Coho and Chinook Salmon Decline in California during the Spawning Seasons of 2007/08

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2 February 2008

The short version

Near final data from across the range of coho salmon on the coast of California reveal there was a 73% decline in returning adults in 2007/08 compared to the same cohort in 2004/05. The problem extends beyond California: preliminary data from the Oregon coast show a 70% decline. The low coho salmon numbers come on the heels of the Pacific Management Council's report of exceptionally low Chinook salmon returns to California's Central Valley (and other streams in California, Oregon, Washington, and British Columbia) in the fall of 2007. Because of the broad spatial extent of the decline and the similar ocean ecology of the two species, ocean conditions are suspected as a main causative agent. The Wells Ocean Productivity Index (WOPI), an accurate measure of central California ocean productivity, reveals poor conditions during the spring and summer of 2006, when juvenile coho from the 2004/05 spawn entered the ocean. The WOPI also showed low productivity potential for the spring and summer of 2005, which may explain low returning Chinook salmon numbers in 2007. Further, if the WOPI has predictive power, adult Chinook salmon returns in 2008 should be low.

The long version

The Pacific Fisheries Management Council (PFMC) reported on 29 January 2008 unexpectedly low Chinook salmon returns to California in 2007, in particular to the Central Valley. Adult returns to the Sacramento River, the largest of Central Valley Chinook salmon runs, failed to meet resource management goals (122,000-180,000 spawners) for the first time in 15 years.

Now preliminary reports near the end of the 2007/08 spawning run indicate coho salmon are experiencing poor returns as well. As coho spawning season is nearing an end in California, state and federal biologists, using a variety of techniques, including visual, video, spawner/carcass, and redd surveys have found coho salmon returns to be far below what was expected, based on returns three years earlier, which are the same populations or yearclass lineages. Coho salmon are listed as endangered and threatened in the Central California Coast and Southern Oregon-Northern California Evolutionarily Significant Units (ESU), respectively, under the U.S. Endangered Species Act (ESA). Coho have essentially a fixed three-year life cycle in California, in contrast to Chinook salmon, which may return as mature adults as three (primarily), four, and some five year olds. For coho, each yearclass can be considered essentially a separate population because there is little mixing among yearclass lineages, with the exception of "jacks" that return as 2-year old males in limited numbers.

In California, mature coho salmon return to natal streams between late November and late January into February in coastal streams between the Oregon border and Scott Creek in Santa Cruz County. They return earlier in the northern part of the state grading to mid-December to mid-February in Scott Creek. In recent years, returns to Scott Creek were essentially complete by the end of January. Typically, spawning occurs within a month

or so after stream entry, whereas at the southern end of the range, it occurs almost immediately. Juvenile salmon emerge from redds in late winter – early spring and spend one year in the stream before migrating to the ocean in the following spring. They spend about 1.5 years in the ocean and return to spawn in the late fall-early winter three years hence.

Coho salmon returns in 2007/08

Of 13 streams between the Smith River and Scott Creek where surveys are conducted, there has been a 73% decline in returning coho salmon, compared to the same yearclass lineage returns in 2004/05 (Fig. 1). No stream had an increase or level returns. One stream, Redwood Creek in Marin County had a complete failure, with no returns for the first time on record. Scott Creek had only four jack returns, compared to 329 adults in 2004/05. There is a slight trend of greater declines toward the south, but for the most part, the data show large reductions in returning adults throughout the California coast. It appears that this phenomenon extends beyond California; preliminary and incomplete surveys of 22 streams through January in the Oregon Coast ESU found a mean decline in coho returns of 70% relative to returns in 2004/05. Their estimate of 51,000 returning adults to the Oregon Coast ESU in 2007/08 is the lowest since 1999. Further, their data show the decline has been continuing for the past three years.

