Revised

Fish Population Characterization Near the Drop Structure Study Plan for Energy Northwest's Packwood Lake Hydroelectric Project FERC No. 2244 Lewis County, Washington

Submitted to

P.O. Box 968
Richland, Washington 99352-0968

Submitted by

1155 North State Street, Suite 700
Bellingham, Washington 98225
360.734.5915 phone, 360.734.5918 fax

August 22, 2005

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

Energy Northwest's Packwood Lake Hydroelectric Project, FERC No. 2244 (Project), received its initial license in 1960. The majority of the Project is located in the Gifford Pinchot National Forest. The Project consists of an intake canal, a concrete drop structure (dam) and intake building on Lake Creek located about 424 feet downstream from the outlet of Packwood Lake, a 21,691-foot system of concrete pipe and tunnels, a 5,621-foot penstock, a surge tank, and powerhouse with a 26,125 kW turbine generator.

The source of water for the Project, Packwood Lake, is a natural lake situated at an elevation of approximately 2,857 feet above mean sea level (MSL), about 1,800 feet above the powerhouse. Water discharged from the Project is released to the Cowlitz River via a tailrace channel. Power from the Project is delivered over an 8,009-foot 69 kV transmission line to the Packwood substation.

During the recreation season, May 1 through September 15, Packwood Lake is maintained at its approximate natural elevation (2,857 feet MSL). During the remainder of the year, the existing FERC license allows lowering the lake level not more than eight feet below the summer lake level down to an elevation of 2,849 feet MSL.

Figure 1-1 is a photograph of the drop structure; Figure 1-2 is a diagram of the drop structure; and Figure 1-3 is a plan view of the stilling basin.

