Attachment E-9: Draft Biological Assessment

Boundary Hydroelectric Project (FERC No. 2144)

Draft Biological Assessment

Seattle City Light

September 2009

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List of Acronyms and Abbreviations

AHTSP	Advanced Hydro Turbine System Program
ATV	all-terrain vehicle
BA	Biological Assessment
BLM	Bureau of Land Management
BMP	best management practice
BPA	Bonneville Power Administration
BWP	Boundary Wildlife Preserve
cfs	cubic feet per second
CNF	Colville National Forest
DO	dissolved oxygen
DPS	Distinct Population Segment
EAP	Emergency Action Plan
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAMP	Fish and Aquatics Management Plan
FAWG	Fish and Aquatics Workgroup
FPA	Federal Power Act
FERC	Federal Energy Regulatory Commission
fps	feet per second
GIS	geographic information system
HQR	habitat quality rating
HSI	habitat suitability index
HUC	Habitat Unit
ILP	Integrated Licensing Process
INFISH	Inland Native Fish Strategy
km	kilometers
KNRD	Kalispel Natural Resources Department
LAU	Lynx Analysis Unit
LMZ	Lynx Management Zone
LWD	large woody debris
NAVD	North American Vertical Datum
NBT	neutrally-buoyant targets
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Council
NOAA	National Oceanic and Atmospheric Administration
NTU	nephelometric turbidity units
NWU	Northeast Washington Unit

PAD	Pre-Application Document
PCSRF	Pacific Coast Salmon Recovery Fund
PHS	Priority Habitat and Species
PM&E	protection, mitigation, and enhancement
PRM	Project river mile
Project	Boundary Hydroelectric Project
PUD	Public Utility District
RM	river mile
RP	relicensing participant
RSP	Revised Study Plan
SCL	Seattle City Light
SRFB	Washington Salmon Recovery Funding Board
SWI	Shannon-Weiner diversity index
TDG	total dissolved gas
TES	Threatened and Endangered species
TMDL	total maximum daily load
TRMP	Terrestrial Resources Management Plan
TRWG	Terrestrial Resources Workgroup
USACE	U.S. Army Corps of Engineers
USFS	USDA Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USR	Updated Study Report
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources
WECC	Western Electricity Coordinating Council
WRIA	Watershed Resource Inventory Area
WUA	weighted usable area

Draft Biological Assessment
Boundary Hydroelectric Project (FERC No. 2144)

1 INTRODUCTION

The purpose of this Draft Biological Assessment (BA) is to evaluate whether the operation of Seattle City Light's (SCL) Boundary Hydroelectric Project (FERC No. 2144) (Project), as proposed in SCL's application to the Federal Energy Regulatory Commission (FERC) for a new Project license, might affect any of the Threatened or Endangered species listed below. This BA has been prepared in accordance with legal requirements set forth under Section 7 of the Endangered Species Act (ESA) (16 U.S.C. 1536 [c]) and follows the standards established in FERC's National Environmental Policy Act (NEPA) guidance (FERC 2009). The Threatened and Endangered species considered in this document are listed in Table 1.0-1.

Table 1.0-1. Threatened and Endangered species in the Boundary Project Action Area addressed in this BA.

Species common name	Scientific name	Status
Bull trout	*Salvelinus confluentus*	Threatened
Canada lynx	*Lynx canadensis*	Threatened
Grizzly bear	*Ursus arctos*	Threatened
Woodland caribou	*Rangifer tarandus caribou*	Endangered

1.1. Background

The Project, located on the Pend Oreille River in Pend Oreille County, Washington (Figure 1.1-1), was constructed in the mid 1960s and operates under an existing FERC license. The present license for the Project expires on September 30, 2011, and in accordance with FERC regulations, SCL must file its application for a new license no later than September 30, 2009. For the relicensing of the Project, SCL used the FERC Integrated Licensing Process (ILP) to provide the framework for its consultation with agencies, tribes, and other relicensing participants (RPs) during the period leading up to the filing of the License Application.

The filing of this BA fulfills one of SCL's obligations under the ILP. The BA presents SCL's assessment of the proposed Project's potential impacts on Threatened and Endangered species in the Project's Action Area, as well as the effects of relevant Conservation Measures. The filing of SCL's License Application, to which this BA is an attachment, presents SCL's proposed Project operations and non-operational protection, mitigation, and enhancement (PM&E) measures.

