Revised Study Plan
Boundary Hydroelectric Project (FERC No. 2144)

Study No. 9
Fish Distribution, Timing and Abundance Study

Seattle City Light

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Study No. 9 – Fish Distribution, Timing and Abundance Study

1.0 INTRODUCTION

Fishery resources in the Boundary Project (Project) area consist of native and introduced salmonids, native non-game species, and introduced warmwater sport fish. During summer months, the water temperature of the Pend Oreille River upstream of Boundary Dam (i.e., Boundary Reservoir) is at the upper limit for trout, which means that trout may congregate in coldwater refugia such as the mouth of tributary streams during warm summer months. When the weather turns cold, native salmonids may distribute throughout the reservoir, but little information is available on fish distribution in Boundary Reservoir during the late fall, winter and early spring. Boundary Reservoir supports bass and other warmwater sport fish, and it is unclear how those species interact with native salmonids. Bass typically spawn and rear in shallow littoral habitats, so understanding seasonal habitat use of the variety of fish and other aquatic biota inhabiting Boundary Reservoir will be important to evaluating the effects of Project operations.

Bull trout is a native salmonid that has rarely been observed in Boundary Reservoir or its tributaries; however, the species is listed as threatened under the Endangered Species Act (ESA), and the potential recovery of bull trout is a major concern of relicensing participants. Westslope cutthroat trout is another native salmonid that, although not currently listed under the ESA, is a concern of relicensing participants.

The physical habitat modeling efforts proposed in Attachment 2, Study Nos. 7 and 8 of this RSP require information on the distribution and periodicity of different life stages for the fish species of interest. Not all life stages of the target fish species may be present in Boundary Reservoir. For example, bull trout and cutthroat trout spawn in streams and rivers, but are not known to spawn in Boundary Reservoir. Mountain whitefish are known to spawn along shorelines and gravel bars in large river/reservoir systems, but whitefish spawning has not been documented for Boundary Reservoir.

This study is designed to provide baseline biological information and supporting information for the Mainstem Aquatic Habitat Modeling Study (see Study No. 7). This study will obtain key life history information about the fish in Boundary Reservoir using two sampling approaches. The first sampling approach uses active and passive capture methods to identify the seasonal timing, distribution and abundance of fish at a variety of locations in Boundary Reservoir and downstream of Boundary Dam. The second sampling approach uses biotelemetry to monitor the movements and habitat utilization of tagged fish.

2.0 STUDY PLAN ELEMENTS

2.1. Nexus Between Project Operations and Effects on Resources

Boundary Project load-following operations described in the Mainstem Aquatic Habitat Modeling Study plan (Study No. 7), affect water depths and velocities in Boundary Reservoir

and the Project tailrace (Boundary Tailrace Reach), and affect the frequency of inundation and dewatering of the littoral zone. These changes to aquatic habitats can affect the growth and reproduction of fish and other aquatic organisms. An understanding of the timing, distribution and abundance of native and non-native fish species that inhabit Boundary Reservoir and the Boundary Tailrace Reach is needed to support an evaluation of the effects of existing operations and alternative operational scenarios. Biological information such as seasonal movements of native salmonids and the magnitude and periodicity of adfluvial and riverine fish migrations can aid discussions regarding the feasibility and need for habitat connectivity for native salmonids at the Boundary Project.

2.2. Agency Resource Management Goals

A description of relevant agency management goals is provided in the Mainstem Aquatic Habitat Modeling Study (see Study No. 7, section 2.2).

2.3. Study Goals and Objectives

The goal of this study is to fill data gaps in the existing information regarding the abundance, distribution, and periodicity of fish in Boundary Reservoir and to provide additional information to aid discussions regarding the feasibility and need for habitat connectivity for native salmonids at the Boundary Project. The objectives of this study are as follows:

1) Determine seasonal changes in the distribution and relative abundance of native salmonids, non-native salmonids and non-salmonids, particularly important sport fish species, in Boundary Reservoir.
2) Determine seasonal changes in the distribution and relative abundance of native salmonids and the magnitude and periodicity of upstream and downstream adfluvial fish migration behavior in selected tributaries to Boundary Reservoir;
3) Determine seasonal changes in the distribution and relative abundance of native salmonids in the Tailrace Reach.
4) Identify movements of target fish species (i.e., bull trout, westslope cutthroat trout, and mountain whitefish) in Boundary Reservoir and the Boundary Tailrace Reach.
5) Evaluate the effects of Boundary Project operations on hourly, daily and seasonal native salmonid movements in the Boundary Reservoir and the Boundary Tailrace Reach.
6) Obtain information on habitat-use characteristics of target fish species to support validation of Habitat Suitability Indices using site-specific data (see HSI-fish component of the Mainstem Aquatic Habitat Modeling Study, Study No. 7).
7) Collect tissue samples to identify the genetic signature of any bull trout or cutthroat trout captured in Boundary reservoir or tailrace.

2.4. Need for Study

Summary of Existing Information

A primary source of recent information on the general distribution and abundance of fish and other aquatic biota in Boundary Reservoir are surveys conducted by the Washington Department of Fish and Wildlife (WDFW) in 2000 (McLellan 2001). The electrofishing and gill net sampling surveys were conducted seasonally (spring, summer, and fall) throughout the reservoir. Based upon these sampling efforts, McLellan (2001) observed that Boundary Reservoir is dominated by non-salmonids. Northern pikeminnow and largescale sucker were the most abundant species, making up 33.4 percent and 26.8 percent of the total catch, respectively (Table 2.4-1). Salmonids represented 3.4 percent of the total catch, and the majority of salmonids in the catch were mountain whitefish (67 percent). No bull trout or white sturgeon were captured during the WDFW surveys. Supplemental sampling designed to evaluate whether white sturgeon inhabit Boundary Reservoir was conducted in 2005; Howell and McLellan (2006) conducted set line fishing but did not capture any sturgeon in Boundary Reservoir. McLellan (2001) concluded that most fish in Boundary Reservoir used the littoral zone, while few fish used the deep water zone.

Table 2.4-1. Species composition in Boundary Reservoir during 2000 from surveys conducted during spring, summer, and fall. Source: McLellan (2001).

Species	Species Composition				Size Range (TL in mm)	
	by Number		by Weight			
	(n)	(%n)	(kg)	(%W)	Min	Max
Black crappie *(Pomoxis nigromaculatus)*	6	0.3	0.7	0.2	135	218
Brown bullhead *(Ictalurus melas)*	21	1.2	5.7	1.4	231	292
Brown trout *(Salmo trutta)*	6	0.3	3.0	0.7	271	452
Burbot *(Lota lota)*	4	0.2	0.7	0.2	241	431
Cutthroat trout *(Oncorhynchus clarki)*	2	0.1	0.5	0.1	312	375
Lake trout *(Salvelinus namaycush)*	2	0.1	1.0	0.2	318	474
Largemouth bass *(Micropterus dolomieui)*	8	0.4	3.4	0.8	81	432
Largescale sucker *(Catostomus macrocheilus)*	489	26.8	185.5	44.6	32	552
Longnose sucker *(Catostomus catostomus)*	31	1.7	12.8	3.1	68	434
Mountain whitefish *(Prosopium williamsoni)*	42	2.3	9.3	2.2	91	411
Northern pikeminnow *(Ptychocheilus oregonenesis)*	609	33.4	118.4	28.5	50	550
Peamouth *(Mylocheilus caurinus)*	126	6.9	20.5	4.9	70	357
Pumpkinseed *(Lepomis gibbossus)*	5	0.3	0.3	0.1	110	167
Rainbow trout *(Oncorhynchus mykiss)*	11	0.6	4.3	1.0	182	480
Redside shiner *(Richardsonius balteatus)*	197	10.8	3.6	0.9	43	180
Smallmouth bass *(Micropterus dolomieui)*	131	7.2	15.7	3.8	55	402
Tench *(Tinca tinca)*	29	1.6	22.3	5.4	145	460
Yellow perch *(Perca flavescens)*	103	5.7	8.1	1.9	52	252

McLellan (2001, Appendix E) reported the results of their surveys by species, season, and reservoir section, but no discussion of spatial (by section) or temporal distribution patterns was included in the body of the report. Analysis of the data tables in the appendices to the McLellan (2001) report suggest that catch rates were generally higher in the summer and fall relative to the spring surveys. Electrofishing surveys generally had higher capture rates in the Upper Reservoir compared to the Canyon and Forebay Reaches (Figure 1.0-1 in Study Plan 7), while horizontal gill net catch rates were variable with no strong patterns discernable among the different sections. McLellan (2001) reported that high flows occurred during the spring surveys. Seasonal differences in catch per unit effort may have been the result of spring high flows or fish activity levels, which may have affected capture efficiency rather than actual changes in fish abundance or distribution. Apparent spatial differences in capture rates for electrofishing surveys may have occurred because the Upper Reservoir Reach (upstream of Metaline Falls) is relatively shallow and is likely to result in higher electrofishing efficiency compared to the deeper Canyon Reach and Forebay Reach (Boundary Dam to the downstream end of the Canyon Reach). Overall, the available information from McLellan (2001) provides an indication of spatial and temporal patterns of reservoir use by the fish community, but represents only one year of sampling effort.

