Snake River fall-run Chinook

Overall vulnerability—High (35% Moderate, 65% High)
Biological sensitivity—High (35% Moderate, 65% High)
Climate exposure—High (100% High)
Adaptive capacity—High (2.3)

	Snake River fall-run 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	2.1	2	
	Marine stage	2.6	2	
	Adult freshwater stage	2.9	2.8	
	Cumulative life-cycle effects	2.5	2.3	
	Hatchery influence	3.7	2.8	
	Other stressors	3	3	
	Population viability	2.3	2.8	
	Ocean acidification sensitivity	2	1.8	
	Sensitivity Score	High		
Exposure variables	Stream temperature	3.5	2.3	
	Summer water deficit	2	1.8	
	Flooding	2.4	2	
	Hydrologic regime	2.1	2.5	
	Sea level rise	2.4	2.3	
	Sea surface temperature	3	2	
	Ocean acidification exposure	3.8	2.5	
	Upwelling	2.3	1.8	
	Ocean currents	1.9	1.3	
	Exposure Score	High		
	Overall Vulnerability Rank	High		

Low
Moderate
High
Very High

Life History Synopsis

Snake River fall-run Chinook adults enter the lower Columbia River from late summer through early fall (August-October). Females are predominately age 4-5, with small proportions of age-3 and age-6 spawners, whereas adult males are predominately age 3-5. Hatchery adults are skewed toward younger ages (~3 years), particularly among males. After entering the Columbia River, the majority of adults migrate over 400 km to pass Lower Granite Dam, typically within 2-3 weeks. Because this DPS is close to maturity upon freshwater entry, individuals spawn a relatively short time after entering fresh water, from late October to early November (Connor et al. 2003b). Eggs incubate in stream gravel through winter and emerge from early April in the Hells Canyon reach of the Snake River, where most individuals return to spawn, to late May in the Grande Ronde and Imnaha Rivers (Connor et al. 2003b). Low winter temperatures may extend incubation times or limit the suitability of egg incubation in some locations (Connor et al. 2003b).

Warm temperatures in summer may limit the time that juveniles spend near natal locations, except in the cooler Clearwater River (Connor et al. 2005). Most juveniles below the Clearwater River migrate to the ocean as subyearlings, whereas within the Clearwater, a small proportion of juveniles migrate as yearlings. Hatchery releases are a mixture of subyearling and yearling juveniles. All upper Snake and Clearwater rearing locations produce some juveniles that overwinter in the lower Snake and Columbia Rivers. The extent of estuary use and residence by these juveniles is not well known, but individuals are present in the estuary during summer and early fall (Teel et al. 2014). During the first summer of ocean residency, subyearlings and yearlings remain in local waters both south (Oregon) and north (to West Coast Vancouver Island) of the Columbia River mouth (Fisher et al. 2014, Teel et al. 2015). Adults are captured in coastal fisheries from Southeast Alaska to Oregon (Weitkamp 2010).

Climate Effects on Abundance and Distribution

For Snake River fall-run Chinook, the upstream migration and pre-spawn holding period extends from mid-August through October (Connor et al. 2018). Returning adults are exposed to temperatures exceeding 20°C, with cumulative exposures highest for early-returning adults (Keefer and Caudill 2015). Exposure to *stream temperature* in the Snake River Basin was ranked ***high*** for this DPS, and models suggest that future migrants may experience lower migration and spawning success due to rising temperatures (Connor et al. 2018). Nonetheless, the vulnerability of this DPS during the *adult freshwater stage* was ranked ***moderate*** because most adults migrate after temperatures have peaked and spawn after temperatures have declined in the fall.

Egg development is constrained by cold winter temperatures (Connor et al. 2003b), so rising *stream temperature* during incubation is less of a concern for this DPS. This was reflected in the ***low*** sensitivity score for *early life history*. Juvenile emergence, growth, and migration occur earlier in warmer than in cooler spawning and rearing areas, and certain areas not used as spawning habitat appear to be too cold (Connor and Burge 2003, Connor et al. 2003a, Connor et al. 2003b). Juveniles were observed to tolerate constant temperatures of 22°C and fluctuating temperatures up to 27°C (Geist et al. 2010), and they grew well even at reduced rations (Geist et al. 2011). Rapid growth and thermoregulatory behavior (Tiffan et al. 2009) during the predominantly subyearling migration of this DPS allows fish to avoid thermal stress, despite generally warm summer temperatures in the lower Snake River (Connor and Burge 2003). Juveniles rearing in cooler reaches of the Clearwater River have shown a yearling life history, and hence adaptability to a wide temperature range. Thus sensitivity at the *juvenile freshwater stage* was ranked ***low***.

Snake River fall-run Chinook exhibits a wide distribution across the eastern Pacific Ocean, ranging from coastal British Columbia to California and Oregon. A moderate relationship has been reported between survival of subyearlings and the Pacific Decadal Oscillation, and between the northern copepod anomaly index and survival of Columbia River fall chinook (Peterson et al. 2014). These findings were reflected in a ***moderate*** score for *marine stage*.

Extrinsic Factors

Snake River fall-run Chinook salmon production is dominated by hatcheries, and the DPS received a ***very high*** score for hatchery influence on climate resilience. Extrinsic factors downstream in the Snake and Columbia Rivers range from an increasing proliferation of nonnative species (Sanderson et al. 2009) to a growing list of contaminants (Yeakley et al. 2014). Dams on the mainstem Snake and Columbia Rivers present challenges for both juvenile and adult migration (Smith et al. 2003, Keefer and Caudill 2015). These factors were reflected in a ***high*** sensitivity score for *other stressors*.

Adaptive Capacity

Despite the considerable influence of hatcheries on this DPS, Snake River fall-run Chinook has extensive opportunity for habitat shift and flexibility in age at juvenile migration, resulting in an overall ***high*** adaptive capacity.

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