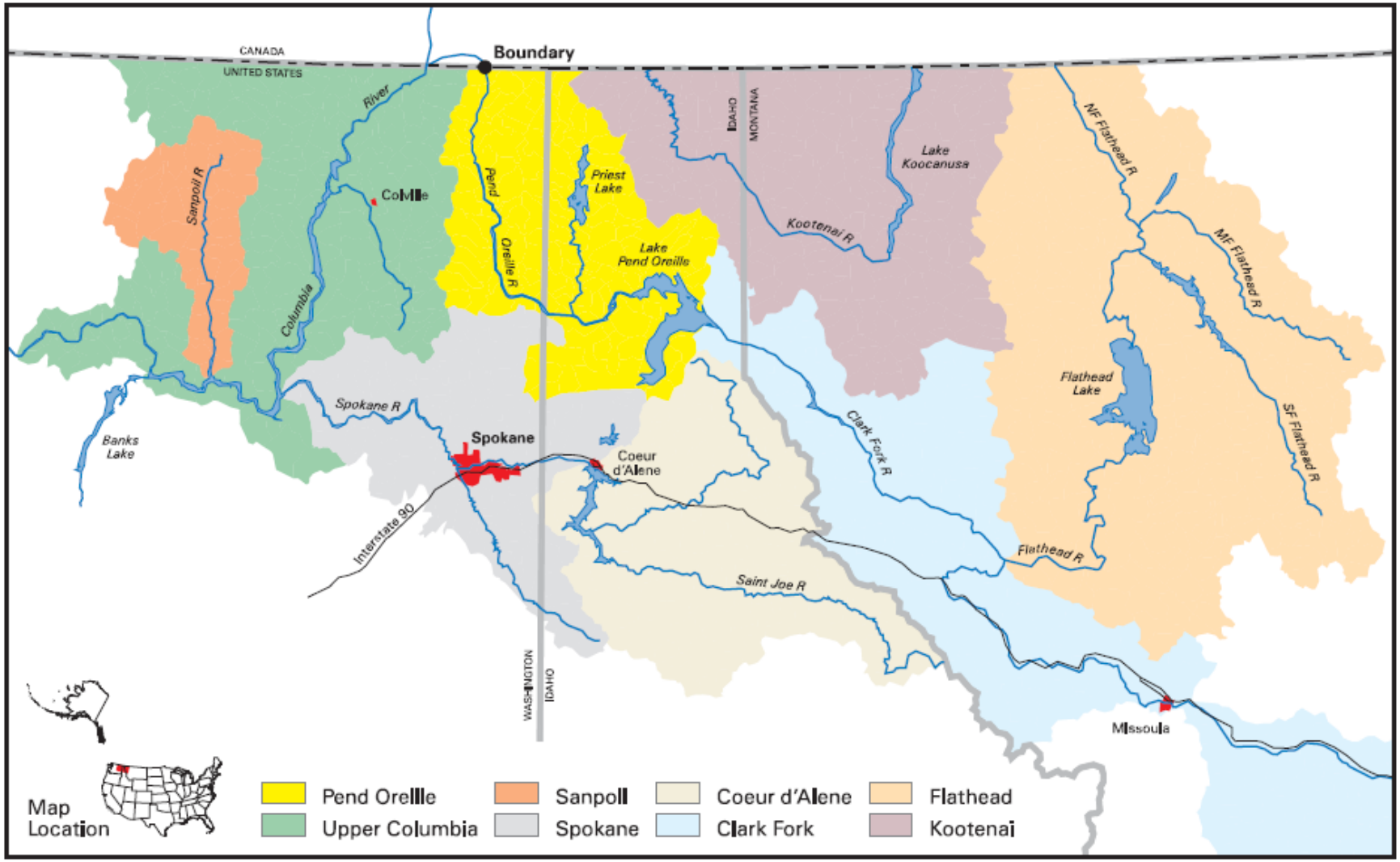


Figure 1.1-1. Pend Oreille River basin within the larger Columbia River basin.

Under the new FERC license term, SCL proposes to operate the Project as it is currently licensed, but with the formalization of two currently voluntary operational measures: forebay water surface elevation restrictions primarily for summer recreation enhancement and turbine unit sequencing to reduce total dissolved gas (TDG) production. SCL's proposed operations and nonoperational PM&Es are described in greater detail in Section 2.3 of Exhibit E of the License Application and in Section 3.1 of this BA.

1.2. Project Purpose

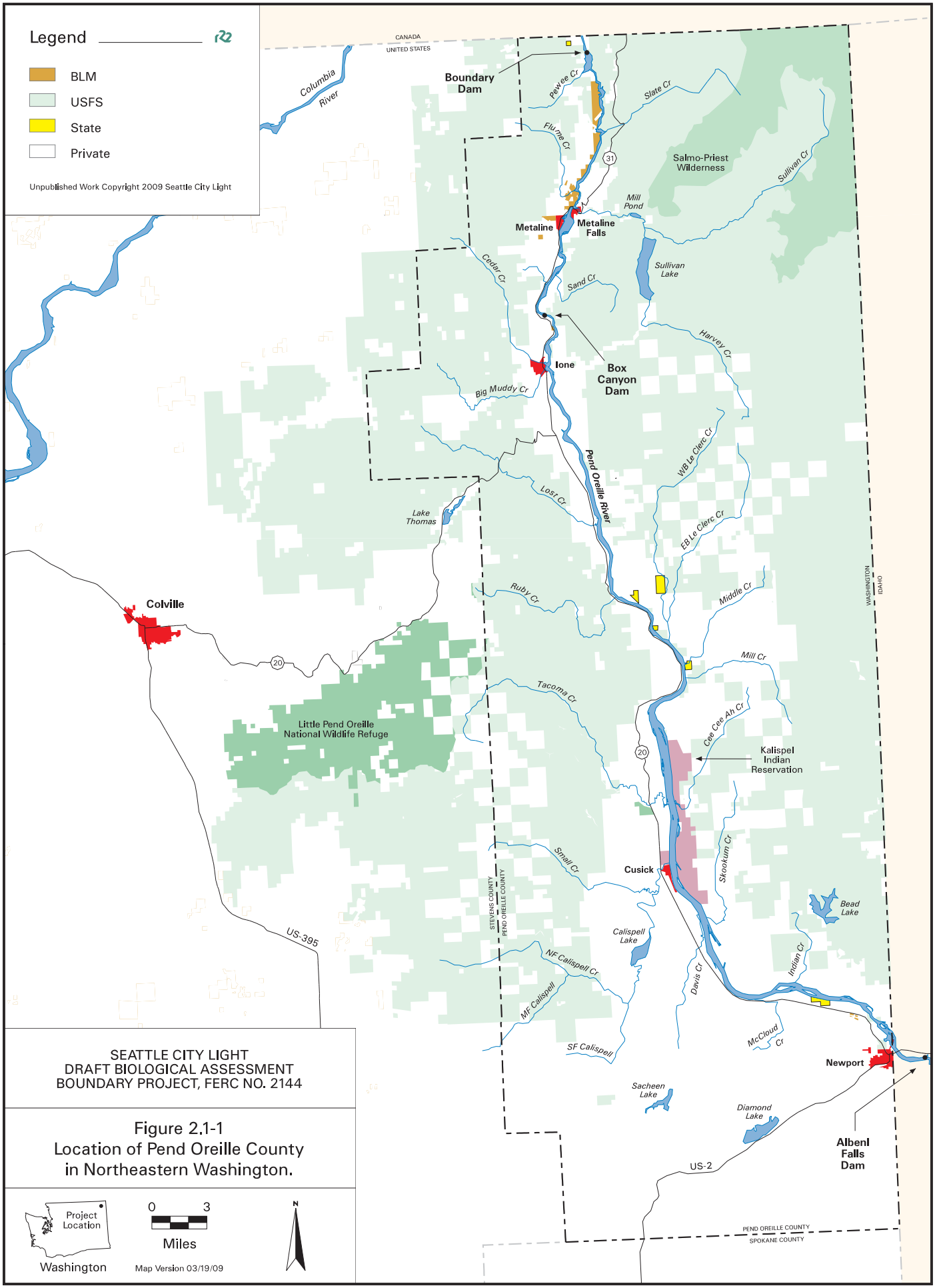
FERC, under the authority of the Federal Power Act (FPA), may issue new licenses for a period of 30 to 50 years for the construction, operation, and maintenance of jurisdictional hydropower projects. FERC is considering the issuance of a new license to SCL for the existing Boundary Project. The purpose of the proposed action is to allow the Project to continue to provide reliable, low-cost electrical energy for the benefit of residential, industrial, and government customers, and to serve the energy needs of the region.

