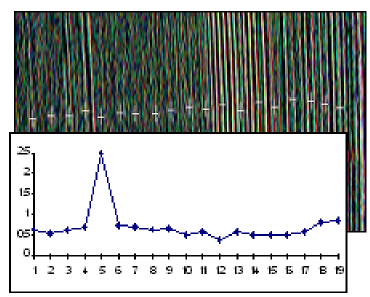
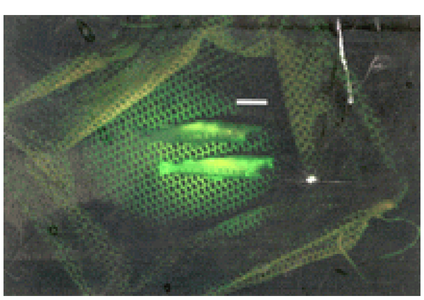
Evaluation of strontium and calcein for marking hatchery and wild juvenile chum salmon

Mass marking of hatchery chum salmon has been identified as a critical need for effective management of large-scale enhancement, to assess ecological and genetic interactions of hatchery and wild stocks and assure enhanced chum production is adequately marked. Presently the accepted method of mass marking and identifying hatchery fish is otolith thermal marking. This technology is being applied in hatcheries in Alaska, Japan and Russia which release nearly 1 billion otolith marked salmon yearly. However, the practical number of unique mark codes that can be applied is limited due to various factors of embryonic otolith development such as the physical size and the relatively short time available for inducing marks. The ability of readers to visually recognize marks is also limited. As more facilities utilize this technology, mark duplication will become more common. In addition, remote enhancement projects or studies of wild salmon stocks cannot usually implement this technology as it is not feasible to install and operate the heating or chilling equipment needed to induce otolith marks. The development of alternate techniques to mass mark chum salmon are needed, either as an adjunct to thermal marking or as a main marking tool for research on remote or wild stocks.

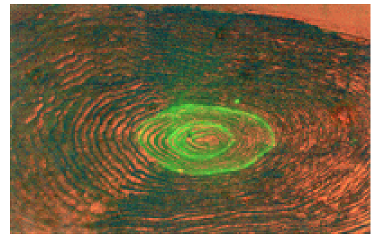
This project (initiated in 2003) investigates the feasibility of marking juvenile chum salmon using immersion exposure to solutions of strontium and calcein, two compounds that have shown promise for mass-marking in other fish species including salmonids. The project will test the efficacy of different immersion times or dosages of strontium and calcein under varying environmental conditions in order to develop and establish protocols for use.



When fish are exposed to strontium or calcein by immersion or ingestion, these chemical compounds are absorbed and incorporated into calcified structures such as otoliths, fin rays, vertebrae, and scales. Once incorporated into these anatomic structures, the compounds are stable and concentrations reportedly do not diminish with age. A microprobe-equipped electron microscope is used to detect and quantify strontium contained in the calcified structures. The picture and graph to the right shows a radial transect on a juvenile salmon otolith, along which the microprobe has sampled otolith material for strontium concentrations. The large spike in strontium level on the graph indicates the fish was marked with strontium. Calcein, on the other hand, fluoresces under ultraviolet light and can be detected in calcified structures using fluorescence microscopy.



The photo (left) shows an unmarked and a calcein marked fish. The boney structures in the jaw, operculum and fin rays glow under filtered ultraviolet light.



The picture at the right shows the scale of a salmon which was marked by calcein immersion on two separate occasions (note the two distinct fluorescent bands). Use of either of these compounds provides researchers with permanently marked fish. Potential applications are mass marking in hatcheries as an adjunct marking method to otolith thermal marking, and marking fish from remote enhancement projects or wild fish where thermal marking is not feasible.
For our project juvenile chum salmon were obtained from the Douglas Island Pink and Chum, Inc, Ladd Macaulay hatchery near Juneau, Alaska. These fish were exposed to strontium and calcein of varying concentrations and immersion times. The results of the immersion times and solution concentrations for strontium and calcein will be used to develop an experimental design to examine the effects of varying water temperature and salinity on marking efficacy.

The outcome of this project will provide hatchery managers and researchers with better tools needed to successfully implement marking programs in wild or hatchery populations of chum salmon. This will allow hatchery managers and researchers to evaluate the survival success of different rearing strategies; improve the study of stock specific growth rates, migration route and rates; and increase management resolution for fisheries harvesting mixtures of hatchery and wild fish. It also improves researchers ability to examine the interaction of hatchery produced and wild salmon and determine the results of enhancement on wild fish production and survival.

Improved mass-marking technology enhances management resolution for mixed stock fisheries so that harvest strategies can maximize harvest opportunity of hatchery fish without over-harvest of co-mingled wild stocks. Improved mass-marking will also help research efforts to understand the ecological interactions of wild and hatchery chum salmon to ensure that their impacts on wild productivity is minimized. These outcomes increase the capability to sustain both salmon fisheries and the salmon populations that form the basis for the resource.