DELTA SCIENCE FELLOW 2020

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Sea Grant California

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WHY THIS RESEARCH MATTERS

Recent population declines in threatened longfin smelt have been tied to a variety of factors, including reduced freshwater outflow and food availability. However, more information is needed on the early life stages of these fish and how growth and survival are impacted by environmental conditions. New methods that apply linked age and chemical analysis of otoliths allow for detailed reconstructions of the environmental conditions experienced by even long-dead specimens. Using these new approaches, researchers can now gain extensive information on an individual's prior movements and life-history.

Defining habitat quality for young-of-year longfin smelt: historical otolith-based reconstructions of growth and salinity history in relation to geography, climate, and outflow

A high-resolution composite image of a larval Longfin Smelt. Note the otoliths present in the cranial cavity and the presence of the characteristic "triangular" swim bladder.

PROJECT

This project aimed to use experiments to develop new otolith-based tools for longfin smelt and to then apply them to an extensive collection of archived wild Longfin Smelt specimens, to build a better understanding of longfin smelt life history, habitat use, and the interactions between stressors and abundance. In addition, the project aims to improve the understanding of how longfin smelt populations are affected by freshwater outflow. The project also aims to provide tools to support and evaluate habitat restoration, and facilitate development of a plan to recover this threatened species.

RESULTS

Lewis first used laboratory experiments to validate new otolith-based techniques to assess the age, hatch date, growth rate, salinity, and movements of longfin smelt. These otoliths (ear bones) grow continuously through a fish's life, which creates a record of their growth rate as well as information about their chemical environment, much like a tree ring.

Using these new tools, Lewis analyzed otoliths of fish collected throughout the San Francisco Estuary to assess variation in growth and habitat use. Results identified several life-history strategies used by longfin smelt in the San Francisco Estuary. While most of the smelt migrated from freshwater to higher salinity water at around 150 days after hatching, there was wide variation in the locations and salinity of waters where they hatched or reared. This variation is supported by other recent embryological studies and could be important for population resilience in a changing climate.

MANAGEMENT APPLICATIONS

Results from this project will be integrated into the Longfin Smelt Management, Analysis, and Synthesis Report, which will be used to determine federal listing status and inform adaptive management of freshwater flows for fishes in the upper San Francisco Estuary. Furthermore, results are being used to inform the new Longfin Smelt Science Program being developed by the California Department of Water Resources and California Department of Fish and Wildlife as a requirement of the Incidental Take Permit as a requirement for the operation of the California State Water Project export facility. Results of this work are contributing to on-going research examining the consequences of interannual variation in climate on the growth and movements of this imperiled fish.

Above: Multiple life stages of male and female Longfin Smelt from the San Francisco Estuary.

Below: A whole otolith in the sagittal plane. The dorsal lobe (top) is the most consistent region used for otolith age and chemical analysis.

SELECT PUBLICATIONS AND PRESENTATIONS

Lewis LS, M Willmes, J Hobbs et al. In Prep. Growth and migration of larval and juvenile Longfin Smelt in the San Francisco Estuary. Limnology and Oceanography.

Lewis LS, M Willmes, A Barros, P Crain, J Hobbs. 2019. Newly discovered spawning and recruitment of threatened Longfin Smelt in restored and under-explored tidal wetlands. Ecology. https://doi.org/10.1002/ecy.2868

Lewis LS. 2020. Utilization of Multiple Tracers to Reassess the Life-History, Movements, and Connectivity of Threatened Osmerid Smelts in San Francisco Bay. Lecture - Biannual Ocean Sciences Meeting. San Diego, CA.

Lewis LS. 2019. A fish-eye view of habitat quality in San Francisco's brackish tidal wetlands. Lecture - State of the Estuary Symposium, Oakland CA.

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