In recent years, declines in native resident salmonid populations, such as bull trout and westslope cutthroat trout have placed increased emphasis on these species. Available information specific to the distribution and abundance of native salmonids (Andonaegui 2003; USFS 2006a; R2 Resource Consultants, Inc. 1998; Terrapin Environmental 2000; Cascades Environmental Services 1996; McLellan 2001; TERA Corporation 1982) suggests that bull trout are rare in Boundary Reservoir and are rare or not present in accessible tributaries. Adfluvial fish habitat within tributaries to Boundary Reservoir is limited due to natural upstream migration barriers, small stream size, and poor habitat quality (SCL 2006a). Since the early 1980s, documented observations of ten bull trout have occurred in Boundary Reservoir or its tributaries. One gutted bull trout carcass was observed in Sullivan Creek (McLellan 2001), indicating it had been captured by an angler, but it is unknown if the fish was captured in Sullivan Creek or discarded there by the angler. Three bull trout have been captured in Boundary Reservoir near the mouth of Slate Creek, but have not been observed within the creek (R2 Resource Consultants, Inc. 1998; Andonaegui 2003). Three individual bull trout have been captured within or near the mouth of Sweet Creek (Andonaegui 2003). Gill net and electrofishing sampling throughout Boundary Reservoir during the spring, summer, and fall 2000 failed to capture any bull trout (McLellan 2001).

Cutthroat trout and mountain whitefish have been more frequently observed in Boundary Reservoir and its tributaries compared to bull trout. During the WDFW nighttime surveys (McLellan 2001), mountain whitefish (42 fish) and cutthroat trout (2 fish) represented about 2.4 percent of the 1,822 fish captured in Boundary Reservoir during their gill net and electrofishing surveys. Recreational anglers surveyed by R2 Resource Consultants, Inc. (1998) captured 3 cutthroat trout and 3 mountain whitefish out of a total catch of 455 fish during 1997. Most of the mountain whitefish were captured in the Upper Reservoir Reach and a few were captured in the Canyon Reach. No mountain whitefish were captured in the Forebay Reach. Cutthroat trout are known to be present in Pewee Creek, Slate Creek, Threemile Creek, Sullivan Creek, Sweet

Creek, Sand Creek, and Lost Creek. Mountain whitefish are known to be present in Sweet Creek and Sullivan Creek (McLellan 2001, USFS 2006a).

During 1994 and 1995, fisheries studies were conducted on behalf of British Columbia Hydro (BC Hydro) in anticipation of expanding the capacity of the Seven Mile Project. Between summer 1999 and spring 2000, additional fisheries studies were funded by Seattle City Light (SCL). The fisheries studies during 1999 and 2000 in Seven Mile Reservoir utilized a variety of capture methods including boat electrofishing (depths less than 13.1 feet), backpack electrofishing (depths less than 4.9 feet), setlines, beach seines, and Gee (minnow) traps. The boat electrofishing captured nearly 96 percent of all fish collected (17,809 fish). Investigators were particularly interested in determining if white sturgeon and bull trout were present within Seven Mile Reservoir. Set lines targeting sturgeon were fished a total of 21,618 hook-hours (one hook fished for one hour is one hook-hour) during the 1994/1995 and 1999/2000 studies, but no sturgeon were captured. R.L. & L. and Taylor Associates (2001) concluded that currently no white sturgeon utilize Seven Mile Reservoir. Four bull trout were captured during the 1994 surveys and two bull trout were captured during the 1999/2000 surveys in lower Seven Mile Reservoir.

Snorkel surveys, spawning surveys, and radio telemetry studies in the Salmo River have confirmed five areas with bull trout spawning, and the Salmo River spawning population of bull trout has been estimated at approximately 200 individuals (Baxter 1999). Baxter (1999) concluded that the Salmo River bull trout population exhibits a fluvial life history pattern. That is, bull trout spawn in the Salmo River and its tributaries, remain in the river, and rarely migrate into Seven Mile Reservoir. Baxter (1999) based this conclusion primarily on the size of bull trout observed during snorkel and spawning surveys and the behavior of radio-tracked bull trout, none of which were observed to move into Seven Mile Reservoir. BC Hydro is planning to conduct a biotelemetry study to evaluate potential adfluvial bull trout movements in the Salmo River and Seven Mile Reservoir in 2007.

The upper section of Seven Mile Reservoir, between Boundary Dam and the Salmo River confluence, is shallower and narrower than the lower section of the reservoir (R.L. & L. and Taylor Associates 2001). The greatest depth measured at a water quality sampling site just north of the U.S.-Canada border was approximately 19.7 feet. Mean daily water temperatures measured at this site from August 19, 1999, to June 19, 2000, ranged from 33.8°F (1.0°C) to 75.0°F (23.9°C).

Redside shiners, largescale and longnose suckers, northern pikeminnow, and peamouth dominate the fish community in the upper Seven Mile Reservoir. Sport fish are a minor component to the fish community. The major difference between the lower Seven Mile Reservoir and the upper Seven Mile Reservoir was the relatively low abundance of smallmouth bass and the relatively high abundance of mountain whitefish in the upper section. During 1999/2000, R.L. & L. and Taylor Associates (2001), conducted beach seine and backpack electrofishing adjacent to the island located across and slightly downstream from the Boundary tailrace boat ramp. No fish were captured by beach seine (five hauls total during fall, winter, and spring) while 6 largescale suckers were captured by electrofishing (average area fished was 2,839 ft^2 during spring,

summer, fall, winter). No bull trout were captured anywhere in the upper section during sampling conducted in 1999/2000 (R.L. & L. and Taylor Associates 2001).

In addition to bull trout observed in the Salmo River, bull trout have been observed in three of the smaller tributaries to Seven Mile Reservoir: Nine Mile Creek (5 fish), Harcourt Creek (1 fish), Lomond Creek (1 fish), and Tillicum Creek (R.L. &. L. and Taylor Associates 2001; R.L. & L. 1999; Andonaegui 2003). R.L. & L. and Taylor Associates (2001) assessed the habitat conditions in the lower 328 to 984 feet of eight tributaries draining to Seven Mile Reservoir. Five of these tributaries, including Harcourt Creek, had impassable barriers (4 with natural barriers, 1 with a culvert barrier) within 328 feet of their confluence with the reservoir. Tributaries without impassable barriers in their lower reaches included Nine Mile Creek (3.5 miles long), Russian Creek (1.0 mile long) and Lomond Creek (4.7 miles long). Although no bull trout were captured in Tillicum Creek during the surveys by R.L. & L. and Taylor Associates (2001) and R.L. & L. (1999), Andonaegui (2003) cited information indicating that bull trout had been observed in the creek during the early 1980s by the USFS. An impassable culvert barrier in lower Tillicum Creek was identified by R.L. & L. and Taylor Associates (2001).

