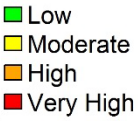
Lower Columbia River coho

Overall vulnerability—High (30% Moderate, 60% High)
Biological sensitivity—High (29% Moderate, 71% High)
Climate exposure—High (2% Moderate, 98% High)
Adaptive capacity—Moderate (2.4)
Data quality—89% of scores ≥ 2

	Lower Columbia River Coho	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Early life history	1.7	2.8	
	Juvenile freshwater stage	3.2	2.8	
	Estuary stage	1.8	2.8	
	Marine stage	3	2.3	
	Adult freshwater stage	1.7	3	
	Cumulative life-cycle effects	2	2.3	
	Hatchery influence	2.9	2.8	
	Other stressors	2.5	2.5	
	Population viability	2.9	3	
	Ocean acidification sensitivity	1.9	1	
	Sensitivity Score	High		
Exposure variables	Stream temperature	3.3	2.8	
	Summer water deficit	2.7	2	
	Flooding	1.5	2	
	Hydrologic regime	2.2	3	
	Sea level rise	2	2	
	Sea surface temperature	2.8	2.5	
	Ocean acidification exposure	3.9	3	
	Upwelling	1.8	2	
	Ocean currents	1.9	1	
	Exposure Score	High		
	Overall Vulnerability Rank	High		



Life History Synopsis

Lower Columbia River coho salmon is an ocean-maturing phenotype, typical of its species, with adults returning to spawn in freshwater tributaries of the lower Columbia Basin from late September through November. Fish tend to enter larger rivers earlier, and may delay migration into smaller tributaries until precipitation and stream discharge is sufficient (Clark et al. 2014). Information on age at reproduction indicates that females predominately return at age 3, whereas males may return at age 3 or 2, after only 6 months at sea (Weitkamp et al. 1995).

Eggs of Lower Columbia River coho salmon incubate from October through March, with juveniles emerging throughout late winter and spring. Most juveniles enter the ocean at age 1 (Weitkamp et al. 1995). Juveniles are believed to move quickly through the Columbia River

estuary, although some individuals may make extensive use of estuarine habitats (Weitkamp et al. 2012, Craig et al. 2014). Upon entry into the open ocean, juveniles use nearshore marine habitats with some fish remaining in local waters and others moving northward along the continental shelf to central Alaska (Van Doornik et al. 2007, Fisher et al. 2014, Beamish et al. 2018). Maturing coho salmon are caught in ocean fisheries from Vancouver Island to Monterrey Bay (Weitkamp and Neely 2002). Females typically spend about 16 months at sea (Sandercock 1991), while male residence times are variable, as noted above.

Climate Effects on Abundance and Distribution

In September, early-returning adults may encounter seasonally warm temperatures or low flows that delay entry into spawning tributaries. However, these adults will typically hold in estuaries or larger rivers and rapidly ascend tributaries to spawn when conditions become suitable (Clark et al. 2014). Seasonal drops in stream temperature and increases in discharge improve conditions for adult migration as well as egg incubation. Thus, incubating eggs of Lower Columbia River coho salmon are unlikely to be exposed to excessively warm temperatures or desiccation.

Because juveniles typically spend at least one year in fresh water, they can be stressed by warm stream conditions or low flows in summer (Ebersole et al. 2009) and floods that may displace juveniles or reduce survival in winter (Nickelson et al. 1992). ***High*** ranks for sensitivity in the *juvenile freshwater stage* and for exposure to *stream temperatures* were reflective of these findings, and resulted in the juvenile freshwater stage ranking as a ***highly vulnerable life stage***. Though the quality of information is mixed, sensitivity in the *marine stage* is certainly ***high***, and exposure to changing marine conditions, namely high levels of *ocean acidification*, will occur. However, data quality used to evaluate climate-related threats was limited, and future evidence may alter these rankings.

Extrinsic Factors

Although production hatcheries are present and were historically more prevalent, the latest status review reported that multiple populations consist predominantly of natural spawners (Ford et al. 2015), and sensitivity to *hatchery influence* ranked ***moderate***. Similarly, the importance of other stressors such as dams that block access to colder spawning tributaries and effects of urbanization were ranked ***moderate***. Lower Columbia River coho salmon is listed as threatened under the U.S. Endangered Species Act, and *population viability* was ranked ***moderate*** for this DPS.

