Anomalous ocean conditions in 2015 may bode poorly for juvenile Chinook salmon survival

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Different body weight of similar length juvenile Chinook salmon representing lower growth during warm ocean conditions (upper fish) and higher growth during cold ocean conditions (lower fish).

Credit: Oregon State University

Fisheries managers have been predicting a slightly below-average run of

spring Chinook salmon on the Columbia River this year but a newly published suggests that it may be worse.

According to researchers from Oregon State University and the National Oceanic and Atmospheric Administration, ocean conditions were historically bad in the spring of 2015, when migrating yearling fish that will comprise the bulk of this spring's adult Chinook salmon run first went out to sea. In fact, Pacific Decadal Oscillation values – which reflect warm and cold sea surface temperatures – suggest it was one of the warmest nearshore oceans encountered by migrating Chinook salmon dating back to at least 1900.

The lack of food for the salmon in 2015 may have resulted in significant mortality that will show in this year's run of Columbia River springers. One way or another, it will provide new information on fish survival and whether juvenile salmon prey data can help resource managers predict future returns.

Results of the research, which was funded by the Bonneville Power Administration and NOAA, have just been published in the journal *Marine Ecology Progress Series*.

About 80 percent of a typical spring Chinook run on the Columbia River come from fish that went out to sea as yearlings two years earlier, according to lead author Elizabeth Daly, a senior faculty research assistant with the Cooperative Institute for Marine Resource Studies, jointly operated by OSU and NOAA out of the Hatfield Marine Science Center in Newport.

"When juvenile salmon first enter the ocean, it is a critical time for them," Daly said. "They are adjusting to a salt-water environment, they have to eat to survive, and they have to avoid becoming prey themselves. When we sampled juvenile salmon in May and June of 2015, the fish

were much smaller and thinner than usual, and many of them had empty stomachs. There just wasn't anything for them to eat."

Two key statistics stand out from 2015, the researchers noted. The California Current system off the West Coast was more than 2.5 degrees Celsius (or 4.5 degrees Fahrenheit) warmer than normal, and the juvenile Chinook were smaller and skinnier than during a cold-water year, weighing an average of 17.6 percent less.

When the oceanic waters off Oregon and Washington are cold, young salmon primarily feed on readily available fish prey such as Pacific sand lance and smelts, which triggers their growth spurt. When waters are warmer, there is less food available, and they primarily eat juvenile anchovies and rockfish, which are less-desirable prey than cold-water species.

Daly said 2015 began on a somewhat positive note. Although cold-water larval fish species were absent, the researchers found abundant amounts of other larval fish in January, February and March, the fourth highest biomass in the last 18 years. Thus even in the absence of preferred cold-water species, there was food in the California Current system – at least for a while.

However, by the time the juvenile Chinook salmon migrated to the ocean later that spring, these larval anchovies and rockfish had all but disappeared – making even backup food sources for the salmon scarce.

The researchers theorize that these larval fish died off because they themselves had little to eat. Long-time NOAA biologist Bill Peterson told Daly and her colleagues that the Pacific Ocean off the Northwest coast in early 2015 was devoid of cold-water, lipid-rich copepods, a key element in the food chain. In 2015, it was so warm offshore that virtually no lipid-rich copepods were to be found.

"We think the larval anchovies and rockfish had nothing to eat, so they died off," Daly said. "So when the salmon entered the ocean later that spring of 2015, the cupboard was bare."

"During warm years, there is typically less upwelling that brings cold, nutrient-rich water to the surface," said Richard Brodeur, a biologist with the NOAA Northwest Fisheries Science Center and co-author on the study. "Salmon populations may be able to handle one year of warm temperatures and sparse food. But two or three years in a row could be disastrous."

"The young salmon may have to travel farther north to find food, and they become highly susceptible to becoming prey themselves because of their weakened condition."

Preliminary results from 2016 by study co-author Toby Auth suggest that ichthyoplankton biomass was again high in late winter, but it was dominated once more by anchovies and sardines, which normally spawn off Oregon in summer. Juvenile salmon sampled in the spring were small and somewhat thinner than normal, Daly said.

"For the first time, we found that the salmon were eating juvenile sardines in 2016 – a new prey for them," she noted. "Sardines were spawning off the central Oregon coast for one of the first times because of the warm water. We don't know the long-term impact this will have on salmon. Hopefully, it can become a new food source for them if waters remain warm."

As this year's run of spring Chinook salmon unfolds on the Columbia River, Daly and her colleagues will be watching to see if the numbers of adult fish returning align with predictions of a poor return based on 2015 ocean conditions, prey availability, and juvenile fish size.

It could provide valuable information to resource managers in the future.

Provided by Oregon State University