Snake River spring/summer-run Chinook

Overall vulnerability—High (54% High, 46% Very high)
Biological sensitivity—High (97% High, 3% Very high)
Climate exposure—Very high (55% High, 45% Very high)
Adaptive capacity—High (2.1)
Data quality—79% of scores ≥ 2

Snake River spring/summer-run Chinook		Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Early life history	1.5	2.8	
	Juvenile freshwater stage	3.5	3	
	Estuary stage	1.5	2.8	
	Marine stage	2.9	2.3	
	Adult freshwater stage	3.5	3	
	Cumulative life-cycle effects	3.1	2.5	
	Hatchery influence	2.9	2.5	
	Other stressors	3.1	2.8	
	Population viability	3.3	2.8	
	Ocean acidification sensitivity	1.9	1.8	
	Sensitivity Score	High		
Exposure variables	Stream temperature	3.5	2.3	
	Summer water deficit	2.7	1.8	
	Flooding	2.3	2	
	Hydrologic regime	3.5	2.5	
	Sea level rise	1.8	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	Very High		
Overall Vulnerability Rank		Very High		

Life History Synopsis

Snake River spring/summer Chinook adults enter the Columbia River from April through June. Most adults in this DPS pass eight major dams spanning 462 km in the Columbia and Snake River within about 2-3 weeks. The Tucannon River population leaves the Snake River downstream from Lower Granite Dam, and the Grande Ronde populations leave the Snake River downstream from its confluence with the Salmon River. Salmon River populations continue another 800-1500 km to elevations as high as 2000 m, with a full migration that usually spans several months.

Adults in this DPS typically arrive in tributaries at least one month before spawning, and hold over the summer in deep pools before spawning in August or September. Populations at

higher elevation streams spawn earlier than those at lower elevations. Eggs incubate during winter and hatch in spring. Parr rear near spawning areas or in lower elevation reaches, such as the Salmon and Grand Ronde Rivers. However, little is known about specific overwintering habitat usage or impacts of overwintering location on survival. The majority of juveniles from these populations spend a whole year in freshwater before smolting in April and May.

Most fish spend little time in estuary habitats and exhibit a rapid, directed juvenile migration. Once they enter coastal waters, these fish move north along the continental shelf (Fisher et al. 2014, Teel et al. 2014, Weitkamp et al. 2015). Like other stream-type Chinook, Snake River spring/summer Chinook salmon are thought to have oceanic marine distributions and are rarely caught by coastal fisheries (Healey 1983, Myers et al. 1998, Riddell et al. 2018). Most adults return after 2-3 years at sea, although some, mostly hatchery fish and males, return after 1 year.

Climate Effects on Abundance and Distribution

Snake River spring/summer Chinook salmon has been closely studied as a threatened and indicator species and is the subject of life-cycle modeling under climate change conditions. The ***high*** overall sensitivity rank of this DPS stemmed largely from characteristics of its migration. Negative effects of high temperatures encountered during the adult and juvenile freshwater stages have been documented (Crozier and Zabel 2006, Crozier et al. 2017a, Crozier et al. 2017b). Populations within this DPS that migrate later are called summer-run fish. Examples are the Pahsimeroi and South Fork Salmon River populations, which encounter stressful temperatures during the adult migration. However, both spring- and summer-run populations are at risk for prespawn mortality while holding in tributary habitats during peak summer temperatures (Bowerman et al. 2016). This DPS was ranked ***very high*** for the adult freshwater stage.

Because juveniles spend a full year in fresh water, they can experience negative effects on survival from warm summer temperatures and low flows (Crozier and Zabel 2006, Crozier et al. 2008b). Juvenile survival during the smolt migration depends strongly on rapid flows from snowmelt (Zabel et al. 2008, Faulkner et al. 2018). Thus, sensitivity in the *juvenile freshwater stage* was ranked ***high***. The Interior Columbia recovery domain is likely to lose a substantial portion of snowpack, so this DPS was ranked ***very high*** for *hydrologic regime* shift. Furthermore, exposure to *stream temperature* change ranked ***very high***, elevating vulnerability to ***very high*** in both the *juvenile* and *adult freshwater stages*.