Need for Additional Information

Site-specific knowledge of the distribution, timing and abundance of fish in Boundary Reservoir primarily depends on the results of surveys conducted by WDFW during the spring, summer and fall of 2000 using multiple sampling methods (McLellan 2001). Collection efforts specific to bull trout have observed few bull trout or other cutthroat trout (R2 Resource Consultants, Inc. 1998; Terrapin Environmental 2000), but some uncertainty exists regarding potential seasonal movements. Additional surveys will supplement and help to verify assumptions drawn from the previous surveys concerning the distribution and relative abundance of fish in Boundary Reservoir and the Tailrace Reach. Additional surveys are needed to verify assumptions regarding temporal and spatial patterns of fish use, particularly juvenile fish that could be vulnerable to stranding. This study is intended to fill gaps in information needed to support discussions regarding Boundary Project operations and issues of habitat connectivity (see Study No. 12).

In addition to collecting baseline fish and aquatic information, aspects of this study are designed to complement and support other fish and aquatic studies as follows:

- Mainstem Aquatic Habitat Modeling Study (Study No. 7) — Fish collected during electrofishing and biotelemetry will provide information to validate literature-based habitat suitability index (HSI) curves.
- Sediment Transport and Tributary Delta Habitats (Study No. 8) — Gill net, angling, electrofishing and fyke nets will provide data on fish use of tributary delta habitats.
- Fish Entrainment and Connectivity (Study No. 12) — Deployment of gill nets in the Forebay Reach, especially if gill nets are placed immediately in front of the spillway during springtime periods without active spilling, may provide information on the size and species of fish potentially entrained during spill conditions.

2.5. Detailed Description of Study

Study Area

The study area encompasses all of Boundary Reservoir from Box Canyon Dam downstream to the tailrace of Boundary Dam and a portion of upper Seven Mile Reservoir that could potentially be affected by Boundary Project operations. The study area is divided into four reaches (Study No. 7, Figure 1.0-1):

- Upper Reservoir Reach — Box Canyon Dam downstream to Metaline Falls (RM 34.5 to RM 26.8)
- Canyon Reach — Metaline Falls to downstream end of Z-Canyon (RM 26.8 to RM 19.4)
- Forebay Reach — downstream end of Z-Canyon to Boundary Dam (RM 19.4 to RM 17.0)
- Tailrace Reach — Boundary Dam to Red Bird Creek, British Columbia (RM 17.0 to RM 13.1)

During early 2007, SCL and the Technical Consultant will investigate the potential issues and legal requirements for conducting cross-boundary studies with the respective US and Canadian border security agencies. In addition, SCL will continue discussions regarding the downstream extent of studies with relicensing participants during development of the implementation plan. If deemed appropriate based upon logistical constraints and the potential value of the information to relicensing, SCL may limit downstream investigations to the U.S.-Canada border. [1] The lower reaches of selected tributaries draining to Boundary Reservoir will also be monitored to determine the timing and magnitude of adfluvial movements. For planning purposes, tributary deltas of interest are Sullivan Creek, Slate Creek, Sweet Creek and Flume Creek, but surveys of other tributaries may be added or substituted in response to additional information.

Description of Study Components

The study utilizes two approaches for obtaining key life history information about the fish that inhabit Boundary Reservoir. The first approach uses passive and active methods to capture fish throughout the year at a variety of locations in Boundary Reservoir and downstream of Boundary Dam. The second method utilizes biotelemetry to monitor the movements and habitat utilization of individuals.

Passive and Active Sampling

A combination of gill net, electrofishing, angling, minnow trap, snorkeling, and fyke net trapping techniques will be used to sample fish in the Tailrace Reach, Boundary Reservoir, and moving in and out of selected tributaries draining to Boundary Reservoir. Several assumptions are associated with the use of the proposed methods:

[1] Initial inquiries by the Technical Consultant suggest that cross-boundary movement of staff and equipment for conducting studies could be problematic, even though the Consultant has both US and Canadian sub-contractors.

- Boat-mounted electrofishing is the most effective means of capturing fish in littoral areas (<10 feet deep) of Boundary Reservoir. Gill net sampling is the most effective means of capturing fish in deep water areas (>10 feet deep) of Boundary Reservoir.
- Boat electrofishing and gill net sampling will require nighttime sampling to increase the efficiency of fish capture.
- All fish sampling and handling techniques described within this study will be conducted under state and federal biological collection permits, and state and federal regulatory agencies will grant permission to conduct the sampling efforts.
- Fish sampling techniques provide imperfect estimates of fish use and abundance. Comparison of multiple sampling methods provides the opportunity to identify potential biases, highlight strengths and weaknesses of each method and ultimately improve estimates of fish distribution and abundance.
- Native salmonids utilize thermal refugia near the mouths of, or within, tributaries during the summer when mainstem Pend Oreille River temperatures exceed thermal tolerance thresholds (approximately 15°C), providing a high likelihood of capturing target species if they are present.
- Some details of the sampling scheme have been provided for planning purposes; however, modifications may be appropriate as the results of 2006 reconnaissance sampling are reviewed. A final sampling scheme will be developed by the Technical Consultant in the first quarter of 2007 in coordination with SCL and relicensing participants.
- Proposed Methodology

The work effort for active and passive fish sampling is divided into 14 tasks, as described below.

Task 1) Reservoir Gill Net Sampling

Deploy variable mesh gill nets approximately once per month during 2007 and 2008 (see Table 2.5-1). Depending on weather conditions, gill nets may not be deployed during December through February if freezing weather conditions restrict the use of nets. Gill nets will be deployed in a stratified sampling scheme designed to cover a range of habitat types. Where possible, similar habitat types will be sampled in each of three reaches (i.e., Upper Reservoir, Canyon and Forebay). The location of each gill net set will be mapped using handheld Global Positioning System (GPS) units and marked on high resolution aerial photographs. If a single net provides sufficient depth coverage, shallow water habitats (less than 50-foot depth) can be sampled using single gill nets set horizontally. Where the reservoir is greater than 50 feet but less than 100 feet, habitats will be sampled using paired horizontal sets, with one net deployed at the surface and one net deployed near the bottom. Deep water habitats, where the reservoir is greater than 100 feet deep, will be sampled using single gill nets deployed vertically. The length, number of panels, and mesh of the gill nets will be consistent with nets used by WDFW to sample the reservoir in 2000 (McLellan 2001).

Table 2.5-1. Proposed sampling methods and intensity for determining distribution, timing, and abundance of fish in Boundary Reservoir.

Sample Method	Sample Period [1] (2007/2008)	Survey Frequency	Sample Time (day/night)
Gill net	Jan – Dec	monthly	night
Electrofishing	Jan – Dec	Monthly	day and night
Angling	Mar – Nov	Monthly	day and night
Mainstem fyke net	Mar – Nov	Monthly	night
Tributary fyke net	Mar –- Nov	6 days/month	day and night
Tributary snorkeling	Mar – Nov	Monthly	night

1 No boat work will occur in the reservoir Forebay Reach during periods of potential spillway use.

For planning purposes, it is assumed there will be five sample sites in each of the Upper Reservoir, Canyon, and Forebay reaches. The Upper Reservoir Reach is assumed to consist of three shallow-water sites and two moderate-depth sites. The Canyon and Forebay reaches are assumed to consist of three deep-water sites, one moderate depth site and one shallow-water site per reach. In addition to the 15 sample sites identified through a stratified sampling scheme, two additional sites will be selected if needed to increase the capture of native salmonids for the biotelemetry studies. Gill net soak times are assumed to consist of three 1-hour sets per site; however, the soak time may be adjusted based on mainstem water temperatures and potential mortality of native salmonids. If the mortality or injury rate of captured fish becomes unacceptable, sampling frequency for gill nets may be reduced to less than once per month. If fish mortalities associated with gill net sets are acceptable to the regulatory agencies, overnight gill net sets may be substituted for two 1-hour sets for some months of the year. Protocols for selecting gill net soak times will be developed in early 2007 when the Technical Consultant finalizes the study implementation details in coordination with SCL and relicensing participants. [2]

Task 2) Tailrace Gill Net Fishing

Deploy variable-mesh gill nets, horizontally in the pool at the base of the spillway, within the turbine outfall pool, and at one site near or below the hydraulic control below the tailrace, for at least three 1-hour sets during monthly sampling efforts (Table 2.5-2). Deep pools near the base of the dam may contain exposed rebar or jagged pieces of concrete and where the water depth exceeds 50 feet, gill nets will not be deployed within 20 feet of the channel bottom. Gill nets will also not be deployed within 20 feet of the dam structure to avoid potential entanglement with protruding rebar and construction debris. Sample sites located in water exceeding 50 feet will consist of paired net sets, with one net set towards the surface and one net set mid-water column. The location of each gill net set will be mapped using handheld GPS units and marked on high-resolution aerial photographs. The gill net soak time will be developed in coordination

[2] The results from a preliminary study (Terrapin 2007) suggests appropriate soak times that minimize injury and mortality to fish are likely related to ambient water temperatures.

with the relicensing participants after the results of the 2006 gill net reconnaissance efforts are available and detailed in the implementation plan to be developed by the Technical Consultant performing the study. The length, number of panels and mesh of the gill nets will be consistent with nets used by WDFW to sample the reservoir in 2000 (McLellan 2001).