Adaptive Capacity

The adaptive capacity of Lower Columbia coho was ranked ***moderate***. It likely has a similar amount of flexibility in the juvenile rearing period as other coho. Adults are less constrained in freshwater entry timing than California coho, and thus could potentially respond temporally to changing environmental conditions.

Literature Cited

Much information in the *Climate Effects on Abundance and Distribution* section was summarized from a recent review by (Wainwright and Weitkamp 2013), which focused on Oregon Coast coho salmon. This DPS shares much in common with lower Columbia River coho salmon in terms of climate sensitivity and exposure.

Beamish, R. J., L. A. Weitkamp, L. D. Shaul, and V. I. Radchenko. 2018. Ocean ecology of Coho Salmon. Pages 391-554 *in* R. J. Beamish, editor. The ocean ecology of Pacific salmon and trout. American Fisheries Society, Bethesda, MD.

Clark, S. M., J. B. Dunham, J. R. McEnroe, and S. W. Lightcap. 2014. Breeding site selection by coho salmon (*Oncorhynchus kisutch*) in relation to large wood additions and factors that influence reproductive success. Can J Fish Aquat Sci **71**:1498-1507.

Craig, B. E., C. A. Simenstad, and D. L. Bottom. 2014. Rearing in natural and recovering tidal wetlands enhances growth and life-history diversity of Columbia Estuary tributary coho salmon *Oncorhynchus kisutch* population. J Fish Biol **85**:31-51.

Ebersole, J. L., M. E. Colvin, P. J. Wigington Jr, S. W. Lightcap, J. P. Baker, M. R. Church, J. E. Compton, and M. A. Cairns. 2009. Hierarchical modeling of late summer weight and summer abundance of juvenile coho salmon across a stream network. Trans Am Fish Soc **138**:1138-1156.

Fisher, J. P., L. A. Weitkamp, D. J. Teel, S. A. Hinton, J. A. Orsi, E. V. Farley, J. F. T. Morris, M. E. Thiess, R. M. Sweeting, and M. Trudel. 2014. Early ocean dispersal patterns of Columbia River Chinook and coho salmon. Trans Am Fish Soc **143**:252-272.

Ford, M. J., K. Barnas, T. Cooney, L. G. Crozier, M. Diaz, J. J. Hard, E. E. Holmes, D. M. Holzer, R. G. Kope, P. W. Lawson, M. Liermann, J. M. Myers, M. Rowse, D. J. Teel, D. M. V. Doornik, T. C. Wainwright, L. A. Weitkamp, and M. Williams. 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Dep Commerce NOAA Fisheries Northwest Fisheries Science Center, Seattle, WA. Available from www.nwfsc.noaa.gov/publications/scipubs/searchdoc.cfm.

Nickelson, T. E. R., J.D., S. L. Johnson, and M. F. Solazzi. 1992. Seasonal changes in habitat use by juvenile coho salmon (*Oncorhynchus kisutch*) in Oregon coastal streams. Can J Fish Aquat Sci **49**:783-789.

Sandercock, F. K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*).*in* C. Groot and L. Margolis, editors. Pacific Salmon Life Histories. UBC, Press, Vancouver, BC, Canada.

Van Doornik, D. M., D. J. Teel, D. R. Kuligowski, C. A. Morgan, and E. Casillas. 2007. Genetic analyses provide insight into the early ocean stock distribution and survival of juvenile Coho salmon off the coasts of Washington and Oregon. N Am J Fish Manage **27**:220-237.

Wainwright, T. C., and L. A. Weitkamp. 2013. Effects of climate change on Oregon coast Coho salmon: Habitat and life-cycle interactions. Northwest Sci **87**:219-242.

Weitkamp, L. A., P. J. Bentley, and M. N. C. Litz. 2012. Seasonal and interannual variation in juvenile salmonids and associated fish assemblage in open waters of the lower Columbia River estuary. Fish Bull **110**:426-450.

Weitkamp, L. A., and K. Neely. 2002. Coho salmon (*Oncorhynchus kisutch*) ocean migration patterns: insight from marine coded wire tag recoveries. Can J Fish Aquat Sci **59**:1100-1115.

Weitkamp, L. A., T. C. Wainwright, G. J. Bryant, G. B. Milner, D. J. Teel, R. G. Kope, and R. S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. U.S. Dep Commerce NOAA Tech Memo NMFS NWFSC 24, Seattle, WA.