

Appendix A: Information Sources & Annotated Bibliography

Information sources and contact information

LCFRB website

Data sets are available in ESRI ArcMap format. Versions that are compatible with Google Earth can be provided upon request.

- Habitat action polygons
- Landscape Unit polygons
- Historical fish presence geodatabase
- EDT streamlines
- IWA subwatershed polygons
- Contact details for Lewis County GIS data (culverts, levees, parcels, etc.), as they require data requests
- Contact details for US Forest Service Randle Station, because many data sets were draft/unpublished documents provided by work group member Ken Wieman. Published data sets are included on the LCFRB webpage.

DNR's Washington Lidar Portal

- Lidar data sets
- Tacoma Power Utilities

Tacoma Power's Habitat Data

- Geomorphic assessment
- Hydraulic model

Tacoma Power's Hydropower Management and Monitoring Data

Current information can be found on the Fisheries Technical Committee website.

Overview Summaries of information Sources

The following information source summaries were compiled at the outset of this planning effort and may not represent the entire suite of available information for the Upper Cowlitz Cispus basin.

Fish Population Information

Fish population information includes: Fish movement data (Kock et al. 2016; Kock et al. 2015; Kock et al. 2012; Liedtke et al. 2009; Liedtke et al. 2010; Liedtke et al. 2018; TP2004; TP 201); Fish distribution (Statewide Washington Integrated Fish Distribution data, USFS fish distribution data); stream habitat surveys (McIntosh et al. 1990, USFS Level 2 Stream Inventories); and EDT (MBI 1999).

Available fish information, including basic population biology and life history is substantial. While reliable data from the previous 40 years do not exist at a scale and comprehensiveness to directly inform a basin-wide habitat strategy, they do provide important background and life history information for the focal fish populations.

Adult tracking reports are available from USGS efforts in the upper basin (Kock et al. 2016). These provide useful information regarding distributions and usage of upper basin reaches. However, the results bear the important caveat that these adult fish have been released at point locations, after being trapped and hauled around mainstem dams. Thus, it would be erroneous to infer that these tracking data represent wholly volitional behaviors.

USGS has conducted a body of work describing downstream juvenile movements as they approach and interact with passage structures at Cowlitz Falls Dam (Kock et al. 2015; Kock et al. 2012; Liedtke et al. 2009; Liedtke et al. 2010; Liedtke et al. 2018). These provide an important record of juvenile fish behaviors at both a coarse (e.g., reservoir wide) and fine (e.g., interacting with collectors) scale.

Both Washington Department of Fish and Wildlife (WDFW, Henning 2010) and a team of researchers including University of Washington, US Geological Society (USGS), WDFW, and Pacific Northwest National Lab (PNNL) (Klett et al. 2013) conducted spawning surveys in the lower Cowlitz. Henning (2010) also reported results of a juvenile-to-adult survival study in the lower basin. These sources provide regionally relevant information, but unfortunately do not specifically address the upper basin.

McIntosh et al. (1990) compiled summary reports of stream habitat surveys conducted during 1938-1942. This compilation appears to be relatively comprehensive, and serves as a good benchmark reference for basin-wide condition before recent development. Substantial habitat degradation already occurred by the time these surveys were completed, so these data do not represent a true “before” state that should be accounted as a reference benchmark.

Two FHMP documents published by Tacoma Power (TP 2004; TP 2011) also contain important summaries and syntheses of background fish ecology and life history data within the basin, including basinwide estimates of production and a summary of identified limiting habitat factors.

The US Forest Service has a host of information on fish populations, including information in Watershed Analysis reports, fish distribution databases, barrier databases, and others.

Physical Habitat Information

Physical processes as they relate to habitat condition and limiting factors are described in: LCFRB (2010) (IWA and other elements), Geoengineers (2003), Cardno (2014), Herrera (2004), USFS Watershed Analysis reports, and others.

Similar to the findings regarding fish data discussed above, physical process and habitat data are either very general, discussing the watershed and sub-basins as a whole, or very specific, intensely studied short reaches within the study area.