A vast majority of populations in this DPS exhibit the yearling life history strategy. Therefore, loss of this rearing strategy would mean loss of a significant characteristic of this DPS, a threat reflected in the ***high*** score for *cumulative life-cycle effects*. Carryover effects between life stages also increased the *cumulative life-cycle effects* risk, as discussed below.

Snake River spring/summer Chinook sensitivity was ranked ***moderate*** at the *marine stage*, although some scorers considered the marine mortality risk to be high. Marine survival for

this DPS is lower during warm phases of the Pacific Decadal Oscillation, and rising *sea surface temperature* will likely have impacts similar to the warm ocean conditions related with both warm phases of the PDO and low adult survival (Zabel et al. 2006, Crozier et al. 2008b). On the other hand, while the smolt migration is slower in low snowpack years, earlier smolt migration timing might benefit this DPS in relation to ocean upwelling. At present, much of the population enters the ocean later than the optimal period for survival (Scheuerell et al. 2009).

Snake River spring/summer Chinook have a relatively short estuary rearing period (Weitkamp et al. 2012, Weitkamp et al. 2015), which resulted in ***low*** scores for *estuary stage* and *sea level rise*. Observations suggest that longer freshwater rearing produces larger smolts, which then spend less time in the estuary.

Of primary concern in the *cumulative life-cycle effects* attribute is loss of unique life history types, including the spring/summer adult run type and the yearling juvenile life history strategy. Cumulative effects from shifts in successive life stages may reduce survival in subsequent life stages. For example, earlier migration timing at the juvenile freshwater stage may mean fish are smaller at ocean entry and less likely to encounter favorable ocean feeding conditions. Such a timing alteration could in turn reduce early marine survival (Crozier et al. 2008a). Thus, sensitivity of this DPS was considered ***high*** for *cumulative life-cycle effects.*

Extrinsic Factors

Snake River spring/summer Chinook is listed as threatened, with most populations at high risk (Ford et al. 2011), especially in the upper Grande Ronde and upper Salmon Rivers. Estimated extinction risk under climate change scenarios is significantly higher than under the historical climate regime (Crozier and Zabel 2013). At present, abundance is low for this DPS, and it is considered highly sensitive to marine conditions, with abundance declining rapidly in poor ocean years (Zabel et al. 2006). Early returning runs are susceptible to increased marine mammal predation in the lower Columbia River (Sorel et al. 2017). Hatchery production is substantial in the DPS, with an estimate of 86% of yearling Chinook passing Lower Granite Dam being of hatchery origin (Faulkner et al. 2018). Nonetheless, some of the hatcheries do have supplementation control rules in place that prioritize conservation objectives. This DPS was scored ***moderate*** in hatchery influence.

Habitat loss and reduction in spatial structure are lesser concerns for much of this DPS compared with others in this assessment because a relatively large proportion of its spawning habitat is protected wilderness area. Nonetheless, some populations are highly impacted by anthropogenic factors (e.g., Upper Grand Ronde and Lower Snake), especially land development and agriculture. Major dams throughout the migratory corridor can hinder passage of both juveniles and adults, especially in warm years. Therefore, sensitivity to other stressors was ranked ***high***.

Adaptive Capacity

Overall Snake River spring/summer Chinook salmon was ranked ***high*** in adaptive capacity. This DPS may have sufficient adaptive capacity to increase the production of subyearling smolts, or for yearling smolts to migrate earlier in spring. Adults may have some flexibility in migration timing to avoid high stream temperatures in the migration corridor. However, this would likely have a differential impact on different populations, which could ultimately reduce diversity in the basin. However, early migrating adults in this DPS will still need to hold for extended periods until temperatures cool in the fall, and this will increase exposure to high stream temperatures and risk from harvest. Energetic costs during the holding period might limit adaptive capacity in the adult stage.

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