USDA Forest Service
Gifford Pinchot National Forest
Existing Information Analysis
For
Flow and Sediment Resources

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Abstract

The Packwood Lake Hydroelectric project alters flow and sediment regimes within the Lake Creek Subwatershed, which results in changes to the physical structure and function of the aquatic and riparian ecosystem and the distribution and abundance of aquatic and riparian species.

I. Existing Situation

Changes in the flow and sediment regime resulting from the project has affected the aquatic and riparian habitat, and habitat connectivity both upstream and downstream of the projects.

The Packwood Lake Hydroelectric project alters the flow regime by diverting flow out of Lake Creek, bypassing approximately five miles of the stream and returning the flow via the tailrace from the powerhouse to the Cowlitz River. This diversion from Lake Creek alters the magnitude, frequency and timing of peak flow events, reduces base flows in Lake Creek reaches downstream of the project, and changes the sediment regime in the low gradient reach of Lake Creek.

The project alters the water levels in Packwood Lake by drawing it down in October, exposing previously inundated tributaries, and altering aquatic and riparian habitat.

Peak Flows

Peak flows from the upper Lake Creek Watershed sometimes result in spill over the dam that contributes to peak flows within the lower Lake Creek Watershed. The timing, frequency and magnitude of spills is summarized in Energy Northwest's Packwood Lake hydrology report (EES Consulting 2004). The timing of the peak flow from the spill may be later than the surrounding streams due to the reservoir's function to store peak flows. The magnitude of the peak flow is sometimes reduced due to retention of flow within the reservoir. This results in changes to the magnitude, timing and frequency of these peak flows in downstream reaches which is critical to maintaining channel complexity and large woody debris routing.

Bankfull flow can be considered a flow with a recurrence interval of approximately 1.5 years. USGS data does not give statistics for a 1.5 Year peak flow event but does for a 1.2 peak flow event. The 1.2 peak flow at the Lake Creek USGS site 14225500 (located at the drop structure) estimated from 34 non-consecutive pre-project years between 1912 and 1963 is 285.1 cfs (USGS, 1985). Spill events with the magnitude of 285.1 cfs occurred at least 25 out of the 38 years (66%) during the pre-project period while only 17 out of 40 years (42%) during the post project period 1964-2003.

Stream morphology, in particular the shape of a channel and substrate character, is formed during bankfull flows. The infrequent occurrence of bankfull flows may be reducing the transport of gravel sized sediments into the anadromous reach of Lake Creek, thereby altering the substrate character and reducing channel complexity. The infrequent occurrence of bankfull flows have little influence on the shape of the Lake Creek channel due to it steep gradient and bedrock/boulder predominance.

Reach 1 of Lake Creek is the lowest gradient reach at the base of the watershed near the confluence with the Cowlitz River. The reduction of the magnitude of peak flows within this reach may have altered substrate character and floodplain development. In the lowest portion of Reach 1, the channel width and bank height has been altered by a berm, presumably constructed to minimize flooding to a sheltered picnic structure, parking area and house.

Base flows

The current license requires a minimum release of 3 cfs into Lake Creek, at the diversion point just below Packwood Lake, throughout the year. Baseflow in the bypass reach also includes groundwater accretion and tributary flows. The current minimum flow released into Lake Creek is small and affects the quantity of aquatic habitat in Lake Creek below Packwood Lake. The reduction of instream flows alters habitat conditions by reducing depth and wetted streambed areas, thereby reducing habitat for fish, amphibians, benthic invertebrates and other species (See Aquatic Biology EIA).

The constant release of one flow rate into Lake Creek does not reflect the natural variation of base flow. Mean monthly flows measured at the drop structure USGS gage prior to the project varied from a mean monthly flow of 151.1 cfs in July to 89.0 cfs in November but post-project only varied slightly with mean monthly flow in July of 16.3 cfs and mean monthly flow in November of 10.1 cfs. This results in flows with less variation among years than the normal range of flows that occurred under natural conditions. Designating one flow for minimum flows during the low flow period decreases the variation in which riparian and aquatic species habitat evolved.

Subsurface aquatic habitats (hyporheic zones) are reduced as a result of decreases in wetted streambed area. These well oxygenated aquifer layers extend out from the margins of the stream, are sites for nutrient cycling, and support species contributing to the food chain. Biological connectivity within the riparian area for riparian dependent species is disrupted by this reduction in hydrological connectivity in this reach.

Sediment Supply and Transport

Coarse sediments (fine gravel and larger) input from lake tributaries would not be transported through the lake with or without the dam. Only the transport of coarse sediments close to the natural lake outlet have been interrupted by the dam. Therefore, the project has had a limited affect to the quantity of coarse sediment supply from the upper Lake Creek Watershed.

The transport of fine sediment (sand and smaller) from the lake into Lake Creek is altered by the dam. The magnitude of this alteration is unknown.