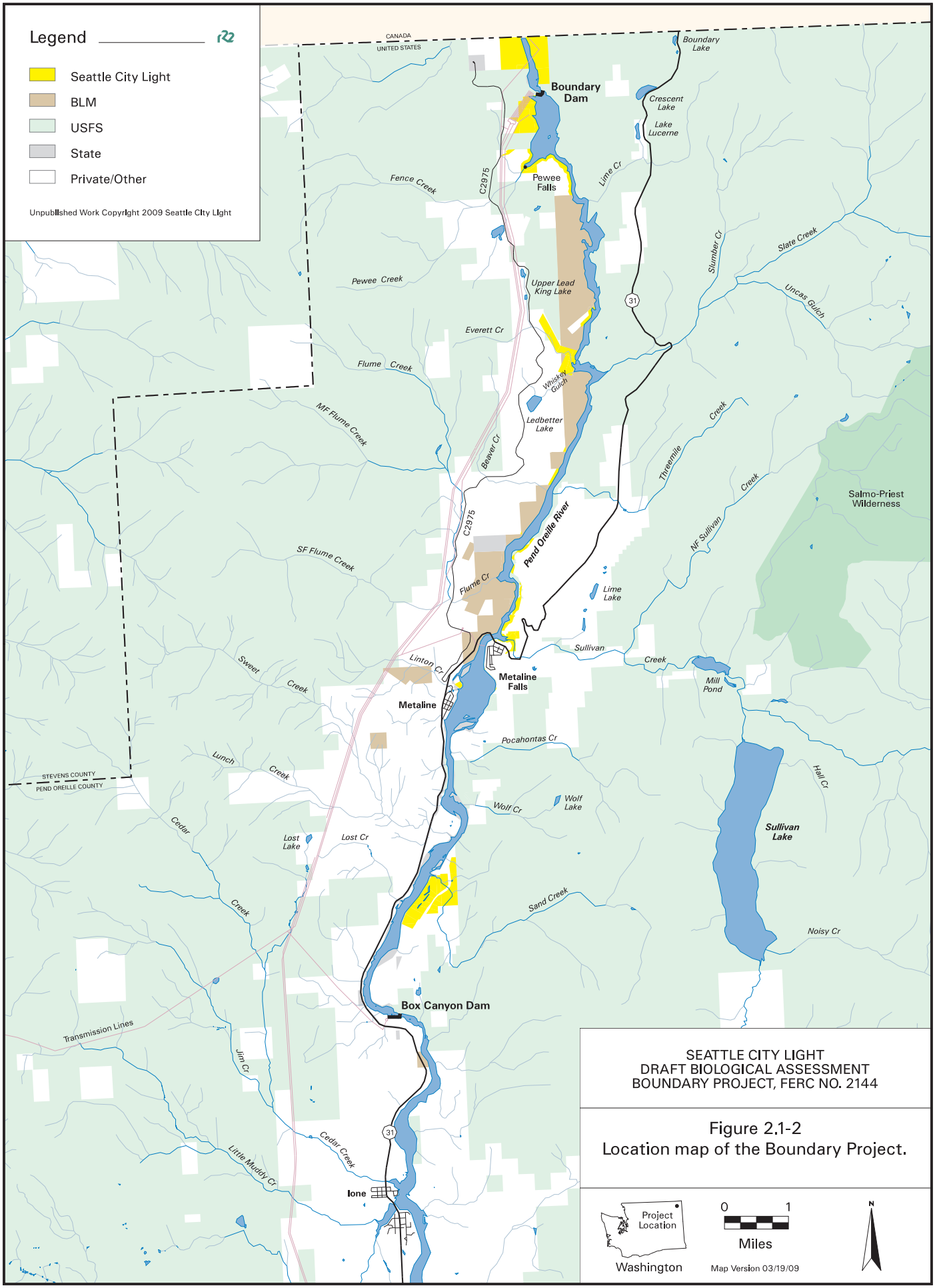
In making a determination as to whether to issue a license for a hydroelectric project, FERC must conclude that the Project will be best adapted to a comprehensive plan for improving and/or developing a waterway. Beyond the power generation and developmental purposes (e.g., flood control, irrigation, water supply) for which licenses are issued, FERC must afford equal consideration to energy conservation; protection, mitigation, and enhancement of fish and wildlife, including Threatened, Endangered, and Sensitive species, and their habitat; protection and enhancement of recreational opportunities; and the overall preservation of environmental quality. In deciding whether and under what terms and conditions a new license should be issued to SCL for the Project, FERC is required to balance the relevant economic, environmental, and engineering factors pertinent to its decision.

