Effects of 2015 drought on Pacific Northwest Salmonids

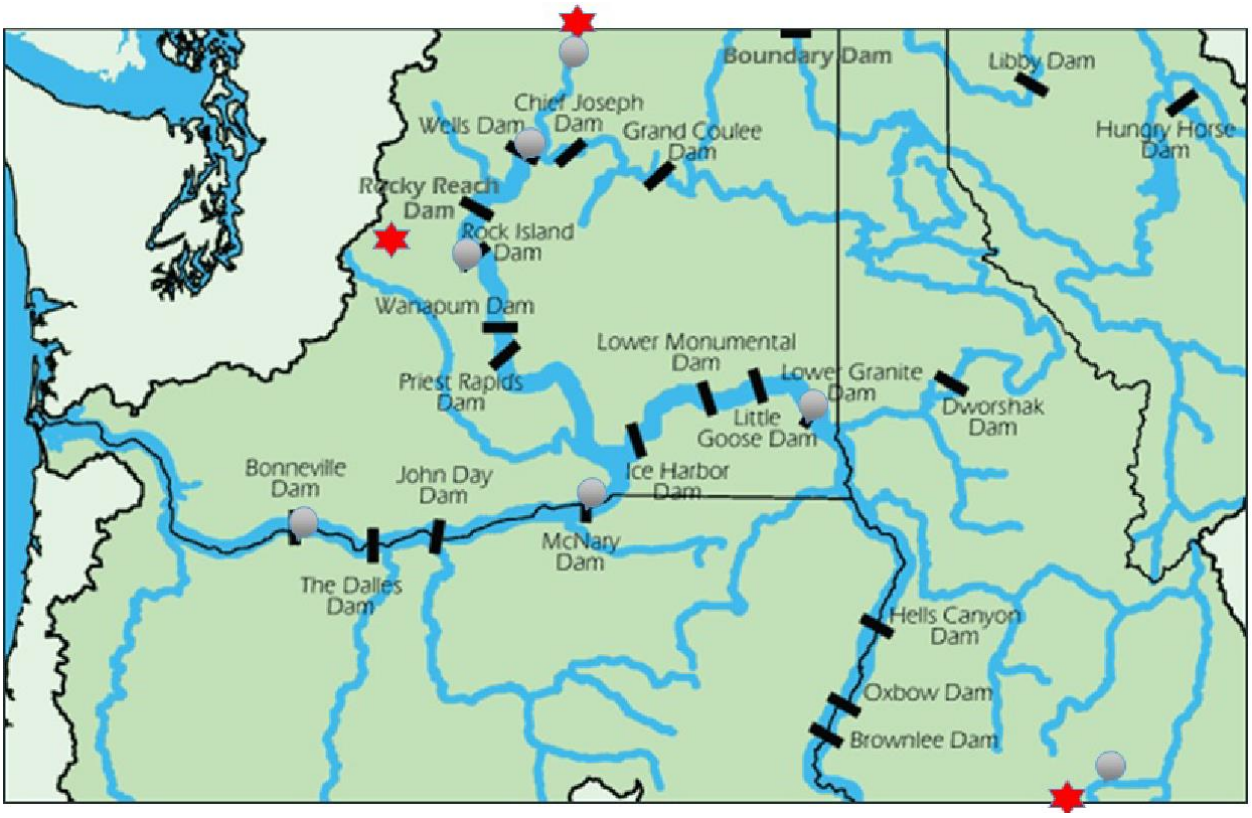

Figure 1: Map of the Columbia River Basin showing large hydroelectric projects, PIT tag detectors that NOAA uses to estimate adult sockeye salmon survival rates (grey circles), and the location of sockeye salmon spawning populations (red stars). From NOAA Fisheries, 2016.

Low snowpack and warm temperatures devastated salmon populations on the Columbia River in 2015. Temperatures in the mainstem Columbia River were the highest on record from mid-June to mid-July, due to lower flows and higher air temperatures, resulting in a 95 percent loss of adult sockeye salmon between Bonneville and Lower Granite dams (NOAA Fisheries, p. 3).

Environmental Conditions

Even though precipitation in the Columbia Basin above The Dalles Dam in 2015 was 84 percent of average, the runoff volumes in Columbia River Basin from winter through summer were near the lowest observed in a 56-year water history. This was caused by two factors: (1) the winter temperatures, important for snow accumulation, were above average and much of the precipitation fell as rain, (2) spring precipitation was below average. These conditions, combined with above-average air temperatures in June, resulted in abnormally high water temperatures in tributaries and mainstem Columbia Basin rivers (NOAA Fisheries, 6). Water temperatures between mid-June and mid-July in the Lower Columbia River exceeded 20°C (68°F) which is unusual for that time of year (NOAA Fisheries, 14).