Figure 1-1. Packwood Lake Hydroelectric Project Drop Structure

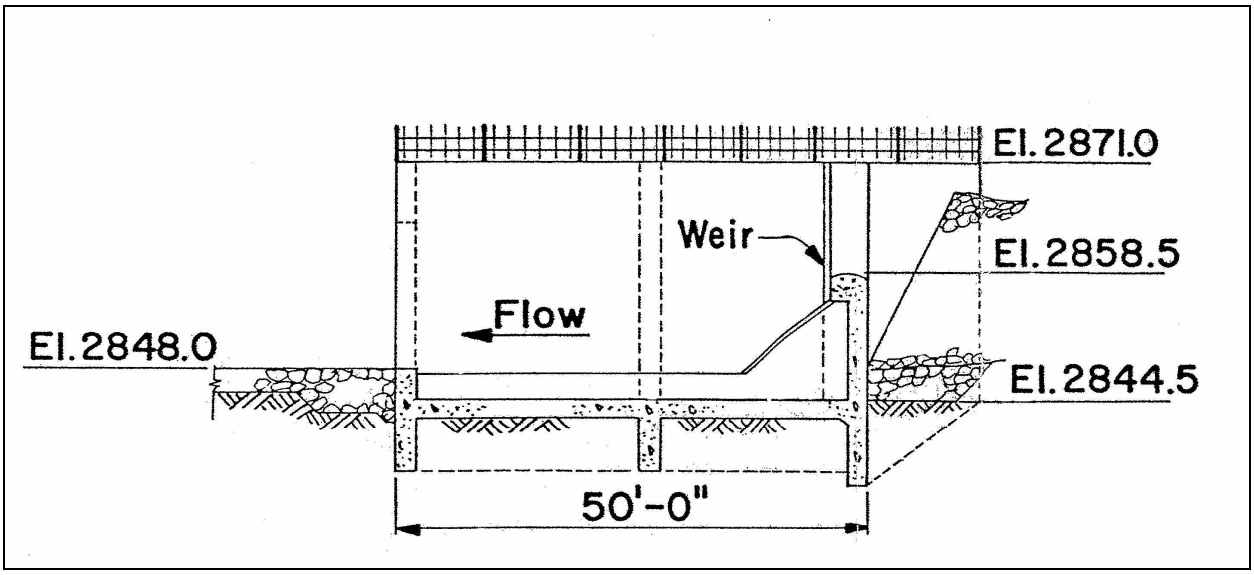

Figure 1-2. Diagram of the Drop Structure

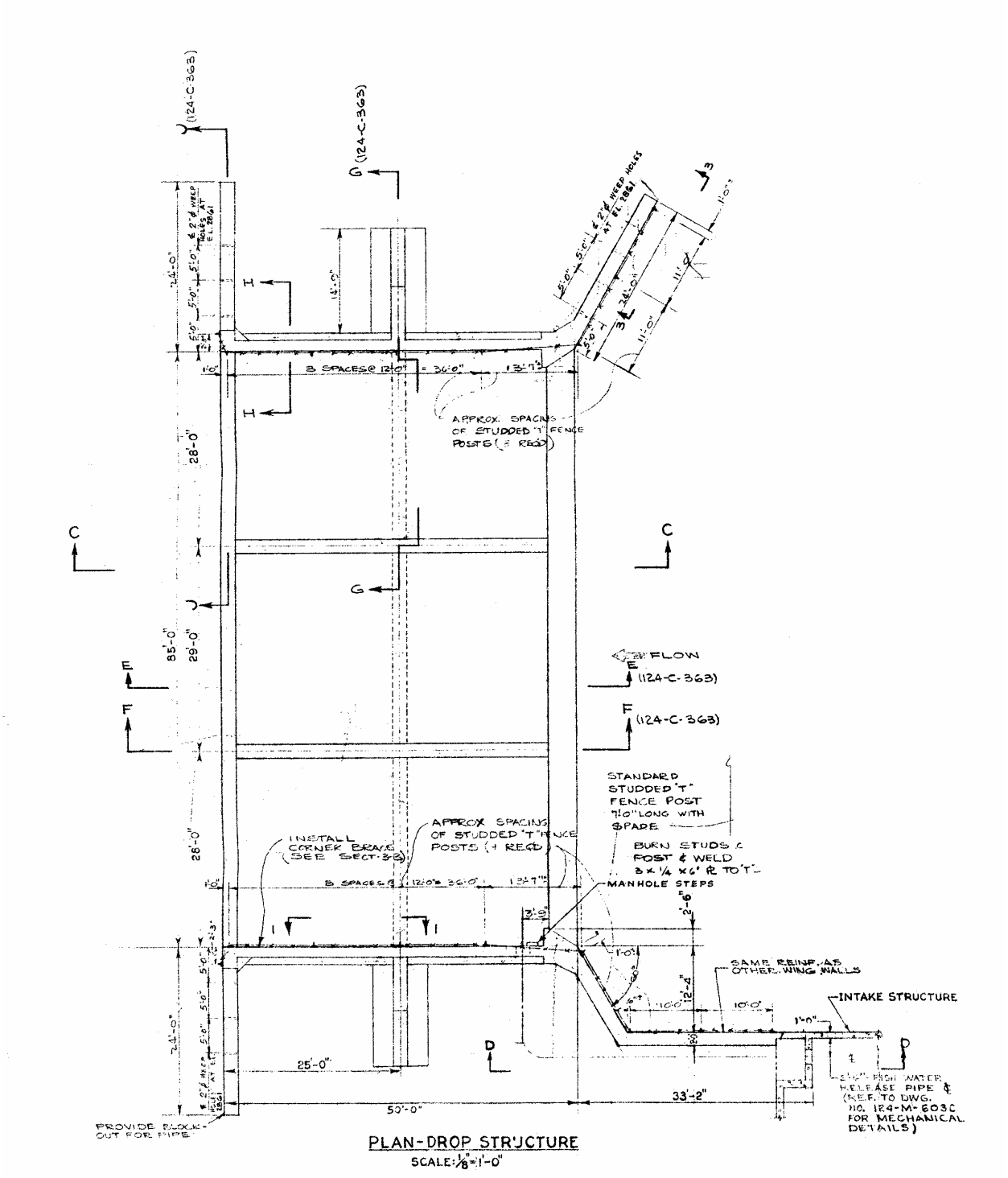

Figure 1-3. Plan View of the Stilling Basin

1.1 Study Plan Goals and Objectives

This study will characterize the abundance, distribution, movement, and structure of the fish communities and available habitat that are potentially impacted by the Packwood Lake Project drop structure.

