

California's lost Salmon: Reconstructing fish life history using strontium isotope analysis

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Chinook Salmon (*Oncorhynchus tshawytscha*) are an iconic anadromous fish species and are an important part of the fisheries and the present and past cultures along the Pacific. In California, salmon populations are at a critical juncture, with many populations rapidly declining due to a combination of interacting factors, including long term climatic shifts, blockage and degradation of habitats, and overfishing. Conservation and management of salmon depends on our understanding of their life history and migratory patterns and geochemical tracers are well-suited to address these questions.

Otoliths (fish ear bones), are small calcium carbonate structures in the inner ear of most bony fishes. Otoliths accrete daily layers throughout the life of a fish, are metabolically inert, and incorporate trace elements from the environment. Consequently, geochemical analysis of otoliths allows the time-resolved reconstruction of fish life history movements between different environments. Strontium isotope ratios ($^{87}\text{Sr}/^{86}\text{Sr}$) are a particularly useful geochemical tracer, because they vary between different watersheds, based on the age and composition of the underlying bedrock geology and are not affected by physiological processes during incorporation into the otolith.

Here we analyzed $^{87}\text{Sr}/^{86}\text{Sr}$ isotope ratios from modern and historic Chinook Salmon from the Central Valley, California, to determine their origins and life history strategies. Using baseline maps and mixing models we reconstructed the use of different watersheds in freshwater systems and the use of varying salinity habitats in the San Francisco Estuary. Furthermore, we were able to quantify the contribution of hatchery origin fish to the wild population which is of direct management concern. By combining life history reconstructions with environmental and climatic data, we can investigate the underlying drivers and mechanisms of different migratory patterns, which is important for more effective management and conservation of salmon.