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'Ocean ranching' has led to a pink salmon boom — but there might be a catch

Unintended interbreeding between hatchery-bred and wild-born pink salmon could reduce resiliency of fish stocks.

By Alix Soliman

Pink salmon at a hatchery pool in Canada. Credit: Juergen Freund/Nature Picture Library

Salmon raised in captivity and released into rivers bound for the North Pacific are breeding with wild salmon, raising concerns among scientists about the fishes' future. A new study[1] published this month on pink salmon (*Oncorhynchus gorbuscha*) in Alaska predicts that such interbreeding will increase the size of the species' population but decrease its diversity. This could change mating behaviours in wild fish, making them less resilient to climate change and other disasters.

"There are too many fish being released," says Peter Westley, a fisheries ecologist at the University of Alaska Fairbanks and an author of the paper. He suggests that pink-salmon hatcheries reduce their output.

Fishery regulators are resisting calls to scale back operations, however, citing lingering unknowns about the ecological interactions between wild and hatchery-bred fish, as well as economic competition from neighbouring Russia.

"It's a contentious issue, but everyone wants to get to the bottom of it," says Samuel May, a salmon research geneticist at the US Department of Agriculture (USDA) Agricultural Research Service in Orono, Maine, and the lead author of the study.

Fishy family tree

Hatcheries in Alaska pump about one billion pink salmon into the North Pacific Ocean each year, and are credited with boosting harvests for the state's pink-salmon industry, which was worth some US$100 million last year. The fish grow in the ocean and, if they're not caught, typically try to return to the place where they hatched when it's time to breed. But not all of the fish released find their way back to the facilities that reared them. Some 1–5% — millions of individuals a year — stray into nearby streams, where they can breed with wild salmon.

Hatchery-bred fish are expected to return to where they were born to spawn, but some don't. Credit: Doc White/Nature Picture Library

Alaskan state law prohibits hatchery production from harming wild salmon populations, and for decades researchers have been trying to work out how the practice impacts the species. In an effort to understand how genes are moving between hatchery-bred and wild fish, the Alaska Department of Fish and Game, based in Juneau, partnered with scientists at the University of Alaska, local aquaculture associations that run the hatcheries and the National Marine Fisheries Service to form the Alaska Hatchery Research Program.

Huge harvest

Between 2011 and 2020, field teams collected carcasses of pink salmon that had returned and died in streams that drain into Prince William Sound, home to the largest pink-salmon hatchery programme in the world. Through genetic analysis, researchers drew up family trees for 284,867 individual fish, making it the largest salmon pedigree study ever done. May

and his colleagues then extracted population-level dynamics from this massive data set to model how hatchery strays might affect 25 future generations of pink salmon.

The simulation showed hatchery strays increasing the overall population of wild pink salmon, which might help to explain reports of a recent surge. Last year, fishing fleets were expected to harvest 19 million fish — hatchery and wild combined — in Southeast Alaska. Instead, they caught almost 48 million.

"I think this is really good work," says Jim Murphy, a fisheries research biologist at the Alaska Fisheries Science Center of the US National Oceanic and Atmospheric Administration in Juneau, who was not involved in this study but has previously collaborated with some of the authors.

Genetic erosion

However, the population boom has potential repercussions, May says. The team's model predicted that cross-breeding between hatchery and wild fish would reduce variation in an important trait related to reproduction — the time at which fish return to their spawning grounds — by up to 20%. In Prince William Sound, most hatchery pink salmon swim upstream about a week later than the average wild fish does, a trait selected by hatchery officials in part to reduce the chances of cross-breeding.

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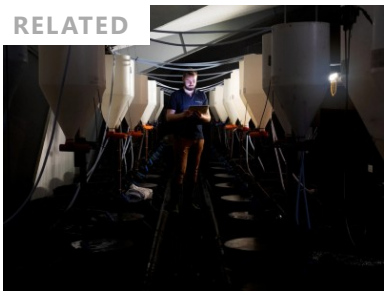

Best spawn in the game: improving the sustainability of fish stocks

Wild fish return at various times throughout the summer, which helps to reduce the impact on reproduction of a crisis such as a heatwave, disease outbreak or beaver dam collapse at spawning sites. If more pink salmon start returning at the same time, as the model predicts, such environmental disturbances could be devastating.

One of the big risks facing salmon is "the genetic erosion of wild diversity," May says. "What might happen in the future if these kinds of extreme weather events or warming becomes more frequent?" asks May. "Will these populations be able to cope?"

In the pink

John McMillan, a fisheries ecologist at the Conservation Angler, an advocacy organization based in Edmonds, Washington, focused on protecting wild fish, says he thinks that this is a significant finding. "We're going through a rapidly changing climate, and animals are going to need every ounce of diversity that they have," he says.

But he adds that the model is limited by simplification. The study looks only at spawning-ground dynamics and holds constant all other factors, such as the survival of young fish and competition for food at sea, which are important to fully understand interactions between hatchery and wild salmon.

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And the results should not be taken out of context or applied to other salmon species such as sockeye (*Oncorhynchus nerka*), coho (*Oncorhynchus kisutch*) or chum (*Oncorhynchus keta*), McMillan says, because pink salmon live a more predictable life. They don't spend much time feeding in streams and they all return to spawn at age two during the same season. But in a review[2] of more than 200 papers investigating the global impacts of hatchery salmon of all species on their wild counterparts, McMillan and his colleagues found that 83% of papers reported a slightly or moderately adverse effect.

The Alaska Department of Fish and Game issues permits that allow hatcheries to operate and stipulates how many fish they can release. Doug Vincent-Lang, the department's commissioner, says he needs more evidence that hatchery fish are harming wild populations for the department to reduce hatchery production.

"We're always a little cautious when you're trying to speculate what's going to happen many generations into the future," he says. "This kind of information that's been collected now, by my staff and the university, is raising some flags that we need to sit back and look at."

Hatcheries also support Alaska's coastal communities, Vincent-Lang says. Statewide, they funded at least 4,200 jobs and US$219 million in wages per year between 2018 and 2023.

Salmon glut

But there are other complicating factors. This year, demand for pink salmon did not meet supply, and the USDA purchased US$70 million in canned pink salmon to stabilize the market. Meanwhile, Russia has scaled up its hatchery production. "They're flooding the market with pink salmon and chum salmon right now, and that's lowering the price," Vincent-Lang says.

He adds that questions about ocean interactions between the fish drive a lot of debate. Alaskan and Russian salmon presumably compete for food in the North Pacific. If the state was to shut down hatcheries because of their impact on wild salmon, Russian production might hurt wild stocks anyway, Vincent-Lang suggests.

"Are we going to, in Alaska, just completely shut down all of our hatchery programmes for pink salmon?" Vincent-Lang asks. "That's a tough question when you're hurting your own economy."

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