A few reaches within the project area have been studied intensely. Herrera (2004) examined erosion issues associated with the 1996 flood event in the Cispus River. They also identified habitat limiting factors that include blocked passage, reduced wood loading, and sedimentation. The 2006 flood event caused a large channel avulsion on the Muddy Fork of the Cowlitz, above Packwood. NRCS (2009) reports on hydrologic, hydraulic, and geomorphic analyses performed to understand channel dynamics and risk resulting from the avulsion for 6.5 miles of channel that includes a portion of the mainstem Cowlitz. GeoEngineers provided a geomorphic analysis and channel migration zone delineation for the upper mainstem Cowlitz from Lake Scanewa to the Muddy Fork confluence.

The USFS has performed Watershed Analysis for many of the watersheds within National Forest Lands within the upper Cowlitz and Cispus. This is from Ken Wieman (USFS, personal communication 2019): “As a component of the NWFP Aquatic Conservation Strategy, all HUC 5 have both a preliminary and a v.2 edition of analysis...These documents are interdisciplinary and comprehensive and provide good summary of Historic Conditions, Current Conditions, and Desired Future Conditions. Not only aquatic conditions but also an account of fire and other resources.”

The USFS has performed Level 2 Stream Inventories on most of the wadeable streams across the National Forest. These contain information on aquatic habitat conditions, stream substrate, and riparian conditions. The USFS has also performed stream temperature monitoring throughout the National Forest.

Limiting Factors to Focal Populations

Data on limiting factors is from the following sources: EDT model (Wade, 2000) and Limiting Factors Analysis (MBI 1999). Future steps include evaluating hydrologic conditions during critical life stages, and habitat use. If possible, we will tie limiting factors to specific reaches or subbasin areas. We plan to use limiting factors identified in existing sources, and supplement as appropriate with data generated in this project.

An important element of the Habitat Strategy is identifying and prioritizing areas and actions that support the focal population recovery.

Two previous Limiting Factors Analyses (LFAs) were conducted in the Cowlitz, one included with the EDT analysis from 1999 (MBI 1999), and the Wade LFA from 2000. Although these analyses are now nearly twenty years old, reviewing and including findings and conclusions associated with these LFAs can provide meaningful insights regarding salmon and steelhead population bottlenecks/limiting factors and associated watershed processes.

Mobrand and others completed the EDT for the Cowlitz in 1999 (MBI 1999). This effort included 20 stakeholder meetings that were brokered by MBI, and generated a comprehensive document that diagnoses conditions, including limiting factors, and develops prescriptions for addressing these limiting factors. Along with other Lower Columbia watersheds, EDT results and prescriptions for the Cowlitz are summarized in the LCRFB Recovery Plan (LCFRB 2010a).

In addition, an Integrated Watershed Assessment (IWA) was completed during Recovery Plan development (LCFRB 2010b). This IWA relies upon GIS and remotely sensed data to evaluate sediment, flow and riparian processes associated with the habitat conditions that are evaluated by the Wade LFA and EDT.

US Forest Service Watershed Analysis studies, and other various USFS reports, provide information on fish population limiting factors.

Past Projects in the Basins

Past project information includes that captured in the following references: SalmonPORT website, Cardno (2014), Herrera (2004), NRCS (2009). Next steps include incorporating this project information into the reach description table (TM2, Table 2), identifying additional sources of past project information (eg USFS, Cowlitz Indian Tribe), and incorporating projects/lessons learned into the Habitat Strategy if applicable.

Information on past work exists in several formats, ranging from academic papers discussing the merits of individual projects to spatial databases of project locations. SalmonPORT, an online database managed by the LCFRB, includes basic location and project summary data for recently completed restoration work. Herrera (2004) and NRCS (2009) provide concept-level project information and alternatives for their respective study areas. Abbe et al. (1997) discuss the construction of engineered log jams to provide bank stability and also offer suggestions on future strategies. The USFS Watershed Improvement Tracking (WIT) spatial dataset includes project types and locations but has limited site-specific information. The dataset covers the entire Upper Cowlitz but is a work in progress. Cardno (2014) describes an approach for protection projects.

The US Forest Service has a long history of restoration planning and project implementation on streams and hillslope areas within the National Forest. The information on these efforts is contained in numerous USFS documents.

Relevant Literature

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Annotated Bibliography

This annotated bibliography was developed at the outset of this planning effort and only contains bibliographic entries for a subset of the entire list of relevant references included previously.

Abbe, T. B., et al. (1997). Design of stable in-channel wood debris structures for bank protection and habitat restoration: An example from the Cowlitz River, WA. Conference on Management of Landscapes Disturbed by Channel Incision. S. S. Y. Wang, E. J. Langendoen and F. D. Shields, Jr. University of Mississippi. Oxford, MS: 809-814.

