Salmon smolt survival similar in Columbia and Fraser rivers

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A new study by researchers in Oregon and British Columbia has found that survival of juvenile salmon and steelhead during their migration to the sea through two large Northwest rivers – the Columbia and the Fraser – is remarkably similar despite one major difference.

The Columbia River has a series of dams, while the Fraser has none. However, the researchers point out, there clearly are other differences between the rivers. And though the study – using both acoustic and transponder tags – found that the average mortality in both rivers was between 70 and 80 percent over a four-year period, the results should be viewed with caution.

Findings of the study were published this week in the journal *PLoS Biology*.

"Despite the obvious comparison, it would be overly simplistic to say that dams have no impact on smolt survival, because we know they do," cautioned Carl Schreck, a professor of fisheries and wildlife at Oregon State University and the U.S. Geological Survey and an author of the study. "There also may be some additional delayed mortality of Columbia River smolts caused by the stress of passage through the hydrosystem that is not manifested until the fish reach the ocean."

Columbia River juvenile salmon can be stressed by navigating the series of dams from Lower Granite to Bonneville. Other stress-inducers can include water temperature, contaminants, predation attempts, and

availability of food, forcing fish to channel their energy into survival instead of growth, Schreck pointed out.

"Stress in fish delays development," he said. "It also suppresses the immune system, which can increase the chance that fish will be susceptible to disease or parasites. Even though these data suggest that the fish survive the freshwater phase of their migration, that kind of weakened condition can be the difference when a young salmon tries to adapt to a salt water environment."

Schreck, a leading expert on the impacts of stress on fish, last year received the Meritorious Presidential Rank Award at a White House ceremony for his contributions to fisheries science. His work during the past 36 years has centered on the causes of stress in juvenile and adult salmon and steelhead, and the impacts that stress can have.

During the past dozen or so years, OSU scientists have been using telemetry to study survival rates of juvenile salmon below Bonneville Dam. They discovered a high rate of mortality in the estuaries, which led to the surprising discovery of the impact of predation from colonies of terns. In 2000, OSU introduced the use of a new tool – acoustic telemetry – for studying salmon on the West Coast. Acoustic telemetry allows the signals emitted from tagged fish to be picked up by underwater hydrophones in salt water, as well as fresh.

A team led by David Welch, a British Columbia scientist and lead author of the PLoS paper, subsequently established a series of listening stations along the continental shelf, and also began using the same acoustic technology used by OSU researchers to study the survival of smolts in the Fraser River.

Comparing smolt survival from one river system to another is complex, because there can be a huge difference in the overall "quality" of smolts

– even before they begin their long journey to the Pacific Ocean, according to Shaun Clements, a biologist with the Oregon Department of Fish and Wildlife and co-author of the study, who conducted some of the tagging studies.

Clements, a former senior research associate at OSU, said the health and fitness of the smolts that are captured at the Columbia River's Lower Granite dam varies significantly.

"One day, we'd get a group of fish that were released from one hatchery and they'd be relatively weak, then a few days later we'd get a bunch of fish from a different hatchery and they would be robust," Clements said. "Hatcheries weren't the only variable – sometimes fish from the same hatchery would range from poor to excellent in quality, possibly due to environmental factors such as water temperature in the reservoirs. These same mechanisms may also apply to wild fish where we see different watersheds producing smolts of differing quality.

"The point is that the quality of smolts entering into the system can have an impact on their ability to survive the entire migration – and the transition into the ocean," Clements added. "We don't really have a good understanding of the link between fish quality, hydrosystem operations and delayed mortality."

The PLoS study used a variety of methods to evaluate survival. In the impounded reach of the Columbia River, the researchers used Passive Integrated Technology (PIT) tag data to evaluate survival between the upper and lower most dams. Tens of thousands of smolts in the upper river are routinely implanted with PIT tags by a number of resource agencies and the data is available online. Below Bonneville Dam and in the Fraser River they had to use acoustic tags, which are bigger, to pick up a signal from greater distance. The researchers tagged between 300 and 600 fish annually during a four-year period.

The studies in the Fraser River and the Columbia River determined that the survival rate of the smolts – at least to the estuary – was almost identical. Interestingly, both Clements and Schreck have been involved with other studies, on Oregon's Nehalem and Alsea rivers, that also found a general mortality rate of about 60 percent. In rivers without dams, mortality can be a function of predation – especially by fish, birds and seals – or it can be from disease, poor water quality, or lack of food.

"One question that this study raises is: Is significant mortality during in-river migration natural? And if so, what proportion of the fish that are killed by dams in the Columbia – directly or indirectly – would have died anyway," Clements said.

Judging historic survival rates of smolts is practically impossible, according to Schreck. Though there is good historical data on returns of adult salmon to river systems, it is difficult to estimate how many smolts they produced and how many young salmon survived their migration to the ocean. Judging what is a healthy survival rate – in historic terms – is a challenge.

Schreck did say that new fish passage technologies and increased release of water over spillways has improved smolts' initial survival of the eight dams on the Columbia River. But there also is evidence that smolts delay their migration for days before trying to navigate past the first dam, which combined with lower river flow rates because of the dams, leads to a delay in entering the ocean.

"We can't emphasize enough how complex salmon survival is," Schreck said. "It begins with the adults returning from the ocean loaded with contaminants, some of which is passed on through the eggs. There can be an impact on the embryo development and transition to the smolt phase. Parasites and disease play a role, as do water quality and other factors.

"Navigating dams may have become easier," he added, "but the process could still be inducing enough stress to cause higher mortality upon reaching the ocean."

Citation: 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. PLoS Biol 6(10):e265. doi:10.1371/journal.pbio.0060265
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