Upper Willamette River Chinook

Overall vulnerability—Very high (15% High, 85% Very high)
Biological sensitivity—Very high (20% High, 80% Very high)
Climate exposure—High (78% High, 22% Very high)
Adaptive capacity—Moderate (1.6)
Data quality—74% of scores ≥ 2

	Upper Willamette River Chinook	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Early life history	1.4	3	
	Juvenile freshwater stage	2.9	3	
	Estuary stage	1.9	2.3	
	Marine stage	2.3	1.8	
	Adult freshwater stage	3.6	2.8	
	Cumulative life-cycle effects	3.3	2	
	Hatchery influence	3.8	2.5	
	Other stressors	3.5	3	
	Population viability	3.6	2.8	
	Ocean acidification sensitivity	1.9	1.8	
	Sensitivity Score	Very High		
Exposure variables	Stream temperature	3.6	2.3	
	Summer water deficit	2.4	1.8	
	Flooding	2.8	2	
	Hydrologic regime	3.2	2.5	
	Sea level rise	2	2.3	
	Sea surface temperature	3.4	2	
	Ocean acidification exposure	3.8	2.5	
	Upwelling	2.3	1.8	
	Ocean currents	1.8	1.3	
	Exposure Score	High		
	Overall Vulnerability Rank	Very High		

Life History Synopsis

Upper Willamette River Chinook adults arrive in fresh water from late winter through early summer, hold in the river system, and mature throughout the warmest temperatures of the year. Spawning occurs from late summer through much of fall, with eggs incubating over the winter. Juvenile life histories can be diverse (Schroeder et al. 2016). Fry emerge over a protracted period from early winter through mid-spring, with juveniles rearing in fresh water for 8-16 months and exhibiting diverse patterns of habitat use. Some juveniles migrate as subyearlings, with migration peaks in both spring and fall. However, the majority remain in fresh water for a full year prior to migration.

Estuarine use by subyearlings from this DPS can be extensive (Teel et al. 2014, Rose 2015), while yearlings migrant rapidly through the estuary 1-2 months earlier than other yearling Chinook smolts in the Columbia River (Weitkamp et al. 2015). Marine distribution of subyearling migrants is poorly understood, but yearlings move rapidly northward along the continental shelf during their first summer, and then likely rear in the central Gulf of Alaska (Fisher et al. 2014, Teel et al. 2014, Riddell et al. 2018). As adults, Upper Willamette River Chinook are widely dispersed in marine waters, from southeast Alaska to the Oregon coast (Weitkamp 2010). Most adults return after 2-3 years at sea. Because both juveniles and adults use habitats throughout the Willamette River year-round, they are exposed to climate risks in all seasons.

Climate Effects on Abundance and Distribution

Exposure attributes for Upper Willamette River Chinook salmon were ranked ***high*** overall, due to ***very high*** scores for ocean acidification and stream temperature. Mean August temperature was projected to increase 1.4°C by the 2040s, and 2.4°C by the 2080s. Other ***high*** exposure attributes included sea surface temperature and hydrologic regime shift. Although approximately 90% of the basin is already rain-dominated, the remaining 10% is very likely to change to rain-dominated by the 2040s. Scores for ocean acidification and sea surface temperature were similar to those of most DPSs.

Sensitivity attributes for this DPS were ranked ***very high*** due to a host of factors, including vulnerability in the adult freshwater stage and cumulative threats to the species' entire life cycle and to its life history diversity.

Extrinsic Factors

All three categories of extrinsic factors scored ***high*** or ***very high*** for this DPS. Keefer and Caudil (2010) and Myers et al. (2018) highlighted the factors posing potential or demonstrated threats to Willamette River salmonids. Upper Willamette River Chinook is listed as threatened under the U.S. Endangered Species Act. This DPS has low numbers of wild adults, with the majority of individuals resulting from production hatcheries. Thus, Upper Willamette River Chinook was ranked ***very high*** in for population viability and hatchery influence. A ***high*** ranking for other stressors reflected the following pressures on this DPS:

1) Loss of hundreds of kilometers of historically occupied habitats due to lack of passage above major dams
2) Low survival of fish transported above dams
3) High pre-spawn mortality of adults linked to impaired temperatures and flow regimes below dams
4) Widespread invasion of nonnative species
5) A host of contaminants, ranging from traditionally important contaminants (e.g., metals) to newer and more poorly understood contaminants, including nanoparticles, personal care products, and human and animal pharmaceuticals (Yeakley et al. 2014).

These and other fundamental transformations of the Willamette River will be difficult to reverse, given constraints imposed by human resource needs in a heavily populated watershed along with projected climate change impacts (Moore 2015).

Adaptive Capacity

Modified environments available to Chinook salmon in the Willamette River have exerted powerful selection pressures, such that the DPS itself may be fundamentally transforming. For example, in the Green Peter Reservoir, individuals have been collected that appear to have completed their entire life cycle in fresh water as the offspring of adfluvial parents rather than as hatchery releases (Romer and Monzyk 2014). Use of reservoirs may be under-reported, as are other juvenile life history patterns (Bourret et al. 2014). However, the extent to which alternate rearing patterns represent either a viable strategy or an ecological trap is unknown (Bourret et al. 2014). Nonetheless, actions to modify reservoir operations to benefit juvenile production are being considered (Johnson and Friesen 2014), despite uncertain outcomes (C. Murphy, Oregon State University, personal communication).

A ***moderate*** score for adaptive capacity reflected the conclusion that although Upper Willamette River Chinook exhibit a remarkable ability to survive in such a highly altered system, given its elevated extrinsic pressures and depressed natural production, whether this DPS has further adaptive capacity is unclear.

Literature Cited

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