Early ELJ project by Abbe on the upper Cowlitz. Appears to have been relatively successful at trapping LW recruited during subsequent 20Y flood event. Project was hampered by adjacent landowner refusal to cooperate.

Allee, Brian. 1993. Cowlitz Falls Project Fisheries Management Plan: Anadromous Fish Reintroduction Program. Bonneville Power Administration. MZ5775.

This report discusses the anadromous fish reintroduction plan for the Upper Cowlitz. Five alternatives are discussed regarding how to facilitate spawning and release above and below the dams. When the juveniles head downstream, the plan is to trap and truck them to locations below the dams. The document outlines the need for a limiting factors analysis of the Cowlitz, Cispus, and tributaries in order to identify areas that could benefit from restoration. Species of initial focus are N-type coho, spring Chinook, late winter run steelhead. The project will be funded by BPA until 2032.

Angilletta, M. J., et al. (2008). "Big dams and salmon evolution: Changes in thermal regimes and their potential evolutionary consequences." *Evolutionary Applications* 1(2): 286-299.

Exploration/evaluation of potential impacts to developing salmon from large river dams, including Mayfield on the Cowlitz. Work focused on modeling temperature effects and the impacts on salmon life histories.

Bauersfeld, K. 1978. Stranding of juvenile salmon by flow reductions at Mayfield Dam on the Cowlitz River 1976. State of Washington Department of fisheries. Technical Report No. 36. MZ 5050.

This study analyzed fish mortality in response to stranding from dam operations below Mayfield Dam. Test flow reductions, fish counts, and extrapolation based on airphoto analysis suggests significant mortality. Recommendations to reduce stranding are provided and include minimum flow limits and additional testing to determine ramping rates.

Beechie, T. and H. Imaki (2014). "Predicting natural channel patterns based on landscape and geomorphic controls in the Columbia River basin, USA." *Water Resources Research* 50(1): 39-57.

Multivariate model to predict natural channel patterns for 200m reaches of mid order and larger channels (BFW >8 m) with moderate to wide floodplains (confinement ratio >4), throughout the CRB. Method relies upon readily available geospatial datasets. Authors develop predictions of four channel patterns (straight, meandering, anabranching, braided) with 82% accuracy.

Bond, M., et al. (2016). Estimating spring Chinook habitat capacity in the Columbia River basin (Powerpoint Presentation). Seattle, WA, United States Department of Commerce, National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center.

This presentation describes ongoing efforts to scale up (expand) estimates of rearing capacity. Method builds on Beechie & Imaki (2014) channel typing, estimating habitat area from type, then applying known fish densities to areas of each habitat type. This approach would enable estimates of historical and predicted capacity, and could help both locate important sites and set benchmark targets. This version of talk contains reference values for scaling up channel length and width to habitat areas, and fish densities in each of mainstem (bank, bar, mid-channel) and side-channel habitat.

Cardno Entrix. 2014. Upper Cowlitz River Basin Reach Characterization Project – Identifying River Reaches Suitable for Protection. Prepared for Tacoma Power.

This effort was an evaluation/analysis to identify reaches in Upper Cowlitz for protection. Importantly, "examination did not reveal any preexisting information at a suitable reach scale that credibly characterized geomorphic conditions or the spatial distribution and nature of habitats suitable to support native salmon reintroduction. An Ecosystem Diagnostic and Treatment (EDT) analysis completed in 1999 (Mobrand Biometrics, Inc.) did offer some coarser grained characterization of conditions, but it is unclear if these were based on actual field data or simply expert opinion, as we were unable to find data to support the EDT conclusions." Generally found a "current lack of empirical data on which to base advancing restoration projects." Document also contains list of sources compiled during "extensive review of existing data and reports that describe environmental conditions and highlight key factors limiting salmonid productivity in Project Area." Key limiting factors identified generally stem from dam construction and land use practices, and include blocked passage, sediment loading, and low large wood recruitment.

City of Tacoma. 2004. Cowlitz Hydroelectric Project FERC No. 2016. Fish Habitat Fund Allocation Plan for the Lower Cowlitz.

This document details the planned use of the fish habitat fund, with objectives that include process and protocols for funding prioritization, selection, and application.

