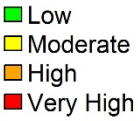
Central Valley fall/late fall-run Chinook

Overall vulnerability—Very high (21% High, 79% Very high)
Biological sensitivity—Very high (24% High, 76% Very high)
Climate exposure—High (87% High, 13% Very high)
Adaptive capacity—Low (1.5)
Data quality—68% of scores ≥ 2

	Central Valley fall/late fall-run Chinook	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Early life history	2.3	2.5	
	Juvenile freshwater stage	2.9	2.8	
	Estuary stage	3.4	2.3	
	Marine stage	3.3	2.5	
	Adult freshwater stage	2.8	2.8	
	Cumulative life-cycle effects	3.6	2	
	Hatchery influence	3.9	3	
	Other stressors	3.6	2.5	
	Population viability	2.6	3	
	Ocean acidification sensitivity	1.8	1.5	
	Sensitivity Score	Very High		
Exposure variables	Stream temperature	2.8	2	
	Summer water deficit	3.1	1.8	
	Flooding	3.2	1.3	
	Hydrologic regime	2.7	1.8	
	Sea level rise	3.4	2.3	
	Sea surface temperature	3.4	2	
	Ocean acidification exposure	4	2.5	
	Upwelling	3.3	1	
	Ocean currents	1.9	1	
	Exposure Score	High		
	Overall Vulnerability Rank	Very High		



Life History Synopsis

Adults of the Central Valley fall-run/late fall-run Chinook DPS enter rivers fully mature and move quickly to spawning grounds (Williams 2006, Moyle et al. 2017). Peak spawning typically occurs during October-November but can continue into early January. Naturally spawned juveniles emerge from the gravel from December through March and rear in fresh water for 1-7 months, moving downstream into large rivers after only a few weeks, with most movement at night.

This Chinook DPS has a life history that minimizes time spent in fresh water. Juveniles migrate to the ocean in spring before water temperatures become too warm. Thus these fish can exploit the lower-elevation reaches of Central Valley rivers prior to being exposed to summer

temperatures that exceed thermal tolerances for salmon. These characteristics also make them the preferred broodstock for use in hatcheries.

Turbidity has a strong positive relationship with survival during juvenile migration, in part through its association with high flows and cooler temperatures (CDWR 2016, Johnson et al. 2017). Historically, juvenile migrants likely foraged for 1-2 months on floodplains, where growth is demonstrably much faster than in rivers (Sommer et al. 2001). Today, most river-reared fish enter the estuary at a relatively small size and suffer high mortality as a consequence. Hatchery fish are typically released to rivers at a larger size than their naturally spawned cohorts (Huber and Carlson 2015), but releases into clear, shallow water subject naïve fish to heavy predation.

From the estuary, juvenile salmon move into the Gulf of the Farallons, a food-rich region in most years due to wind-driven upwelling associated with the California Current (Wells et al. 2012). Fish spend 2-5 years at sea, where they feed on fish and shrimp. Early ocean distribution in juveniles is related to shallower waters with high chlorophyll concentrations and proximity to the natal river (Hassrick et al. 2016). As adults, most of these fish remain off the California coast between Point Sur and Point Arena, but some move into the coastal waters of Oregon (Palmer-Zwahlen and Jormos 2015, Satterthwaite et al. 2015).

Climate Effects on Abundance and Distribution

Central Valley fall-run/late fall-run Chinook is sensitive to changing conditions at all life stages but is particularly sensitive to conditions in the ocean and in estuaries, where individuals from this DPS spend most of their lives (Moyle et al. 2017, Herbold et al. 2018). Sensitivity in the *juvenile* and *adult freshwater stages* ranked ***moderate***, while sensitivity in the *estuary* and *marine stages* ranked ***high***. Due to the dominance of hatchery fish, variation in estuary arrival timing is greatly reduced, making the DPS as a whole much more vulnerable to cohort collapse (Lindley et al. 2009). More generally, highly altered freshwater habitat and the severe reduction in viable life histories (Sturrock et al. 2015), caused *cumulative life-cycle effects* to rank ***very high***.

Overall exposure attributes ranked high, with nearly every score in the high category. *Flooding* was ranked ***high*** due to expected dramatic increases in atmospheric river intensity and frequency. Adults migrate in fall, often during the first large seasonal storms, and thus are affected by storm timing. Exposure to *hydrological regime* shift was ranked ***moderate*** because of the important role that snowpack plays in the larger region for water management. Thus although the actual spawning area of this DPS is already rain-dominated, snowfall in the Sierra Nevada Mountains still plays an important role. The Sacramento River is heavily managed, and the role future reservoir management will play in limiting impacts of flooding and loss of snowfall was uncertain.

As noted above, juveniles of this DPS emerge in winter and move quickly downstream to the estuary in the late winter through spring. However, they are vulnerable to stranding during

low flows or as a result of regional water management practices. Exposures to *sea surface temperature*, *upwelling*, and *sea level rise* were all ranked ***high***.

Extrinsic Factors

The California Central Valley and San Francisco Bay-Delta are highly altered systems, with impassable dams on nearly every major river and with high concentrations of predators in altered waterways. Salmon runs are largely maintained by hatcheries that exhibit high stray rates, so the overall influence of domestication selection is high, with genetic homogenization occurring among populations (Williamson and May 2005, Johnson et al. 2012). Survival rates of fall/late-fall juvenile salmon are variable among years but are generally low (Perry et al. 2010, Michel et al. 2015). Thus sensitivity to *other stressors* ranked ***very high***. Moyle et al. (2017) rated both the late fall run and fall run Chinook components of this DPS as "of high concern," on a pathway to extinction as wild fish.

This DPS is regarded as species of concern by the National Marine Fisheries Service, and population viability was ranked as ***moderate***. Nonetheless, concern is very high for the late-fall life history and wild fish (Moyle et al. 2017). The DPS is now dominated by hatchery fish and comprised of a single, genetically uniform population under artificial selection (Williams 2006, Lindley et al. 2009), driving its *hatchery influence* score to 3.9, the highest score of all DPSs for this attribute.

Adaptive Capacity

Adaptive capacity for Central Valley fall/late fall-run Chinook ranked ***low***, in large part due to highly altered freshwater and estuary ecosystems, which have reduced the number of viable life histories. As a result of these alterations, the DPS is highly dependent on human management of resources, such as design flows from reservoirs to cue migrating adults and keep temperatures cool.

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