The objective of the fish population characterization near the drop structure (Fish Characterization) study is to provide the stakeholders with information to assess potential drop structure impacts on fish populations in Project affected waters and make informed decisions on the management of the fish communities.

Specific study goals include the following:

1. Determine the location of the first fish passage barrier waterfall downstream of the drop structure, thereby delineating the isolated reach of Lake Creek. The isolated reach is defined here as the reach from the drop structure downstream to the first barrier waterfall.
2. Determine the amount of suitable spawning and rearing habitat available for rainbow and cutthroat trout and other fish species within the isolated reach.
3. Determine the fish species present within the isolated reach.
4. Determine the population size and age/size structure of all fish species within the isolated reach.
5. Determine upstream migration timing (spawning, foraging, and other movement) of rainbow and cutthroat trout and other fish species within the isolated reach.

2.0 AGENCY AND TRIBE RESOURCE GOALS AND OBJECTIVES

The USDA Forest Service and US Fish and Wildlife Service (USFWS) requested the fish Population Characterization study (USDA Forest Service 2005, USFWS 2005). The resource management goals provided by these agencies in their study requests are listed below.

2.1 Forest Service Resource Management Goals

As stated by the Forest Service, 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 and the aquatic ecosystems contained within them. Objectives pertinent to this study include:

> *Objective 1 – Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.*
>
> *Objective 2 – Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically*

unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.

Objective 3 – Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

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.

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.

Objective 9 – Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

2.2 USFWS Resource Management Goals

The USFWS seeks the accomplishment of several resource goals and objectives through the re-licensing process for the Project.

2.2.1 General goals

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Recover federally proposed and listed species.
3. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.
4. Ensure that once the licensing process is complete, there is an adaptive management plan to allow the use of new information or new management strategies over the term of the license, bringing us closer to the desired level of protection for fish and wildlife resources. The adaptive approach is particularly appropriate where there are insufficient data and/or biological uncertainties about those measures that will be most effective for meeting ecosystem goals and objectives.

2.2.2 Goals for Aquatic Ecosystems

1. Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Maintain and/or restore aquatic habitat connectivity in the watershed to provide movement, migration, and dispersal corridors for salmonids and other aquatic organisms and provide longitudinal connectivity for nutrient cycling processes.

3. Restore naturally reproducing stocks of native anadromous and resident fish to historically accessible riverine habitat, using stocks that are native to the Cowlitz River basin where feasible, with priority given to the restoration of listed native stocks.
4. Provide an instream flow regime that meets the spawning, incubation, rearing, and migration requirements of wild salmonids and other resident fish and amphibian species, throughout the project area.
5. Meet or exceed federal and state regulatory standards and objectives for water quality in the basin.
6. Minimize current and potential negative project operation effects on water quality and downstream fishery resources.

2.2.3 Goals for Endangered, Threatened and Proposed Species

1. Reduce project effects on bald eagles, spotted owls, and other threatened, endangered, and proposed species.
2. Explore opportunities for potential protection, mitigation and enhancement measures for threatened, endangered, and proposed species.
3. If bull trout are discovered within the Cowlitz River basin, gain a better understanding on bull trout population trends, migration, habitat loss, present usage and continuing impacts as related to the Project.

In addition, an overarching USFWS goal for the new licensing of the Project is to succeed in having the Commission include as license conditions, protection, mitigation and enhancement measures that sustain normal ecosystem functional processes including geomorphic, hydrologic and hydraulic patterns, and water chemical and physical parameters. Maintaining and improving these functional processes throughout the term of the new license will, in turn, provide the habitat to support healthy fish and wildlife populations.

