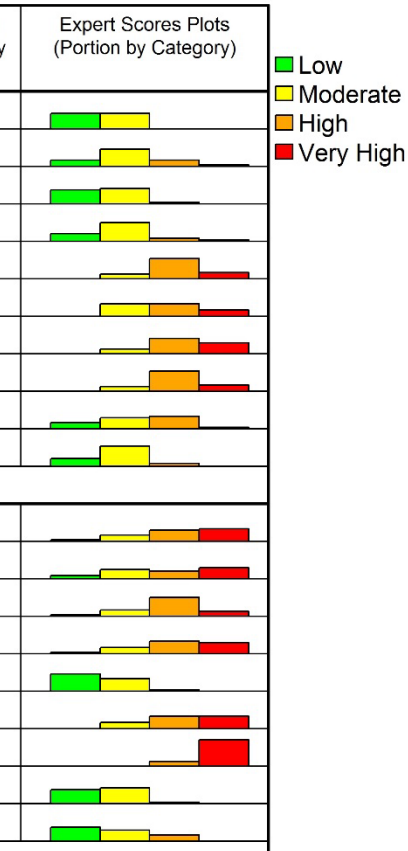
Middle Columbia River steelhead

Overall vulnerability—High (10% Moderate, 90% High)
Biological sensitivity—High (10% Moderate, 90% High)
Climate exposure—High (99% High)
Adaptive capacity—Moderate (2.0)
Data quality—84% of scores ≥ 2

	Middle Columbia River 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	3.1	2.5	
	Cumulative life-cycle effects	2.8	2	
	Hatchery influence	3.2	2.5	
	Other stressors	3.1	2.5	
	Population viability	2.3	2.8	
	Ocean acidification sensitivity	1.9	1.8	
	Sensitivity Score	High		
Exposure variables	Stream temperature	3.1	2.5	
	Summer water deficit	2.9	2	
	Flooding	2.9	2	
	Hydrologic regime	3.1	2.8	
	Sea level rise	1.5	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

Mid-Columbia River steelhead include both a summer run, or stream-maturing phenotype and a winter-run, later-returning, or ocean-maturing phenotype. Arrival of adults in the Columbia River may occur nearly every month of the year, with those that return early spending well over 6 months in fresh water before spawning. Following this, spawning by steelhead of this DPS occurs over a 7-month window, from January to July. Spawn timing varies by phenotype (ocean or freshwater maturing) and ambient conditions (e.g., flow, temperature). Emergence occurs over a smaller window, generally ranging from May through July.

As do other DPSs, Mid-Columbia River juvenile steelhead generally spend 2-3 years in fresh water prior to migration, and some individuals complete their life cycles entirely within fresh water (Kendall et al. 2015). Migrating juvenile steelhead are believed to spend little time in the Columbia River estuary (Daly et al. 2014, Weitkamp et al. 2015) and move directly to offshore feeding areas across the subarctic Pacific Ocean (Myers 2018).

Climate Effects on Abundance and Distribution

Though marine exposures were ranked ***high*** for Mid-Columbia River steelhead, the corresponding sensitivity of this species is poorly understood, and this was reflected in the generally low data quality ranks for both marine and estuarine attributes. Linkages between adult returns and marine conditions have not been extensively evaluated for this DPS, although some inferences can be made from general ocean distribution information and temporal patterns in smolt-to-adult return rates.

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 subarctic waters south of the Alutian Islands 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 return ratios found similarities in annual marine survival patterns, with regional groupings for Puget Sound, British Columbia and coastal Washington and Oregon (Kendall et al. 2015). These groupings suggest that for steelhead, marine/estuarine factors associated with the point of ocean entry may be a more important determinants of year class survival than general conditions in the adult ocean range.

The life stage of Mid-Columbia River steelhead with the highest sensitivity to climate change was the *adult freshwater stage*. Because many adults spend months in fresh water prior to spawning and hold during the warmest temperatures and lowest flows of the year, they may be particularly vulnerable to climate-related influences on these factors. Because of the general threat to the summer-run life history, this DPS was scored ***moderate*** in *cumulative life cycle effects*.

Extrinsic Factors

Exposure to *other stressors* ranked ***high***, and for Mid-Columbia River steelhead, these include migration challenges from dams, especially limiting their movement up and downstream while over-summering and for repeating spawning. They are also vulnerable to predators and angling in thermal or flow refuges. Many of these stressors influence adults primarily, but juveniles also face habitat stress. Other stressors likely to be exacerbated in the face of climate change include widespread invasion of nonnative, warm-water species (Sanderson et al. 2009) and contaminants (Yeakley et al. 2014). *Hatchery influence*, both within and outside of the mid-Columbia, was ranked ***high*** in reducing the resilience of steelhead in this DPS. Straying of hatchery fish from populations outside of this DPS is a well-known phenomenon. Mid-Columbia River steelhead is listed as threatened under the U.S. Endangered Species Act, but this DPS is considered at lower risk than other interior steelhead (Ford et al. 2015).

Adaptive Capacity

Mid-Columbia River steelhead exhibits diverse life histories. Recent work on interactions between anadromous and resident types of *O. mykiss* in the middle Columbia region and throughout the range of steelhead has shown that both types can and often do interbreed (Hard et al. 2015, Kendall et al. 2015), as is the case for many salmonids (Sloat et al. 2014). Local factors such as reproductive isolation in space or time or population sizes of either type may govern how different forms of *O. mykiss* interact. There is good evidence that resident rainbow trout can increase resilience of steelhead, as returning adults of the latter can be traced to resident parents (Kendall et al. 2015). Overall Mid-Columbia River steelhead ranked ***moderate*** for adaptive capacity.

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