Tributaries and hillslopes within the bypass reach drainage area are the primary sources of coarse sediment to the bypass reach, and this source has not been changed by the project.

The curtailment of sediment movement by the reduction of flows through Lake Creek created two primary adverse effects: 1) reduction or alteration of sediment storage and transport to downstream reaches including their floodplains, and 2) change to substrate character in the low gradient reach upstream of the confluence with the Cowlitz River.

The reduction in sediment transport may be limiting downstream supply of desired sediments such as spawning gravels, as well as the transport of finer sediments that would normally have reached the low gradient reach in Lake Creek near its confluence with the Cowlitz River. The highest concentration of gravel present in the entire length of Lake Creek was observed in the lower half of Reach 4-RM 3.5-4.2 (EES Consulting Physical Habitat Assessment Survey, 2004). Reach 2 and Reach 3 are high gradient reaches, mean slope 7.3% and 8.0% respectively, and would carry gravels through these reaches to Reach 1. Reach 1 has low amounts of gravel. Limited bankfull events curtailing sediment transport may be limiting the amount of gravels entering Reach 1 where anadromous habitat exists.

Packwood Lake is drawn down at the end of September to accommodate the power plant closures. During the drawdown period the sections of normally inundated tributary reaches are exposed and lack riparian vegetation which results in disconnected riparian habitat with adverse effects to invertebrate populations (food source for fish).

Large wood accumulations are low (less than 18 pieces/mile) in Lake Creek below the dam. The disruption of transport and recruitment of large wood also affects sediment transport and storage. Low levels of large wood can decrease sediment storage capacity, facilitating scour of permanent and temporary pockets of gravel thereby reducing habitat suitability of aquatic organisms.

Providing flow and sediment regimes that closely mimic natural flows and geomorphological processes to the greatest extent biologically and technically feasible is the desired goal. This could optimize conditions downstream by reestablishing proper channel function and assuring channel maintenance for riparian and aquatic biota life cycles (i.e. spawning, rearing, holding).

II. Mangement Direction

Forest Plan

The Gifford Pinchot National Forest Land and Resource Management Plan Amendment 11 (1995) provides the management direction for all National Forest System lands and their associated resources directly affected by or within the project vicinity of the Packwood Lake hydroelectric project in the Lake Creek Subwatershed. Amendment 11 is a compilation of the current direction as expressed in the standards and guidelines from the Record of Decision for the Northwest Forest Plan and the Gifford Pinchot National Forest Management Plan (1990).

The Aquatic Conservation Strategy (ACS), a core component of the Northwest Forest Plan, provides management direction aimed at maintaining or restoring the ecological health and functioning of watersheds (defined as HUC 5th field) and the aquatic ecosystems contained within them. Lake Creek drainage area is one subwatershed (defined as a HUC 6th field) of the Upper Cowlitz River Watershed. Specifically, objectives 5, 6 and 9 pertain the most to this Existing Information Analysis. These objectives are stated as follows:

> *Objective 5 – Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.*
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> *Objective 6 – Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.*
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> *Objective 9 – Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.*

The Northwest Forest Plan Standard and Guideline LH-2 states: "During the relicensing of hydroelectric projects, (the Forest Service shall) provide written and timely license conditions to FERC that emphasize in-stream flows and habitat conditions that maintain or restore riparian resources and channel integrity."

The federally managed lands within the Lake Creek Watershed are designated as a Tier 1 Key Watershed. Tier 1 Key Watersheds were selected for directly contributing to anadromous salmonid and bull trout conservation. Key watersheds are highest priority for watershed restoration.

III. Forest Plan Desired Condition

The maintenance of a sediment and flow regime in Lake Creek similar to pre-development is important to meeting the provisions of the Clean Water Act, as well as the Northwest Forest Plan's Aquatic Conservation Strategy.

- Mimic the flow and sediment regimes, which provide for the maintenance and enhancement of channel structure and habitat for aquatic and riparian dependent species.
- Re-establish and maintain the connectivity of the creek and lake system including physical and biological processes so that native aquatic species in the Lake Creek Subwatershed can utilize all available habitats and maximize their productivity levels.

IV. Need for Change

There is a need to change flow releases to Lake Creek so that hydrologic processes that occur during bankfull or peak flow events such as sediment transport and floodplain maintenance occur. Transporting spawning gravels and maintaining floodplain characteristics such as side channels and refuge areas are necessary for the anadromous fish using the lowest reach of Lake Creek.

Project operations release a minimum flow (3 cfs) into Lake Creek below Packwood Lake throughout the year. Survey information is needed on the amount and type of aquatic habitat to be gained if additional flow were released, thereby quantifying the continued effect to Lake Creek from diverting water for power generation.

