Transporting juvenile salmon hinders adult migration

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Scientists have discovered that management efforts intended to assist migrations of salmon and steelhead trout can have unintended consequences for fish populations. Juveniles that are transported downstream on boats can lose the ability to migrate back to their breeding grounds, reducing their survivorship and altering adaptations in the wild.

Transportation programs have been in place for over three decades to improve the survival of fish that hatch in rivers but migrate downstream to the ocean, where they live most of their adult lives. Adults then swim back up the river to mate, lay eggs and finally die in the same area where they were born. These fish can travel hundreds of miles and make dramatic ascensions up waterfalls and past dams.

When dams block rivers, however, the migrating fish – especially juveniles – can have a tough time traveling between their spawning grounds and the open ocean.

"Juveniles trying to get back to sea usually go over the spillways or past the dam's turbines," says Matthew Keefer, a biologist at the University of Idaho and the lead author on the study, which appears in the November issue of *Ecological Applications*.

Going past a dam's turbines, however, can kill many young fish. In response, management efforts help salmon and steelhead trout avoid dams altogether by transporting juveniles past dams toward the ocean on

river-faring barges.

But Keefer has found that this free ferry ride can create problems when the juveniles grow up. He and his colleagues Christopher Caudill, Christopher Peery and Steven Lee at the University of Idaho tracked the movement patterns of adult salmon and steelhead trout along the Columbia and Snake rivers in Washington and Oregon. They found that, when compared to fish that migrated naturally, transported juveniles had lower survivorship as adults and were less likely to find their way home.

"Adult fish usually move steadily upstream toward their spawning grounds, but some will instead move back downstream over dams," says Keefer. This phenomenon, called fallback by fisheries managers, occurs more often in adults that were barged out as juveniles than in those that migrated naturally.

"It's not clear if they're just running out of steam swimming up the river or if they get disoriented and move back downstream in search of cues from their home river," Keefer says.

The scientists believe that being carried on a barge prevents young fish from learning about important environmental signals during a formative time of their juvenile lives. A barge can take them the same distance in two to three days that would normally take them several weeks, Keefer explains. Traveling great distances by boat – in this study, at least 215 miles – appears to garble the natural cues these fish use to find their way home.
Keefer's results also suggest that transported fish are more likely to stray from their home tributary. If these lost fish – often from hatchery populations – breed with another wild population, the resulting gene flow can reduce that population's evolutionary fitness.

"Salmon have a life history that represents a long legacy of adaptation to

local conditions," Keefer says. "The fish are well-adapted to specific rivers, and when you dilute their unique genetic makeup, it can reduce the productivity of the overall population."

A satisfactory solution is difficult to find, Keefer says. Managers could barge fewer juveniles, but then more fish would die while trying to pass the dams. They could also release more water over dam spillways to help juveniles pass downstream, but that would reduce the amount of energy the dams produce. A third option is to slow down the barges so the trip resembles the time it takes juveniles to swim to the ocean. But boats are a stressful environment for fish, and the close quarters within the ships increase the risk of disease.

"It's tough to find a solution that could handle all the challenges in this system," Keefer says. Scientists and salmon managers hope to find the ideal solution: one that would preserve native fish populations and maximize their survival while keeping the integrity of energy-producing dams.

Source: Ecological Society of America