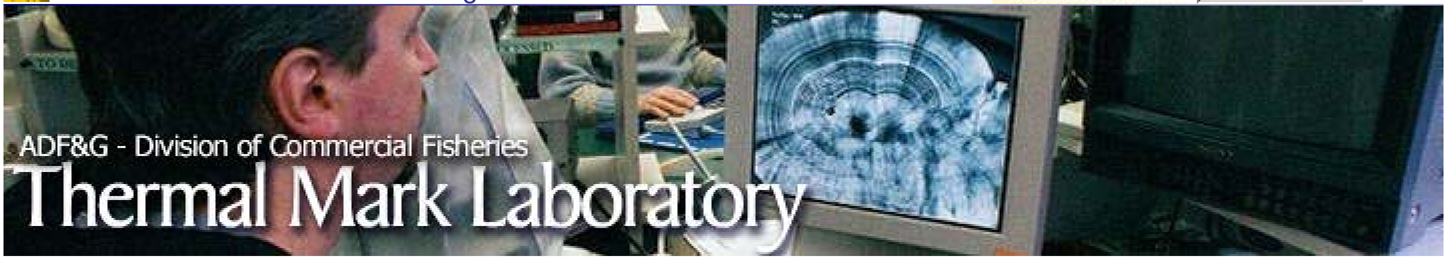

Otoliths and Thermal Marking

Otoliths

Otoliths or "fish ear bones" consist of three pairs of small carbonate bodies that are found in the head of teleost (bony) fish. Otoliths are used by fish for balance, orientation and sound detection, thus they function similarly to the inner ear of mammals.

These pairs of otoliths differ in location, function, size, shape, and structure. The three pairs *(Figure 1)* of otoliths are most commonly called the lapilli, asterisci, and sagittae.

In Pacific salmon, the asteriscus and lapillus are usually quite small, only a millimeter in size, but the sagittae are much larger, ~5 mm. Thus, the sagittae are the most studied. They are often referred to as "the otoliths," although this term more correctly applies to all three structures *(Figure 2)*.

The otolith is a crystal; consequently, it grows by the precipitation of ions on its exposed surfaces. During this process, protein and calcium carbonate are laid down on the surface of the otolith, although the relative amounts vary with time and season. Thin sections of an otolith reveal a detailed microstructure consisting of bands of opaque and translucent material, sort of like the rings on a tree trunk. Fisheries biologists have discovered that they can extract a variety of information about a fish by looking at changes in these patterns. In some cases, these patterns are a natural record; in other cases they are induced by man.

Because otoliths provide useful information on age, growth rate, life history, recruitment, and taxonomy, they are widely used in fisheries management. Fisheries biologists like to think of otoliths as information storage units; a sort of CD-ROM in which the life and times of the fish are recorded. If we learn the code, we can learn about that fish.

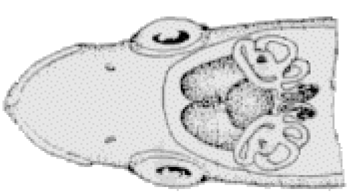

Figure 1.

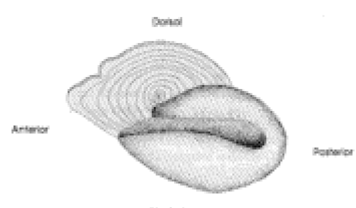

Figure 2.

Thermal Marking Otoliths

What is Thermal Marking?

An otolith is thermal marked by changing the water temperature during incubation. This induces a "dark ring" in the microstructure of a fish's otolith. Usually these rings are created by a rapid temperature decline of at least 3° Celsius followed by a cold interval of 24 to 48 hours. This disrupts normal otolith growth, and when the otolith is viewed under a microscope using transmitted light, a "dark ring" is visible. This ring contrasts sharply with the adjacent, narrow "white ring," which results from the relatively warm portion of the thermal cycle.