2 EXISTING CONDITIONS

2.1. Site Description

The Project is located on the Pend Oreille River in northeastern Washington, one of a total of eleven hydroelectric and storage projects within the Clark Fork-Pend Oreille River basin. The dam is located 1 mile south of the U.S.-Canada border, 16 miles west of the Idaho border, 107 miles north of Spokane, and 10 miles north of Metaline Falls, in Pend Oreille County (Figure 2.1-1). The dam is located at Project river mile (PRM) 17.0 on the Pend Oreille River, in the NE ¼ of Section 10, Township 40N, Range 43E, Willamette Meridian. The upstream end of the Project reservoir (Boundary Reservoir) is located immediately downstream of the Box Canyon Dam, at PRM 34.5, in the NE ¼ of Section 19 of Township 38N, Range 43E. The Project, surrounding geographic features, and general land ownership are shown on the location map in Figure 2.1-2. The Project area lies within the Washington Department of Ecology's (Ecology) Watershed Resource Inventory Area (WRIA) 62 and U.S. Geological Survey (USGS) Hydrologic Unit (HUC) 17010216.


Legend
BLM
USFS
State
Private
Unpublished Work Copyright 2009 Seattle City Light
CANADA
UNITED STATES
Columbia River
Boundary Dam
Pewee Cr
Slate Cr
Fluma Cr
31
Salmo-Priest Wilderness
Sullivan Cr
Mill Pond
Metaline
Metaline Falls
Cedar Cr
Sand Cr
Sullivan Lake
Harvey Cr
Ione
Box Canyon Dam
Big Muddy Cr
WB Le Clerc Cr
Pend Oreille River
Lost Cr
Lake Thomas
EB Le Clerc Cr
Ruby Cr
Middle Cr
Colville
20
Mill Cr
Tacoma Cr
Little Pend Oreille National Wildlife Refuge
Cee Cee Ah Cr
Kalispel Indian Reservation
Small Cr
Cusick
Skookum Cr
STEVENS COUNTY
PEND OREILLE COUNTY
Bead Lake
US-395
Calispell Lake
NF Calispell Cr
Davis Cr
Indian Cr
MF Calispell
McCloud Cr
SF Calispell
Newport
Sacheen Lake
Diamond Lake
Albeni Falls Dam
US-2
PEND OREILLE COUNTY
SPOKANE COUNTY
WASHINGTON
IDAHO
SEATTLE CITY LIGHT
DRAFT BIOLOGICAL ASSESSMENT
BOUNDARY PROJECT, FERC NO. 2144
Figure 2.1-1
Location of Pend Oreille County
in Northeastern Washington.
Project Location
Washington
0
3
Miles
Map Version 03/19/09
N


Legend
Seattle City Light
BLM
USFS
State
Private/Other
Unpublished Work Copyright 2009 Seattle City Light
CANADA
UNITED STATES
Boundary Lake
Boundary Dam
Crescent Lake
Lake Lucerne
Fence Creek
C2975
Pewee Falls
Lime Cr
Slumber Cr
Slate Creek
Pewee Creek
Upper Lead King Lake
Uncas Gulch
Everett Cr
Flume Creek
Whiskey Gulch
MF Flume Creek
Ledbetter Lake
Beaver Cr
Threemile Creek
Salmo-Priest Wilderness
NF Sullivan Creek
Pend Oreille River
SF Flume Creek
Flume Cr
Lime Lake
Sullivan Creek
Linton Cr
Metaline Falls
Sweet Creek
Metaline
Mill Pond
Pocahontas Cr
Lunch Creek
STEVENS COUNTY
PEND OREILLE COUNTY
Hall Cr
Wolf Cr
Wolf Lake
Cedar Creek
Lost Lake
Lost Cr
Sullivan Lake
Sand Creek
Noisy Cr
Box Canyon Dam
Transmission Lines
Jim Cr
Cedar Creek
Little Muddy Cr
Ione
SEATTLE CITY LIGHT
DRAFT BIOLOGICAL ASSESSMENT
BOUNDARY PROJECT, FERC NO. 2144
Figure 2.1-2
Location map of the Boundary Project.
Project Location
Washington
0
1
Miles
Map Version 03/19/09
N

With a total drainage area of 26,260 square miles (25,090 square miles in the United States and 1,170 square miles in Canada), the Pend Oreille River is one of the two main tributaries to the Columbia River, contributing approximately 10 percent of the Columbia River's flow on an annual basis (Muckleston 2003). The Pend Oreille River is approximately 120 miles long from its head at the outlet of Lake Pend Oreille to its confluence with the Columbia River. On average, the Pend Oreille River gains about 1,300 cubic feet per second (cfs) between Albeni Falls Dam and Boundary Dam, about 18 percent of that inflow coming from Sullivan Creek, the major tributary to Boundary Reservoir. However, most of the Pend Oreille River's tributaries in Washington are small streams.

Average annual flows in the Pend Oreille River for the 92-year period of record (1912-2004) were analyzed to determine historical trends in basin hydrology (SCL 2008a). The long-term average flow during this period was 26,370 cfs. Annual runoff is produced primarily by melting snow upstream of the Project, with peak flows typically occurring from April through June. A detailed report containing hydrologic statistics that describe the period–calendar years 1987 through 2005–used to characterize existing operations can be found in SCL (2008a). The report also provides a comparison of this dataset to the historic period of record (1912 to 2004).

Lands adjacent to Boundary Reservoir are owned by a mixture of public and private entities. North of Metaline Falls, the reservoir shoreline is owned by private and federal entities, with a large portion of the eastern shoreline falling within the Colville National Forest, which is managed by the USDA Forest Service (USFS). The Bureau of Land Management (BLM), Spokane District, manages a large area along the western shoreline. The portion of the reservoir shoreline south of Metaline Falls is predominantly in private ownership, with some USFS-managed land along the eastern shoreline. Because of the steeply sloping topography and large amount of public land in the Project vicinity, much of the land is undeveloped, with more than two-thirds of the area currently consisting of forested open space.

