

**NEWS FROM:  
University of Idaho  
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**Something's Fishy with Columbia Chinook:  
Females Carry Male's Genetic Signature**

MOSCOW--Samples in 1999 from fall chinook salmon in the Columbia River's Hanford Reach show that four-fifths of the females spawning there apparently began life as males.

The finding could provide an important clue in sorting through the complex reasons for the decline of Northwest salmon runs, although the Hanford's wild fall chinook run is among the healthiest. The researchers ruled out radiation as a possible cause of the apparent sex reversal but suggested environmental contaminants that mimic hormones or water temperature changes could be the culprits.

The research by University of Idaho and Washington State University scientists in cooperation with the Pacific Northwest National Laboratory was published in *Environmental Health Perspectives*, a journal of the National Institute of Environmental Health Sciences.

James J. Nagler, UI assistant professor of zoology who led the study, said the results of the genetic testing on the natural-spawning chinook came as a surprise.

"We have found that a majority of the female chinook salmon sampled carry a genetic marker that is found only in male salmon. The best explanation for these results is that these females have been 'sex reversed' and are in fact male," Nagler said. "This is not unheard of as salmon can be sex reversed experimentally under laboratory conditions. What is surprising is that this is the first report of this from a wild population of fish."

Gary Thorgaard, WSU's School of Biological Sciences director and a co-author of the paper, says that experiments in his laboratory and others have shown it is possible to reverse the sex of trout embryos through the use of hormones. A study in Canada showed changing temperature could alter the sex of young sockeye salmon.

Other authors include Jerry Bouma, UI graduate student, and Dennis Dauble, a salmon biologist at the Pacific Northwest National Laboratory operated by Battelle in Richland. Dauble, PNNL natural resources manager, has conducted research on salmon spawning and habitat in the Hanford Reach for 27 years.

Nagler gathered the original Hanford Reach samples in fall 1999 and took additional samples in November 2000. He has expanded the research to other rivers, including the Yakima, a major Columbia tributary. Pesticides and other chemicals that could mimic estrogen and disrupt the normal development of salmon are present in the Columbia's water, Nagler said, but at very low concentrations, far below those used in laboratory experiments.

Records also show daily changes in the Columbia's water temperature as water flows fluctuate to generate hydroelectricity.

"These results may explain in part the difficulties some salmon have had reproducing in the Columbia River Basin. The cause of the apparent sex-reversal in these chinook salmon is presently unknown," Nagler added.

DNA tests of female chinook raised in the adjacent Priest Rapids Fish Hatchery showed no such changes. The close genetic relationship of those Priest Rapids fish to the Hanford Reach chinook suggested that the river environment was responsible for the unusual results in the Hanford females. Tests of female spring chinook from Dworshak National Fish Hatchery along Idaho's Clearwater River at Ahsahka likewise showed no evidence of the male-linked genetic marker.

The genetically altered females, instead of carrying the normal two X chromosomes, appear to carry one X and one Y chromosome, the normal genetic signature of the male. The altered females of the Hanford Reach produced eggs, spawned and then died as is normal in the Pacific salmon's life cycle. DNA from small pieces of fin showed the genetic markers that indicate their male genotype. The mating of a genetically altered female and a normal male could then produce males with two Y

chromosomes, and such males could then only produce male offspring, thus imbalancing the sex ratio of spawners.

The Hanford Reach remains the most important natural spawning area for fall chinook salmon in the main-stem Columbia River, and this wild chinook run is the largest upstream from dams in the Columbia Basin. The reach is the last free-flowing stretch of the Columbia upstream from Bonneville Dam.

The research is the result of just one season's testing, Nagler noted. Still, the preliminary findings raise provocative questions about other factors that may be responsible for the decline of the Northwest's famed salmon runs.

"The current study by the research team at WSU and UI published in *Environmental Health Perspectives* by the NIH is one of the first insights that basic problems in fish reproduction and genetics could be a significant factor affecting the decline of salmon populations," said Michael Skinner, director of the WSU-UI Center for Reproductive Biology. Nagler and Thorgaard are affiliated with the center.

"Understanding these basic biological issues helps define solutions to the endangered salmon recovery that are scientifically based," added Skinner. He said that 30-some projects at UI and WSU focus on salmon restoration issues.

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Editors: James Nagler's journal article is online at: < <http://ehp.niehs.nih.gov/docs/admin/newest.html>>. Photos or video clips are available online at [www.uidaho.edu/salmon](http://www.uidaho.edu/salmon) or by contacting [bloftus@uidaho.edu](mailto:bloftus@uidaho.edu)

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