Oregon Coast Coho Salmon: Reconstructing Freshwater Habitat Use Through Otolith Microchemistry

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Salmonid Life Cycle Monitoring

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Background

- Oregon Coast Coho Salmon threatened since 1998
- Oregon Department of Fish and Wildlife's Life Cycle Monitoring (LCM) program tracks juvenile production and adult returns to assess salmon populations
- LCM data creates smolt-to-adult return rate (SAR) used in forecasting by Pacific Fisheries Management Council (PFMC)
- Otoliths (fish ear stones) record chemical signatures from the water fish inhabit, helping reconstruct life histories and habitat use
- Linking freshwater habitat use with SAR and PIT-tag data may provide additional context for interpreting variation in survival estimates

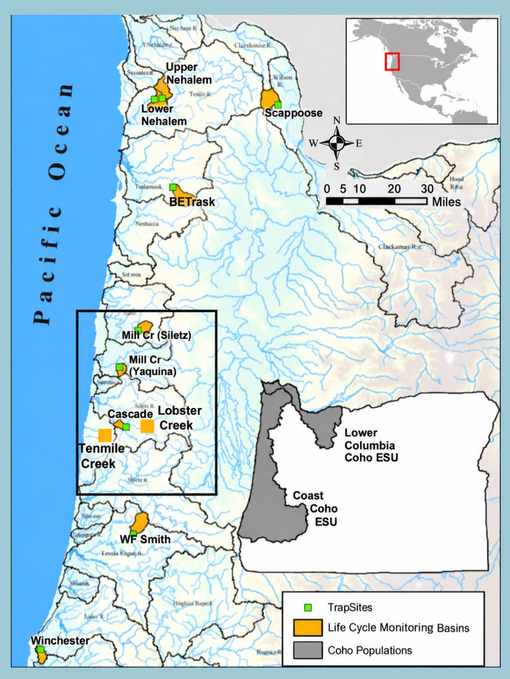


Figure 1. Historic and current Oregon Department of Fish and Wildlife (ODFW) Life Cycle Monitoring (LCM) sites along the Oregon Coast in the western United States. The boxed area highlights active study sites, including Mill Creek, the focus of this study. Lobster Creek and Tenmile Creek are partial monitoring sites with adult fish traps but no smolt traps.

SAR = Adults Returned / Smolts Out

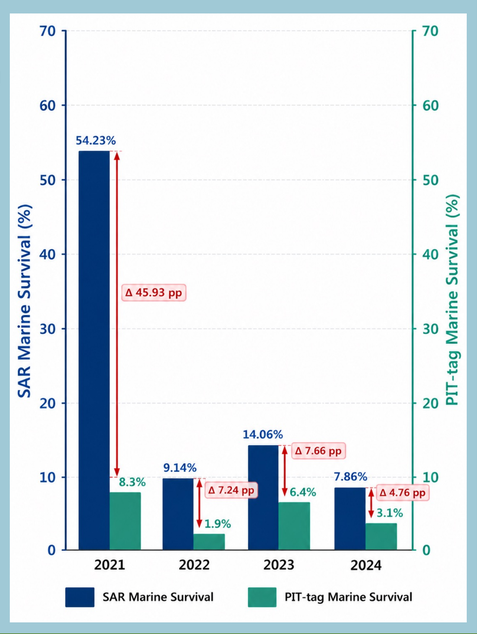


Figure 2. Comparison of wild smolt-to-adult (SAR) marine survival and passive integrated transponder (PIT)-tag marine survival estimates for adult return years 2021–2024 at the Mill Creek Life Cycle Monitoring (LCM) site. Red arrows indicate differences in percentage points between estimates.

Research Question

Can otolith microchemistry identify freshwater rearing habitats used by Coho Salmon within a watershed?

