

DELTA SCIENCE FELLOW 2017



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WHY THIS RESEARCH MATTERS

Sacramento River winter-run Chinook salmon have been listed as endangered since 1994. Historically, the fish spawned during summer in cool tributaries upstream of the Sacramento, but dams have limited spawning habitat to a small reach of the river. Today, climate change poses additional challenges to winter-run salmon, because of an increase of drought frequency and water temperature in the current spawning grounds. Knowing which habitats may be available in drought and non-drought years and identifying the migratory pathways used by successful individuals during contrasting conditions is a key management goal.

Monitoring Sacramento River winter-run Chinook salmon life history diversity, growth, and habitat use among varying hydroclimatic regimes



The Shasta (left) and Keswick (right) dams prevent winter-run Chinook salmon from spawning in the cold waters of the upper Sacramento River basin. *Pedro Morais*

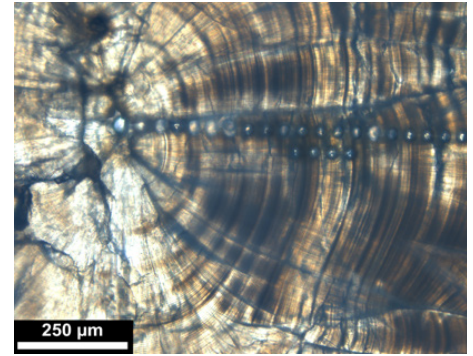
PROJECT

This project tackled two outstanding questions about winter-run salmon ecology. The first was how winter-run Chinook use different rearing habitats during drought and non-drought periods, and the second was to explore which habitats provide enhanced growth during drought and non-drought periods.

To answer these questions, UC Berkeley post-doc Pedro Morais used isotopic analysis of otoliths, or fish ear bones, which grow continuously throughout their lives and therefore carry a record of their environment and growth. Using otoliths, researchers can reconstruct details of fishes' lives, including water temperature and migration patterns.



The carcass of an adult winter-run Chinook salmon collected downstream from the Keswick dam in the Sacramento River. The fish earbones (otoliths) are extracted from the carcasses to reconstruct how different habitats and migration behaviors contribute to survival into adulthood. *Pedro Morais*



A sectioned otolith from an adult Chinook salmon shows the daily increments that provide information on fish age and growth (much like tree rings). The chemical composition of the otolith is used to reconstruct fish movement and then paired with fish growth in different habitats as the salmon migrate from where they were born to the ocean. The round spots on the otolith are the marks left by the laser used to analyze the otolith's chemical composition. *Pedro Morais*

RESULTS

This project was the first to estimate differences in winter-run growth during periods of drought and non-drought, and assign each individual into their brood year since 2 and 4-year-old fish might be present in each escapement year.

MANAGEMENT APPLICATIONS

As climate change progresses, droughts are expected to increase in California's Central Valley, making it even more difficult for water managers to balance the many needs for water. The results of this project will provide state and federal agencies and the Delta Conservancy with valuable information for securing a healthy ecosystem that supports both winter-run Chinook salmon as well as a reliable water supply.

RESEARCH MENTOR

Stephanie Carlson, University of California, Berkeley

COMMUNITY MENTOR

Rachel Johnson, NOAA Fisheries and University of California, Davis

SELECT PUBLICATIONS AND PRESENTATIONS

Morais P, Sturrock AM, Phillis CC, Whitman G, Carlson SM, Johnson RC (2018) Death on two legs: featuring the Sacramento River winter-run Chinook salmon during the 2012-2016 drought. Episode II. *10th Bay-Delta Science Conference*. Sacramento, CA (USA), September 11.

Morais P, Sturrock AM, Phillis CC, Whitman G, Carlson SM, Johnson RC (2018) Living to tell a drought story: featuring the Sacramento River winter-run Chinook salmon. Episode I. *6th International Otolith Symposium*. Keelung (Taiwan), April 16.

Morais P, Dias E, Cerveira I, Carlson S, Johnson R, Sturrock AM (2018) How scientists reveal the secret migrations of fish. *Frontiers for Young Minds* 6: 67. doi: 10.3389/frym.2018.00067.

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