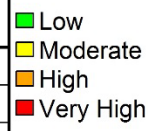
Lower Columbia River Chinook

Overall vulnerability—Moderate (1% Low, 87% Moderate, 12% High)
Biological sensitivity—Moderate (1% Low, 94% Moderate, 5% High)
Climate exposure—High (93% High, 7% Very high)
Adaptive capacity—High (2.4)
Data quality—74% of scores ≥ 2

	Lower Columbia River Chinook	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Early life history	1.3	3	
	Juvenile freshwater stage	1.5	3	
	Estuary stage	2.2	2.3	
	Marine stage	2.8	2.5	
	Adult freshwater stage	1.6	3	
	Cumulative life-cycle effects	1.3	1.8	
	Hatchery influence	3.3	2.5	
	Other stressors	2.4	2.3	
	Population viability	2.5	2.5	
	Ocean acidification sensitivity	1.9	1.8	
	Sensitivity Score	Moderate		
Exposure variables	Stream temperature	3.4	2.3	
	Summer water deficit	2.3	1.8	
	Flooding	2	2	
	Hydrologic regime	2.4	2.5	
	Sea level rise	2.1	2.3	
	Sea surface temperature	3.4	2	
	Ocean acidification exposure	3.8	2.5	
	Upwelling	2.3	1.8	
	Ocean currents	2	1.3	
	Exposure Score	High		
	Overall Vulnerability Rank	Moderate		



Life History Synopsis

Lower Columbia River Chinook exhibit two major life history types (Myers et al. 2006): a stream-maturing spring-run and an ocean-maturing fall-run. Each type represents a coordinated suite of juvenile and adult life-history traits. For example, spring-run adults enter fresh water in spring with a rising thermograph and historically return to the upper reaches of larger watersheds; areas that are not readily accessible except during high flow (snowmelt) periods. Spring-run Chinook hold in these headwater areas through summer and into early fall, when they spawn.

Alternatively, fall-run adults return to natal streams in September and October following the onset of seasonal rains, with a falling thermograph. At freshwater entry, adults are at an advanced stage of maturity. Fall-run fish tend to spawn in the lower reaches of most streams, although in some rivers they may migrate a considerable distance (e.g. Cowlitz River). A variant of the fall-run is the late-fall run; these fish enter the Columbia River at an early stage of maturity, retaining much of their ocean slivering, and for this reason are called upriver brights. Their spawning begins in November and extends into the winter months (Marshall et al. 1995).

In general, juvenile Chinook can move downstream as fry in late winter, but may migrate throughout the year and into their second spring, depending on incubation and rearing conditions. In headwater areas, where spring-run Chinook spawn, water temperatures are colder, incubation and growth are slower, and juveniles may migrate in autumn as subyearlings or in the subsequent spring as yearlings. Both fall- and late-fall juveniles migrate to the ocean primarily during their first year, with relatively few yearling migrants observed (Rich 1920, Groot and Margolis 1991, Healey 1991). Subyearling migrants from this DPS make extensive use of estuary habitats, while yearlings are less estuarine dependent (Fresh et al. 2005, Teel et al. 2014).

After ocean entry, subyearlings will spend some time in the Columbia River plume before migrating northward along the coast, at times as far as the southeast Alaskan panhandle, but more commonly off British Columbia (Fisher et al. 2014, Teel et al. 2015). Yearling migrants, predominantly spring-run fish, move more rapidly through the estuary, but are ultimately captured in the same coastal fisheries as subyearlings. Both life history types have evolved freshwater traits that respond to changes in temperature and precipitation, and are therefore susceptible to the climate effects (Brannon et al. 2004). These fish will spend 1-5 years in the ocean, maturing predominantly as 3 and 4-year-olds, although early maturing (2 year-old) "jacks" are common (Myers et al. 2006). While spring and fall-run Chinook have distinct life history traits, both exhibit considerable plasticity in trait expression.

Climate Effects on Abundance and Distribution

Lower Columbia River Chinook had a ***high*** exposure score for summer stream temperature. If spring-run adults or yearling juveniles are restricted to lower river reaches due to lower flows, summer temperatures might become limiting. This DPS scored ***moderate*** for hydrologic regime shift, indicating that reduced snowmelt and higher winter flows may affect these fish in some areas. To access headwater areas, spring-run Chinook rely upon high flows from snowmelt during April-June; thus a reduced spring freshet might require earlier migration. Timing of river entry for the spring run is triggered by a rising thermograph (Keefer et al. 2008). If spring temperatures are higher and spring flows lower, adults may move into headwater reaches sooner than normal. It is conceivable that their energy stores might be insufficient to oversummer through to the early fall spawning period, when temperatures decline. Higher resolution study of specific habitats is needed to clarify the extent of this risk.

Fall-run adults return to fresh water at an advanced state of maturation during September-October. For these fish, river entry is triggered by a falling thermograph, so warmer

temperatures may delay arrival at spawning grounds or require fish to hold and spawn in waters at lethal or sublethal temperatures, resulting in direct or indirect mortality (Schreck et al. 2013, Keefer et al. 2018). There is some indication that holding in sublethal temperatures can degrade the quality of both male and female gametes (McCullough et al. 2001, Lahnsteiner and Kletzl 2012). Late-fall adults from this DPS may be less subject to deleterious temperatures given the November timing of their freshwater entry. Timing of maturation and spawning strongly influences the susceptibility of different run types to climate change.

As for all DPSs, warmer winter temperatures will likely accelerate embryonic development and emergence timing. Delayed spawning might reduce temperature effects on emergence timing. However, warmer developmental temperatures can still lead to lowered condition in alevins (Fuhrman et al. 2018), which may have less yolk to tide them over until external food sources are available. At present, we lack sufficient information on how stream productivity changes with warming temperature to determine whether bioenergetic constraints will be detrimental to salmon. Nevertheless, downstream migration is triggered by flow and facilitated by snowmelt in spring. Whether directly or indirectly, Lower Columbia River Chinook salmon juveniles will be affected by warmer stream temperatures, as well as by changing estuary and coastal ocean conditions (Daly and Brodeur 2015).

Extrinsic Factors

Lower Columbia River Chinook ranked ***high*** in sensitivity to the role of hatcheries. This DPS is listed as threatened under the U.S. Endangered Species Act, and was scored ***moderate*** for population viability. Spatial structure is compromised in this DPS because major dams limit or exclude access to historically important spawning habitat. Development in lowland areas and diking has also diminished freshwater and estuary habitats. Diversity in this DPS is also affected by major hatchery programs.

Adaptive Capacity

Lower Columbia River Chinook ranked ***high*** in adaptive capacity overall, largely because of their high diversity in both juvenile and adult run timing across the DPS as a whole. This does not mean that specific populations might not be at higher risk, or that diversity within the DPS will not diminish in the future.

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