Table 2.5-2. Proposed sampling methods and intensity for determining timing, distribution and abundance of fish in the Tailrace Reach.

Sample Method	Sample Period (2007/2008)	Survey Frequency	Sample Time (day/night)
Electrofishing	Jan – Dec	monthly	day and night
Snorkel	Jan – Dec	monthly	day and night
Gill Net	Apr – Nov	monthly	night
Fyke Net	Apr – Nov	monthly	night

Task 3) Reservoir Electrofishing Sampling

Conduct monthly, boat-mounted electrofishing surveys using standardized transects within the Upper Reservoir, Canyon, and Forebay reaches of Boundary Reservoir (see Table 2.5-1). The electrofisher will be operated and configured with settings consistent with guidelines established by WDFW (WDFW 2005). For planning purposes, it is assumed there will be eight sample transects in the Upper Reservoir Reach, six sample transects in the Canyon Reach, and four sample transects in the Forebay Reach. The location of each electrofishing transect will be mapped using handheld GPS units and marked on high-resolution aerial photographs. Where significant portions of transects are too shallow to be sampled using a boat-mounted electrofisher, select portions of transects will be sampled using a backpack-mounted electrofisher.

To the extent possible, electrofishing transects will be standardized and repeated during each sampling period to evaluate temporal changes in fish distribution. Habitat measurements will be collected at each site and changes noted between sample periods. The length and width of each sample transect will be recorded, and a map of each transect developed showing the bottom profile, substrate, macrophytes and other cover types. The electrofishing start and stop times will be recorded and the reservoir water surface elevation relative to an arbitrary benchmark will be measured using a hand level. The site of fish captured during each electrofishing effort will be recorded on a map of the sample area. Where safety concerns can be adequately addressed, electrofishing will be conducted after sunset; otherwise electrofishing surveys will be conducted during daylight hours.

In order to develop HSI information, mean column velocity information will be collected when target lifestages and species are captured (see list of target species and lifestages in the HSI-Fish component of the Mainstem Aquatic Habitat Modeling Study, Study No. 7). The velocity data associated with capture sites, and depth and substrate information from the transect maps will allow the development of HSI data for validation of literature-based HSI curves.

The electrofishing transects will be used in conjunction with stranding and trapping surveys described in the HSI-fish component of the Mainstem Aquatic Habitat Modeling Study (Study No. 7).

Task 4) Tailrace Electrofishing

A boat-mounted electrofisher will be used to sample standardized transects within the tailrace area between Boundary Dam and the U.S.-Canada border (see Table 2.5-2). For planning purposes, it is assumed that four transects will be surveyed in the Tailrace Reach. The electrofisher will be operated and configured with settings consistent with guidelines established by WDFW (WDFW 2005). The location of each electrofishing transect will be mapped using handheld GPS units and marked on high-resolution aerial photographs. To the extent possible, electrofishing transects will be repeated during each sampling period to evaluate temporal changes in fish distributions. Where safety concerns can be adequately addressed, electrofishing will be conducted along two transects during daylight hours and conducted along all four transects during nighttime hours.

Task 5) Reservoir Fyke Net Sampling

Conduct fyke net sampling using fyke nets set overnight once per month in shallow (≤ 6 feet deep), slow-velocity (< 1 feet per second) areas of Boundary Reservoir (Table 2.5-1). For planning purposes, it is assumed that two fyke nets will be deployed in the Upper Reservoir Reach, one net deployed in the Canyon Reach, and one net deployed in the Forebay Reach. Each fyke net will be configured with one or two wings to guide fish to the net mouth. A live car with a watertight reservoir will be located at the small end of the fyke net throat to hold captured fish until they can be processed. The live car will be checked regularly to ensure that captured fish do not become stranded during receding water levels. The location of the fyke net sets will be mapped using a handheld GPS unit and marked on high resolution aerial photographs.

Task 6) Tailrace Fyke Net Trapping

Conduct fyke net sampling using one fyke net set overnight once per month in a shallow (≤ 6 feet deep), moderate-velocity (< 3 feet per second) area of the Tailrace Reach (see Table 2.5-2). The fyke net will be configured with one or two wings to guide fish to the net mouth. A live car with a watertight reservoir will be located at the small end of the fyke net throat to hold captured fish until they can be processed. The live car will be checked regularly to ensure that captured fish do not become stranded by receding water levels. The location of the fyke net set will be mapped using a handheld GPS unit and marked on high-resolution aerial photographs. The location of the fyke net may vary between sampling periods to maximize the opportunity to identify a location where fish can be captured; however, due to the high velocities experienced in the tailrace during periods of power generation, there may be few potential sites to install a fyke net. Placement of super sacks, or other environmentally-friendly anchoring techniques, may be needed to deploy fyke nets in the tailrace.

Task 7) Tributary Fyke Net Sampling

Deploy fyke nets designed to collect downstream migrating fish near the mouth of Slate, Sullivan, Flume, Sand, and Sweet creeks. The nets will be installed in a run habitat section of the tributaries above the reservoir fluctuation zone. Once a satisfactory site has been identified, the same location will be used during each of the subsequent collection periods. The traps will be operated continuously for a three-day period every two weeks from March through November 2007 and 2008, weather and flow conditions permitting. Each fyke net will be configured with two wings to guide the majority of water and fish to the net mouth. Where possible, the guide nets will be configured to maintain a narrow open channel along one bank. Where the channel size or configuration does not allow an open channel to be maintained, the area below the fyke net will be checked regularly to asses whether fish are blocked and cannot pass upstream. A live car will be located at the downstream end of the fyke net throat to hold captured fish until they can be processed. The fyke net wings and live car will be checked regularly to clear debris and to ensure that captured fish do not become injured. The location of the fyke net sets will be mapped using a handheld GPS unit and marked on high-resolution aerial photographs.

Task 8) Tributary Snorkeling

Two experienced biologists will conduct monthly nighttime snorkel surveys within 1,000-foot reaches starting within or below the reservoir fluctuation zone and extending upstream into the tributary above the maximum reservoir water surface elevation in Slate, Sullivan, Flume, Sand, and Sweet creeks. Snorkelers will record water temperatures at the start and end of the survey and will visually identify and record the number of fish by size and species. The location of each snorkel survey transect will be mapped using handheld GPS units and marked on high-resolution aerial photographs.

Task 9) Tailrace Snorkeling

Two experienced biologists will conduct snorkel surveys along two standardized transects in littoral areas during both day and night during each field survey effort. Snorkelers will visually identify and record the number of observed fish by size and species. The location of each snorkel survey transect will be mapped using handheld GPS units and marked on high resolution aerial photographs.

Task 10) Angling

During field trips organized for gill net sampling, hook-and-line angling will be conducted on an opportunistic basis to sample near the mouths of Boundary Reservoir tributaries targeting the capture of native salmonids using artificial lures with single barbless hooks. The primary objective of hook and line sampling will be to capture native salmonids for use in biotelemetry studies; a secondary objective will be to evaluate seasonal fish distribution.