Increasing the minimum base flow release to Lake Creek would increase habitat for fish, amphibians, benthic invertebrates and other species native to Lake Creek and increase subsurface aquatic habitats where nutrient cycling and aquatic species contribute to the food chain.

Theere is some disruption of large wood transport within Lake Creek because of the dam. Since large wood is limited in Lake Creek below the dam, large wood in lower Lake Creek should be supplemented to provide for sediment storage and facilitate permanent and temporary pockets of gravels.

Packwood Lake is drawn down in October so that the power plant can close down for a month of maintenance. Eliminating or reducing the extent of the lake drawdown would eliminate or lessen the effects to exposed tributaries of Packwood Lake. It would also provide more natural flow rates within lower Lake Creek during a time when anadromous fish spawn. Reducing the extent of the drawdown would facilitate occasional October spill events. October spill events could mimic the occurrence of the natural first flushing events associated with the first rains after the dry summer period and provide additional flows during the anadromous spawning period.

V. USDA Forest Service Interests and Preliminary Objectives

In order to meet Aquatic Conservation Strategy objectives 5, 6, and 9, Forest Service will support actions that strive to re-establish and maintain the connectivity of the river system, including physical and biological processes, so that native aquatic species in the Lake Creek Subwatershed can utilize all available habitats and maximize their productivity. The Forest Service would support efforts to mimic as closely as technically feasible, the flow and sediment regimes, which provide for the maintenance and enhancement of channel structure and habitat for aquatic and riparian dependent species.

Preliminary objectives include:

1) Flow releases retaining patterns of sediment, nutrient and wood routing that will maintain riparian and aquatic habitats. In particular, transporting spawning gravels and maintaining floodplain characteristics, such as side-channels and refuge areas, are important for the anadromous fish using the lowest reach of Lake Creek.

2) Increase base flows of Lake Creek by increasing the minimum flow released to increase aquatic habitat along the entire 5.3 miles of lower Lake Creek.

3) Assess the degree to which reservoir management is affecting the transport of available large wood from the upper portion of Lake Creek Watershed.

4) Assess the quantity of large wood within Lake Creek to ensure large wood structure and function occurs at levels to create desired aquatic habitat.

5) Eliminating the drawdown of the lake prior to power plant maintenance and allowing the lake to spill at the rate of inflow during October would provide flows that mimic natural rates during the spawning period of the anadromous species using the lower reach of Lake Creek. **OR** Reduce the drawdown of the lake prior to power plant maintenance and allow the lake to spill when the lake elevation rises higher than the dam level. October spill events could mimic the occurrence of the natural first flushing events associated with the first rains after the dry summer period and provide additional flows during the anadromous spawning period

VI. Study Requests

Several studies have been conducted to date that describe flow and sediment conditions in the Lake Creek Subwatershed:

- Draft Summary of Packwood Lake Hydroelectric Project Hydrology (Ferc No. 2244) Lake Creek and Upper Cowlitz River. Provides hydrologic information to support the 401 Water Quality Certification – June 2004.
- Analysis of Annual Peak Discharges of Packwood Lake Hydroelectric Project, WY 1912-2003 June 2004.
- Lake Creek Physical Habitat Assessment Survey – June 2004. Purpose: to assess fisheries habitat of Lake Creek.

Additional Studies are necessary for the following information:

1. Determine if the minimum flow release set at 3 cfs is preventing the transport of spawning gravels. Determine what flow level would transport spawning gravels from Reach 4 (RM 3.5-4.9) through the high gradient reaches 2 and 3, to Reach 1, the anadromous habitat reach. Determine what flows would maintain floodplain characteristics such as side channels and refuge areas, especially in the anadromous reaches.
2. Determine the area of available aquatic habitat for different species and life stages at different base flows in Lake Creek.
3. Document existing aquatic habitat characteristics in Lake Creek below the dam including the determination of the level of instream large wood, and assess how operation of the Hydroelectric Plant under the present operational plan would affect stream morphology and aquatic habitat characteristics during the period of the new license.
4. Determine the advantages to anadromous spawning habitat if stream flows reflected natural flow conditions during the month of October.
5. Delineate and characterize existing stream reaches above Packwood Lake drop structure that periodically becomes biologically disconnected due to lowering of the lake level.

VII. References Cited

EES Consulting. 2004. Summary of Packwood Lake Hydrolelectric Project Hydrology. Energy Northwest (ENW) Richland, Washington.

EES Consulting. 2004. Draft Lake Creek Physical Habitat Assessment Survey. Energy Northwest (ENW) Richland, Washington.

USDA Forest Service 1995. Land and Resource Management Plan Gifford Pinchot National Forest.

U.S. Geological Survey 1985. Streamflow and Statistics and Drainage-Basin Characteristics for the Southwestern and Eastern Regions, Washington Volume 1 Southwestern Washington. U.S. Geological Survey Open-File Report 84-145-A.