The USFWS indicates that its study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop conservation measures, reasonable and prudent measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. § 1531 *et seq.),* the Fish and Wildlife Coordination Act (48 Stat. 401), as amended, (16 U.S.C. § 661 *et seq.),* and the Federal Power Act (FPA) (16 U.S.C. § 791a, *et seq.).*

3.0 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

3.1 Existing Information

In 1993, the Forest Service conducted fisheries and habitat surveys of Lake Creek, dividing Lake Creek into 6 reaches. The upper reach extended from RM 4.9 to RM 5.4. The Forest Service noted 3 falls and 8 chutes in this reach. The uppermost falls is approximately 1200 feet below the drop structure (EES Consulting 2004). Table 3-1 summarizes relative fish abundance by reach per the Forest Service (1993).

Table 3-1. Relative Fish Abundance by Lake Creek Reach

Reach	River Mile From	River Mile To	Species	Adult	Juvenile	Total
1	0.0	0.7	*O. mykiss*	3	1	4
2	0.7	1.3	*O. mykiss*	14	40	54
3	1.3	2.2	*O. mykiss*	16	39	55
4	2.2	3.1	*O. mykiss*	52	116	168
5	3.1	4.9	*O. mykiss*	28	90	118
6	4.9	5.4	*O. mykiss*	18	47	65

Source: USDA Forest Service 1993

As part of the study to develop information to support the water quality certification for the Project, a physical habitat assessment of Lake Creek was conducted during April and May of 2004 (EES Consulting 2004). The assessment was undertaken to collect part of the data needed to complete the instream flow study plan. Data were collected and consolidated, habitat frequencies were calculated, and the creek was segregated into distinct study reaches. Habitat was sampled every 150 feet down the stream channel. Measurements were taken on the wetted channel width, the bank full channel width, depths, and dominant and subdominant substrate. Potential fish passage barriers and chutes were documented and photographed. Lake Creek is a high gradient, stair-step type creek with long series of cascades and plunge pools comprising a majority of the stream habitat.

EES Consulting secured a Scientific Collectors Permit from WDFW in October to conduct electrofishing surveys in Lake Creek below the drop structure and above the confirmed anadromous barrier at RM 2.0. Table 3-2 summarizes results of the electrofishing efforts. Electrofishing was conducted in November and did not include all of the reach above the uppermost barrier.

Table 3-2. Summary of Electrofishing Survey Below the Lake Creek Drop Structure

Date	Species	Length (mm)
18-Nov-04	Rainbow	25
18-Nov-04	Rainbow	75
18-Nov-04	Rainbow	75
18-Nov-04	Rainbow	150
18-Nov-04	Rainbow	150
18-Nov-04	Rainbow	126
18-Nov-04	Rainbow	101
18-Nov-04	Rainbow	101

3.2 Need for Additional Information

Although the physical habitat assessment conducted by EES Consulting (2004) describes general habitat types and identifies potential fish passage barriers, there has not been a thorough determination of the uppermost fish passage barrier waterfall. It is necessary to identify the

uppermost fish passage barrier in order to delineate the reach of Lake Creek that is isolated between the barrier waterfall and the drop structure. Any fish present within the isolated reach cannot move upstream of the drop structure, and there is only potential for downstream movement out of the isolated reach. Currently, any recruitment of fish from Packwood Lake into the isolated reach is dependant on spill events. In addition, the existing habitat assessment did not quantify the amount of spawning and rearing habitat available to fish species present within the isolated reach. This information is important to assess the potential viability of fish populations present within the isolated reach.