Objective 1: Quantify contributions of isotopically distinct freshwater habitats to returning adult Coho Salmon using otolith $^{87}Sr/^{86}Sr$ Signatures

Objective 2 Evaluate relationships between freshwater habitat use, smolt-to-adult return rates (SAR), and PIT-tag survival estimates

Methods

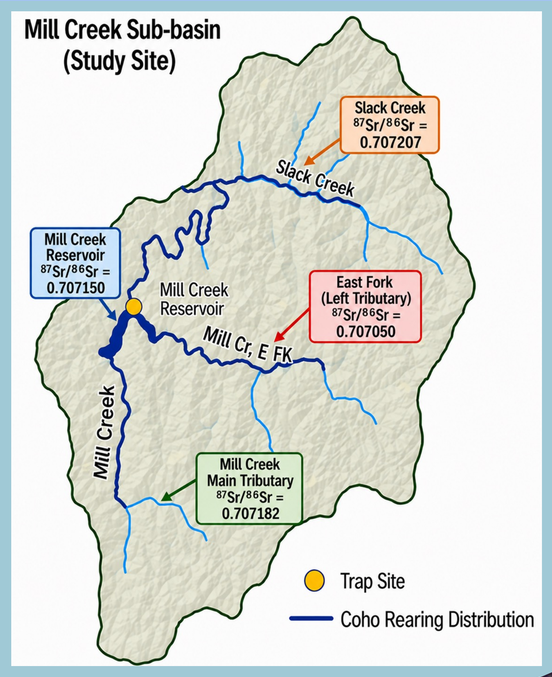


Figure 3. Map of the Mill Creek study site in the Yaquina River sub-basin showing the adult and juvenile trap site, juvenile Coho Salmon rearing distribution, and reference water locations with corresponding $^{87}Sr/^{86}Sr$ values.

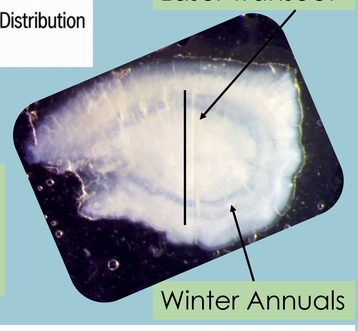


Figure 4. Polished adult Coho Salmon otolith showing the laser ablation transect and first-year winter growth annuals.

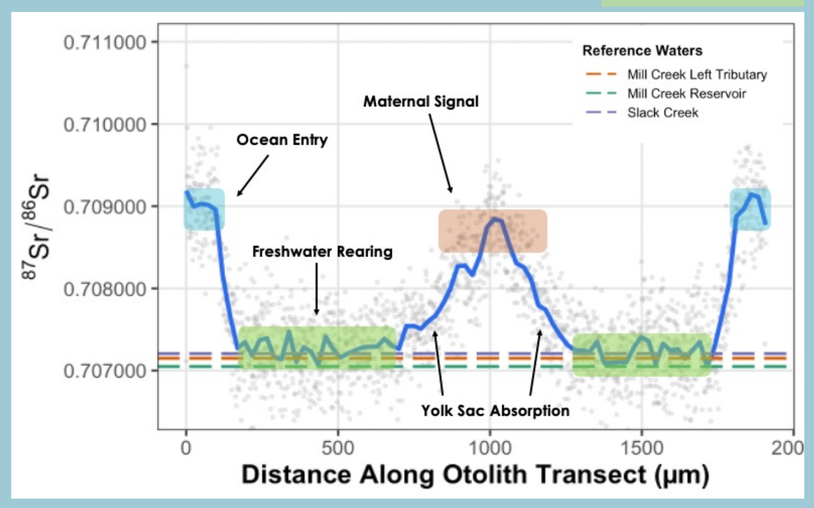


Figure 5. Otolith $^{87}Sr/^{86}Sr$ transect from an adult Coho Salmon analyzed using LA-MC-ICP-MS. Gray points represent individual laser spot measurements, and the blue line shows a 10-point smoothed trend. Colored dashed lines indicate $^{87}Sr/^{86}Sr$ values of reference waters.