Boundary Dam, which is situated in a narrow canyon and founded on inter-bedded limestone and dolomite of the Metaline Limestone formation, is a variable-radius concrete arch dam with a total height of 360 feet above the lowest part of the foundation and a structural height of 340 feet. The dam varies in thickness from 8 feet at its crest to 32 feet at its base, has a crest length of 508 feet, and has a total length, including the spillways, of 740 feet. The dam impounds the Pend Oreille River to a normal high water surface elevation of 1,994 feet North American Vertical Datum (NAVD) 88[1], as measured in the forebay. The average elevation of the river surface below the dam is at approximately 1,731 feet NAVD 88; the reservoir provides approximately 263 feet of gross head for power purposes. Greater detail regarding the Project, its facilities, and operation can be found in SCL's License Application.

At its normal maximum water surface elevation at the forebay (1,994 feet NAVD 88), the 17.5-mile-long Boundary Reservoir has a surface area of approximately 1,794 acres, a shoreline length of roughly 47 miles, and a maximum depth in the forebay of approximately 270 feet. The reservoir's gross storage capacity is approximately 87,913 acre-feet (elevation 1,744 NAVD 88 to elevation 1,994 NAVD 88), and its usable storage capacity is approximately 40,843 acre-feet (elevation 1,954 feet NAVD 88 to elevation 1,994 feet NAVD 88). Because of the large amount

[1] Elevation values are in datum NAVD 88 unless otherwise noted.

of water flowing through the system and the limited amount of storage capacity in the reservoir, the residence time of the reservoir is very short. Maximum residence time is less than four days, but more typically residence time is less than two days (Pickett 2004).

Metaline Falls is a geological feature that geographically divides the reservoir into two distinct reaches: an upstream reach that extends from Box Canyon Dam to Metaline Falls and a downstream reach that extends from Metaline Falls to Boundary Dam. The Pend Oreille River passes through a bedrock-controlled constriction located at Metaline Falls (elevation 1,970.6 feet NAVD 88). Gradient and depth of the upstream reach are much less than those of the downstream reach. Depths in the upstream reach typically range from 10 to 25 feet.

The reservoir has been delineated into four reaches based on habitat characteristics: the Forebay Reach (PRM 17.0 – 18.0), the Canyon Reach (PRM 18.0 – 26.8), the Upper Reservoir Reach (PRM 26.8 – 34.5), and the Tailrace/Seven Mile Reservoir Reach (PRM 13.9 – 17.0). The Forebay Reach is wide and deep, with steep-walled banks and maximum water depths to approximately 270 feet. The Canyon Reach is predominantly narrow with steep, rock walls. The Upper Reservoir Reach is relatively wide, with depths from 10 to 25 feet. The Tailrace Reach is characterized by deep pools (> 75 feet) in the spillway and turbine afterbays but is generally less than 30 feet deep. At low Seven Mile Reservoir water surface elevations, riverine habitat is present in the Tailrace Reach downstream to the confluence with Red Bird Creek. At high Seven Mile Reservoir water surface elevations, the riverine habitat above the Red Bird Creek confluence up to the base of Boundary Dam becomes reservoir habitat. Greater detail regarding the physical habitat and aquatic resources in the Project area can be found in SCL's Pre-Application Document (PAD; SCL 2006) and Updated Study Report (USR; SCL 2009a).

Summer water temperatures in Boundary Reservoir at times exceed 20 ˚C (68 ˚F), which is too warm to provide optimum summer habitat for native trout species (i.e., generally less than 16 ˚C [61˚F], Bjornn and Reiser 1991). Phosphorous and nitrogen concentrations are low throughout the year, and phytoplankton chlorophyll *a* concentrations (at times < 2.8 µg/l) indicate that the system is oligotrophic. The zooplankton community is limited by food availability in the reservoir, which is controlled to a large degree by nutrients and phytoplankton entrained in the inflow from Box Canyon Reservoir.

At least 28 species of fish occur in the Project area (SCL 2009b). Although anadromous fish are not found in Boundary Reservoir, some fish species (especially bull trout) potentially found in the reservoir can have adfluvial life histories. Densities of all fish species are low in deep water within the reservoir, most of which occurs in the Forebay and Canyon reaches. The Forebay Reach fish community is dominated by largescale sucker, northern pikeminnow, peamouth, yellow perch, and smallmouth bass. Hatchery-reared rainbow trout are commonly observed, cutthroat trout are rarely found, and no bull trout have been captured or observed. The Canyon Reach is dominated by northern pikeminnow, largescale sucker, redside shiner, and peamouth. Smallmouth bass and yellow perch are abundant, and hatchery-reared rainbow trout are commonly observed. Bull trout have been captured near the mouth of Slate Creek in this reach (see Section 2.3 of this BA). Based on the Shannon-Weiner diversity index (SWI) (Ricklefs 1979), fish species diversity is higher in the Upper Reservoir Reach (SWI 2.08) than it is downstream of Metaline Falls (SWI ranges from 1.55 to 1.87), likely as the result of increased

habitat diversity. The fish community in the Upper Reservoir Reach is also dominated by minnows and suckers, although mountain whitefish are found in greater abundance than they are below Metaline Falls.

The fish community in the Tailrace Reach is dominated by northern pikeminnow, largescale sucker, redside shiner, and peamouth. Smallmouth bass is the most abundant sport fish species. Mountain whitefish and both wild and hatchery-reared rainbow trout are commonly observed. In the past, bull trout rarely have been captured. Three bull trout were captured in the Boundary Dam tailrace during 2007 - 2008 as part of fisheries studies conducted by SCL, and a fourth bull trout, radio-tagged as part of BC Hydro's Salmo River bull trout telemetry study, was detected by a receiver in the Boundary Dam tailrace in 2008 (SCL 2009b). Two of the bull trout captured in the tailrace were large enough to radio-tag (SCL 2009b). Genetics analysis confirmed that two of the captured bull trout originated in tributaries to Lake Pend Oreille and one originated in the Salmo River (P. DeHaan, USFWS, personal communication, November 14, 2007 and January 12, 2009).