Because there is no current data on species using Lake Creek, Energy Northwest conducted a fish survey throughout Lake Creek in 2004. Rainbow trout were observed throughout Lake Creek. Although some fish surveys have been conducted in Lake Creek, they mainly have focused on presence/absence of salmonids. There remains a need to identify all species present within the isolated reach to get a better understanding of all species that may be impacted by the Project. In addition, the existing data does not provide an estimate of the population size of rainbow and cutthroat trout in the isolated reach, and does not determine age/size classes of these two populations and other fish species. No determination of upstream migration, foraging, or other timing has been made. This information is important in order to determine the extent of effects on fish species, if present.

4.0 NEXUS BETWEEN PROJECT OPERATIONS AND EFFECTS ON RESOURCES

Prior to construction of the drop structure, there was no permanent barrier to fish movement either upstream from Lake Creek into Packwood Lake or downstream from Packwood Lake to Lake Creek at that site. Low flow conditions may have restricted fish access between Packwood Lake and Lake Creek during certain times of the year. The presence of a log jam at the Lake outlet most likely did not pose a total barrier to fish passage. In general, log jams have numerous water routes over, around, and through, that allow fish to migrate past. In addition, log jams are constantly changing, with wood lost and new wood added during high flow events.

Energy Northwest recognizes that the drop structure is a barrier to fish migration, with the exception of when high flows spill over the top of the drop structure and fish may pass downstream. The Packwood Lake Project began operation of the drop structure in 1964 in order to divert flow from Packwood Lake into a pipeline and the powerhouse. The drop structure currently has a bypass pipe that allows water to flow from Packwood Lake into Lake Creek. However, the inlet of the bypass pipe is located on the downstream side of the intake debris/fish screen, therefore no fish currently can pass downstream of the drop structure except possibly during spill events. Spill events have occurred on a sporadic basis when lake elevations exceed 2,858.5 ft. There is no upstream fish passage at the drop structure.

Results from this study would quantify the population size, age/size, migration timing, and available suitable habitat to fish species present in the isolated reach downstream of the drop structure. These fish currently are unable to migrate up into Packwood Lake for potential foraging, rearing, or lake tributary spawning.

5.0 STUDY AREA AND METHODS

5.1 Study Area

The study area will be that portion of Lake Creek above the uppermost natural barrier to resident fish and the drop structure at RM 5.4. Physical habitat surveys conducted by EES Consulting in 2004 (EES Consulting 2004) indicated that the barrier is approximately 1,200 feet below the drop structure.

5.2 Methodology

5.2.1 Analysis of Upstream Barrier

The protocol entitled, "Analysis of barriers to upstream fish migration. An investigation of the physical and biological conditions affecting fish passage success at culverts and waterfalls" (Powers and Orsborn 1985), will be utilized to determine the location of the first barrier waterfall downstream of the drop structure. EES Consulting (2005) has recently used this protocol on a potential fish passage barrier waterfall at river mile 1.03 on Lake Creek. This protocol will be modified to exclude the Fish Condition Factor based on the recommendation of Pat Powers and his use of the protocol over the past 20 years (Powers, 2005). The barrier evaluation would start immediately downstream of the drop structure and work downstream. The first potential fish passage barrier waterfall encountered would be evaluated. If this waterfall is determined not to be a barrier, the evaluation will continue downstream. The evaluation would end at the first waterfall determined to be a passage barrier. Rainbow and cutthroat trout, along with other fish species present within the reach would be assessed.

It is important to note that Powers and Orsborn (1985) identify swimming speeds and leaping abilities for anadromous fish; however, this report does not address the leaping ability of resident rainbow and cutthroat trout. Bell (1991) lists swimming speeds for cutthroat trout, but not for rainbow trout. Energy Northwest proposes using the cutthroat trout cruising, sustained and darting speeds for both rainbow and cutthroat trout. A leaping curve for these two species will be developed per methods described in Powers and Orsborn (1985). As an alternative to creating the leaping curve, EES Consulting has in the past used as criteria for resident salmonids a barrier height of 4 feet and suggests that a vertical falls in this range be considered a barrier for these species. Fish of this size were observed by EES Consulting leaping unsuccessfully at the falls/chute complex at RM 1.03 at released flows of 3 cfs, 16 cfs, and 34 cfs. Maximum vertical leap of these fish into the falls did not exceed 1.5 feet. The leaping curves based upon Bell will need to be modified and Powers and Orsborn's equation used to calculate leaping ability, or 4 feet will be used as the barrier height.

