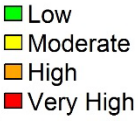
Southern Oregon/Northern California Coast coho

Overall vulnerability—Very high (28% High, 72% Very high)
Biological sensitivity—Very high (44% High, 56% Very high)
Climate exposure—High (66% High, 34% Very high)
Adaptive capacity—Low (1.56)
Data quality—58% of scores ≥ 2

Southern Oregon/Northern California Coast Coho		Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Early life history	2.5	1.8	
	Juvenile freshwater stage	3.7	2.8	
	Estuary stage	3.2	1.5	
	Marine stage	3.4	2.8	
	Adult freshwater stage	1.6	2.5	
	Cumulative life-cycle effects	3.3	1.5	
	Hatchery influence	2.2	2.8	
	Other stressors	3.6	2.3	
	Population viability	3.5	3	
	Ocean acidification sensitivity	1.8	1.8	
	Sensitivity Score	High		
Exposure variables	Stream temperature	3.7	2	
	Summer water deficit	2.7	1.8	
	Flooding	3.4	1.3	
	Hydrologic regime	1.4	2.3	
	Sea level rise	3.3	2	
	Sea surface temperature	3.3	2	
	Ocean acidification exposure	4	2.5	
	Upwelling	2.9	1	
	Ocean currents	1.9	1	
	Exposure Score	High		
Overall Vulnerability Rank		High		



Life History Synopsis

In general, coho salmon within the Southern Oregon/Northern California Coast DPS exhibit a 3-year life cycle. Adults enter natal streams and rivers from mid-November to January, coincident with the onset of rain-induced freshets in the fall or early winter. However, entry into the Rogue River can occur as early as late August or early September (Weitkamp et al. 2015). Spawning may take place in small-to-moderate-sized coastal streams and tributaries or larger rivers and usually occurs within a few days to a few weeks of freshwater entry. Depending upon water temperature, eggs incubate for approximately 8-12 weeks before hatching, after which alevins or "sac-fry" continue to reside in the gravel for an additional 2-8 weeks (Sandercock 1991). Fry emerge in early spring.

Juveniles exhibit a range of behaviors, life histories, and habitat associations. The majority reside about one year in fresh water before migrating to sea. Some juveniles may reside in estuaries for variable periods depending on temperature, dissolved oxygen, and salinity levels, and subsequently move back upstream (Miller and Sadro 2003, Koski 2009, Jones et al. 2014, Wallace et al. 2015). Within the Southern Oregon/Northern California Coast coho DPS, Wallace et al. (2015) found that the estuaries of stream tributaries to Humboldt Bay provided major rearing habitats for juvenile coho, including those of small streams in which no coho spawned.

In more northern latitudes, a significant proportion of juveniles may spend a second or even third full year in fresh water (Sandercock 1991). This life-history pattern has been documented in the California portion of this DPS (Bell and Duffy 2007) and in the Central California Coast coho DPS to the south (Gallagher et al. 2014), although only a small-to-modest fraction may spend a second year in fresh water before migrating to sea.

During winter, juvenile coho need refuge from high, turbid flows. Typically, these refuges are side-channels (Bell 2001), complex masses of large woody debris, and small, tributaries (Ebersole et al. 2006).

In the Southern Oregon/Northern California Coast coho DPS, smolt migration occurs in spring, generally peaking in April or May (Weitkamp et al. 1995). Migratory behavior can be triggered by a range of environmental stimuli (Spence and Dick 2014), reflecting adaptation to differences in time and predictability of favorable ocean conditions (Spence and Hall 2010). Characteristics that have been recognized as influencing migratory behavior include stream flow, fish size, day length, water temperature, and food density.

The ocean phase of coho salmon typically lasts about 1.5 years; however, often a proportion of male fish return after only 6 months at sea as precocious males ("jacks") that are substantially smaller than adults returning after a full 18 months at sea (Weitkamp et al. 1995). The proportion of precocious males in the escapement population can be highly variable (Sandercock 1991).

After entering the ocean, juvenile salmon initially remain in inshore waters near the natal stream as suggested by tag recovery data from hatchery populations north of this DPS (Beamish et al. 2018). Coho salmon can range widely in the North Pacific Ocean, but specific ocean movements of Southern Oregon/Northern California Coast coho are poorly understood. Beamish et al. (2018) provide a detailed overview of coho marine diets. In general, they summarize coho salmon off the coast of North America as opportunistic visual predators with typical prey items found in fish collected from the California Current, including larval or juvenile fishes, decapod larvae, euphausiids, amphipods, juvenile squid, and terrestrial insects.