The dominant vegetation cover in the study area is mixed coniferous forests of Douglas-fir, western red cedar, and western hemlock (Franklin and Dyrness 1988), growing on moderately steep slopes of rocky, well-drained soils. Most of the area surrounding the Project is forested, with both dry and moist mixed coniferous forests present, although the moist type is dominant. Harvested stands, including clear cuts and selective cuts harvested since the mid 1970s, account for 24 percent of the land in the Project vicinity and contain a species composition similar to forested lands. Other vegetation and cover types include shrub- and grass-dominated areas, sparsely vegetated rock outcrops, and some wetlands. For greater detail regarding the vegetation communities, see the USR (SCL 2009a).

Of the total of 308 terrestrial vertebrate wildlife species that potentially occur in the area surrounding the Project, 152 species were confirmed during relicensing studies (SCL 2006; SCL 2009a). Species present represented all major groups of terrestrial vertebrates (i.e., mammals, birds, reptiles, and amphibians). Threatened and Endangered wildlife species that could occur in the Project vicinity include Canada lynx, grizzly bear, and woodland caribou.

2.2. Action Areas

2.2.1. Aquatic Action Area

For aquatic Threatened species, the Action Area extends from the Canada Border, which is located 1.0 mile downstream of Boundary Dam in Seven Mile Reservoir, British Columbia, upstream to the FERC Project boundary located just downstream of Box Canyon Dam.

2.2.2. Terrestrial Action Area

For terrestrial Threatened and Endangered species, the Action Area includes the entire area within the FERC Project boundary (Project area). Information on terrestrial Threatened and Endangered species (TES) was obtained primarily from the RTE Wildlife Species Study Final Report (RTE Wildlife Study; SCL 2009a) and incidental observations during other field studies.

The study area described in the final report extends beyond the range of the Project's influence. This study area, referred to in this document as the Project vicinity, is described below:

- *Downstream of Metaline Falls* – The reservoir, fluctuation zone allowed under the current license (as defined in the RTE Wildlife Study) and land within the FERC Project boundary (Project area), which includes most Project facilities, the area 200 horizontal feet (i.e., perpendicular to the shoreline) beyond the high water level along both reservoir shorelines, and the transmission line right-of-way from the power plant to the Bonneville Power Administration (BPA) interconnection.
- *Upstream of Metaline Falls* – The reservoir, fluctuation zone (approximately 1,986 – 2,020 feet NAVD 88, as measured at the USGS gage below Box Canyon Dam), and the land within approximately 200 horizontal feet above the high water level (approximately 2,020 feet NAVD 88) along both reservoir shorelines extending to the FERC Project boundary for the Box Canyon Project.
- The Boundary Wildlife Preserve (BWP; 149[2] acres) and adjoining SCL-owned BWP Addition (89[3] acres).
- 100 horizontal feet along both sides of the river from Boundary Dam to the U.S.-Canadian border (approximately 0.9 mile).
- 50 feet along both sides of Project-related roads, which include the road between the Boundary Dam and the Vista House, the road to the dam off County Road 2975, and the road from the Vista House to SR 31.

2.3. Aquatic Species

Gilbert and Evermann (1894) observed that bull trout (*Salvelinus confluentus*) were "abundant in the Pend d'Orielle River" during their surveys in the late 1800s. Smith (2000), in his ethnography of the Kalispel Tribe, noted that "char" (presumably bull trout) were a component of the Tribe's subsistence along with other resident fish (suckers, trout, chub, and whitefish) and salmon captured near the Salmo River and Kettle Falls. However, there are currently no bull trout spawning populations in the Action Area (Pend Oreille river mile [RM] 17.0 to RM 34.5), although individual bull trout are occasionally observed. Bull trout in the Action Area are within the Pend Oreille Core Area of the Northeast Washington Unit (NWU) of the Columbia River Distinct Population Segment (DPS) (Table 2.3-1). The available information suggests there are two, and perhaps four, populations of bull trout in tributaries to the Pend Oreille River, but only one of them (LeClerc Creek, a tributary to Box Canyon Reservoir) is within the Pend Oreille Core Area. The Salmo River located in British Columbia at RM 12.7 and the Priest River at RM 95.2 are both known to sustain reproducing bull trout populations. LeClerc Creek is suspected of having a small self-reproducing population of bull trout, but its status is unknown (Scholz et al. 2005). Five juvenile bull trout have been observed in Nine Mile Creek, which drains into Seven Mile Reservoir in British Columbia, but additional monitoring is needed to determine if a self-reproducing population is present there. The Salmo River and Nine Mile Creek are located downstream and the Priest River is located upstream of the core area.

[2] Due to parcel delineation updates, this summation has been changed from the previously cited value of 155 acres.
[3] The size of the adjoining SCL-owned parcels is 89 acres, not 88 acres as previously reported.

Table 2.3-1. Threatened fish species that occur in the vicinity of the Boundary Hydroelectric Project.

Species	Scientific Name	Designated ESU/DPS	Federal Status	Listing History
Bull Trout	*Salvelinus confluentus*	Columbia River DPS	Threatened	Listed as Threatened on November 1, 1999.

Tributaries with particular pertinence to bull trout that drain into Boundary Reservoir include Sullivan Creek (RM 27.9), Slate Creek (RM 23.1), and Sweet Creek (RM 32.0). There are also 12 other named tributaries and 13 unnamed tributaries that drain into the Boundary Reservoir. Adfluvial fish habitat is very limited in tributaries to Boundary Reservoir because of stream size and the presence of natural passage barriers at or near the mouths of the tributaries (Table 2.3-2).

Sullivan Creek is the largest tributary, with a drainage area of 142.5 square miles. Two potential natural fish barriers occur at RM 0.60 and RM 0.65 on lower Sullivan Creek. Surveys of these two potential barriers by CES (1996) resulted in the conclusion that while the barriers would be extremely difficult to ascend, passage at some flow levels could not be ruled out. A recent study by a regionally recognized expert in salmonid fish passage concluded that the series of cascades and chutes in Sullivan Creek under low flow (99 cfs) conditions would be passable by bull trout 18 inches or larger, but at high flows (1,528 cfs) the falls is a complete barrier (Powers 2008). Turbulence makes passage difficult at flows higher than 300 to 500 cfs. In addition, the dam at Mill Pond, located 3.25 miles from the mouth of Sullivan Creek, does not include any fish passage facilities and is a complete barrier to upstream fish passage. The dam at the outlet of Sullivan Lake on Outlet Creek is also a complete barrier to upstream fish passage.