Preliminary Data

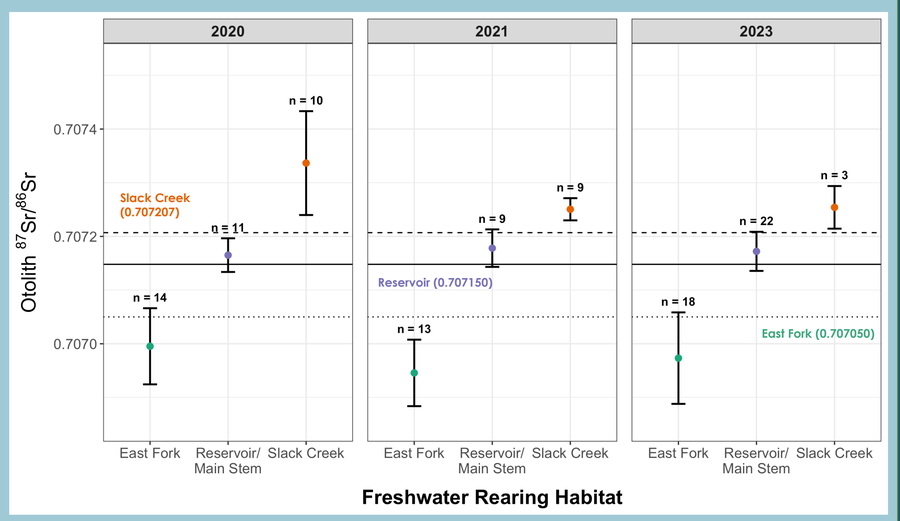


Figure 6. Grouped mean $^{87}Sr/^{86}Sr$ ratios in otoliths of adult Coho Salmon by freshwater rearing habitat and brood year (2020–2023). Points represent mean values for each habitat-year group, and error bars indicate ±1 SD among fish. Horizontal lines indicate the $^{87}Sr/^{86}Sr$ reference-water values for Mill Creek Reservoir/Main Stem, Mill Creek East Fork, and Slack Creek. Sample sizes (*n*) indicate the number of fish in each group.

Otolith $^{87}Sr/^{86}Sr$ Freshwater Rearing Habitat Classifications of Returning Coho Salmon
Number of fish (and percent of total) by brood year

Brood Year	East Fork	Reservoir / Main Stem	Slack Creek	Stray	Two-step	Total
2020	14 37.8%	11 29.7%	10 27.0%	0 0.0%	2 5.4%	37
2021	13 37.1%	9 25.7%	9 25.7%	1 2.9%	3 8.6%	35
2023	18 40.9%	22 50.0%	3 6.8%	1 2.3%	0 0.0%	44

Table 1. Number and percentage of returning adult Coho Salmon assigned to each freshwater rearing habitat based on otolith $^{87}Sr/^{86}Sr$ signatures, by brood year (2020, 2021, and 2023). Habitat classifications were based on comparisons between otolith isotope ratios and reference-water signatures. Two-step fish showed evidence of rearing in two different freshwater habitats, while strays had isotope signatures that could not be matched to the sampled reference waters.

Relevance & Future Directions

- Improve salmon survival forecasts and management decisions
- Expand water sampling to refine the Mill Creek watershed $^{87}Sr/^{86}Sr$ map
- Analyze juvenile otoliths to refine habitat classification confidence intervals

Acknowledgments

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[1]Suring, E., P. Burns, R.J. Constable, C.M. Lorion, D.J. Wiley. (2015). *Salmonid Life Cycle Monitoring in Western Oregon streams, 2012-2014.* (Monitoring Program Report Number OPSW-ODFW-2015-2, Oregon Department of Fish and Wildlife, Salem)
[2]Oregon Department of Fish and Wildlife (ODFW). Unpublished Life Cycle Monitoring (LCM) data, Mill Creek, Yaquina Basin, Oregon