Collins, B.D., & Montgomery, D.R., Fetherston, K.L., & Abbe, T.B. (2012). The Floodplain Large-Wood Cycle Hypothesis: A Mechanism for the Physical and Biotic Structuring of Temperate Forested Alluvial Valleys in the North Pacific Coastal Ecoregion. *Geomorphology*. s 139–140. 460–470.

This is the foundational paper on the floodplain large-wood cycle hypothesis for the North Pacific Coastal Ecoregion. LiDAR was used to examine topography and forest canopy heights. The Upper Cowlitz (upstream of Packwood) is used as an example of how logging, and specifically the removal of larger logs, triggered a doubling of channel width and overall reduction in channel complexity. It is implied that channel migration rates are also increased as a result.

Dammers, W., Foster, P., Kohn, M., Morrill, C., Serl, J., & Wade, G. 2002. Draft Cowlitz River Subbasin Summary. Prepared for the Northwest Power Planning Council.

This summary document provides overviews of the physical characteristics of the Cowlitz watershed, including disturbance and hydrologic regimes. Historical and current information on fish populations are summarized, as are past re-introduction efforts. The limiting factors identified in the EDT model are summarized and goals of the present subbasin management presented.

Dethier, DP. 1988. Chapter F: The soil chronosequence along the Cowlitz River, Washington. USGS Bulletin 1590-F.

This report documents the development of a soil chronosequence along the Cowlitz River. Soils range from thick to thin and are underlain by glacial outwash deposits. Various physical and chemical properties show systematic changes in soil properties over time. Background geological information that may be useful for hydrological assessments, sediment studies/budgets, etc.

Easterbrooks, J.A. 1980. Salmon production potential evaluation for the Cowlitz River system upstream of the Cowlitz Falls Dam site. State of Washington Department of Fisheries.

This study was part of the larger feasibility study for hydropower production at Cowlitz Falls dam site. The goal was to provide an estimate of salmon production potential upstream of the dam site. Methods included nine days of fieldwork on the mainstem Cowlitz, Cispus and tributaries. Information was collected on discharge, grain size, riparian vegetation characteristics, stream stability assessments, rearing habitat, and the presence of fish. Maximum annual smolt production estimates were developed. The study concluded that there was great potential to produce salmon smolts, but the inability to successfully collect juveniles is a fundamental limitation. The report presents a prioritized list of streams for stocking efforts.

Friends of the Cowlitz. 1992. Project genesis: The rebirth of the Cowlitz Basin.

This letter outlines enhancement goals, management goals, and minimum actions required to meet those goals for re-building populations of native fish to pre-dam levels. The document contains fish number targets for populations sizes, escapement, and harvest.

GeoEngineers. 2003. Report Geomorphic Evaluation and Channel Migration Zone Analysis for the Upper Cowlitz River and Rainey Creek. Lewis County, Washington. Prepared for Lewis County Public Works.

This effort to delineate the Channel Migration Zones (CMZ) and identify migration potential areas was initiated as part of Comprehensive Flood Hazard Management Plan (CFHMP) for the Upper Cowlitz, which called for an understanding of the relationship between property damage and bank erosion. The study covers approximately 40 river miles of Upper Cowlitz, from Lake Scanewa to Lewis County Northern boundary (RM126.7) and also includes Rainey Creek. Methods included site visits and historical data review. The study mapped out migration types per reach and delineated a CMZ with a 100-year planning window. Migration Potential Areas (MPA) were given severity ratings, identifying the highest hazard areas.

Gleizes, C., et al. (2014). Lower Cowlitz River Monitoring and Evaluation, 2013. Vancouver, WA, Washington Department of Fish and Wildlife, Fish Program. FPA 14-10.

Results from the first year of the Lower Cowlitz (below Mayfield) M&E plan, including spawner abundance and composition, hatchery returns and composition, and fishery impacts on populations of winter

steelhead, coho, and spring and fall Chinook in lower river. Provides regional information regarding life history, phenology, etc.

Hager, R. C. and C. W. Hopley, Jr (1981). A Comparison of the Effect of Adult Return Timing of Cowlitz and Toutle Hatchery Coho on Catch and Escapement. Technical Report No. 58, State of Washington Department of Fisheries.

WDFW report describing effects of Cowlitz coho run timing on ocean distribution (N versus S turning), and capture in fisheries.

Harza. 1995. Juvenile Coho monitoring study in tributaries to the Upper Cowlitz River. Unpublished report prepared for BPA.

