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Local Adaptation in New Zealand Chinook Salmon

Hi Rasmus,

I'm responding to your email of 24 February 2020 seeking a scientific perspective on Fish & Game New Zealand's (FGNZ's) recent decision to close its sea-run Chinook salmon hatchery operations in the North Canterbury region.

Based on our understanding of this species in New Zealand waters I believe this decision to be justified on scientific grounds. This conclusion is well supported by the results of a six-year joint NZ (NIWA)/US research programme, conducted during the 1990s, which used New Zealand as a natural laboratory to study evolutionary changes and local adaptation in a newly established fish population isolated from its parent stock. Our results, which appeared as a series of scientific publications over the decade from 1993–2003, are well recognised internationally and include a core of 15 papers which have collectively been cited over 1,600 times.

Chinook salmon from the Sacramento River in California were introduced into the Waitaki River in the early 1900s, and by 1915 had established self-sustaining populations in large east coast South Island rivers such as the Rangitata, Rakaia, and Waimakariri. Hatchery releases were discontinued shortly thereafter, leaving the progeny of the original liberations to adapt through natural selection. Our research used this process as a natural experiment by rearing stocks from three distinct populations under controlled environmental conditions, and comparing their physical, behavioural, and genetic traits as they grew to maturity.

Our key finding was that within 90 years of their introduction — roughly 30 generations — Chinook populations in different New Zealand rivers had already begun to diverge in an evolutionary sense, in both behavioural and genetic traits. This created locally adapted, river-specific stocks with a marked advantage over stocks from other rivers, with lifetime survival rates up to three times higher for stocks released into their natal river relative to stocks originating from other rivers.

FGNZ re-established hatchery releases into North Canterbury rivers approximately 20 years ago but were only rarely able to draw on locally-sourced populations for their broodstock. In many instances, hatchery stock sourced from the salmon aquaculture industry were used as a surrogate, despite having been reared in captivity for up to 30 years under a selection regime which favoured maximising commercial production rather than survival in the wild.

Despite some initial successes, declining survival rates in recent years have led FGNZ managers to acknowledge the possibility that these releases have ultimately been counter-productive, creating populations of spawning adults that have reversed some of the evolutionary changes which occurred over the previous 90 years. Specifically, Chinook salmon returning to Canterbury rivers in 2020 may now be less well adapted to their local environment than the largely natural stocks which FGNZ hoped to enhance by supplementary hatchery releases.

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FGNZ's shift in focus, emphasising habitat preservation and harvest management in preference to hatchery supplementation, is well supported by the underlying science. As one of my US colleagues put it in a 1999 review paper[1] on the application of our findings to managing salmon populations under the US Endangered Species Act:

> "*… for the most part we need to give salmon access to healthy, diverse physical habitats and allow these habitats to be filled (or over-filled) with the full community of salmonid species native to the region. The salmon can take it from there.*"

Kind regards,

Martin Unwin

Fisheries Scientist

[1] Quinn, T. P. (1999). Revisiting the stock concept in Pacific salmon: insights from Alaska and New Zealand. Northwest Science 73:312-324.