Reproductive success improves after a single generation in the wild for descendants of some hatchery Chinook salmon

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Researchers who created "family trees" for nearly 10,000 fish have found that first-generation, wild-born descendants of hatchery-origin

Chinook salmon in an Oregon river show improved fitness.

The finding, based on data collected over 13 years, is encouraging for Chinook salmon recovery efforts, said Kathleen O'Malley, an associate professor at Oregon State University and the study's senior author. In this study, fitness is measured by the number of adult offspring a fish produces, with higher fitness leading to more offspring.

"Previous studies have shown that hatchery-origin Chinook salmon have lower reproductive success relative to their natural-origin counterparts when they spawn in the wild, but this study looks beyond that," said O'Malley, who directs the State Fisheries Genomics Lab.

"While our work doesn't contradict the earlier findings, we found that the first-generation descendants of these hatchery-origin Chinook salmon produced more offspring than hatchery-origin salmon spawning alongside them in the river, meaning that reproductive success may improve in the wild as quickly as it declines in the hatchery."

The results are published in the journal *Evolutionary Applications*. The paper's lead author is David Dayan, who was a faculty research assistant in O'Malley's lab and now works for the U.S. Fish and Wildlife Service.

Spring Chinook salmon in the Upper Willamette River are listed as threatened under the federal Endangered Species Act. The McKenzie River, a tributary to the Upper Willamette River, has historically supported one of the largest populations of spring Chinook salmon, and today supports a large portion of the natural-origin spring Chinook salmon in the Upper Willamette Basin.

Cougar Dam on the South Fork McKenzie River blocks about 40 kilometers of historical spawning habitat within the McKenzie sub-basin. At the base of the dam, an adult fish collection facility, constructed in

2010, allowed fisheries managers to collect and reintroduce returning adult Chinook salmon above the dam.

Researchers collected tiny fin samples from salmon arriving at the collection facility over the years and used them to determine parent and offspring relationships and quantify their numbers.

"Essentially, we created family trees for each fish, similar to how you would trace your own ancestry using a DNA service," O'Malley said. "We were able to create a pedigree for nearly 10,000 fish in this system."

They found that first-generation, wild-born descendants of two hatchery-origin fish produced significantly more adult offspring than hatchery-origin salmon that spawned alongside them in the river. These first-generation descendants produced similar numbers of offspring to natural-origin fish.

"Attempts to recover or reintroduce a population using wild salmon are often limited by the lack of a healthy nearby donor population," O'Malley said.

The findings offer hope that naturally spawning Chinook salmon populations can be established from hatchery-origin salmon and that reestablished populations may experience generational increases in fitness as they spawn naturally in the wild.

The researchers' study design did not allow them to determine what led to the increase in fitness between the first generation, wild-born salmon and the hatchery-origin salmon.

"We don't know if it's genetic, if it's the environment or if the two interact," O'Malley said.

Concerns remain over the risk hatchery-origin salmon pose to the genetic integrity and productivity of natural populations. Continued interbreeding between hatchery-origin and natural-origin salmon could contribute to a decline in overall fitness for the natural-origin fish, unless the level of interbreeding is carefully managed, she said.

The study's authors also cautioned that their conclusions may not apply to other river systems that have reduced natural production or historical transfers of non-local origin salmon stock; the conclusions also may not apply to other species, such as steelhead. In addition, practices specific to the McKenzie River hatchery may have maintained adaptive genetic diversity and the capacity for increased fitness among the wild-born descendants of hatchery-origin salmon.

Nonetheless, the study's findings offer encouraging news for the use of hatchery salmon in support of conservation and recovery efforts, O'Malley said.

O'Malley, Dayan and co-author Cristin Fitzpatrick are all affiliated with OSU's Coastal Oregon Marine Experiment Station, which is part of the College of Agricultural Sciences and based at Hatfield Marine Science Center in Newport.

Additional co-authors include Nicholas Sard of the State University of New York—Oswego; Marc Johnson, formerly of the Oregon Department of Fish and Wildlife and now with the National Marine Fisheries Service; and Ryan Couture of the Oregon Department of Fish and Wildlife.

More information: David I. Dayan et al, A single generation in the wild increases fitness for descendants of hatchery-origin Chinook

salmon (Oncorhynchus tshawytscha), *Evolutionary Applications* (2024).
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