This unpublished report presents results of fish monitoring work on juvenile coho salmon released into the Upper Cowlitz in 1995. The purpose was to evaluate success in terms of growth rate, condition factor, habitat use, density per mile in 10 tributaries (Davis Creek, Hall Creek, Johnson Creek, Lake Creek, Siler Creek, Skate Creek) in the upper basin. Resident fish populations residing in the same tributaries were also assessed. Methods included fish surveys and habitat mapping. Every tenth habitat unit, defined as pools, riffles, glides, and cascades, was sampled for fish. In total, 122 habitat units were sampled and fish density and growth rates calculated. The only salmonids found were coho, rainbow trout, and cutthroat trout. All habitat types supported substantial fish.

Harza Northwest. 1997. A review of historical fisheries and water quality conditions in the Upper Cowlitz River basin, draft.

This draft report provides a literature review on the fisheries and water quality in the Upper Cowlitz, with the goal of populating a patient/template analysis for EDT. Information summarized in the report includes species abundance, spawning distribution, habitat quantity, and other variables. Much of the data reported is qualitative and not site specific, though some metrics are provided (e.g., fish density estimates from planting information).

Henning, J. A. (2010). Cowlitz River Evaluation Program: Annual Report for 2009. Olympia, WA, Washington Department of Fish and Wildlife, Fish Program, Fish Management Division. FPA 10-02.

Report contains spawning (redd and carcass) survey data for the Lower Cowlitz, which may be regionally relevant but is not specific to the study area. Also contains results from a juvenile-adult survival study from the Lower Cowlitz.

Herrera 2004. Reach Analysis and Erosion Hazard Management Plan: Cispus River from River Mile 12.3 (Greenhorn Creek) to River Mile 17.6 (Cispus Road Bridge). Prepared for Lewis County Public Works

This reach-scale analysis examined erosion hazard issues stemming from the 1996 flood event in a small community on the Cispus River. Methods included historical data review, desktop and field assessments, spawning site identification, flow gage analysis, habitat feature mapping, and a sediment supply assessment. Riparian habitat was classified and notes on fish use of the available aquatic habitat included.

Limiting factors for several species were identified and include sedimentation from eroding banks, channel confinement, blocked passage, reduced wood loading and recruitment. The delineation of a channel migration zone was used to characterize erosion hazard for the reach. Overall recommendations include process-based strategies to protect both habitat and infrastructure. General concepts for prioritized areas include cost estimates.

HSRG (2009). Hatchery Scientific Review Group Review and Recommendations: Cowlitz River Coho Population and Related Hatchery Programs. Seattle, WA, United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Hatchery Scientific Review Group.

Provides population status, targets, and programmatic approach for recovery of Cowlitz coho. Describes distinction between LC/UC populations, and pHOS/NOS within each. Recommendation to designate upper watershed population "Primary" and lower population "Contributing."

Isaak, D. J., et al. (2007). "Chinook salmon use of spawning patches: Relative roles of habitat quality, size, and connectivity." *Ecological Applications* 17(2): 352-364.

Spawning habitat connectivity (measured by adapting Moilanen and Nieminen (2002) negative exponential kernel method) and size are more important than quality (stream width and depth, cover, large wood density, mean temperature, sinuosity, etc.) in predicting use by adult Chinook salmon. Connectivity and size interact, with size becoming more important when abundance is low. Recommendation to focus protection of intact large patches of spawning habitat, and to focus restoration on project sites that will increase connectivity, while excluding sites that do not meet minimum size/connectivity thresholds. Conclusion is that efforts focused on improving habitat quality will be less effective than increasing total amount and connectivity of adequate patches.

Klett, K. J. C., et al. (2013). "Spatial consistency of Chinook salmon redd distribution within and among years in the Cowlitz River, Washington." *North American Journal of Fisheries Management* 33(3): 508-518.

Analysis of Lower Cowlitz (below Barrier Dam) aerial survey spawning location data, suggesting that Chinook spawn in same locations across 1991-2009. Side channels reaches tended to be overrepresented, whereas reaches with high sinuosity were underrepresented.

Kock, T. J., et al. (2016). Behavior Patterns and Fates of Adult Steelhead, Chinook Salmon, and Coho Salmon Released into the Upper Cowlitz River Basin, 2005-09 and 2012, Washington. Reston, VA, Prepared by: United States Department of the Interior, U.S. Geological Survey. Prepared in cooperation with: the Public Utility District Number 1 of Lewis County, Washington, and the Washington Department of Fish and Wildlife. U.S. Geological Survey Open-File Report 2016-1144.

