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Otolith Research for Puget Sound

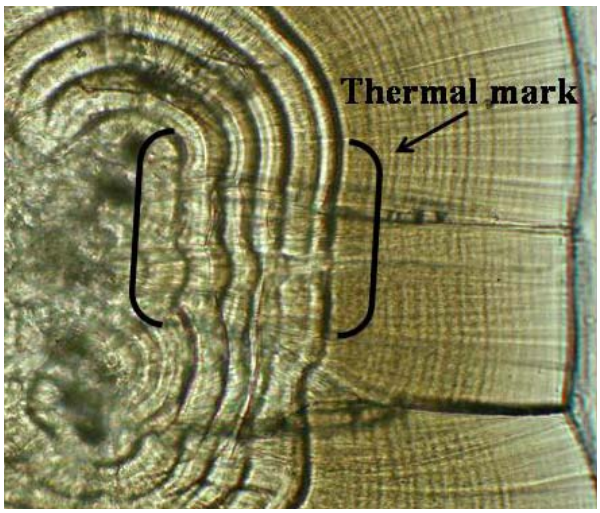
Background

Otoliths are hard structures located in the brain cavity of fish. These structures are formed by a buildup of calcium carbonate within a gelatinous matrix that produces light and dark bands similar to the growth rings in trees. The width of the bands corresponds to environmental factors such as temperature and food availability. As juvenile salmon encounter different environments in their migration to sea, they produce growth increments of varying widths and visible "checks" corresponding to times of stress or change. The resulting pattern of band variations and check marks leave a record of fish growth and residence time in each habitat type. This information helps Puget Sound restoration by determining the importance of different habitats for the optimal health and management of different salmon populations. The USGS Western Fisheries Research Center (WFRC) provides otolith research findings directly to resource managers who put this information to work.

Otolith Applications

Annual Growth

Otoliths have long been recognized as a way to determine the age of fish. Differences in summer and winter growth appear visually on the otolith as light and dark bands called annuli. Additionally, freshwater and ocean growth can be distinguished. For example, a 5-year old fish might have 2 freshwater and 3 ocean annuli visible, indicating the general life history pattern of the individual fish. Individual based growth rates can be determined, since otolith size is related to fish size.



Microstructure: Where did the fish grow up?

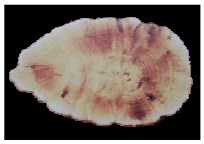
Daily growth increments are used to infer growth patterns and residency time in different habitats (FW-freshwater, D-delta, and B-bay). This type of analysis is also useful in determining the age of very young fish (in days) and whether a fish is wild or from a hatchery.

Fish Identification

Otoliths can be marked with an otolith "tag" by manipulating temperatures to create a unique pattern on the otolith or by bathing the fish in a chemical that leaves a fluorescing band on the otolith. This is useful in identifying individuals from a certain research treatment or hatchery group.

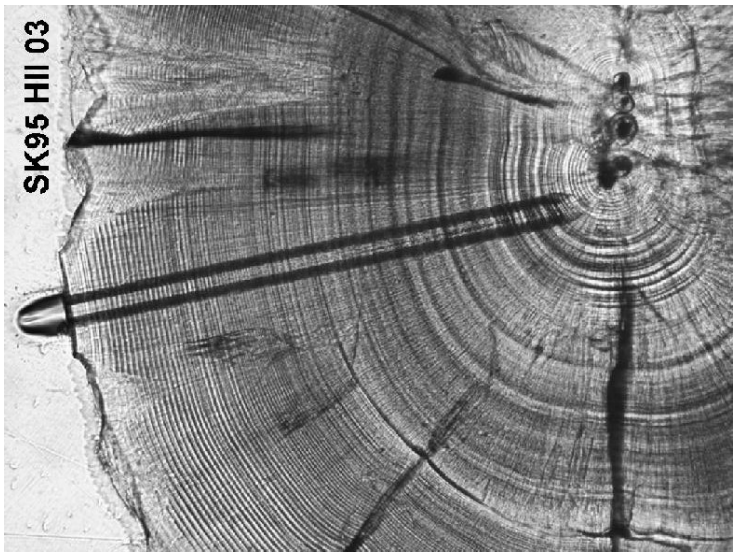
Microchemistry Reveals Details of Habitat Use

Quantities of certain elements (strontium and calcium have been used so far) can be measured from core to edge of the otolith. The results correspond to the migration history of the fish, since different environments have different amounts of these elements which get incorporated into the otolith. This can be used independently or in conjunction with the analysis of daily growth to indicate saltwater entry on the otolith. Since the elemental composition of water from various river systems differs, this technique can be used to discriminate among stocks or determine lake or river of origin. This technique can be applied in verifying the anadromy (salt water migration) of individual fish by looking for a marine signal. It can even be used to identify the maternal life history type (i.e. freshwater (kokanee) v. anadromous (sockeye) based on the signal in the otolith nucleus.



Future Needs

An important USGS focus is to support restoration of Chinook salmon populations in Puget Sound by determining the importance of estuaries as nursery habitat for juvenile fish. This information helps managers and stakeholders choose restoration projects to achieve the most efficient use of limited funds. This knowledge would be developed by documenting variations in estuary habitat use by Chinook salmon populations in Puget Sound and elsewhere. Restoration depends on knowing length of residence and growth of juvenile salmon in various estuaries, and most importantly, how these fish contribute to the adult populations returning to spawn. Other research may focus on life history and growth of Puget Sound forage fish, bull trout, and baseline research on Elwha River salmon before and after removal of dams. Otolith analysis by USGS would be the primary tool, supported with field sampling by various Tribal, federal, and state partners and USGS.



Community Conservation in Action: USGS Partners

- Skagit River-Skagit River System Cooperative, Seattle City Light
- Snohomish River-NOAA Fisheries, Tulalip Tribe
- Nisqually River-U.S. Fish and Wildlife Service, Nisqually Indian Tribe, NW Indian Fisheries Commission, Ducks Unlimited
- Elwha River- USGS (Water Resources Division, Biological Resources Division, Geologic Division, Coastal Division), Lower Klallam Elwha Tribe
- Cedar River-Seattle Public Utilities, Washington Trout, WA Dept. of Fish and Wildlife
- Snake River-U.S. Fish and Wildlife Service, Idaho Fish and Game, USGS, UC Berkeley
- Deschutes River-U.S. Fish and Wildlife Service, Confederated Tribes of the Warm Springs Reservation
- Fisheries and Oceans, Canada-Pacific Biological Station

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