Task 11) Fish Handling

Record the date, start and stop times, and level of effort for all sampling efforts. Record water temperature and dissolved oxygen. Identify all captured fish to species, measure to the nearest millimeter (mm) total length, and weigh to the nearest gram (g). If present, observations of poor

fish condition, lesions, external tumors or other abnormalities will be noted. When more than 30 fish of a similar size class and species of fish are collected at one time, the total number will be recorded and a subset of the sample measured and weighed to provide at least 30 measurements for each species and size class.

SCL will examine fish for external signs of gas bubble trauma when scheduled surveys below Boundary Dam are conducted within one week following a spill event. This evaluation will only occur if a scheduled fish sampling event occurs within one week following a spill event; no fish collection surveys will be scheduled specifically to evaluate evidence of gas bubble trauma on fish below Boundary Dam. Although a systematic appraisal of all fish captured will only be conducted during the one-week period following spill, records will be kept of any fish showing obvious signs of gas bubble trauma, regardless of when those fish are captured in relation to spill. The following information will be recorded for each fish showing signs of trauma: species, life-stage, and capture location, time, and date. All fish showing signs of trauma will be photographed.

Tissue samples will be collected from all captured bull trout and cutthroat trout using protocols prescribed by an accredited conservation genetics laboratory, such as the USFWS Region 1 Conservation Genetics Lab in Longview, Washington. All native salmonids greater than 250 mm in length will be scanned for passive integrated transponder (PIT) tags using a portable tag reader. A PIT tag will be implanted into all trout/char that do not have tags and are 250 mm and larger (See Table 2.5-3 [3]). All sportfish greater than 250 mm in length, other than native salmonids and triploid trout that are in good condition will receive a numbered external tag that is visibly different than tags used on fish implanted with biotelemetry tags; i.e., the external tag type for fish utilized as biotelemetry subjects will be different than other fish[4]. If appropriate, ice, aerators, and anti-stress (slime-coat) medications will be used to reduce stress and injury to captured salmonids. Sampling operations may be halted or modified at locations which have a high likelihood of capturing native salmonids when water temperatures are high enough (greater than 20°C) to present a risk to captured native salmonids. This sampling effort will be coordinated with biotelemetry studies to maximize use of captured native salmonids.

If native salmonids are recaptured in the Box Canyon or Boundary Project tailrace that have exhibited continued efforts to move upstream, these fish will be considered for transport and release to upstream habitats. A decision to move a fish upstream will be developed in coordination with SCL, other relicensing participants, and Pend Oreille County PUD's upstream transport program. A decision to move a fish upstream will consider whether the natal stream can be identified through genetic testing and the value of gathering additional information on fish movement obtained by releasing the fish at its point of capture.

[3] Table 2.5-3 has been added to clarify the tagging scheme for captured fish.

[4] The WDFW expressed concern that using similar external tags on triploid trout and native trout/char might result in undesired harvest of native trout/char. Anglers will be rewarded for returning tags from triploid trout as part of recreational harvest evaluations. SCL has modified their approach to tagging to address this concern and to avoid placing multiple external tags on fish. Minimum fish size for receiving an external tag has been increased to avoid tagging large numbers of sport fish such as yellow perch.

Table 2.5-3. Tagging scheme for captured fish greater than 250 mm total length.

Fish Species	PIT[(2)]Tag	Numbered External Tag [(1)]	
		Type A	Type B
Native trout/char (bull trout, cutthroat trout) with radio or CART[(2)] tag	Yes	No	Yes
Native trout/char (bull trout, cutthroat trout) without radio or CART tag	Yes	No	No
Mountain whitefish with radio or CART tag	No	No	Yes
Mountain whitefish without radio or CART tag	No	No	No
Triploid trout with radio or CART tag	No	No	Yes
Triploid trout without radio or CART tag	No	No	No
Other salmonids (brook trout, brown trout)	No	Yes	No
Other sportfish (e.g. bass and walleye)	No	Yes	No
Non-sportfish (e.g. northern pike minnow and suckers spp.)	No	No	No

(1) Type A and Type B tags will be visibly different so that anglers can readily distinguish among them. For example, Type A might be red Floy tags while Type B might be yellow streamer tags.

(2) CART: combined acoustic and radio transmitter
PIT: passive integrated transponder

Task 12) Data Analysis

Evaluate spatial and temporal comparisons of catch per unit effort by species and sampling method and length/weight/condition factor. Identify sampling areas and reaches where there is spatial and temporal overlap by fish species utilizing Boundary Reservoir. Evaluate spatial and temporal overlap using the results of the gill net, electrofishing and angling efforts and the results of the biotelemetry tracking of native salmonids, smallmouth bass and triploid trout.

Native salmonid tissue samples will be provided to an accredited conservation genetics lab. SCL will fund the lab to conduct analyses to describe the genetic relationship of sampled fish with other samples taken in the general area. The contracted genetics laboratory must have access to the existing genetic signatures of bull trout from the Salmo River and the Lake Pend Oreille/Priest River populations and the existing genetic signatures of westslope cutthroat trout from Lake Pend Oreille and tributaries to Box and Boundary reservoirs. The statistical results should include the probabilities associated with correctly or incorrectly assigning the captured trout to nearby known populations (i.e., probabilities associated with Type I and Type II errors). The results of the genetics analyses will be provided to relicensing participants. Although the analyses will be done by the genetics lab, interpretation of the results will likely require consultation with SCL, other relicensing participants, and the Bull Trout Recovery Team.

Task 13) Alternative 2008 Reservoir Sampling Methods

Depending upon the results of the 2007 surveys, alternative sampling methods may be appropriate for the 2008 field season, including beach seines and other trap types. Beach seines can be a very effective capture method for some species and lifestages within some habitat types (e.g., gravel or sand substrates and a shallow, gradually sloping bathymetry). Because beach

seine effectiveness is strongly influenced by site characteristics, comparisons between sites may be limited. If the currently proposed methods (gill net, electrofishing, fyke net, and angling) are ineffective during 2007, alternative sampling methods will be considered for 2008.

Work Products

An interim study report describing survey methods, results of 2007 monitoring, and discussion of recommendations for 2008 fish sampling, and a final study report describing survey methods and results of 2007 and 2008 monitoring will be produced. Electronic copies of processed data sheets will be made available upon request.

Schedule

The schedule for completing the Passive and Active Sampling component of the Fish Distribution, Timing and Abundance Study is provided in Table 2.5-4.

Table 2.5-4. Schedule for conducting Passive and Active Sampling study component.

Activity	2007				2008				2009
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
Technical Consultant study refinement	------								
Reservoir gill net sampling	▲	▲▲	▲▲	▲▲	▲▲	▲▲	▲▲	▲	
Monthly tailrace gill net sampling		▲▲	▲▲	▲		▲▲	▲▲	▲	
Monthly reservoir electrofishing	▲	▲▲	▲▲	▲▲	▲▲	▲▲	▲▲	▲	
Monthly tailrace electrofishing	▲	▲▲	▲▲	▲▲	▲▲	▲▲	▲▲	▲	
Monthly reservoir fyke net	▲	▲▲	▲▲	▲	▲	▲▲	▲▲	▲	
Monthly tailrace fyke net sampling		▲▲	▲▲	▲		▲▲	▲▲	▲	
Angling	▲	▲▲	▲▲	▲▲	▲▲	▲▲	▲▲	▲	
Tributary fyke net	▲	▲▲	▲▲	▲	▲	▲▲	▲▲	▲	
Prepare interim study report (first-year results)				●					
Distribute interim study report					●				
Meet with relicensing participants to review first year efforts and results and discuss plans for any second year efforts					●				
Include interim study report in Initial Study Report (ISR) filed with FERC					●				
Hold ISR meeting and file meeting summary with FERC					●				
Reservoir Beach seine*					▲	▲▲	▲▲	▲	
Prepare "draft" final study report								●	
Distribute "draft" final study report for relicensing participant review								●	
Meet with relicensing participants to review study efforts and results and "cross-over" study results									●
Include final study report in Updated Study Report (USR) filed with FERC									●
Hold USR meeting and file meeting summary with FERC									●

* Alternative sampling methods to be considered for 2008 if other methods are ineffective.

