PROJECT CROOS
Collaborative Research on Oregon Ocean Salmon

www.PacificFishTrax.org & www.projectCROOS.com

Otolith Project Summary *(as of June 14, 2010)*

Jessica A. Miller

Summary

A component of ProjectCROOS involves an on-going effort to determine the feasibility of providing relevant information on the ocean ecology of Chinook salmon using otolith structural and chemical analyses. Otoliths are crystalline structures comprised primarily of calcium carbonate, located in the inner ear of bony fishes, which function as balance organs. Otoliths grow by continuous deposition of calcium carbonate, which generates growth increments much like the annual rings in trees. Therefore, an otolith provides a permanent chronological record. If fish reside in water masses with different chemical compositions and/or temperatures, those properties are reflected in the otolith composition. Certain elements, such as strontium and barium provide different types of information about the life of an individual fish. Studies that examine a suite of elemental ratios, such as Ba:Ca, Sr:Ca, and Mg:Ca, within otoliths can provide information on whether fish collected from different areas mixed together during past periods. By measuring the strontium and oxygen isotopic composition in otoliths, we can generate relative information about natal sources, maternal run timing, and the temperature of the waters in which the salmon lived. By examining the concentration of Sr:Ca across the otolith growth axis, we can determine when an anadromous fish, such as Chinook salmon, entered the ocean can be determined. These chemical analyses can be combined with microstructural analysis, which is the counting of daily or annual increments within the otoliths, to provide information about discrete periods in the life of a fish. Therefore, otolith chemical and structural analyses can be combined to provide novel information on individual life histories.

Progress

- ⇨ Chemical information has been collected from over 200 CROOS otoliths to develop a methodology for reconstructing juvenile migratory history and examining the relative contribution of distinct juvenile migration patterns to the adult Central Valley Chinook salmon population.
- ⇨ Chemical information from CROOS otoliths contributed to the development of a methodology to differentiate between spring and fall Chinook salmon based on their otolith strontium isotopic composition.
- ⇨ Preliminary data on oxygen isotopic composition of ProjectCROOS otoliths from the Rogue River, mid-Columbia River, and Central Valley Chinook salmon stocks identified distinct patterns within stocks, which indicate that this marker may provide information on stock-specific ocean migration patterns.
- ⇨ A summer intern from the National Science Foundation's Research Experience for Undergraduates (NSF REU) program worked with Oregon State University researchers in Newport and Corvallis to collect additional information on the oxygen isotopic composition of otoliths from the Rogue River, mid-Columbia, and Central Valley stocks. She presented her results at the 2010 Ocean Sciences meeting in Portland, Oregon.

Results to Date

- ⇨ A manuscript detailing the methodology to differentiate between spring and fall Chinook salmon based on their otolith strontium isotopic composition was published in Fisheries Research in 2009.

Miller, J. A. and A. J. R. Kent. 2009. The determination of maternal run time in Chinook salmon (*Oncorhynchus tshawytscha*) based Sr/Ca and 87Sr/86Sr within otolith cores. Fisheries Research. 95:373-378.

⇨ A manuscript describing the method for reconstruction of juvenile migratory history based on otolith chemistry and structure was published in Marine Ecology Progress Series in 2010. We focused on adults from the Central Valley fall Chinook salmon. In the Central Valley, the majority of naturally spawned fall Chinook juveniles leave their natal rivers in 2 pulses: (1) as small juveniles (referred to as fry) that leave freshwater early in the year and (2) as larger juveniles (smolts) that leave freshwater later in the spring. Hatcheries release predominantly larger (smolt-size) juveniles. Although there is little information on how well these groups of naturally-produced juveniles survive, much of the CV water and hatchery management efforts are focused on survival of the larger juveniles. Using otolith chemistry, we determined the juvenile migration pattern of the CV fall adults collected by ProjectCROOS. We found that the adult sample was comprised of individuals that emigrated at intermediate sizes (48%), followed by the larger smolts (32%) and the smaller fry (20%). A significant point is that the smaller, fry-sized emigrants likely represent natural production because hatcheries don't release many fish at those small sizes. Given recent estimates that natural production comprises a relatively small proportion of the adult return to the Central Valley (as low as 10%), the fry migrant contribution may represent a substantial portion of the natural production. We conclude that the contribution of juveniles with distinct migratory patterns to the adult population indicates that management and recovery efforts should focus on the maintenance of life history variation.

Miller, J. A., A. Gray and J. Merz. 2010. Quantifying the contribution of juvenile migratory phenotypes in a population of Chinook salmon *Oncorhynchus tshawytscha*. Marine Ecology Progress Series 408:227-240.

⇨ A manuscript presenting a study that combined the GAPS baseline with otolith chemistry to examine the stock composition of adult Chinook salmon in the Elk River terminal fishery was published in Fisheries Research in 2010. Here, we provided an estimate of mixed stock composition at finer spatial scales than previous approaches had accomplished. This allowed us to examine stock composition around a spatial management boundary and provide some empirical information on the efficacy of that boundary as a management tool.

Miller, J. A., M. R. Bellinger, J. T. Golden, L. Fujishin, and M. A. Banks. 2010. Integration of natural and artificial markers in a mixed stock analysis of Chinook salmon (*Oncorhynchus tshawytscha*). Fisheries Research 102:152-159.