By planning a sequence of temperature changes, a hatchery is able to produce a pattern of dark rings in the otoliths of all fish exposed to those temperature changes.

Why Thermal Mark Otoliths?

Thermal marking of otoliths allows fisheries biologists to mass mark hatchery-reared salmon by taking advantage of the otolith's ability to record abrupt changes in temperature.

As of the year 2000, over five billion Pacific salmon have been thermal marked by hatcheries in four countries around the North Pacific Ocean.

This technology has performed extremely well for salmon management programs in coastal fisheries, and high seas researchers are focusing on the use of otolith marks for salmon population studies in offshore waters, where various stocks mingle.

How Can You Find a Thermal Mark?

To find a thermal mark on an otolith, fish must be sampled, then their sagittae otoliths (the largest of the 3 pairs) are removed.

The left sagittae otolith is glued to a glass slide with thermoplastic cement then ground on a grinder.

When the center of the otolith is reached, it is examined under a microscope for the presence of a thermal mark.

Different numbers of rings organized by groups or "bands" to create different patterns indicate the hatchery from which the fish originated.

Other Types of Otolith Marking

Fluorescent Substances

A - Strontium Marking

Thermal marking of otoliths appears to be a benign and universal method of marking embryonic salmonids. It does, however, require that fish be cultured or held for several days or longer. In some instance, it is desirable to quickly mark wild fish or those produced from spawning channels or other large incubation settings where thermal marking is not practical.

Trefethen and Novotny (1963) recommended that stable isotopes be used to create recognizable marks. Since then, several investigators have exposed salmonids to bone-seeking cations, such as strontium chloride by holding them in solutions of strontium or using strontium enriched diets.

Experiments, such as these, have shown that salmonid fishes can be mass marked using strontium solutions at diverse life history stages. The widespread use of this method will depend on its acceptance by federal regulatory agencies.

B - Fluorescent Marks

The Japanese have used alizarin complexone (ALC) to mass mark chum salmon. They used eggs from Syokanbetsu River on the northern coast of the Sea of Japan. Eggs were immersed in for 24 hours in a solution of ALC (200 mgl/l) with 1 N KOH before dilution. These fish were recaptured from 1995-2000 and they were able to observe the fluorescent marks under a UV light microscope.

C - Dry Marks

The dry method of otolith marking is based on periodic changes of the water regime during incubation of the eggs. The eggs are dried in incubators according to pre-determined schedules, usually at 24-hour intervals. During one marking cycle, when one dark and one light ring are formed, the eggs are kept dry for 24 hours (without water, in a humid atmosphere), and washed with water during the next 24 hours. To retain a humid atmosphere and prevent abrupt changes in temperatures, the incubators should be covered with a plastic film or some type of heat-insulating material.

Eggs may be marked using this method during the eyed-egg stage until hatching. In Russia, where this technique has been used the most, this period lasted from 20-35 days.

The flaw of the dry marking method is that it cannot be used for marking salmon larvae and fry. But, in general, the method is simple, convenient and requires no special equipment.

Procedures:

Otolith Port Sampling Manual 192 KB
The Otolith Port Sampling Manual details steps to be taken to prepare otolith specimens for laboratory processing. Field collectors should follow these to ensure the successful processing and reporting of their samples.

Online Reports:

Mark Summary Report
The Mark Recovery Report provides information regarding the number of thermally marked salmon recovered from Alaskan and Canadian commercial and test fisheries in southeastern Alaska. This report gives you the option of selecting the fishery

year, species of fish, the sampling district, and stat week.

Voucher Summary Report

The Voucher Summary Report shows details of thermal marks induced in Alaska hatchery salmon fry. Facility operators attempt to create a specific mark pattern in groups of their developing fish using methods such as shifting water temperature. They strive for a particular "target" mark of a specific pattern chosen to be readily identifiable. After attempting inducement, salmon samples are collected and sent to the Mark Lab for analysis. The actual marks that were found in the specimens are reported here. Images of representative specimens are also displayed for selected samples.

Note:

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