Puget Sound steelhead

Overall vulnerability—High (39% Moderate, 69% High)
Biological sensitivity—High (30% Moderate, 70% High)
Climate exposure—High (1% Moderate, 99% High)
Adaptive capacity—High (2.1)
Data quality—84% of scores ≥ 2

	Puget Sound 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	1.7	2.3	
	Marine stage	2.7	2	
	Adult freshwater stage	1.7	2.8	
	Cumulative life-cycle effects	2.3	2	
	Hatchery influence	3.2	2.5	
	Other stressors	3.1	2.5	
	Population viability	2.7	2.5	
	Ocean acidification sensitivity	1.9	1.8	
	Sensitivity Score	High		
Exposure variables	Stream temperature	3	2.5	
	Summer water deficit	2.7	2	
	Flooding	3.1	2	
	Hydrologic regime	2.8	2.8	
	Sea level rise	1.4	2	
	Sea surface temperature	3.2	2.3	
	Ocean acidification exposure	3.9	3	
	Upwelling	1.5	1.8	
	Ocean currents	1.8	1	
	Exposure Score	High		
Overall Vulnerability Rank		High		

Life History Synopsis

In Puget Sound steelhead, winter-run adults migrate from November to May, and summer-run adults from May to October. Migration distances in Puget Sound are relatively short (<150 km). Spawning occurs primarily in March and April, although it can start as early as January in lowland, rain-dominated areas, and peak as late as May or June in cooler, snow-dominated locations (Myers et al. 2015). In some locations there is a clear distinction between winter-run and summer-run spawning areas. For example in basins with, partially impassable barriers, winter migrants are blocked, and only the summer-run is successful; whereas in short rain-dominated basins, most spawners are winter-run. However, there is also overlap in spawning areas and timing, and segregation of the two run types is not clear (Myers et al. 2015).

Survival through the incubation period is not well documented, but there are potential temperature effects for the summer run. Temperatures and flow levels during incubation are generally below maximum limits for most populations. Most juveniles migrate to Puget Sound at age 2. In the White, Nisqually, and Green Rivers, 16-20% of juvenile migrants are age 1, while in the Skagit, Snohomish, and Elwha Rivers, 15-27% are age 3. Puget Sound steelhead appear to have a relatively short estuary residence time, moving to the Strait of Juan de Fuca within 1-3 weeks (Weitkamp et al. 2014). Ocean migrations are poorly understood, but limited data indicate that they travel to the central subarctic North Pacific Ocean (Burgner et al. 1992, Myers 2018). In general, North American steelhead undergo extensive ocean migrations into the Gulf of Alaska and subarctic North Pacific Ocean, areas with an absolute thermal range of 2.8-15.8°C for all seasons and a frequently observed range of 6-12.5°C from spring through fall and 5-11°C in winter (reviewed in Abdul-Aziz et al. (2011).

There is a moderate amount of variation in age at maturity, but most individuals in this DPS spend 2 years at sea and typically mature after 1 to 3 years. Deer Creek summer-run steelhead spend one year at sea (Myers et al. 2015).

Climate Effects on Abundance and Distribution

Steelhead rear year-round in Puget Sound, where exposure to *summer water deficit* was ranked ***moderate*** and to changes in *stream temperatures* and *flooding* were ranked ***high*** (see also Wade et al. 2013). All three freshwater life stages were scored ***low*** to ***moderate*** in sensitivity. However, because spawning typically occurs after peak storm season, this DPS received a lower sensitivity score for *early life history* (egg stage) compared with Puget Sound Chinook and coho. Winter-run adults are not sensitive to summer stream temperature or low flows during migration (Beechie et al. 2013). However, to the extent that partially impassable barriers constrain migration timing for the summer-run, they may have higher sensitivity. The relatively short juvenile migration distances reduce dependence on the size of the spring freshet, so that these juveniles are less sensitive to changes in snowpack than those from interior steelhead DPSs.

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. However, West Coast steelhead salmon populations may be vulnerable to the projected displacement of high seas thermal habitat. Exposure ranked ***high*** for *sea surface temperature*, and sensitivity ranked ***moderate*** for the *marine stage*.

Extrinsic Factors

Puget Sound steelhead is listed as threatened under the U.S. Endangered Species Act, and therefore ranked ***moderate*** for sensitivity to population viability. All extant and viable summer-run populations are in the North Cascades population group, indicating a relatively limited spatial distribution. Habitat fragmentation (Hard et al. 2015) led to a ***high*** rank in the *other stressors* category. Outplanting of hatchery fish has historically been widespread in Puget Sound, and this DPS ranked ***high*** in sensitivity to *hatchery influence*. Most DPSs have low scores for diversity and spatial structure, largely because of extensive hatchery influence, breeding populations, and freshwater habitat fragmentation or loss. There has been some loss of accessible habitat above dams in some river basins (Hard et al. 2015).

Adaptive Capacity

Adaptive capacity ranked ***high*** for Puget Sound steelhead. Steelhead has a very flexible life history that is responsive to environmental conditions. If growth conditions change, these fish are relatively capable of changing the age at which they smolt. Adults migrate across a wide temporal window even to the same spawning areas, and thus migrations are likely to have the flexibility to change if needed. Nonetheless, there might be some locations involving partially impassable barriers that become inaccessible due to altered temperatures and flows.

Literature Cited

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