Lake Ozette sockeye adults migrate a short distance over 2-3 days (on average) through the Ozette River between April and mid-August, with peak returns in May or June. Adults then hold in Lake Ozette for 3-9 months before spawning, when they display two different spawning behaviors: beach spawning and tributary spawning. Beach spawning occurs between mid-October and early February, with a peak in early January. The largest aggregation of tributary spawners migrates an additional 5-8 km upstream to Umbrella Creek, where early arriving fish may hold for up to several weeks before spawning. Tributary spawning occurs somewhat earlier than beach spawning, from early October to early January, with a peak in late November.
Fry typically emerge from both habitats in late March-April, and rear to a large size, relative to other sockeye populations, for a full year in the lake. Estuarine residence is not well known in terms of location and duration. After ocean entry, Lake Ozette sockeye juveniles are thought to stay nearshore until fall before migrating offshore to the Gulf of Alaska, although a few juveniles genetically identified as Lake Ozette sockeye have been recovered in coastal waters of British Columbia (Beacham et al. 2014). Marine distributions of sockeye are thought to encompass oceanic regions of the subarctic Pacific (Farley et al. 2018). Marine survival in this DPS is relatively high compared with other sockeye. Most adults spawn as 4-year-olds, but in the past decade spawner age has expanded to include 3- and 5-year-olds.

Climate Effects on Abundance and Distribution

Lake Ozette sockeye scored mostly moderate and low in life stage sensitivity to climate change. Adults might face higher predation while migrating through low flows and can experience some temperature stress if heat spells coincide with migration (Haggerty 2009). However, the migration is short and occurs in spring and early summer, so adults can likely avoid both high temperatures and low flows. Lake temperatures are relatively cool and do not pose an imminent threat for either the adult or juvenile freshwater stages. High flows might reduce suitable spawning habitat due to conditions during spawning or accumulation of fine sediment in spawning gravel.

Although marine survival presumably fluctuates with climate, as has been observed widely in sockeye, the relatively large smolt size of this population appears to have buffered it historically from severely depressed returns during poor climate years. In terms of exposure attributes, this DPS was scored high for sea surface temperature and stream temperature, and very high for ocean acidification.

Extrinsic Factors

For Lake Ozette sockeye, sensitivity was ranked high for population viability and other stressors. The abundance of this population is still low, and there has been some loss in the spatial distribution of beach spawners. Nonetheless, spatial and temporal diversity has been increasing, and productivity has fluctuated.

This DPS received one of its higher sensitivity scores (mean 2.7) for other stressors. Extensive timber harvest in the basin has increased fine sediments in stream and beach habitats, reducing suitable spawning area. Increased peak flows and temperatures may exacerbate the effects of fine sediment. Large amounts of fine sediment were recruited into the tributaries and then expelled into the lake during extensive forest harvest in the last century. Beach spawning at the tributary mouths is no longer observed, presumably because of fine sediment accumulation in the spawning gravel. The two remaining beach spawning locations are far from tributary mouths (5-56 km). Furthermore, introduced largemouth bass is present in the lake in low numbers and is likely to expand in a warmer climate.
Negative hatchery impacts are thought to be relatively low for this population. There is a supplementation hatchery, but use of non-native brood stock is minimal. Overall, supplementation has enhanced diversity in spatial distribution and age structure, which should improve resilience to climate change. Nonetheless, the population is not self-sustaining, and negative hatchery impacts are possible; this risk led to moderate scores for hatchery influence.

Adaptive Capacity

Lake Ozette sockeye scored low in adaptive capacity. Sockeye are unlikely to respond to climate change by changing life-history characteristics. Furthermore, little habitat exists that could potentially be improved to become more suitable for these fish. Low population abundance and spatial diversity suggest limited genetic heterogeneity that would support rapid adaptation. Adult migration currently spans a broad temporal window (April to mid-August), which might contract to avoid high temperatures and low flows in summer.

Literature Cited


Haggerty, M. 2009. Lake Ozette sockeye limiting factors analysis. Prepared for the Makah Indian Tribe and NOAA Fisheries, in Cooperation With the Lake Ozette Sockeye Steering Committee, Port Angeles, WA.