



RESEARCH LOOKS AT IMPACTS OF WATER TEMPERATURE, 'THERMAL REFUGIA' ON SALMON, STEELHEAD SPAWNING

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Remember when you were a child running barefoot -- how you would run quickly over a hot sidewalk, rest in a shaded spot, and let your feet cool down before braving the hot surface again?

This temperature hopscotch is what a recent summary report is revealing about the migration behavior of adult steelhead and chinook salmon in the Columbia basin. Many of the fish, uncomfortable in the Columbia River's warmer water, have been seeking refuge in cool-water tributaries along their migration route.

Completed in May, the University of Idaho College of Natural Resources report, "Temperature regimes during upstream migration and the use of thermal refugia by adult salmon and steelhead in the Columbia River basin," describes how these fish are seeking out cool spots along their journey, and the potential consequences of warming water temperatures on their ability to survive and spawn.

Authored by Matthew Keefer and Chris Caudill (fisheries scientists with the University of Idaho), and Chris Peery (U.S. Fish & Wildlife Service fisheries biologist), the report states that water temperatures in the 19-22 degrees C range, like those that routinely occur in the Columbia River mainstem, are thought to be stressful for adult migrants. The impacts of higher temperatures on the migrating fish create changes in behavior, and affect disease susceptibility, reproductive development, gamete quality (i.e., over-ripening), survival and fitness.

"Exposure to warm water can affect the quality of their eggs and the amount of energy the fish have remaining for spawning," Keefer said.

Their review states that many adult salmon and steelhead temporarily use thermal refugia -- cooler spots along the margins of the mainstem rivers -- when Columbia and Snake River water temperatures are high. These sites appear to be critically important mid-migration holding habitats for some populations, such as steelhead.

Peery explained that steelhead might stay in a refugia for extended periods, sometimes as long as three or four weeks in the lower Deschutes River or in Drano Lake where cold water from the Little White Salmon River enters the Columbia. Chinook salmon, which have long migrations in a shorter window of time, might stop at a refugia site for days as opposed to weeks, if at all.

"Twenty percent of the chinook salmon might use refugia versus 70 percent of the steelhead," Peery said.

As to whether it helps them on their journey -- more data needs to be gathered. "It's really hard to quantify what happens to those that do or don't use the refugia," said Peery. "Plus the issue of harvesting throws a monkey wrench into the data."

He said that it appears that steelhead use of refugia sites likely has a survival benefit, whereas using the refugia can delay the chinook. This potentially gives them a spawning disadvantage.

In both species, the benefits of thermal refugia are reduced by fisheries harvest that occurs while fish are holding in the cool water.

"These cold water pockets are very small in comparison to the mainstem rivers," Keefer said. "These refugia sites range from a quarter-mile long, to a few hundred yards, depending on the size of the tributary. At the Herman Creek confluence, it's just a small refugia pocket, whereas a river like the Deschutes creates longer stretches of cold water."

The information on fish behavior was gathered from the large-scale radiotelemetry studies funded by the U.S. Army Corps of Engineers dating back to 1996. These studies focused on adult salmonid behavior at dams, but most major tributaries were also monitored to help estimate hydrosystem escapement and identify individual populations. The antenna arrays at tributary confluence areas and adjacent reservoir sites allowed data collection at several critical refugia sites.

The most threatened species are listed interior populations including Snake River chinook salmon and steelhead, and the steelhead from the Upper Columbia.

According to the review, "A series of cool-water refugia are located along the migration corridor at tributary confluences with the mainstem rivers. Many of the most-used refugia sites are located between Bonneville and John Day dams in the lower Columbia River, where cool-water tributaries draining the Cascade Range enter reservoirs. These sites are often 2-7 degrees C cooler than the mainstem."

"Higher water temperatures is what prompted this study," said Peery. "The managers wondered about the potential impacts of climate change. Climate change is more than just warming; it also encompasses changes in rainfall and snowpack. If there is less snowpack, there will be a dramatic change in the life cycle of salmon."

Both Peery and Keefer mentioned the need to fill remaining data gaps, such as gaining a better understanding of migration temperature exposure on pre-spawn mortality. They've studied steelhead and fall chinook extensively, but have had only one season studying sockeye salmon.

"We're seeing fish dying before they get to the spawning areas, and we'd like to know if it is

correlated to temperature exposure," Peery said. "When fish are temperature-stressed, do we get a higher pre-spawn mortality rate?"

The group is also studying chinook salmon in the Willamette River, and it is looking forward to seeing results of sockeye salmon studies now underway in the Fraser River, British Columbia, where there has been high adult mortality associated with warming river temperatures.

"Some scientists think of the more sensitive sockeye as the canary in the coal mine," Peery said. "If there are stressors in the sockeye, it probably will show up later in other species."

Peery also is interested in finding the answers to other fish issues, especially surrounding the management of water in the Willamette. "Can we manage the system's flows that create river conditions good for fish without risking floods to downtown Portland?" he asked.

Another factor is the impact of harvesting in thermal refugia sites.

"At the mouth of the Deschutes River in July, it's inundated with fisherman," said Keefer. "That makes it difficult to balance demands for fisheries with temperature concerns, especially if these sites are designated critical habitat. Then we have a real management conflict."

Keefer said that the main takeaway from the review is that the mainstem Columbia and perhaps the lower part of the Snake are warmer than they have been historically, and it's not clear whether fish can adapt as rapidly as the system is changing.

"This issue may become more acute if warmer regional temperatures predicted by climate models come to pass," said Keefer. "These refugia sites can be considered critical habitat for adult migrants, and they will increase in importance if climate continues to warm or if main stem water temperatures continue to increase."

The report is available at: <http://www.cnr.uidaho.edu/uiferl/Archive.htm>

