EVALUATING SPRING CHINOOK SALMON RELEASES ABOVE COUGAR DAM, ON THE SOUTH FORK MCKENZIE RIVER, USING GENETIC PARENTAGE ANALYSIS

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Primarily hatchery-origin (HOR) spring Chinook salmon have been released above Cougar Dam on the South Fork McKenzie River since 1993 to restore ecosystem functions and access to historically productive spawning grounds. Since construction of a trap-and-haul facility at the base of Cougar Dam in 2010, natural-origin (NOR) salmon have also been released above the dam. Genetic parentage analysis has been used to evaluate this reintroduction effort since 2007. Here, we extend the previous research to provide genetic and demographic inferences into the parental cohorts above Cougar Dam from 2007 – 2015, and their offspring that returned from 2010 – 2020.

Most (71%) NOR salmon collected at the Cougar Trap were produced above the dam. The remaining 29% were likely immigrants produced elsewhere. We also found that the proportion of NOR immigrants collected at the Cougar Trap increased throughout the season, from less than 5% when the first salmon arrived to ~50% on September 1. Since 2015, all NOR salmon collected at the Cougar Trap have been tagged, released downstream, and only released above the dam if they were collected a second time at the trap. We found that NOR salmon produced above the dam were more likely to return a second time than NOR immigrants. From 2015 – 2020, downstream recycling limited above dam transport of 75% of NOR immigrants and 31% of NOR salmon produced above the dam.

Most returning offspring in the South Fork McKenzie River were age-4 or age-5 (55% and 42%, respectively), with few returning at age-3 or age-6 (1.6% and 1.8%, respectively). Twenty percent of salmon released above Cougar Dam produced one or more adult offspring. The mean total lifetime fitness (TLF) was 0.36. For the subset of years when both NOR and HOR salmon were released above the dam, mean TLF was 2.1-fold greater for NOR than HOR salmon (0.49 *vs.* 0.23, respectively).

The cohort replacement rate (CRR), defined as the number of future spawners produced by a spawner, never approached one, whether CRR was calculated using all individuals (CRR_{total}), only females (CRR_F), or only males (CRR_M). The maximum CRR_{total} was 0.44 (2007) and the minimum was 0.08 (2009). The effective number of breeders ranged from 139.8 to 368.8, indicating that the risk of inbreeding depression was minimal.

We found that three variables and two interactions were predictive of TLF among salmon released above the dam. After accounting for all other significant predictors, NOR males were predicted to be 2.1-fold more fit than HOR males, and NOR females were predicted to be 1.6-fold more fit than HOR females. Male-biased sex ratios were predicted to result in greater fitness primarily among females. Salmon

released on the earliest release day in the dataset were predicted to be 1.7-fold more fit than those released on the latest release day. Variance in TLF among years and groups of individuals released at the same site on a single day was substantial after accounting for the significant predictors, suggesting that unmeasured variables within years and release groups influence TLF. Finally, NOR salmon were larger than HOR salmon, and larger size at maturity was also associated with higher TLF, indicating that the effect of origin (HOR *vs.* NOR) on fitness may be partially explained by differences in size at maturity.

In summary, the Cougar Trap primarily collects offspring of salmon previously released above Cougar Dam. NOR immigrants arrive at the Cougar Trap later and are less likely to return a second time after downstream recycling. Therefore, both downstream recycling and late season downstream release selectively limit above dam transport of NOR immigrants relative to NOR salmon produced above the dam. Managers can adaptively modify these programs to control the disposition of NOR immigrants and NOR salmon produced above the dam. While NOR salmon produce approximately twice as many adult offspring as their HOR counterparts above the dam, this increased productivity is not sufficient to reach replacement. Therefore, any potential benefits of releasing NOR salmon above the dam must be weighed against the costs of releasing NOR salmon into a demographic sink, which may reduce NOR productivity basin wide.

Reference

O'Malley, K.G., Dayan, D.I., Fitzpatrick, C.K., Couture R. (2023) Evaluating spring Chinook salmon releases above Cougar Dam, on the South Fork McKenzie River, using genetic parentage analysis. U.S. Army Corps of Engineers. PDF.