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Natal origins of nonnative walleye in the Upper Colorado River basin

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Nonnative fishes are considered a primary threat to the recovery of Colorado River large bodied endangered fishes. In-river removal efforts have been challenging and unlikely to be successful unless in-river reproduction and immigration into riverine habitat is halted. For the latter, otolith microchemistry is a widely used tool that can reveal natal origins, migratory patterns, and even habitat use. The strontium isotope composition of otolith material can be particularly useful because it provides a conservative tracer of the geology through which aquatic systems transit. The Upper Colorado River basin is composed of rocks that span a broad range in geologic ages, where older rocks are more radiogenic and therefore enriched in ^{87}Sr. We expand previous work on the natal origins of nonnative walleye collected in the Upper Colorado River Basin, specifically filling in knowledge gaps related to recent expansion in the lower Green and Colorado rivers, as well as a more detailed investigation of Lake Powell walleye. We prepared and measured the strontium isotopic composition of otoliths (lower Green = 24, lower Colorado = 30, Lake Powell = 29), focusing on just outside of the primordia (core) and on the most recent growth band (edge) by laser ablation-multicollector ICP-MS. Our goals were to i) re-evaluate endmember strontium isotope compositions for the lower Green, lower Colorado, and Lake Powell, ii) evaluate residency within these regions of the lower basin, and iii) assess potential source populations contributing walleye to these areas. The median $^{87/86}Sr$ end member value for Lake Powell walleye otoliths was 0.71004, within error of the previous estimate based on smallmouth bass. However, the median $^{87/86}Sr$ value for the Colorado River was 0.70994, far less radiogenic than the previous estimate and more congruent with the range of aqueous $^{87/86}Sr$ compositions near Moab, UT (0.70963 – 0.70997). Isotopic analyses of lower Green River walleye otoliths are still pending. However, assuming a variance of +/-0.00012 (standard deviation for Lake Powell walleye otolith edge compositions), we found approximately 23% and 45% of fish collected in the lower Colorado River and Lake Powell were likely long-term residents, suggesting natural reproduction as in the latter and/or natal origins from waters with similar isotopic compositions. Additionally, otolith core compositions indicated that approximately 50% of the lower Colorado River and 66% of the Lake Powell fish analyzed reared in waters with similar $^{87/86}Sr$ compositions. Currently, the lack of endmember contrast within the lower basin precludes quantitative assessment of potential source populations. However, fish that were significantly higher (or lower) than the median Colorado River and Lake Powell endmembers likely sourced from other sub-basins and we anticipate that otolith data from the lower Green River will provide additional insight.