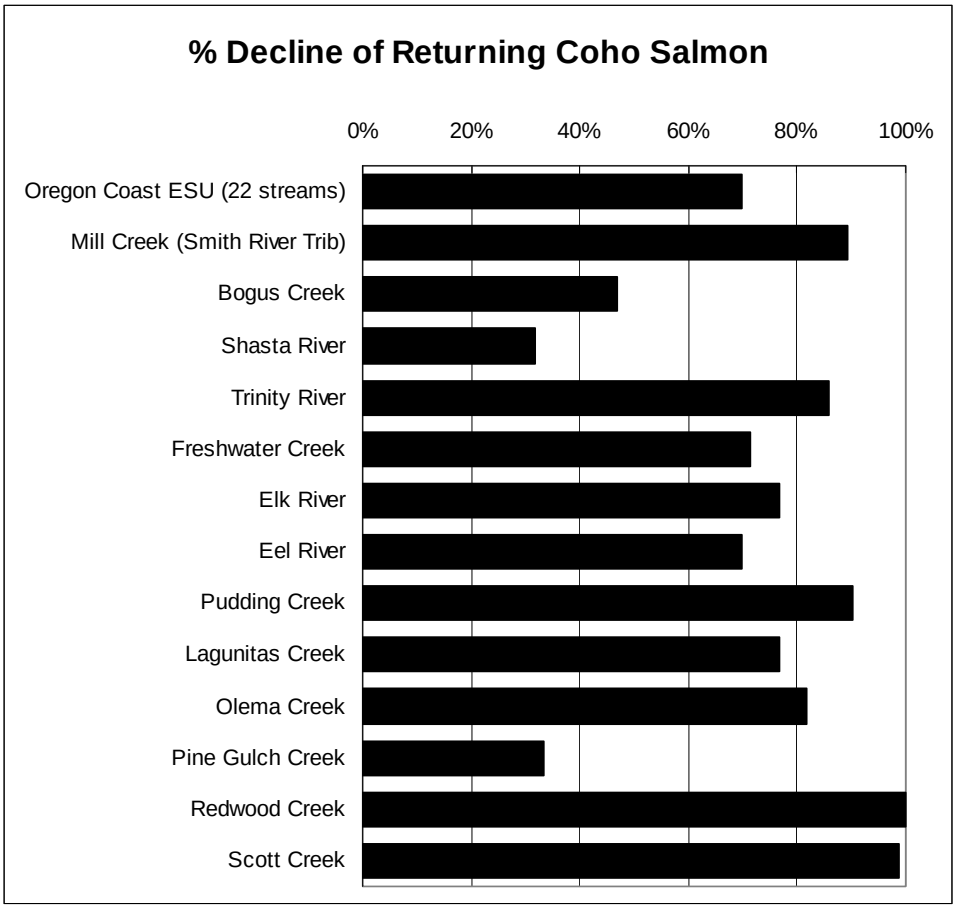

Figure 1. Percent decline of returning coho salmon to streams in California and Oregon 2007/08 relative to returns in 2004/05. Streams listed from north to south.

Causation

Although there are no shortage of potential contributors to the decline, including such wide ranging factors as poor fecundity of the 2004/05 yearclass; hydrologic flushing of fry prematurely to sea by high stream flows in 2005; increased predation by avian, pinniped, and/or other marine predators; and anthropogenic factors such as oil spills, fishing bycatch mortality, irrigation, and water exports from streams, the spatial extent of the problem points toward a broader agent: ocean conditions.

It is known that the first few months in the ocean are a critical period for growth and survival in salmonids. Recent work in the Fisheries Ecology Division shows that the greatest rates of growth and energy accumulation for Chinook salmon occurs in the first one to three months after ocean entry. Chinook salmon in California enter the ocean as subyearling and at a smaller size than coho, which enter the sea as yearlings after about 1.5 years in freshwater. Thus, Chinook and coho hatched in the same year, enter the ocean one year apart. Both enter in late spring to early summer, theoretically driven by evolutionary adaptation to seasonally beneficial feeding and growth conditions from a suite of climate and oceanographic factors that result annually in high biological productivity on the California coast between spring and late fall.

Ocean conditions were poor for salmon growth and survival during the spring–summer of both 2005 and 2006. The Wells Ocean Productivity Index (WOPI), a composite index of 13 oceanographic variables and indices, weighted heavily by sea level height, sea surface temperature, upwelling index, and surface wind stress, has been used to accurately predict zooplankton, juvenile shortbelly rockfish, and common murre production along the California coast, and is thus a valid indicator of ocean productivity. Index values for the spring-summer of 2005 and 2006 were low, indicating poor conditions for growth and survival (Fig. 2). In fact, only the El Niño years (1982-83, 1992-93, 1999) had lower WOPI values. The WOPI assesses conditions on a local scale for California, but has tracked another index, the Northern Oscillation Index (NOI), which is based on the strength of the North Pacific high pressure cell and describes a broader region of the North Pacific Ocean. In 2005 and 2006, the WOPI decoupled from the NOI, suggesting local conditions on the California coast were worse than for the larger North Pacific region. These results indicate that ocean conditions in the spring and summer, when juvenile coho and Chinook salmon enter the ocean, were unfavorable to growth and survival. This may explain the poor returns of both coho in 2007/08 and Chinook salmon in 2007. And, if the WOPI has predictive power, adult Chinook returns in 2008 should be low, supporting independent findings by the PFMC's Salmon Technical Team, which reported a record low in the number of jacks returning to the Central Valley this past fall. Jack returns have been a useful predictor of run size in the next year, in this case, 2008. In 2007, only 2,000 jacks returned compared to the previous low of 10,000 and the long-term average of 40,000.