Biotelemetry

Biotelemetry is the proposed method to collect behavioral, habitat utilization, and periodicity information for native salmonids in Boundary Reservoir and the Tailrace Reach. Due to the low density of native salmonids, particularly bull trout and westslope cutthroat trout in Boundary

Reservoir, capture or observation methods such as electrofishing, gill netting, angling, traps, weirs, or snorkeling/scuba may not collect sufficient numbers of fish to draw conclusions concerning their use of reservoir habitats. In contrast to other methods, biotelemetry collects a relatively large amount of information on relatively few individuals.

Several assumptions, listed below, are associated with the use of the proposed biotelemetry survey techniques. If the following assumptions prove false, the study component may fail to meet one or more of its objectives or may require substantial changes to the methodology:

- Adequate numbers of subject fish will be available for tagging. Native salmonids can be captured as part of the passive and active sampling described above and tagged without injury.
- Behavioral effects of fish capture and tagging can be identified and differentiated from behavioral responses to Project operations. If native salmonids are unavailable for tagging, brown trout and other non-native salmonids are not suitable surrogate species to evaluate behavior of native salmonids.
- Based upon the results of field tests conducted during 2006, radio transmitters will be used in the Tailrace Reach while radio and Combined Acoustic and Radio Transmitter (CART) tags will be used in Boundary Reservoir. [5]
- A variety of transmitter sizes and longevities (5 to 10 sec pulse interval) will be used depending upon the size of fish available for tag implants:[6]
  - fish weighing 295 to 400 grams (approximately 325 to 360 mm in length)
    - position only – 180 to 320 day tag life
  - fish weighing 400 grams (approximately 360 mm in length) or larger
    - position only – 265 to 400 day tag life
    - depth/temp – 40 to 100 day tag life (2 to 5 sec pulse interval)
  - fish weighing 1,256 grams (approximately 535 mm in length) or larger (5 sec pulse interval)
    - CART – 661 days
- Priority for long-life/CART/depth/temperature transmitters, subject to fish size constraints, is as follows: 1) bull trout, 2) westslope cutthroat trout, 3) mountain whitefish. Long-life tags have a higher priority over depth/temperature tags.

[5] Fixed tracking locations will be installed with radio receiving equipment only. Field tests conducted during 2006 (Sisak and Nass 2007) indicated that ambient noise levels were too high for acoustic receiving equipment in the immediate forebay area and near the turbine outflow. However, acoustic biotelemetry can be advantageous if fish occupy deep water in other areas of the project. Mobile tracking will have a combination of acoustic and radio receiving equipment to allow survey of both deepwater and shallow habitats if CART-tagged native trout/char are at-large in the reservoir. Results from the 2007 field season will be used to determine if selected fixed locations should be supplemented with acoustic receiving equipment during 2008.

[6] Fish sizes, pulse intervals, and tag longevity ranges are approximate and subject to change depending upon the choice of vendor for biotelemetry equipment and transmitters. Longer pulse intervals increase transmitter longevity, but increase the risk of non-detection of tagged fish. Larger batteries increase the longevity and size of transmitters, but also increases the minimum fish size required for tagging.

- The risk of stress-related death or abnormal behavior from handling and the surgical procedure is too high when receiving waters are greater than 15°C.
- Nighttime mobile tracking can be conducted safely in Boundary Reservoir and tagged fish locations can be accurately determined.
- A level of effort is described for planning purposes, but the actual sampling program, including selection of equipment, pulse intervals, and battery size will be developed by the Technical Consultant in coordination with SCL and relicensing participants.
- During mobile tracking, the location of the tracking boat, when maneuvered close to the apparent tagged fish position, is presumed to be the fish location.

Proposed Methodology

The work effort for this study element has been divided into five tasks, as described below.

Task 1) Deployment of Detection Equipment

Deploy an array of fixed directional and/or omnidirectional antennas/receivers to detect tagged fish at strategic locations within the reservoir. The number, type and location of antennas/receivers and other aspects of study design will be developed by the Technical Consultant in coordination with SCL and relicensing participants. For planning purposes, fixed receiver coverage will consist of the following locations[7]:

- The mainstem river near the mouth of Sweet Creek and above its confluence with the Pend Oreille River
- Pend Oreille River above Metaline Falls
- The mainstem river near the mouth of Sullivan Creek and above its confluence with the Pend Oreille River
- Pend Oreille River below Metaline Falls
- The mainstem river near the mouth of Slate Creek and above its confluence with the Pend Oreille River
- Pend Oreille River at the downstream opening of the Canyon Reach
- Base of Pewee Falls
- Upstream of Boundary Dam
- Downstream of Boundary spillway tailrace and turbine outfall pools

[7] Fixed tracking locations will be installed with radio receiving equipment only. Results from the 2007 field season will be used to determine if selected fixed locations should be supplemented with acoustic receiving equipment during 2008. Fixed receiver locations were modified slightly from the PSP following the results from Sisak and Nass (2007) and discussions with the Technical Consultant. The fixed detection site near the mouth of Russian Creek has been dropped because the information regarding fish use is considered to be of limited value to the study. The number of receiver stations near Boundary Dam has been reduced from the PSP, but the detection area is anticipated to be similar.

- Pend Oreille River at the U.S./Canadian border (includes the mouth of Lomond Creek)
- Pend Oreille River near the confluence of Red Bird Creek (near the upper end of Seven Mile Reservoir under minimum operating pool levels)

BC Hydro is planning to conduct biotelemetry studies of the Salmo River and lower Seven Mile Reservoir in 2007 and receivers installed as part of those efforts may be substituted for the Pend Oreille River near Red Bird Creek receiver (personal communication, James Baxter, biologist, BC Hydro, February 9, 2006). One or more receivers will also need to be installed immediately below Box Canyon Dam; however, these receivers may be provided by Pend Oreille County PUD. Biotelemetry studies are being conducted by the PUD in response to Box Canyon Project licensing requirements (Pend Oreille County PUD 2006) and it is assumed that receivers installed by the PUD will be complementary to Boundary Project biotelemetry efforts.

Task 2) Fish Collection and Tagging

Fish to be implanted with tags will be captured as part of the Passive and Active Sampling component described previously. Up to 30 bull trout, 30 mountain whitefish, and 30 cutthroat trout[8] from Boundary Reservoir will be tagged with a radio transmitter or CART attached intraperitoneally using surgical techniques similar to those described by McLeod and Clayton (1997) and Brown et al. (1999). Tagged fish will be released in the vicinity of their capture location. Similarly, up to 20 bull trout, 20 cutthroat trout, and 20 mountain whitefish will be tagged and released in the Tailrace Reach. Surgery on the salmonids will only occur if subject fish can be released into water temperatures less than 15°C, either in the form of ambient mainstem temperatures or thermal refugia near tributary mouths. Each fish will also be tagged with a numbered external tag, and native salmonids will also receive a Passive Integrated Transponder (PIT) tag (See Table 2.5-3). Fish utilized for biotelemetry will have a numbered external tag that is visibly different from those applied for other purposes. Up to 20 smallmouth bass, captured during the springtime recreational bass derby, will be tagged with a CART or other transmitter and released. Coordination will occur with the Recreational Fishery Study (Study No. 13) to recover any transmitters implanted in Floy-tagged fish captured and retained by anglers as part of the recreational fishery.