5.2.2 Quantification of Rearing and Spawning Habitat

WDFW's "Fish Passage Barrier Assessment and Prioritization Manual" of the Technical Applications Division (TAPPS 2000) will be used to quantify spawning and rearing habitat. This protocol is widely accepted throughout Washington, and many local, state, and federal agencies and other groups have used, or are currently utilizing, the protocol. The protocol

provides a standard method of data collection across the state and a means to prioritize fish passage barriers. The Priority Index Model portion of this protocol would be used in this study.

Although this protocol is usually used to assess manmade fish blockages, it is appropriate to use the Priority Index Model portion upstream of a natural fish passage barrier. The physical habitat assessment quantifies the amount of spawning and rearing habitat available to each salmonid species present or presumed to occur at the site.

The model generates a priority index (PI) rating that is based on species utilization and habitat gain. The habitat gain is determined by measuring gradient, stream-wetted and ordinary high-water widths, substrate composition, riffle-to-pool-to-rapid ratios, juvenile abundance, canopy cover, instream cover, flow, temperature, and spring water influence. In order to identify the productive capability of the stream for the PI Model, Habitat Quality Modifiers (HQM) are assigned to each reach within the survey area (Table 5-1). The HQM rating is used as a multiplier of the habitat area to obtain H in the PI model (H = habitat quality modifier x habitat in square meters).

The production potential of the stream is determined as square meters available for spawning and rearing habitat. The full physical survey methodology will be utilized, as this provides the most reliable information about the habitat upstream of the barrier.

Habitat will be measured on 30 m sections of 160 m sections if the total stream length is less than 1.6 km. However, habitat measurements will be completed on 60 m sections of 320 m sections if the total stream length is greater than 1.6 km. It is not necessary for the purpose of this study to perform an assessment of the downstream channel to determine if there are any fish passage barriers present. A hip chain will be used to measure the total distance while walking upstream. Stream gradient will be determined by the use of a laser level.

Table 5-1. Criteria Used to Assign Habitat Quality Modifiers (HQM) to Rearing and Spawning Habitat

Habitat Condition	HQM Value	Rearing Habitat Criteria	Spawning Habitat Criteria
Good to Excellent	1	Rearing habitat is stable and in a normal productive state with all components functional	Spawning gravel patches have ≤ 16% fine particle sizes that are < 0.85mm in diameter
Fair	2/3	Rearing habitat shows moderate/widespread signs of instability and/or disturbance known to reduce productive capability (one or more habitat components missing or significantly reduced presence)	Spawning gravel patches/riffles show moderate/widespread signs of instability (scour/filling) and/or > 16% and ≤ 21% fine particle sizes < 0.85mm in diameter
Poor	1/3	Rearing habitat shows signs of major/widespread disturbance likely to cause major reductions in its production capabilities (two or more habitat components missing or severely reduced presence)	Spawning gravel patches/riffles show major/widespread signs of instability (scour/filling) and/or > 21% and ≤ 26% fine particle sizes < 0.85mm in diameter
No Value	0	Rearing habitat severely disturbed so that production capabilities are without value to salmonids at this Time	Spawning gravel patches with > 26% fine particle sizes < 0.85mm in diameter
Sources: USFWS 2005 and USDA Forest Service 2005			

5.2.3 Fisheries Investigations

Electrofishing will generally be conducted following procedures identified by Reynolds (1996), which are commonly employed by fisheries biologists. Electrofishing will be performed during non-spill periods to ensure the safety of the field crew.

The entire isolated reach will be electrofished once during August and once during October 2006. Stream sections will be isolated by using block nets. The field crew will leap-frog the block nets while moving upstream through the isolated reach.

