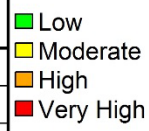
California Central Valley steelhead

Overall vulnerability—Moderate (76% Moderate, 24% High)
Biological Sensitivity –Moderate (76% Moderate, 23% High)
Climate exposure—High (99% High, 1% Very high)
Adaptive capacity—Moderate (1.7)
Data quality—63% of scores ≥ 2

	California Central Valley Steelhead	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Early life history	1.6	2.8	
	Juvenile freshwater stage	2.1	2.8	
	Estuary stage	2.5	1.8	
	Marine stage	1.6	1.3	
	Adult freshwater stage	1.5	2.8	
	Cumulative life-cycle effects	2.1	2.5	
	Hatchery influence	3.1	2	
	Other stressors	2.9	2	
	Population viability	2.1	2	
	Ocean acidification sensitivity	1.9	0.5	
	Sensitivity Score	Moderate		
Exposure variables	Stream temperature	2.8	2.3	
	Summer water deficit	2.6	2	
	Flooding	3.2	1.8	
	Hydrologic regime	1.9	1.8	
	Sea level rise	2.2	2	
	Sea surface temperature	3.4	2	
	Ocean acidification exposure	4	3	
	Upwelling	2.5	1.5	
	Ocean currents	1.9	1	
	Exposure Score	High		
	Overall Vulnerability Rank	Moderate		



Life History Synopsis

The Central Valley steelhead DPS includes populations spawning in the Sacramento and San Joaquin Rivers and their tributaries. Detail on the life history of Central Valley steelhead is covered by Williams (2006) and Moyle et al. (2017). For these steelhead populations, the peak adult migration seems to have occurred historically from late September to late October, with some creeks such as Mill Creek showing a small run in mid-February (Lindley et al. 2006). This DPS was once found throughout Central Valley rivers, but more than 80% of historic habitat is now above dams (Lindley et al. 2006). Juveniles generally migrate from late December through the beginning of May, with a peak in mid-March. There is a much smaller peak in fall, and juvenile migrations are generally cued to high-flow events.

Juvenile steelhead are opportunistic predators on anything available in their rearing streams, from aquatic and terrestrial insects to small fish. However, benthic aquatic insect larvae are the mainstay of their diet. Below reservoirs, zooplankton may be important as well. Diets shift with season and size of the juveniles. At times, salmon eggs, juvenile salmon, sculpins, and suckers may be important prey for yearling steelhead and may be key prey items for rapid growth. Once they migrate to sea, steelhead prey largely on fish and crustaceans. Ocean movements of fish in this DPS are poorly understood.

Juvenile steelhead typically spend little time in estuarine habitats compared to other salmon species (Hayes and Kocik 2014, Myers 2018). During their marine residence period, steelhead move rapidly offshore and are widely distributed across the subarctic North Pacific (Myers 2018). Central Valley steelhead are presumed to have originally spent 1-2 years at sea before returning to spawn at sizes of 40-50 cm FL. Present-day hatchery steelhead spend 1-3 years at sea and spawn at 50-80 cm FL. There is little evidence of repeat spawning.

Climate Effects on Abundance and Distribution

Climate effects are similar to those detailed in the Northern steelhead account of Moyle et al. (2017). Overall climate exposure was ranked ***high*** because of ***high*** exposure to *flooding* and *sea surface temperature*, and ***very high*** exposure to *ocean acidification*. Central Valley steelhead sensitivity was ranked ***moderate***, with the *estuary stage* being the main intrinsic contributing factor.

Extrinsic Factors

Sensitivity to *hatchery influence* was ranked ***high*** for Central Valley steelhead because production hatcheries dominate composition in this DPS (Moyle et al. 2017). Indeed, catch from the U.S. Fish and Wildlife Service Chipps Island midwater trawl indicates a continued decline in steelhead natural production since 2010, with the proportion of adipose fin-clipped steelhead reaching 95% (Johnson and Lindley 2016). Nimbus Hatchery steelhead remain genetically divergent from the other Central Valley lineages because the broodstock originates from coastal steelhead stocks (Pearse and Garza 2015). However, maintenance of this coastal ancestry within the hatchery broodstock creates vulnerability to hybridization with other Central Valley populations (NMFS 2009). For this reason, researchers have suggested that this broodstock should be replaced by *O. mykiss* with native American River ancestry (Abadía-Cardoso et al. in revision).

Central Valley steelhead is listed as threatened under the U.S. Endangered Species Act. This DPS was ranked ***moderate*** for *population viability*, although the latest status review considered the anadromous life history to be at high risk of extinction. There are populations of resident *O. mykiss* above dams that may be more similar genetically to ancestral populations than the present listed populations below the dams (Pearse and Garza 2015, Pearse and Campbell 2018). Resident *O. mykiss* upstream of major dams use reservoirs like the ocean, and this life history type may maintain a genetic reservoir for steelhead and provide some gene flow to populations below dams.

Maintenance of varied steelhead life history types is dependent on the growth-survival-fitness landscape between resident and ocean strategies (Satterthwaite et al. 2010). Many naturally spawned steelhead and rainbow trout have adapted a resident strategy in Central Valley rivers, where temperatures are artificially cool in summer. These fish remain in freshwater, foregoing ocean growth benefits to avoid high mortality during migration through the Sacramento River and San Joaquin River Delta, along with potentially adverse ocean conditions (Lindley et al. 2009, Perry et al. 2016). Considering that dams have blocked access to the majority of historical habitat for this DPS, but that rearing conditions have improved in some reaches for resident life history types, the ranking for *other stressors* was ***moderate***.

Adaptive Capacity

Central Valley steelhead exhibit flexible reproductive strategies, which have historically allowed for persistence in spite of variable conditions in the Central Valley. Adaptive capacity was ranked ***moderate*** for this DPS, because despite a flexible life history, its range is severely limited to areas below dams.

As in other steelhead DPSs, the relationship between anadromous and resident rainbow trout is complex, but populations with both forms offer the greatest adaptive evolutionary potential (Pearse et al. 2014). Anadromous steelhead produce many more eggs than resident fish and improve gene flow among rivers, maximizing genetic diversity. Resident fish persist when ocean conditions cause poor survival of anadromous forms, while anadromous forms can recolonize streams in which resident populations have been wiped out by drought or other natural disasters.

Scorers considered that populations of *O. mykiss* in the California Valley will likely persist, even under severe climate change scenarios, because resident and adfluvial forms will remain in the cold-water streams above dams. Presumably this DPS will be much less abundant, with more scattered populations, in response to climate change. Few populations may remain in valley floor streams except below reservoirs, where coldwater releases can be sustained even through long periods of drought (e.g., Berryessa Reservoir).

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