Task 3) Fixed and Mobile Tracking

During 2007 mobile tracking by boat will occur approximately every other week, weather permitting, during April through October. During November to March mobile tracking will occur once per month, weather permitting. Mobile tracking will occur with radio receiving equipment unless CART-tagged fish are suspected to be in deep water areas. In that circumstance, mobile acoustic receiving equipment will also be used in the Canyon and Forebay reaches to relocate tagged fish. Downloading of stored data and any required maintenance of fixed receivers will occur as part of tracking field trips. If the fixed receivers located at tributary mouths indicate that CART- or radio-tagged fish have entered a tributary, then the upper extent

[8] Trout that have external characteristics of both cutthroat and rainbow trout (i.e., hybrids) will not be used for the biotelemetry study. Only cutthroat trout with a predominantly "westslope" appearance will be used as biotelemetry subjects.

of tributary habitat use by these fish will be documented via mobile tracking. If mobile tracking in tributaries on the ground (on foot or by vehicle) cannot locate tagged fish, at least two attempts at aerial tracking of tagged fish in tributaries using helicopter-mounted or airplane-mounted receivers will be conducted. If data from receivers upstream or downstream of Boundary Dam suggest tagged fish may be present in deep tailrace pools, then underwater antennas will be "trolled" through the pools to determine the presence of tagged fish. Monitoring of tagged fish will continue for a second year (2008), but the frequency may be scaled back if the results of this and other ongoing studies indicate little movement occurs during some months. Any change to sampling frequency will be developed in coordination with relicensing participants. During mobile tracking, GPS units will be utilized to the extent adequate signals are available. Alternatively, tagged fish locations will be pinpointed on aerial photographs. In support of HSI development under Study 7, microhabitat information, utilizing underwater video, if necessary, will be collected at the location of tagged fish including water depth, velocity, temperature, substrate type, macrophyte density, and cover. Coordination will occur with the Recreational Fishery Study (Study No. 13) to collect location information on transmitters implanted into triploid rainbow trout.

Task 4) Intensive Mobile Tracking

Intensive surveys will be conducted on a select number of tagged bull trout or cutthroat trout utilizing coldwater tributary delta habitats when mainstem water temperatures exceed 18°C. The intent of this task is to evaluate potential use of coldwater refugia by bull trout and cutthroat trout and the potential movement of bull trout and cutthroat trout in response to hourly water level fluctuations. If possible, locate and track fish tagged with CART transmitters outfitted with temperature/depth sensors. If not already present as part of Task 1, deploy one or more anchored hydrophones or radio antenna/receivers to monitor movements in and out of the coldwater refugia in the delta area. Utilize mobile tracking techniques on a 24-hour basis to obtain frequent (every 2 hours or less) positions to discern movements. Collect vertical temperature profiles at each tagged fish location. Ideally, the tracking team will obtain information over an entire 24-hour period on all of the tagged fish in a single tributary delta area, such as Slate Creek (or two adjacent coldwater tributary deltas). Intensive mobile tracking will occur during at least three 24-hour periods during each study year, provided bull trout or cutthroat trout with active tags are available. Depending upon the availability of tagged bull trout or cutthroat trout, their observed behavior from every-other-week surveys, and reservoir conditions (e.g., water temperature), alternate intensive mobile tracking strategies (e.g., frequency and duration of surveys) may be developed by the Technical Consultant to maximize the amount and type of information obtained from tagged bull and cutthroat trout[9].

Task 5) Data Analysis and Report Preparation

Hourly operational information on Box Canyon Dam (flow) and Boundary Dam (flow and pool elevation) will be obtained. Conduct analyses to determine if spatial or temporal movement patterns of tagged fish are correlated with Box Canyon and/or Boundary Project operations.

[9] Due to the low capture rates for cutthroat trout and lack of catch of bull trout by McLellan (2001) and Terrapin Environmental (2007), the potential for circumstances triggering a period of intensive tracking is uncertain. Consequently, additional flexibility was added to allow for intensive tracking of bull trout or cutthroat trout under different environmental conditions than proposed in the PSP.

Analyze patterns of habitat utilization from data collected at tagged fish locations. Coordinate analysis of the data with the HSI-Fish component of the Mainstem Aquatic Habitat Modeling Study (Study No. 7).

Work Products

Work products for the Biotelemetry study component include the following:

- Tabular summary of tagged fish length, weight, tag size and model, tagging date, release time, and release site.
- Tabular summary and GIS maps of tagged fish locations.
- Tabular and/or graphic summary of tagged fish habitat utilization.
- Interim and final reports describing the methods and results of the study component.

Electronic copies of process data sheets will be made available upon request.

Schedule

The schedule for completing the biotelemetry component of the Fish Distribution, Timing and Abundance Study is provided in Table 2.5-5.

Table 2.5-5. Schedule for completing the Biotelemetry study component.

Activity	2007				2008				2009
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
Technical Consultant study refinement	----								
Install fixed receivers	▲								
Monitor fish movements using fixed receivers [1]		----	----	----	----	----	----	----	
Monthly mobile tracking [1]		▲▲	▲▲	▲	▲	▲▲	▲▲	▲	
Prepare interim study report (first-year results)				●					
Distribute interim study report					●				
Meet with relicensing participants to review first year efforts and results and discuss plans for any second year efforts					●				
Include interim study report in Initial Study Report (ISR) filed with FERC					●				
Hold ISR meeting and file meeting summary with FERC					●				
Prepare "draft" final study report								●	
Distribute "draft" final study report for relicensing participant review								●	
Meet with relicensing participants to review study efforts and results and "cross-over" study results									●
Include final study report in Updated Study Report (USR) filed with FERC									●
Hold USR meeting and file meeting summary with FERC									●

1 Timing and duration of fish tracking assumes that target species implanted with radio/acoustic tags are available for tracking.

2.6. Consistency with Generally Accepted Scientific Practice

Passive and Active Sampling — Electrofishing, gill nets, minnow traps, and fyke nets are commonly used methods for sampling fish populations (Murphy and Willis 1996; Backiel and Welcomme 1980). Angling is primarily proposed as a collection method to obtain fish for biotelemetry studies rather than a tool for sampling the population, but some biological information (e.g., length and weight) of captured fish will also be collected. Angling using single barbless lures or flies has become a common method for capturing subject fish (especially bull trout) for biotelemetry studies (e.g., Chamberlain 2002; Pillipow and Williamson 2004).

Biotelemetry — Biotelemetry studies on native salmonids and other fish species has occurred as part of licensing studies for the Box Canyon Project (Pend Oreille County PUD 2000) and the Lower Clark Fork Projects (Noxon Rapids and Cabinet Gorge) (Avista Corporation 2005,

Weitkamp et al. 2003). Biotelemetry studies have also been recently completed at the Albeni Falls Project to evaluate the need and feasibility of providing passage at that project (Geist et al. 2004, Scholz et al. 2005). This study proposal utilizes methods similar to those used at these nearby hydroelectric projects.

2.7. Consultation with Agencies, Tribes, and Other Stakeholders

2006 Early Information Studies — During a November 30, 2005, relicensing workshop, SCL was asked to consider initiating biological studies of fish distribution and movement during 2006 prior to submittal of the Proposed Study Plan (PSP). SCL had not planned to initiate field studies in 2006 in advance of the formal PSP process. However, in response to input from relicensing participants, SCL reallocated funds allowing for limited investigations to support study planning and design. The scope of these 2006 efforts was discussed at Fish and Aquatics meetings held on February 1 and February 16, 2006, and a conference call held on March 8, 2006 (see Attachment 4-1 of the PSP). During these meetings and the conference call, relicensing participants requested that biotelemetry studies of native salmonids be initiated in 2006. In response, SCL developed a list of potential study efforts related to biotelemetry study design. During the summer and fall of 2006, SCL implemented the following studies, which were ranked highest in addressing biotelemetry study design uncertainties:

- *Conduct Gill Net Sampling to Evaluate Presence of Native Salmonids within Boundary Tailrace Area* — Determine whether target species (bull trout, rainbow and westslope cutthroat trout, and whitefish) can be captured in the Boundary tailrace area using gill nets and angling.
- *Conduct Gill Net Sampling to Evaluate Presence of Native Salmonids at Mouth of Select Boundary Reservoir Tributaries* — Determine whether target species (bull trout, rainbow and westslope cutthroat trout, and whitefish) can be captured at the mouth of selected tributaries to the Boundary Reservoir using gill nets and angling.
- *Test Use of Biotelemetry Systems* — Identify the effective range of acoustic and radio biotelemetry systems to support the design of biotelemetry studies to be conducted in 2007 and 2008.
- *Evaluation of Boundary Tailrace Access* — Identify conditions affecting boat launch and retrieval at Boundary tailrace boat ramp and hydraulic conditions affecting use of boats in Boundary tailrace area.