The following information will be recorded:

1. stream section captured
2. species
3. fork length (mm)
4. weight (gm)
5. Note of visible deformities or injuries, and eggs or milt present.

The multiple pass removal method will be utilized to calculate abundance estimates. In addition, scales from a representative sample of the fish collected will be selected and analyzed to determine ages of the fish. All fish will be returned to the reach they were captured in, downstream of the block net.

In addition to other data analysis, a graph, by species, will be included depicting weight and fork length. These graphs, along with scale analysis, will aid in the determination of age/year classes for the various fish species present.

5.2.4 Determination of upstream migration timing (spawning, foraging, and other movement) of rainbow and cutthroat trout and other fish species within the isolated reach

In order to determine the upstream migration timing of rainbow, cutthroat, and other fish species within the isolated reach, the stilling basin area between the concrete sill and the drop structure will be netted one day per month for one year and seined twice during May and June. It may not be feasible to net the stilling basin during the winter due to snow cover. Netting generally will be conducted following procedures identified by Hayes et al (1996) and Hubert (1996), which are routinely employed by fisheries biologists. Seining dates should be at least 5 days apart, dependent on flow conditions. A block net will be set at the downstream end of the stilling basin prior to seine or gill netting. All captured fish will be released immediately downstream of the block net in suitable resting habitat. Data will be collected consistent with that noted in Section 5.2.3. If seining proves infeasible, gillnets will be deployed in the stilling basin.

If a gillnet is used to sample the stilling basin, the net will be monitored periodically during the six-hour period each day that it will be set. If mortality is noted, the net will be checked at least hourly to ensure that all fish are removed in a safe and timely manner.

5.2.5. Fish Presence Information in the Vicinity Upstream of the Drop Structure

A separate entrainment study is being conducted for the Project. Please see Entrainment Study Plan.

5.2.6 Literature Review of Potential Injury to Fish Below the Drop Stucture During Spills

A literature review will be conducted to determine the potential for injury or mortality to those fish that could pass over the drop structure during spill events. This information will be compared with the physical characteristics of the drop structure, depth of pools, distance of fall, etc. to determine the potential for injury if fish were to be swept over the drop structure during a spill event.

5.3 Products

The products of the Fish Population Characterization Near the Drop Structure Study will be draft and final reports discussing the results of the barrier, habitat analysis, fish population and migration surveys. Preliminary data collected will be reviewed periodically by the agencies to determine if modifications to the study design are necessary. Draft and final study results will be provided to the agencies and tribes for review and comment.

5.4 Consistency with Generally Accepted Scientific Practice

The survey protocol proposed by Energy Northwest is essentially the same as specified by the USDA Forest Service and the USFWS in their requests. Justification of the study protocols is provided in Section 5.2 for each study proposed.

6.0 CONSULTATION WITH AGENCIES, TRIBES AND OTHER STAKEHOLDERS

Energy Northwest initiated agency consultation in December 2003. A Water Quality and Aquatic Resources Committee was formed in March 2004. Representatives include Energy Northwest, EES Consulting, WDFW, USFWS, NOAA Fisheries, Department of Ecology, the Forest Service, the Cowlitz tribe, and the Yakama Nation. The integrated licensing process plan provides for numerous meetings with stakeholders to discuss, revise and finalize the proposed study plans. Updates will be provided and draft and final reports will be provided to the agencies and tribes for review and comment.

7.0 PROGRESS REPORTS, INFORMATION SHARING, AND TECHNICAL REVIEW

Technical reports, including the draft and final Fish Population Characterization Near the Drop Structure Study reports will be shared with agencies, tribes and stakeholders and will discuss the progress of the studies. Energy Northwest and its consultant will also report on the methods, progress, and results of the study at Water Quality and Aquatic Resources Committee meetings.

Energy Northwest will provide copies of the report to interested stakeholders for review. Review periods will be 30 days, after which Energy Northwest and its consultant will take review comments into consideration when making revisions and producing a final report.

