Reconstructing migratory histories and age of Chinook salmon from the Yukon River and northern Bering Sea with oxygen isotopes and trace elements in otoliths

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Otolith chemical constituents are used reconstruct the migratory history and age of Yukon River Chinook salmon. High resolution spatial maps of zinc (Zn), strontium (Sr), and the crystalline structure of Chinook salmon otoliths were constructed with synchrotron-based hard X-ray microprobe analysis of fluorescence and diffraction. These maps reveal the complex spatial distribution and seasonality of Zn that stems from its association with otolith protein and the highlights the connection between otolith protein and crystalline structure of Chinook salmon otoliths. Otolith δ18O was measured with secondary Ion Mass Spectrometry (SIMS) and molar ratios of zinc and calcium (Zn:Ca) and strontium and calcium (Sr:Ca) were measured with laser-Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS). Zn:Ca covaried with seasonal temperature fractionation of δ18O within freshwater and marine habitats due to the association of Zn with growth and validates its use in age assignments of Chinook salmon. The combination of Zn:Ca and Sr:Ca was used to resolve freshwater and marine ages of Chinook salmon. Age designations based on trace elments indicate that 55% of the adult Chinook salmon examined from the Teslin River (a tributary within the Upper Yukon River drainage) and 8% of the juveniles in the northern Bering Sea were estimated to exhibit a subyearling migration pattern. The proportion of subyearling Chinook salmon in the Teslin River is of particular importance as this migratory type is not thought to be present in wild Chinook salmon stocks within the Yukon River.