Slate Creek has a drainage area of about 32.3 square miles and includes about 3,474 linear feet of adfluvial habitat downstream of a waterfall 19.7 feet in height (McLellan 2001). The Sweet Creek\Lunch Creek drainage has an area of about 11.1 square miles and a series of three waterfalls that limit potential adfluvial habitat to about 2,659 feet. Flume Creek also provides a small amount of adfluvial habitat. McLellan (2001) reported the coordinates of a 13-foot barrier falls approximately 0.2 miles from the mouth of Flume Creek. However, a series of steep cascades and falls within 100 feet of the mouth of Flume Creek may also limit adfluvial access to the creek (Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats Final Report [Tributary Productivity], SCL 2009a). The remaining tributaries average 2.6 square miles in size with a range up to 19.3 square miles.

In the final rule designating critical habitat for bull trout (70 FR 56212), the U.S. Fish and Wildlife Service (USFWS) identified short sections of lower Slate Creek and Sullivan Creek as critical habitat. All impoundments behind dams that have a primary purpose of providing flood control, energy production, or water supply for human consumption were excluded from designation as critical habitat because disruption of these functions could adversely affect human health and safety or would be inconsistent with the President's energy policy at the time of designation (70 FR 56212). Consequently, Boundary Reservoir is not considered critical habitat for bull trout. Except for very small reaches near their mouths, Slate and Sullivan creeks are located on National Forest System lands.

Table 2.3-2. Descriptive statistics for tributaries to Boundary Reservoir.

Stream name	Project river mile	Basin area (mi^2)	Adfluvial habitat length (ft)	2000		2007		2008		Sport fish present[1]
				Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	
Unnamed No. 1	17.2	0.61	82			0.1	9/6	0.1	9/22	
Peewee Creek	17.9	10.37	0	0.4	09/25	2[2]	9/6	2[2]	9/22	CTT, EBT
Unnamed No. 2	17.9	0.02	129			0.004	9/6	Dry	9/22	
Lime Creek	19.45	2.93	6,746	2.8	09/26	2.7	9/6	0.5	9/22	EBT
Everett Creek	21.9	2.18	60			0.3	9/6	2	9/22	
Whiskey Gulch	21.9	0.70	547			Dry	9/6	Dry	9/22	
Slate Creek	22.2	32.33	3,474	10.9	07/31	6.8	9/6	8.3	9/22	CTT, EBT, RBT
Beaver Creek	24.3	1.77	0			0.9	9/7	3	9/22	
Threemile Creek	24.3	4.91	0			0.5	9/7	2	9/22	EBT, RBT
Unnamed No. 3	25.4	0.15	58			0.04	9/7	Dry	9/22	
Flume Creek	25.8	19.33	1,056[3]	8.8	09/06	5.0	9/7	6.6	9/5	EBT
Sullivan Creek	26.9	142.46	21,729	77.7	08/16	40.5	9/10	59.5	9/5	BBT, BRT, CTT, EBT, KOK, MWF, RBT
Unnamed No. 4	27.1	0.08	77			--[4]	--[4]	--	--	
Linton Creek	28.1	2.11	19,159			1.9	9/8	1.8	9/6	
Unnamed No. 5	28.9	0.62	130			0.1	9/8	--	--	
Unnamed No. 6	29.2	0.01	955			Dry	9/11	--	--	
Pocahontas Creek	29.4	3.92	16,480			Dry	9/9	Dry	9/22	
Unnamed No. 7	29.6	0.30	53			Dry	9/11	--	--	
Unnamed No. 8	30.1	0.07	66			Dry	9/11	--	--	
Wolf Creek	30.3	1.57	236			Dry	9/11	--	--	
Sweet Creek / Lunch Creek	30.9	11.12	2,6593	5.3	09/11	2.5	9/11	2.8	9/5	BRT, CTT, EBT, MWF, RBT
Unnamed No. 9	31.1	0.04	67			Dry	9/11	Dry	9/22	
Sand Creek	31.7	8.22	1,3203	0.4	09/07	Dry	9/11	Dry	9/22	CTT, EBT, RBT
Lost Creek	32.2	1.20	165			0.03	9/12	1.4	9/23	CTT
Unnamed No. 10	33.5	0.93	99			0.001	9/12	0.3	9/23	
Unnamed No. 11	33.6	0.23	78			0.002	9/12	Dry	9/23	
Unnamed No. 12	34.0	0.93	<100			0.06	9/12	0.5	9/23	
Unnamed No. 13	34.3	1.72	<100			0.4	9/12	1.5	9/23	

Notes:

1 Blanks = non-fish-bearing or unsurveyed streams: EBT, eastern brook trout; CTT, cutthroat trout; RBT, rainbow trout; MWF, mountain whitefish; BLT, bull trout; KOK, kokanee; BBT, burbot; sources: USFS (2005); McLellan (2001); FERC (1998).

2 Flow rate at the base of Pewee Falls was visually estimated.

3 Adfluvial habitat based on distance from stream mouth to lowermost migration barrier reported in McLellan (2001) and/or Andonaegui (2003).