Salmon Stressors

Water temperatures ranging between 21 and 22°C can kill adult salmonids. High temperatures also affect migration and spawning in several ways. Fish may not migrate or may seek cold-water refuges which can delay or reduce migration (NOAA, 15). Delayed or reduced migration can also be caused by warm water within fish ladders. Fish ladders are fed by warm surface water from the dam reservoirs, ending in cooler tailrace water dragged from the bottom of the reservoir by turbines. A fish migrating upstream would then have to enter a warmer fish ladder to be able to continue its migration. This can lead to multiple entries and exits, which slows migration, causes thermal stress and decreases migration success. Fish exposed to above optimal temperatures also spend more energy on metabolic processes such as respiration and reduce some other activities such as swimming. This results in a longer and more energy-consuming migration that causes reduced size and viability of eggs or even death before they reach their spawning grounds. Bacterial pathogens linked to warm water temperatures -- *Aeromonas salmonicida* and *Aeromonas hydrophila* -- were observed on migrating salmonids and could have led to population declines (NOAA, 15-16).

Resulting Salmon Mortality

Adults: These unfavorable effects resulted in lower survival rates of adult salmon in the area, as they progressed upstream to spawning areas. NOAA Fisheries estimated survival rates for Upper Columbia River and Salmon River sockeye salmon. For the Snake River, estimated survival of adult sockeye salmon from Bonneville Dam to Lower Granite Dam was a mere 8% in 2015 (NOAA Fisheries, 25), compared with an average of 64% in the preceding five years. The total number of Snake River sockeye salmon detected at Bonneville Dam was 677, and 7 fish were detected at the spawning site in Sawtooth Valley. Upper Columbia River salmon fared better. Migrating Snake River salmon are exposed to higher cumulative temperatures than Upper Columbia River sockeyes which probably leads to their lower survival rates (NOAA Fisheries, 20). Timing of the migration is also an important factor for survival. Fish that arrived at Bonneville Dam early in the season had the highest survival rates -- 90% for Upper Columbia River sockeye and 70% for Snake River salmon. As temperatures rose later in the season and exceeded 20°C, the survival rates dramatically dropped, to 20% for Upper Columbia River and zero for Salmon River sockeye (NOAA Fisheries, 18). It also seems that whether salmon were transported or migrated in river as smolts plays a role in migration survival in adulthood. Fish that had been transported as juveniles migrated longer, were longer exposed to elevated temperatures, and had lower survival rates (NOAA Fisheries, 25, 27).

Juveniles: Conditions also affected juvenile salmon, which migrate toward the ocean. For spring-migrating yearling Chinook, steelhead, and sockeye salmon, in the Snake and Columbia rivers in 2015, the estimated survival rate throughout the entire river system for Snake River Chinook salmon was 38.9%, below the long-term average of 49.4%, and the third lowest in 17 years of observations. For Snake River steelhead it was 36.4%, also under the long-term mean of 45.1%, and the fourth-lowest year on record (Faulkner et al., 59-60).

Management Options

Adults: For adult salmon, managers can release cold water from Dworshak Dam to exert some control on temperatures in the tailrace at Lower Granite Dam. Managers planned to use this to reach and maintain a target temperature of 19.2 degrees C in 2015. But two of the temperature monitoring stations near Dworshak Dam malfunctioned, resulting in an error within the computation of how much water should be released from the dam. Discharge was reduced while migration was in its peak and

temperatures downstream were rising, exceeding 21 degrees C in the Lower Granite tailrace, 22 degrees C in the tailrace of Little Goose Dam, and 25 degrees C near the surface in the forebay (NOAA Fisheries, 29). Another management option is to trap and transport salmon, a technique that almost doubled the number of sockeye collected in the Snake River Basin in 2015 (NOAA Fisheries, 42).

Juveniles: The primary strategy for increasing survival of juveniles is to create passage routes by using spill or surface-passage structures, such as removable or temporary spillway weirs at several dams, the ice-trash sluiceway at The Dalles Dam, and the corner collector at Bonneville Dam. In 2015 the spill percentages were high considering low-flow conditions, which sped up migration of young salmon compared to other low-flow years (2001, 2004). Migration times in 2015 were longer than in 2008-2014 but shorter than the long-term average, 1998-2015 (Faulkner et al., 60).

References

Faulkner, J. R., D. L. Widener, T. M. Marsh, S. G. Smith, R. W. Zabel. 2016. Survival estimates for the passage of spring migrating juvenile salmonids through Snake and Columbia River dams and reservoirs, 2015. Report of the National Marine Fisheries Service to the Bonneville Power Administration. Portland, Oregon. https://www.nwfsc.noaa.gov/assets/26/8699_04272016_105156_Spring-Survival-2015.pdf

NOAA Fisheries. 2016. 2015 Adult Sockeye Salmon Passage Report. DRAFT for co-manager review, by NOAA Fisheries, in collaboration with the U.S. Army Corps of Engineers and the Idaho Department of Fish and Game.
http://www.westcoast.fisheries.noaa.gov/publications/hydropower/fcrps/2015_adult_sockeye_salmon_passage_report.pdf

Presentation on NOAA Fisheries' 2015 Adult Sockeye Passage Report (a helpful summary of the document above)
https://www.nwcouncil.org/media/7150172/5.pdf

See also: NOAA releases 2015 sockeye salmon passage report; council hears better news about 2016 sockeye, Columbia Basin Fish & Wildlife News Bulletin, Sept. 16, 2016
http://www.cbbulletin.com/437535.aspx

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