Climate Effects on Abundance and Distribution

An understanding of the geographical make-up of the Southern Oregon/Northern California Coast coho DPS is critical to understanding climate effects on its abundance and distribution. The geographic setting of this DPS includes three large basins and numerous smaller basins across a diverse landscape. The Rogue and Klamath Rivers extend beyond the Coast Range and include the Cascade Mountains. The Eel River Basin also extends well inland, including portions at relatively high elevation and portions that experience dryer and warmer summer temperature. Numerous moderate and smaller coastal basins of the DPS experience relatively wet, cool, and temperate conditions in contrast to the Rogue, Klamath, and Eel interior sub-basins, which exhibit a range of conditions including snowmelt-driven hydrographs, hot dry summers, and cold winters. Lower-elevation portions of these large basins are more similar to the smaller coastal basins in terms of environmental conditions than they are to the interior sub-basins (Williams et al. 2006).

Predicted problems faced by Southern Oregon/Northern California Coast coho include increases in *stream temperatures*, for which sensitivity was rated ***high***, as well as increased variability in flows, reflected in a ***high*** score for *flooding*. This DPS may also be affected by changed ocean conditions, although the nature of such changes remains highly uncertain.

Overall sensitivity attributes were ranked ***high***, although in bootstrap resampling, a majority of resamples produced a ***very high*** score. Thus, this DPS was borderline between ***high*** and ***very high***, indicating that many individual attributes included multiple very high tallies. Nearly all life stages contributed to this result: *juvenile freshwater stage* was ranked ***very high***, and *estuary stage*, *marine stage*, and *cumulative life-cycle effects* were ranked ***high***.

Exposure also ranked ***high*** overall for this DPS. Attributes contributing to this score were *flooding*, *sea surface temperature*, and *sea level rise*, all of which ranked ***high***. *Stream temperature* ranked ***very high,*** and because juvenile coho rear in rivers over the summer, they are highly sensitive to stream temperatures and thus highly vulnerable in the juvenile freshwater life stage. The high exposure rank for *flooding* reflected potential affects of flood risk on the *early life history* and *adult freshwater stage*, because winter storms overlap both adult migrations and spawning. In the future, the combination of changes in storm dynamics and sea level rise may impact lagoon habitat in ways that have not been fully explored. Nonetheless, this DPS is especially diverse in its dependence on lagoon habitat. Specifically, components from the three large inland basins could contribute to greater resilience of this DPS to sea level rise than of the strictly coastal ESUs further south.

Extrinsic Factors

Climate change impacts to Southern Oregon/Northern California Coast coho are superimposed on stressors such as dams, water diversions, and erosion from logging. Thus sensitivity to *other stressors* was ranked ***very high***. These threats increase the likelihood of rapid extirpation as time passes without dramatic action to protect and enhance habitats. Such dramatic action is planned with the removal of four dams on the Klamath River scheduled to

occur in 2021. In addition, genetic management plans are in place for all three hatcheries influencing this DPS, and multiple dams have been removed on the Rogue River.

Southern Oregon/Northern California Coast coho is listed as threatened under the U.S. Endangered Species Act, and sensitivity for *population viability* was ranked ***high***. Although long-term data on abundance in this DPS are scarce, the last two viability assessments indicate little change in abundance trends (Williams et al. 2016). All populations fail to meet viability criteria, although all are extant, unlike the Central California Coast coho salmon DPS immediately to the south.

Adaptive Capacity

Because this DPS is near the southern range limit for coho, it appears to have little capacity to adapt to warmer streams, and adaptive capacity was ranked ***low*** for Southern Oregon/Northern California Coast coho salmon. However, habitat is particularly diverse within this DPS, which will likely cause greater differentiation in response to climate impacts and possibly a wider range of responses than possible for the more southerly Central California Coast coho salmon DPS. The three large basins that penetrate coastal mountain ranges include snowmelt-driven hydrographs, hot dry summers, and cold winters, while the numerous moderate and smaller coastal basins in the DPS experience relatively wet, cool, and temperate conditions. The contrast between coastal and interior sub-basins provides a range of environmental conditions that will most likely be impacted differently by climate-driven changes.

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