Results from multi-year telemetry study of adult steelhead, Chinook, and coho movements in Upper Cowlitz, following trap and haul around dams and release into Lake Scanewa or mainstem of Cowlitz or Cispus Rivers. Primary goal was estimating fallback, but also compared behaviors of HOR and NOR fish: NOR fish showed more directed upstream movement after release. More fish entered (and presumably

spawned in) the Cowlitz than Cispus, regardless of origin. Primarily background ecology/life history information.

Kock, T. J., et al. (2015). Evaluation of Two Juvenile Salmon Collection Devices at Cowlitz Falls Dam, Washington, 2014. Reston, VA, Prepared by: United States Department of the Interior, U.S. Geological Survey. Prepared in cooperation with: Lewis County Public Utility District, Washington. Open-File Report 2015-1054.

Evaluation of effectiveness of downstream juvenile passage infrastructure around CFD. Structures include a weir box above CFD and the Upper Riffe Lake Collector (URLC, a type of floating surface collector) below CFD. Includes background ecology/life history data for Upper Cowlitz salmonids.

Kock, T. J., et al. (2012). "Elevated streamflows increase dam passage by juvenile coho salmon during winter: Implications of climate change in the Pacific Northwest." *North American Journal of Fisheries Management* 32(6): 1070-1079.

Downstream passage of juvenile coho through CFD increases with streamflow during winter, when juvenile passage facilities not operating. Includes background ecology/life history information.

LaRiviere, Mark and Garrick, Craig. 1996. History of anadromous fish passage at the Cowlitz Hydroelectric Project, Cowlitz River, Washington. Cowlitz Hydroelectric Project. City of Tacoma Dept of Public Utilities Light Division and Harza Northwest Inc.

This document presents a timeline of events and considerations and an extensive reference list regarding the development of the Cowlitz Hydroelectric Project, consisting of the Mossyrock and Mayfield generating facilities. The document outlines the success of the hatchery program and lack of success for the downstream migrant collection facilities.

Lewis County. 2002. Comprehensive Plan

Lewis County. 2009. Channel Migration Zone Study

Lewis County. 2017. Shoreline Master Program: Environment Designations, Policies, & Regulations. Ecology Grant: G1200468. Lewis County, Washington.

Liedtke, T. L., et al. (2009). Behavior and Passage of Juvenile Salmonids during the Evaluation of a Fish Screen at Cowlitz Falls Dam, Washington, 2008, Prepared by: United States Department of the Interior, U.S. Geological Survey, Western Fisheries Research Center, Columbia River Research Laboratory (Cook, WA). Prepared for: Tacoma Power (Tacoma, WA). Tacoma Power Report Series 2009-01.

Telemetry and DIDSON camera data evaluating downstream steelhead, coho, and Chinook passage of CFD. Includes background ecology/life history information.

Liedtke, Theresa L., Tobias J. Kock, Brian K. Ekstrom, Ryan G. Tomka, and Dennis W. Rondorf. 2010. Evaluation of Angler Effort and Harvest of Rainbow Trout (*Onchorhynchus mykiss*), Lake Scanewa, Washington. USGS. Open-File Report 2011-1178.

The objective of this effort was to determine the impacts to juvenile anadromous salmon from trout predation in Lake Scanewa. Methods included a creel survey, with angler interviews on catch numbers

relative to stocking numbers. The proponents also examined the contents of rainbow trout stomach samples. The study concluded that predation on juveniles was potentially significant, but ultimately more information is needed to make any definite conclusions.

Liedtke, T. L., et al. (2010). Juvenile Salmonid Collection Efforts in the Upper Cowlitz River Basin: 2009 Evaluations, Prepared by: United States Department of the Interior, U.S. Geological Survey, Western Fisheries Research Center, Columbia River Research Laboratory (Cook, WA). Prepared for: Tacoma Power (Tacoma, WA). Tacoma Power Report Series 2010-01.

Evaluation of fish screen and weir box at CFD on downstream passage of juvenile steelhead, coho, Chinook. Includes background ecology/life history information.

