, *Oncorhynchus mykiss*)

Otoliths are ear bones of a fish, commonly referred to as "lucky stones." As early as the egg stage, a fish begins to form the largest of the three pairs of otoliths, called the sagittae. The two smaller pairs of otoliths form near the time of hatching are the lapilli and asterisci. Fish accumulate material on their otoliths daily and exhibit yearly growth patterns, similar to rings of a tree. However, the ring pattern on an otolith can be visualized best if you picture it as the layers of an onion since they form concentrically around the core. Otoliths are considered to be metabolically inert, meaning that once the material has been accumulated on the structure it will never be reabsorbed into the body. Subsequently, the otolith acts as a journal containing the entire life history of a fish from egg until death.



Figure 2: Sagittal otoliths from (top) young-of-year fish and (bottom) yearling-and-older fish

How does this help us to determine the natal stream of the fish? There are a few pathways for elements to be incorporated into the otolith of a fish. The primary pathway is through the water. When a fish is filtering water through its gills, some of the elements in the water are taken up into the bloodstream of the fish. Various elements can then be incorporated into the crystalline structure of the otolith. In the Lake Michigan watershed, many of the natal streams have unique water chemistry influenced by surficial geology, bedrock geology, and hydrology. Since water is the primary pathway of elemental uptake, a unique water chemistry in a stream will result in a unique otolith chemical signature for fish in that stream.

My research seeks to determine if otolith signatures can be used to determine the natal streams of steelhead. The work represents a collaborative effort between Central Michigan University and Michigan Department of Natural Resources and is funded by the Great Lakes Fishery Trust. We are exploring the utility of otolith chemistry to determine the natal origins of juvenile fish of known origin. To do so, I collect juvenile fish from 40 sampling sites within the Lake Michigan basin in spring and fall. This represents a comprehensive sampling of the basin targeting the primary contributors to the lake population and the major watersheds.

Once the otolith is removed from the fish, dried, sectioned, and polished, a chemical analysis can be performed through the use of laser-ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). In other words, a laser is used to precisely remove minute particles of the otolith. The otolith “dust” is instantaneously removed from the ablation chamber and carried in helium and argon gas to the mass spectrometer where it is transformed into an ionic plasma. This plasma is then sorted by element mass and quantified to obtain the chemical signature of the otolith at different stages during its life history.

To obtain our results, we take a group of fish whose origins are known and run a computer analysis to determine the accuracy at which we can classify the fish back to their correct natal streams compared to otolith signatures from across the region. Our preliminary results are promising and have proved useful for discriminating fish at the individual stream and regional levels with relatively high accuracy. Hatchery fish also have very unique otolith signatures and can be classified back to their hatchery of origin.

As our data base of otolith signatures increases, we believe that our accuracy will improve. The results of this research paves the way in determining the natal origins and success of adult fish and allows for more effective conservation and management of steelhead themselves and their natal habitats.



Figure 3: Field sampling location