Terrapin Environmental of Twisp, Washington, conducted monthly gill net and angling surveys in the Boundary tailrace and at the mouth of four Boundary Reservoir tributaries during July through November 2006. LGL Limited of Ellensburg, Washington, conducted the evaluation of acoustic and radio biotelemetry in the Boundary tailrace and forebay areas. Final reports of these 2006 study efforts will be available to relicensing participants in early 2007.

Passive and Active Sampling — Input regarding the Passive and Active Sampling component to the Fish Distribution, Timing, and Abundance Study was provided by relicensing participants during workgroup meetings. Workgroup meetings were held in Spokane, Washington, on May 23, 2006, and in Metaline Falls, Washington, on June 27, 2006. During the May workgroup meeting, an outline for sampling the Tailrace Reach was presented and discussed with

relicensing participants. During the June meeting, an outline for sampling Boundary Reservoir was presented and discussed. The proposed Passive and Active Sampling component to the study plan was developed from these outlines and relicensing participant comments.

In the PAD/Scoping comment letter (USFWS 2006), the USFWS endorsed the Fish Distribution, Timing and Abundance Study outlines presented at the workgroup meetings. However, the USFWS noted a concern about the use of Floy tags as external markers for native salmonids. Because Floy tags will also be used for triploid trout, the USFWS noted that anglers may misidentify native salmonids, which could lead to inadvertent take of protected species. SCL acknowledges the potential problem and has modified the study plans to consider the use of alternative external tags. As noted in the study plan, final implementation details for the study components will be developed in early 2007 when the Technical Consultant finalizes the study implementation details in coordination with SCL and relicensing participants. The color, size, and marking of external tags, if used, will be developed by species and coordinated with relicensing participants.

In a letter to SCL dated August 28, 2006, WDFW submitted questions regarding the number of sample sites and sampling locations (see letter from WDFW included in PSP Attachment 4-1, SCL 2006b). SCL provided additional detail in the study plans and intends to finalize the study implementation details with the Technical Consultant in early 2007. Any remaining questions regarding the sampling strategy will be addressed in coordination with relicensing participants at that time. WDFW commented that collecting samples of stomach contents from smallmouth bass during the annual bass fishing derby was inadequate to draw conclusions regarding predation. In addition, WDFW noted that an extensive stomach content sampling program involving both native and non-native salmonids would be necessary if the objective is to evaluate potential competition for forage resources. In response, SCL dropped the smallmouth bass stomach content sampling effort and dropped reference to evaluating potential salmonid competition from the study proposal.

In its PAD/Scoping comment letter (USFS 2006b), the USFS recommended that a "Bull and Westslope Cutthroat Trout Genetic Study" be conducted, and if tagged fish are found to have originated from upstream areas, those fish be transported and released to their homewaters. In a follow-up conference call on September 8, 2006, USFS and SCL agreed that if tagged native salmonids were recaptured after exhibiting continued efforts to move upstream, those fish would be considered for upstream transport in coordination with relicensing participants. The USFS also recommended that Sand Creek be included for fyke net sampling, requested more extensive tributary snorkeling and electrofishing surveys, and requested that fish be examined for gas bubble trauma. In response, SCL modified the study plan to include Sand Creek for fyke net sampling, included examining fish in the Boundary tailrace for evidence of gas bubble trauma, but did not modify the study plan to include additional tributary snorkeling and electrofishing surveys. Comments provided by relicensing participants on the review outlines for this study component are summarized in PSP Attachment 4-1 (SCL 2006b) and can be found in meeting summaries available on SCL's relicensing website (http://www.seattle.gov/light/news/issues/bndryRelic/).

General information on species and habitats in tributaries are available through habitat and/or fish surveys conducted during 1997, 1999, and 2000 (R2 Resource Consultants, Inc. 1998, Terrapin Environmental 2000, McLellan 2001). Snorkeling is proposed within 1,000 foot reaches starting within or below the reservoir fluctuation zone and extending upstream into the tributaries, but SCL is not proposing to conducted snorkeling and electrofishing of all representative tributary habitats to develop population estimates. As part of the Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats study (see Study No. 14), critical data gaps in high priority streams will be identified, and where appropriate, surveys will be conducted to fill those gaps. In the follow-up conference call on September 8, 2006, USFS staff indicated that they were in general agreement with the study outlines presented at the workgroup meetings. When compiled, the existing information, information developed in the lower tributary reaches, and through the Tributary Habitats study (see Study No. 14) would be expected to meet the USFS's need for information on tributary habitats and biota.

Biotelemetry — Input regarding the Biotelemetry component to the Fish Distribution, Timing, and Abundance Study was provided by relicensing participants during workgroup meetings. A workgroup meeting was held in Spokane on May 23, 2006. During this workgroup meeting, separate outlines for conducting biotelemetry in the Tailrace Reach and Boundary Reservoir were presented and discussed with relicensing participants. The Biotelemetry component to the study plan was developed from these outlines and relicensing participant comments and recommendations. Comments provided by relicensing participants on the review outlines for this study component are summarized in PSP Attachment 4-1 (SCL 2006b) and can be found in meeting summaries available on SCL's relicensing website (http://www.seattle.gov/light/news/issues/bndryRelic/).

In its PAD/Scoping comment letter (USFS 2006b), the USFS requested that a "Native Salmonid Presence and Migration Study" be conducted. The USFS requested that SCL conduct biological surveys and biotelemetry studies targeting salmonids. The requested study would involve both fixed receiver and mobile tracking, and tracking of radio-tagged fish that enter tributaries to the furthest upstream distance. SCL's Fish Distribution, Timing and Abundance Study, specifically the Biotelemetry component, was designed to provide the information requested by the USFS. As described in Task 3 of the Biotelemetry study component, if the fixed receivers located at tributary mouths indicate that CART-tagged fish have entered a tributary, then the upper extent of tributary habitat use by these fish will be documented via mobile tracking. If mobile tracking in tributaries on the ground (on foot or by vehicle) cannot locate CART-tagged fish, at least two attempts at aerial tracking of tagged fish in tributaries using helicopter-mounted or airplane-mounted receivers will be conducted. In a follow-up conference call on September 8, 2006, USFS staff indicated that there was general agreement on the study outlines presented at the workgroup meetings.

Since filing the PSP with FERC on October 16, 2006, SCL has continued to work with relicensing participants on its proposed study plans. Comments made during the November 15 study plan meeting and comments filed with FERC by the USFS (2007) and USFWS (2007) were supportive of the Fish Distribution, Timing and Abundance Study plan proposed in the PSP. (Comments are summarized in Attachment 3 and consultation documentation is included in Attachment 4 of this RSP.) SCL has further modified the Fish Distribution, Timing and

Abundance Study plan to reflect the results of Sisak and Nass (2007) and Terrapin (2007) to clarify specific aspects of the approach, and to provide more consistency with other study plans. Additional specifics of the study components will be developed in early 2007 when the Technical Consultant finalizes the study implementation details in coordination with SCL and relicensing participants (Attachment 1, section 2.2 of this RSP).

2.8. Progress Reports, Information Sharing, and Technical Reviews

An interim study report describing the first year's tracking results, analyses, and recommendations, if any, for modifying 2008 tracking procedures, and a final study report describing the biotelemetry methods and results of 2007 and 2008 efforts will be produced. Prior to release of the Initial and Updated Study Reports (which will include the results of this study), SCL will meet with relicensing participants to discuss the study results, as described in Attachment 1, section 2.3 of this RSP. In addition, relicensing participants will have opportunities to discuss and comment on study progress during quarterly workgroup meetings and ad hoc subcommittee meetings, as needed.

2.9. Anticipated Level of Effort and Cost

Passive and Active Sampling — Based on a review of study costs associated with similar efforts conducted at other hydropower projects, the estimated cost to implement this study component at the Boundary Project range from $690,000 to $980,000, of which approximately 70 percent is anticipated for reservoir and tributary sampling and approximately 30 percent towards tailrace sampling; estimated study costs are subject to review and revision as additional details are developed.

Biotelemetry — The total estimated cost of implementing the Biotelemetry study component is expected to range from $600,000 to $750,000; estimated study costs are subject to review and revision as additional details are developed.

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