Liedtke, T. L., et al. (2018). Passage survival of juvenile steelhead, coho salmon, and Chinook salmon in Lake Scanewa and at Cowlitz Falls Dam, Cowlitz River, Washington, 2010–16. Open-File Report. Reston, VA, Prepared by: United States Department of the Interior, U.S. Geological Survey. Prepared in cooperation with: Lewis County Public Utility District, Washington. Open-File Report 2018-1050: 56.

Evaluation of survival of steelhead, Chinook, and coho passing downstream through Lake Scanewa and approaching CFD. Includes background ecology/life history information.

Lower Columbia Fish Recovery Board (LCFRB). 2010. Upper Cowlitz Subbasin. Found in Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan, Vol.2, Ch. F.

This chapter of the larger Lower Columbia Recovery Plan details the Upper Cowlitz basin physical characteristics, focal fish species, habitat conditions and limiting factors. The loss of key habitats is related to construction of the dams, development, land use change, forestry practices, and channelization. Competition with hatchery fish is also listed as a reason for reduced productivity. Key priorities are identified and include upstream and downstream passage, preservation of functional reaches and forests, growth management, floodplain reconnection, and others. Document appendices detail EDT and IWA modeling for the subbasin.

Manlow, S. & Andrews, A. 2008. Grays-Elochoman & Cowlitz Detailed Implementation Plan WRIA 25 and 26. WA Department of Ecology. Lead Agency – Lower Columbia Fish Recovery Board.

This is a planning document resulting from the Washington Watershed Management Act, which provides the vehicle for developing water resource management plans for individual basins. The document outlines the planning process and primarily focuses on water supply issues. The plan was developed in coordination with LCFRB in regards to habitat issues.

McIntosh, B., et al. (1990). Bureau of Fisheries Stream Habitat Surveys: Cowlitz River Basin, Summary Report 1934-1942. Portland, OR, Bonneville Power Administration. DOE/BP-02246-4.

Summary report of in-stream habitat surveys conducted during 1938-42, part of a larger project conducted to evaluate migration, spawning, and rearing habitat for migratory fishes. Earliest and most comprehensive records of pre-hydro habitat, providing baseline data that could be used to establish benchmark targets.

Measurements are relatively coarse, but quantified using tape, rule, sounding line, thermometer, etc. Researchers collected general information, station information, watershed characteristics, stream gradient, flow, temperature, pool and riffle area and depth, substrate, spawning area, barriers, diversions, pollution point sources, and fish observations.

MGHC (1976). Memories from Family Albums of School District #206. Centralia, WA, Compiled by: Mossyrock Grange #355 Historical Committee.

Compilation of photographs and written records documenting historical conditions of Cowlitz basin. Photographs and notes could provide useful baseline data to inform benchmark targets.

Mobrand Biometrics, Inc. 1999. Application of the Ecosystem Diagnosis and Treatment Method (EDT) to Analyze Fish Resources in the Cowlitz Watershed in Support of FERC Relicensing Process. Prepared for Resource Planning Group of the Cowlitz River FERC Relicensing Process.

EDT Analysis of Cowlitz by MBI. Report is substantial, and contains multiple appendices detailing process of analysis and decision making.

Mossyrock Grange Historical Committee. 1976. Memories from family albums. School district #206. City of Mossyrock.

First person account of the history of the valley, stretching back to the late 1800s.

NRCS. 2009. Upper Cowlitz River FINAL Flood Hazard Risk Assessment Report. Prepared by TetraTech.

This report is an intensive study of flood inundation, bank erosion, and channel avulsion for 6.5 mi of the Upper Cowlitz, near Packwood. The study was triggered in response to a large channel avulsion that occurred in November of 2006, with the objective to perform hydrologic, hydraulic, sediment, and geomorphic assessments and modeling. The study included an economic damage assessment and results were used to outline potential flood hazard mitigation strategies. Mitigation measures identified included bank revetments, wood management strategies, floodproofing, and property buyouts. Optimal strategies for reducing damage and providing protection are outlined, as well as a strategy for developing project support.

Perry, R.W., T. J. Kock, M. A. Kritter, and D. W. Rondorf. 2006. Migration behavior and dispersal of adult spring Chinook salmon released into Lake Scanewa on the upper Cowlitz River during 2005. U.S. Geological Survey. Final Report to Lewis County Public Utility District, Chehalis, Washington.

