Rethinking Dams: Pacific Salmon Recovery May Rest on Other Factors

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Approaching the confluence of the Snake and Columbia Rivers in 1805, Lewis and Clark marveled at the "almost inconceivable multitudes" of salmon hurling themselves through the roiling waters, but worried at the "emence numbers" of bruised, battered, and dead fish farther upriver. The American explorers, unaware that Pacific salmon die after an orgy of spawning, were mystified at the frenzied spectacle of life and death before them.

An estimated 16 million salmon once swam the ancient migration route from river to ocean and back again, sustaining then-abundant bear, eagle, mink, and river otters along the way and releasing nutrient-rich compounds to replenish Columbia Basin streams and forests as their spent bodies decayed. By 1930, decades of overfishing, unchecked mining, logging, and engineering projects pushed wild stocks into serious decline—just as the US government resolved to fully exploit the hydroelectric and irrigation potential of the Columbia with a massive system of dams.

Today, just under 2% of salmon retrace the improbable journey of their forebears; 13 Columbia salmon stocks are listed as threatened or endangered. Most researchers and environmentalists believe that the extensive network of dams poses the biggest threat to salmon recovery. But a new study by David Welch, Carl Schreck, and colleagues suggests that factors other than dams may also be vital to the survival of ocean-going juveniles (called smolts).

Because salmon declines continued after 1938, when the first dam was built, and were particularly sharp after 1977, when the last Snake River dams were built, recovery efforts have focused on mitigating threats posed by the hydropower system (including warmer waters, fish-grinding turbines, and new predators). These efforts helped reduce the dam-related carnage reported in the 1960s and '70s. But migrating salmon must also contend with habitat destruction, detrimental encounters with hatchery fish, and large-scale changes in ocean climate, which were first detected after dam construction ended in the 1970s. Understanding the primary drivers of the declines is essential for increasing the value of scare resources for salmon recovery.

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This steelhead smolt *(Oncorhynchus mykiss)* was surgically implanted 7 months earlier with an acoustic tag. Two acoustic tags are visible externally; tags identical to the smaller one were used for most of the research reported in the paper.

Efforts to measure the survival of finger-sized smolts have long been limited by the technology used to track them. Short-range radio tags required steering fish near receivers, which can't be done in an undammed river. Only recently were longer-range acoustic and radio tags made small enough to implant in tiny fish without harming them. In this study, Welch et al. used the recently developed Pacific Ocean Shelf Tracking (POST) array, an acoustic telemetry system that works in both marine- and freshwaters.

To gauge the effect of dams on survival, the researchers compared the fate of Chinook and steelhead migrants leaving the heavily impounded Columbia–Snake River system with those leaving the unfettered Thompson–Fraser River system to the north, in south central British Columbia. Smolts implanted with acoustic tags migrating some 240 km from the Thompson tributaries down the undammed Fraser River were monitored for three seasons, starting in 2004. The researchers compared these results to two sets of survival data previously collected on smolts navigating the Columbia system. In one set, smolts outfitted with PIT (passive integrated transponder) radio tags had swum 516 km through eight dams; in the second, smolts with the same acoustic tags used in the Fraser River system traveled through the undammed lower Columbia.

Whole-river survival through the Columbia system was calculated by combining estimates based on the PIT tags in the impounded upper river with those from acoustic tags in the undammed lower river. For a direct comparison of whole-river survival estimates between the dammed and undammed rivers, the researchers also implanted smolts with acoustic tags to track them down the 910-km length of the Snake–Columbia system. (This analysis also allowed them to compare survival results from the acoustic tags with studies using PIT tags from the same year to ensure similar performance for both methods.)

Surprisingly, smolts fared just as well negotiating the heavily dammed Columbia as they did going down the

free-flowing Fraser. Comparing the rivers section by section, Chinook smolts traversing the dammed system actually had higher survival rates than their cousins in the Fraser. Adjusting estimates to consider the distance and time smolts had to migrate to reach the river mouth revealed that average survival rates were much higher for both species from the Snake River than for those in the undammed Fraser. In fact, no matter how they analyzed the data, the researchers reported, "survival is not worse in the Columbia despite the presence of an extensive network of dams."

These results challenge long-held assumptions about the impact of dams and suggest that removing dams may not accelerate salmon recovery, as widely believed. The researchers caution, however, that it's not clear whether the similar survival rates indicate that improved dam management has aided smolt passage through the Columbia or that the Fraser poses unrecognized problems. Although the researchers found that about 20–30% of smolts made it through the dammed river to the river mouth, as few as 0.5% of adults return to spawn.

Clearly, threats beyond the rivers are taking a heavy toll on salmon. The bleak conservation status of Thompson River steelhead has been blamed on inhospitable ocean conditions, which may explain the poor return of both Chinook and steelhead to the Snake River as well. Whether it's the ocean conditions per se or the rigors of dam passage that leave salmon ill-equipped to deal with marine life remains an open question. The researchers argue that it may be time to shift conservation focus away from helping smolts pass through the hydropower system to understanding how dams affect ocean survival.

Welch DW, Rechisky EL, Melnychuk MC, Porter AD, Walters CJ, et al. (2008) Survival of migrating salmon smolts in large rivers with and without dams. doi:10.1371/journal.pbio.0060265