Further Considerations

Given the imperiled nature of coho (2 of 2 ESUs listed by ESA) and Chinook salmon (10 of 13 ESUs listed) in California it is critical that coastwide instream monitoring programs be implemented and maintained to allow warning of impending

problems to these valuable resources. Without the existing minimal monitoring effort, since coho are not commercially fished or regulated, there would be little notice of their decline.

Further, the need for ocean monitoring on a consistent basis to understand the changing conditions, responses of salmon and other marine organisms, and to provide data to improve our ability to forecast impacts on marine resources, including California's salmon, cannot be overemphasized. Implementation of ocean observing systems, as recommended by two independent federal reviews of ocean policy and California's Proposition 40, would greatly improve our understanding of the ocean, which would benefit the sustainability of our valuable marine resources, as well as society in general.

The dire situation evident this year also emphasizes the importance of genetically-diverse captive broodstocks, such as those at Warm Springs Dam on the Russian River and at the Fisheries Ecology Division laboratory (Southwest Fisheries Science Center, National Marine Fisheries Service) in Santa Cruz, which supplies mature fish and their gametes to Kingfisher Flat Hatchery, operated by the Monterey Bay Salmon & Trout Project, in the Scott Creek watershed. With fluctuating, and sometime adverse, ocean conditions that impact salmon over broad areas, maintaining a pool of broodstock derived from extant populations, may be the last best effort at preserving these stocks until more favorable conditions are reestablished.

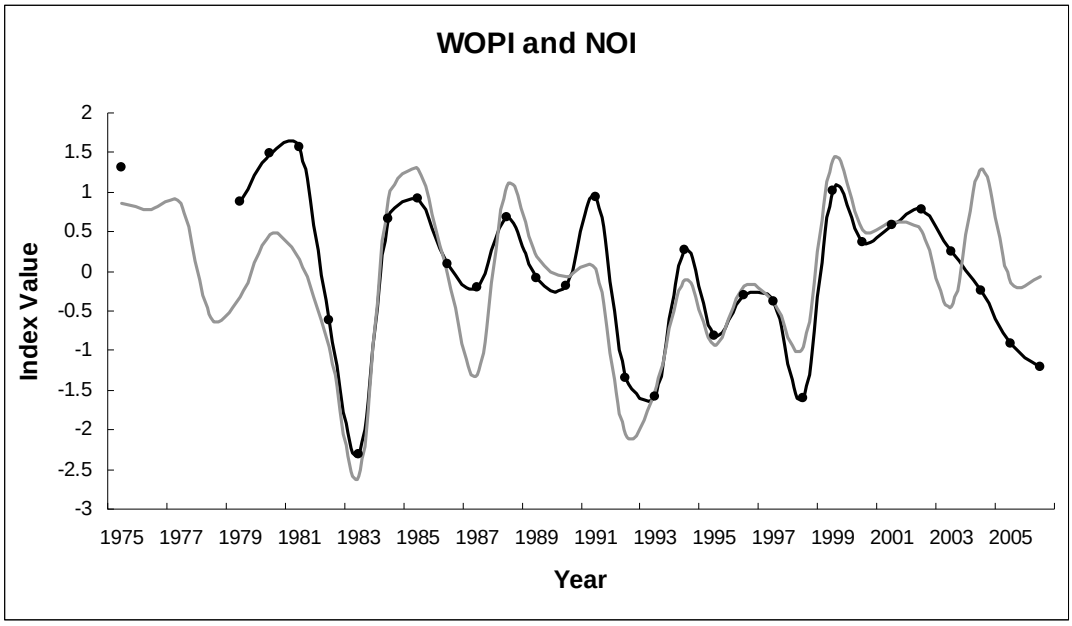

Figure 2. The Wells Ocean Productivity Index (WOPI, black line) and the Northern Oscillation Index (NOI, grey line) between 1975 and 2006. Values derived for March-August. Note the close fit between the larger-scale NOI, which represents the strength of the North Pacific high pressure cell, and local-scale WOPI, except for recent years (2004-2006), suggesting a change in local conditions. Low values indicate conditions for lower biological productivity.