This report examined spring Chinook migratory behavior by using radio tags to track fish movements in the Upper Basin. Differences between hatchery and wild, male and female, and fate locations were examined. Fish were collected from the hatchery, tagged, and placed in Lake Scanewa, with some planted above Packwood. Stream temperature and flow were monitored. Findings include fish spending a lot time in the lake, with many moving downstream, but only a few making it to Riffe Lake. More hatchery fish moved

upstream, compared to wild, with more fish preferring the Cispus overall. Fish that went up the Cowlitz tended to go past Cora, suggesting that most spawning happens above that location.

Quinn, T. P. and K. Fresh (1984). "Homing and straying in Chinook salmon (*Oncorhynchus tshawytscha*) from Cowlitz River hatchery, Washington." *Canadian Journal of Fisheries and Aquatic Sciences* 41(7): 1078-1082.

Quinn's widely cited CWT study of Chinook straying in the Cowlitz. Important findings include (1) very high fidelity to natal river system, (2) increased rate of straying among older age-at-return fish, and (3) increased rate of straying within high return years. Includes background ecology/life history information.

Rawding, D., et al. (2014). Lower Columbia River Fisheries and Escapement Evaluation in Southwest Washington, 2010. Vancouver, WA, Washington Department of Fish and Wildlife, Fish Program. FPT 14-10.

Report contains spawner escapement and harvest rate estimates for Chinook, coho, and steelhead across LCR. Includes background ecology/life history information.

Stober, QJ. 1986. Reintroduction of anadromous fish runs to the Tilton and Upper Cowlitz Rivers. Final Report for Washington State Department of Fisheries and Department of Game. FRI-UW-8602.

The primary objective of this report is to identify alternatives for the reintroduction of salmon and steelhead to the Tilton River and Upper Cowlitz. This effort included reviews of communicable disease information and histories of salmon and steelhead in the basin. Methods included literature review, an examination of thermal profiles through the reservoirs, identification of ~248 miles of available habitat, and a review of fish planting and hauling numbers. In total, 13 alternatives were considered, examining volitional access and hauling options for different species. The least cost alternative was the reintroduction of Coho to the Tilton River and Winston Creek. Potential disease was identified as a concern and ways to prevent focused on managing the temperature of releases.

TP (2004). Cowlitz River Fisheries and Hatchery Management Plan, Final. Tacoma, WA, Tacoma Power.

FHMP for Cowlitz fishery and hatchery. Contains important background ecology/life history, and digest of EDT study including production estimates and limiting factors analysis summary.

TP (2011). Cowlitz River Project FERC No. 2016: Fisheries and Hatchery Management Plan Update, Final. Tacoma, WA, Tacoma Power.

Updated FHMP for Cowlitz fishery and hatchery. Includes background ecology/life history information.

Trotter, PC, Williams, RN, Jaworski, M. 1995. Genetic profile of Upper-Cowlitz resident trout populations and comparison with currently used hatchery stocks of rainbow trout, steelhead, and searun cutthroat trout. Part 1 – Rainbow trout and steelhead. Technical Advisory Committee, Cowlitz falls project.

This study looked at the genetics of seven stream resident rainbow trout populations and one adfluvial population in the Upper Cowlitz and compared them with hatchery trout and steelhead. Primary research questions centered on the impacts of hatchery fish to native populations of rainbow trout and steelhead. Fish were collected for sampling from several sites around the basin. The study found that in certain areas hatchery fish have impacted native fish, while in other areas rainbow trout populations appear to be free of hatchery influence.

U.S. Forest Service (USFS). 1996. Lower Cispus West watershed analysis. Randle Ranger District, Gifford Pinchot National Forest. March, 1996.

U.S. Forest Service (USFS). 1996. Lower Cispus east watershed analysis. Gifford Pinchot National Forest, Randle Ranger District. April, 1996.

U.S. Forest Service (USFS). 1997. Middle Cowlitz watershed analysis. Gifford Pinchot National Forest, North Skills Center.

U.S. Forest Service (USFS) 1997. Upper Cowlitz watershed analysis. Gifford Pinchot National Forest, Packwood and Randle Ranger Districts. July 1, 1997.

U.S. Forest Service (USFS). 2001. Upper Cispus Watershed Analysis. Gifford Pinchot National Forest. Report. Cispus River.

These and other US Forest Service Watershed Analysis documents contain comprehensive information on hillslope, riparian, floodplain, and channel processes and habitat, as well as descriptions of historical and desired future conditions.