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Snake River Juvenile Salmon Survival

The number of adult salmon that pass lower Columbia and Snake River dams in any given year can be accurately assessed. Identifying the survival rate of juvenile salmon and steelhead on their out migration, however, requires sampling and estimation.

This review focuses on Snake River juvenile salmon survival through the 8-dam hydrosystem using the estimates from four government agencies: the U.S. Fish and Wildlife Service (USFWS), the Northwest Power and Conservation Council (NWPCC), the National Oceanic and Atmospheric Administration (NOAA) and the Fish Passage Center (FPC). Also included are survival estimates from the Bonneville Dam tailrace to the ocean.

U.S. Fish and Wildlife Service (USFWS)

The 1976 *Lower Snake River Compensation Plan* (LSRCP)[1] addressed the loss of juvenile salmon as a result of passage through the four lower Snake River's dams and reservoirs. Based on studies of dam-related juvenile losses in the mid-60s, the plan called for the production of sufficient hatchery-reared juvenile fish to make up for an estimated loss of 15% of juveniles per dam/reservoir. The effect of such losses on the lower Snake would result in a cumulative loss estimate of 52% and hence a survival estimate of 48%.

Juvenile fish losses on the four lower Columbia River dams and reservoirs are often higher than on the Snake, possibly due to cumulative stress and injury as the juveniles pass four more dams and reservoirs. Nevertheless, applying the same estimated loss rate of 15% per dam/reservoir, the total loss through the 8 dams complex would be 73%, and thus a survival rate of 27%.

Northwest Power and Conservation Council (NWPCC)

Under the 1980 Northwest Power Act, the NWPCC is required to develop a plan "to protect, mitigate and enhance fish and wildlife on the Columbia River and its tributaries."[2] The Council is currently circulating for public comment an addendum to its last (2014) Fish and Wildlife Program.[3]

Appendix E of that addendum includes the Council's juvenile salmon survival estimates. The agency notes that these estimates "are from studies by the fish and wildlife agencies and hydropower project operators."[3] The Council assumes 90% survival in a reservoir, 98% survival of the approximately 50% of smolts that pass dams through spill or bypass systems, and 85% survival of those that go through turbines. The council concluded that an *optimistic* average survival rate per dam/reservoir is 80%. Applying that rate to the 8-dam hydropower system, the NWPCC estimates that 16.7% of juvenile salmon survive their journey from the beginning of slack water at Lewiston, Idaho to the Bonneville dam's tailrace (the flow on the low water side of a dam).

The National Oceanic and Atmospheric Administration (NOAA)

NOAA provided 2018 survival estimates for Snake River salmon for different river reaches. The federal agency estimated survival through the Lower Granite pool and dam at 88%, Lower Granite dam tailrace to the McNary dam tailrace at 73%, and McNary tailrace to Bonneville tailrace at 59%. [4] These estimates yield a cumulative survival rate through the 8-dam reach of 37%.

Fish Passage Center (FPC)

In a memorandum dated March 6, 2019,[5] scientists at the FPC reported a 2006-2017 average juvenile spring/summer Chinook survival rate through the 8 dams and reservoirs of 60%. FPC suggests that different sampling procedures may have produced the discrepancy between FPC and NOAA juvenile survival estimates.

In that same memorandum FPC states that NOAA's survival estimates for the two reaches Lower Granite to McNary and McNary to Bonneville are consistently about 7% lower than FPC's estimates for those same reaches. Increasing NOAA's survival estimate through each of these two reaches by 7% (80% and 66% respectively) results in an adjusted NOAA cumulative survival estimate of 47%.

In summary, the five survival estimates from the head of the Lower Granite pool to the Bonneville dam tailrace are:

NWPCC	17%
USFWS (from LSRCP)	27%
NOAA	39%
NOAA (FPC adjusted)	49%
FPC	60%

Juvenile Survival Estimates Bonneville Dam to the Ocean

Any hydrosystem-related survival estimates must also address losses between the Bonneville Dam tailrace and the ocean. Scientists use the term *delayed mortality* to identify losses resulting from cumulative stresses and injuries the smolts have experienced passing through those 8 dams and reservoirs. Estimates in the professional literature of losses attributable to delayed mortality range from 34% to 76%.[6] Smolt *survival* is represented by the reciprocal of those rates and thus a survival rate between 24% and 66%. Using a midpoint of this range results in a survival estimate of 45% from the Bonneville tailrace to the ocean.

This review uses a survival estimate through the 8 dams/reservoirs on the lower Snake and Columbia Rivers of 49% (NOAA estimate with FPC upward adjustment) from the head of the Lower Granite pool to the tailrace of Bonneville Dam. The inclusion of losses due to delayed mortality results in the following survival estimates from the head of the Lower Granite pool to the Pacific Ocean.

NWPCC	7.65%
USFWS	12.2%
NOAA	16.7%
NOAA adjusted	17.6%
FPC	28%

Drawing the Data Together

The above estimates provided by federal agencies and the results of additional scientific research tell us for every million juvenile salmon that begin their migratory journey in the free-flowing Snake River and its tributaries, an estimated 720,000 to 932,000 juveniles will perish before reaching the ocean.

In 2018, Idaho hatcheries released 28 million Snake River juvenile salmonids, 13 million of which were spring/summer Chinook.[7] Applying the above estimated survival rates, the number of those juvenile spring/summer Chinook that likely die before reaching the ocean ranges from 9,360,000 to 12,116,000.

The Idaho Department of Fish and Game has identified the long-term average survival of hatchery juvenile spring/summer Chinook through free-flowing streams and rivers to Lower Granite dam to be 65%.[8] If one were to apply this survival rate to the Lower Granite dam, along with estimated survival through the 8-dam

complex of 49% and delayed mortality as outlined above, we would expect over 11 million of those 13 million hatchery juveniles to perish before reaching the sea.

A summary of research on Snake River spring/summer Chinook run size in the late 1880s pegs the annual run at greater than one million fish.[9] In 2019, Snake River spring/summer Chinook reaching Lower Granite Dam (jacks included) totaled 29,617. [10]

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