8.0 SCHEDULE

Data collection efforts will be initiated in 2006 after the necessary permits are secured. Tentatively, electrofishing will be conducted in August and October. The study will continue through 2006 and 2007. Seining of the stilling basin will continue for one year once permits are secured. The first year draft report will be completed and distributed to the agencies and tribes by November 15, 2006. A final report, following the completion of the seining, will be distributed to the agencies and tribes that incorporates the draft comments.

9.0 LEVEL OF EFFORT AND COST

This study will require use of electroshockers, seine and/or gill nets, dip nets, measuring boards, scale, hip chain, measuring tape, laser level, buckets, and other equipment. The electrofishing crew will consist of one backpack shocker and three net/bucket persons. The netting crew will consist of three net/bucket persons. The fish passage barrier and Priority Index assessments will consist of two person crews. Table 9-1 summarizes levels of effort for the Fish Characterization Study.

Table 9-1. Level of Effort		
Activity	**No. Staff**	**Days**
Electrofishing Entire Reach	4	4
Netting Drop Structure	3	14
Fish Passage Assessment	2	1
Priority Index Assessment	2	2.5
Draft Report/Data Analysis	2	1.5
Final Report	3	1.25

Additional costs include equipment purchase and rental, mileage, travel and per diem costs. Ten-hour days are assumed for field work. When possible, other activities will be scheduled concurrent with this study to maximize efficiency. For example, work on the entrainment study or fisheries activities associated with the lake will be scheduled simultaneously with the upstream migration seining when feasible. Travel costs are reduced to reflect this assumed combination of field effort.

Total estimated costs for this study are $51,242.

10.0 LITERATURE CITED

Bell, M.C. 1991. Fisheries handbook of engineering requirements and biological criteria. Fish Passage Development and Evaluation Program. Corps of Engineers, North Pacific Division, Portland, Oregon.

EES Consulting. 2004. Draft Lake Creek Physical Habitat Survey Preliminary Report. June, 2004.

EES Consulting. 2005. Lake Creek Anadromous Barrier Analysis. Preliminary Draft. March, 2005.

Energy Northwest. 2004. Packwood Lake Hydroelectric Project. FERC Project No. 2244. Pre-Application Document. Supplement No. 1. December 6, 2004.

Hayes, D.B., C.P. Ferreri, and W.W. Taylor. 1996. Active Fish Capture Methods. Pages 193-220 in B.R. Murphy and D.W. Willis, editors. Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Hubert, W.A. 1996. Passive Capture Techniques. Pages 157-192 in B.R. Murphy and D.W. Willis, editors. Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Powers, P.D. and J.F. Orsborn. 1985. Analysis of barriers to upstream fish migration. An investigation of the physical and biological conditions affecting fish passage success at culverts and waterfalls. Part 4 of 4. Bonneville Power Administration. Contract DE-A179-82BP36523. Project 82-14.

Powers, P.D. 2005. Personal communication with WDFW staff.

Reynolds, J.B. 1996. Electrofishing. Pages 221-253 in B.R. Murphy and D.W. Willis, editors. Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Technical Applications Division (TAPPS). 2000. Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual. Washington Department of Fish and Wildlife Habitat Program, Environmental Restoration Division.

USDA Forest Service. 1993. Lower Lake Creek R-6 Stream Survey Level II. Gifford Pinchot National Forest, Randle/Packwood Ranger Districts.

USDA Forest Service. 2005. Letter dated March 11, 2005 from Claire Lavendal to Magalie R. Salas, Comments on PAD and Scoping Document 1 and Study Requests Packwood Lake Project No. 2244-012.

US Fish and Wildlife Service (USFWS). 2005. Letter dated March 11, 2005 from Ken S. Berg to Magalie R. Salas, U.S. Fish and Wildlife Service Comments on the Pre-Application Document, Scoping Document 1, and Study Requests for the Packwood Lake Hydroelectric Project, Federal Regulatory Commission Project # P-2244-012.