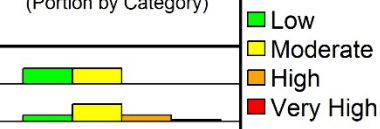
Snake River Basin steelhead

Overall vulnerability—High (9% Moderate, 88% High, 3% Very high)
Biological sensitivity—High (9% Moderate, 91% High)
Climate exposure—High (97% High, 3% Very high)
Adaptive capacity—Moderate (1.8)
Data quality—84% of scores ≥ 2

	Snake River Basin Steelhead	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Early life history	1.5	2.8	
	Juvenile freshwater stage	2.1	2.8	
	Estuary stage	1.6	2.3	
	Marine stage	2	2	
	Adult freshwater stage	3	2.5	
	Cumulative life-cycle effects	2.7	2	
	Hatchery influence	3.3	2.5	
	Other stressors	3.1	2.5	
	Population viability	2.5	2.5	
	Ocean acidification sensitivity	1.9	1.8	
	Sensitivity Score	High		
Exposure variables	Stream temperature	3.5	2.5	
	Summer water deficit	3	2	
	Flooding	2.8	2	
	Hydrologic regime	2.4	2.8	
	Sea level rise	1.4	2	
	Sea surface temperature	3.2	2.3	
	Ocean acidification exposure	3.9	3	
	Upwelling	1.6	1.8	
	Ocean currents	1.8	1	
	Exposure Score	High		
	Overall Vulnerability Rank	High		



Life History Synopsis

The majority of Snake River steelhead adults enter the Columbia River and migrate upstream in late summer/early fall, with migration peaking from August to October (Robards and Quinn 2002, Copeland et al. 2017). Many stocks hold through winter in mainstem Columbia or Snake River reaches and complete migration the following spring (Keefer et al. 2008). Peak spawning generally occurs from April to May, depending on temperature and flow conditions, and spawning tributaries are 800 to 1,500 km upstream from the Columbia River mouth. Depending on spawning timing and temperature, fry emerge from the gravel from May through July.

Age at juvenile migration varies among populations of this DPS, but is generally correlated with elevation and annual stream temperatures (Busby et al. 1996). Lower elevation populations are dominated by 2-year-old juvenile migrants, whereas higher elevation areas tend to produce both 2- and 3-year-olds.

Steelhead juveniles migrate through the Columbia River estuary relatively rapidly in late spring, with a very short window of exposure to estuarine habitat factors (Fresh et al. 2005, Weitkamp et al. 2015). However, avian predation imposes significant mortality on juveniles moving through the estuary (Evans et al. 2012, Evans et al. 2016). Once in the ocean, Snake River Basin steelhead generally exhibit rapid westward movement and have an offshore marine distribution across the subarctic Pacific Ocean (Light et al. 1989, Daly et al. 2014, Myers 2018).

Climate Effects on Abundance and Distribution

The overall sensitivity score for Snake River Basin steelhead was ***high***, in part because of ***high*** sensitivity for the *adult freshwater stage*. Most populations are subject to high stream temperatures during the upstream migration and pre-spawn holding phases (Wade et al. 2013). Moreover, for populations in Lower Snake River tributaries, the presence of mainstem dams (particularly Lower Granite Dam) may exacerbate straying. Exposure to increased *stream temperature* and *summer water deficit* during the upstream migration and holding periods were also ***high*** to ***very high***, indicating a ***high*** climate change vulnerability for Snake River Steelhead in the *adult freshwater stage*.

Although detailed information on ocean distributions for Columbia River steelhead is not available, past studies suggest that steelhead from Pacific coastal systems generally occur in the Gulf of Alaska and the subarctic waters south of the Alutian Islands (Light et al. 1989). Abdul-Aziz et al. (2011) developed spatially explicit representations of open ocean thermal habitat for steelhead. They found that under a multimodel ensemble average of climate model outputs using the A1B emissions scenario summer, habitat area declined by 36% for the 2080s, with the largest habitat losses in the northeast Pacific Ocean. Wintertime habitat area losses were 2%, with reductions at the southern end of the historical range largely offset by habitat area gains in the Bering Sea and Sea of Okhotsk.

Whether a general northward and westward displacement of the most frequently observed thermal open ocean habitat will have substantial impacts on the life-cycle, productivity, or spawning distribution of these steelhead is not known. A recent study of smolt-to-adult survival trends found similar patterns in annual marine survival for stocks within regional groupings for Puget Sound, British Columbia and coastal Washington and Oregon (Kendall et al. 2017). Such patterns suggest that marine/estuarine factors associated with the point of ocean entry may be more important determinants of year-class survival for steelhead than general conditions in the adult ocean range.

Despite ***moderate*** to ***high*** exposure scores for *flooding*, *stream temperature*, and *summer water deficit*, sensitivity scores were ranked ***low*** to ***moderate*** for the *early life history* (egg incubation) and *juvenile freshwater stage*. Sensitivity of egg incubation was rated ***low*** because stream temperature and flows are generally well within tolerance limits. Therefore, vulnerability of Snake River Basin steelhead is likely somewhat lower at the egg incubation and juvenile rearing stages. Sensitivity scores were ***low*** to ***moderate*** for the *estuary stage*. Exposure was ranked ***high*** for *sea surface temperature*, with ***low*** exposure to *ocean currents*, *upwelling*, and *sea level rise*. Sensitivity was ranked ***moderate*** for the *marine stage*.

Extrinsic Factors

High sensitivity scores for *hatchery influence* and *other stressors* contributed to an overall high vulnerability ranking for Snake River Basin steelhead. Both production and conservation hatchery programs are present, and potential for interactions varies considerably across major population groups and populations (Ford et al. 2015, Copeland et al. 2017). Just over one-half of populations in this DPS have relatively low levels of direct hatchery influence, but the potential for impacts is high for many remaining populations. Populations with little direct hatchery influence represent a wide range of habitat conditions across the DPS. However, the majority of populations with high hatchery influence are in upper Salmon River reaches.

Several populations are subject to relatively ***high*** exposures to *other stressors*, including water withdrawals, riparian and stream habitat degradation etc. Water withdrawals in some populations have resulted in reduced flows that impact spawning/rearing habitat and downstream migration/rearing corridors. Altered stream and/or riparian habitats, including loss of side-channel rearing areas, are key impacts affecting populations in all major population groups. These factors could have significant impacts to more than one-half of extant populations.

Adaptive Capacity

The overall rating for adaptive capacity was ***moderate*** for Snake River Basin steelhead, but there was also a large number of low scores. This DPS could have some potential for shifts in adult return and upstream migration timing to avoid peak late summer temperatures, but that may lead to increased negative effects from lower flows. For populations in high temperature or low flow areas, there are limited opportunities to shift juvenile rearing patterns to avoid climate change effects.

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