4 No tributary channel could be found in September 2007.

cfs – cubic feet per second

-- no data collected

Few bull trout have been observed in the Action Area since the early 1980s (Table 2.3-3). Within Sullivan Creek, the one documented bull trout observed was gutted (McLellan 2001), indicating it had been captured by an angler, but it is unknown if the fish was captured in Sullivan Creek or caught somewhere else and discarded there by the angler. Another unidentified char was also observed in Sullivan Creek by snorkelers, but they were unable to confirm its identity (SCL 2009b). Three bull trout have been captured within or near the mouth of Sweet Creek (Lembcke 2001; McLellan 2001). Fyke nets were deployed just upstream of the mouths of both Sullivan Creek and Sweet Creek during 2007 and 2008, but failed to capture any bull trout (SCL 2009b). Three bull trout were captured in the Boundary Dam tailrace during 2007 - 2008 as part of fisheries studies conducted by SCL. A fourth bull trout, radio-tagged as part of BC Hydro's Salmo River bull trout telemetry study, was detected by a receiver in the Boundary Dam tailrace in 2008 (SCL 2009b), and a radio-tagged bull trout captured in Lake Pend Oreille near Memaloose Island and released at the Newport Boat ramp in Box Canyon Reservoir was detected in the Canyon Reach during July 2009 (Olson, J., personal communication, August 4, 2009). Two of the bull trout captured in the tailrace were large enough to radio-tag (SCL 2009b). Genetics analysis confirmed that two of the captured bull trout had originated in tributaries to Lake Pend Oreille and one had originated in the Salmo River (P. DeHaan, USFWS, personal communication, November 14, 2007 and January 12, 2009).

No bull trout have been observed in Slate Creek despite numerous surveys (McLellan 2001; CES 1996; R2 Resource Consultants 1998a; Terrapin 2000). However, bull trout have been observed on several occasions in Boundary Reservoir near the mouth of Slate Creek, and R2 Resource Consultants (1998a) suggested that Slate Creek outflow provides a coldwater refuge for bull trout in the reservoir during warmer months. The USFS reported that several bull trout were captured near the outlet of Slate Creek in 1994 and 1995 using hook and line (USFS 1998; T. Shuhda, USFS Fisheries Biologist, personal communication, April 2005). In addition, a single bull trout was captured twice in 1997 near the outlet of Slate Creek using a trap (R2 Resource Consultants 1998a), and one bull trout was captured in 1999 (FERC 2004). During 1999 a weir designed to capture both upstream- and downstream-moving fish was deployed 150 feet upstream of the creek's mouth between August 19 and November 11, but no bull trout were captured (Terrapin 2000). Fyke nets deployed during 2007 and 2008 also failed to capture any bull trout (SCL 2009b).

Table 2.3-3. Observations of bull trout in Boundary Reservoir, Boundary Dam tailrace, and tributaries to Boundary Reservoir, 1980 - 2009.

Location	No. of Fish	Size (mm)	Month and Year	Genetic Testing[1]	Comment	Source
Mouth of Sweet Cr	1	508	Fall 1980, 81 or 82	U		Andonaegui (2003)
Sweet Cr	1	864	Fall 1980, 81 or 82	U	Dead	Andonaegui (2003)
Sullivan Cr below natural chute at RM 0.65	1		1993	U	Char species ID not verified	Andonaegui (2003)
Boundary Reservoir at mouth of Slate Cr	2		1994	U		Andonaegui (2003)
Boundary Reservoir at mouth of Slate Cr	3	432-483	1995	U		Andonaegui (2003)
Sweet Cr below Falls	1	300	Sept 2000	N		McLellan (2001)
Sullivan Cr	1	757	Sept 1993	N	Gutted carcass	CES (1996)
Boundary Reservoir at mouth of Slate Cr	1	218	Aug and Nov 1997	N	This fish caught twice	R2 Resource Consultants (1998a)
Boundary Reservoir at mouth of Slate Cr	2	457, 508	Aug 1999	N		Terrapin (2000)
Boundary Tailrace	1	285	June 2007	Y	Population Source: Salmo R.	SCL (2009b)
Sullivan Cr	1		Sept 2007	N	Char species ID not confirmed	SCL (2009b)
Boundary Reservoir	1		April 2008	Y	bull/brook hybrid	SCL (2009b)
Boundary Reservoir	1	305	Aug 2008	N	Char species ID not confirmed	SCL (2009b)
Boundary Tailrace	2	248, 530	Nov/Dec 2008	Y	Population Source: Tributaries to Lake Pend Oreille	SCL (2009b)
Boundary Tailrace	1[2]		Dec 2008	NA	Population Source: Salmo River	SCL (2009b)
Boundary Reservoir Canyon Reach	1	538	July 21, 2009	Y	Radio-tagged fish Population Source: Gold Cr	Olson J. (pers. comm. 2009)
Total	21	218 - 864				

Notes:

1 U: Unknown, but unlikely that genetic testing occurred; N: No genetic testing occurred; Y: genetic testing occurred.

2 Radio-tagged individual detected by a receiver in the Boundary Dam tailrace.

Currently, adfluvial bull trout may use the Pend Oreille River on a seasonal basis, but water temperatures are too high during summer for continuous use (Figure 2.3-1). The range of water temperature recorded at 15-minute intervals between May 2007 and September 2008 was 3.3 - 25.2 ˚C and averaged 13.9 ˚C. Although it does not occur every year, the Forebay Reach was observed to ice-over for a period during the winters of 2007 and 2008. Water temperatures in the Action Area exceed 20 ˚C every year and at times exceed 24 ˚C. Temperatures in excess of 20 ˚C commonly occur during the months of July through September (Water Quality Constituent and Productivity Monitoring Final Report [Water Quality Constituent and Productivity], SCL 2009a). Vertical water temperature profiles taken monthly at seven locations in Boundary Reservoir show that there is little or no thermal stratification of the water column. Water temperature modeling (CE-QUAL-W2) conducted in support of SCL's application for Clean Water Act, Section 401 certification and the Interstate (Idaho and Washington) Temperature Total Maximum Daily Load (TMDL) process demonstrates that existing water temperatures in the Pend Oreille River are similar to what they were under natural conditions, i.e., the modeling indicates that water temperatures in the mainstem under natural conditions often exceeded 20 ˚C during summer months (see Section 4.5.2.2.2 in Exhibit E of the License Application for greater detail regarding the results of temperature modeling).

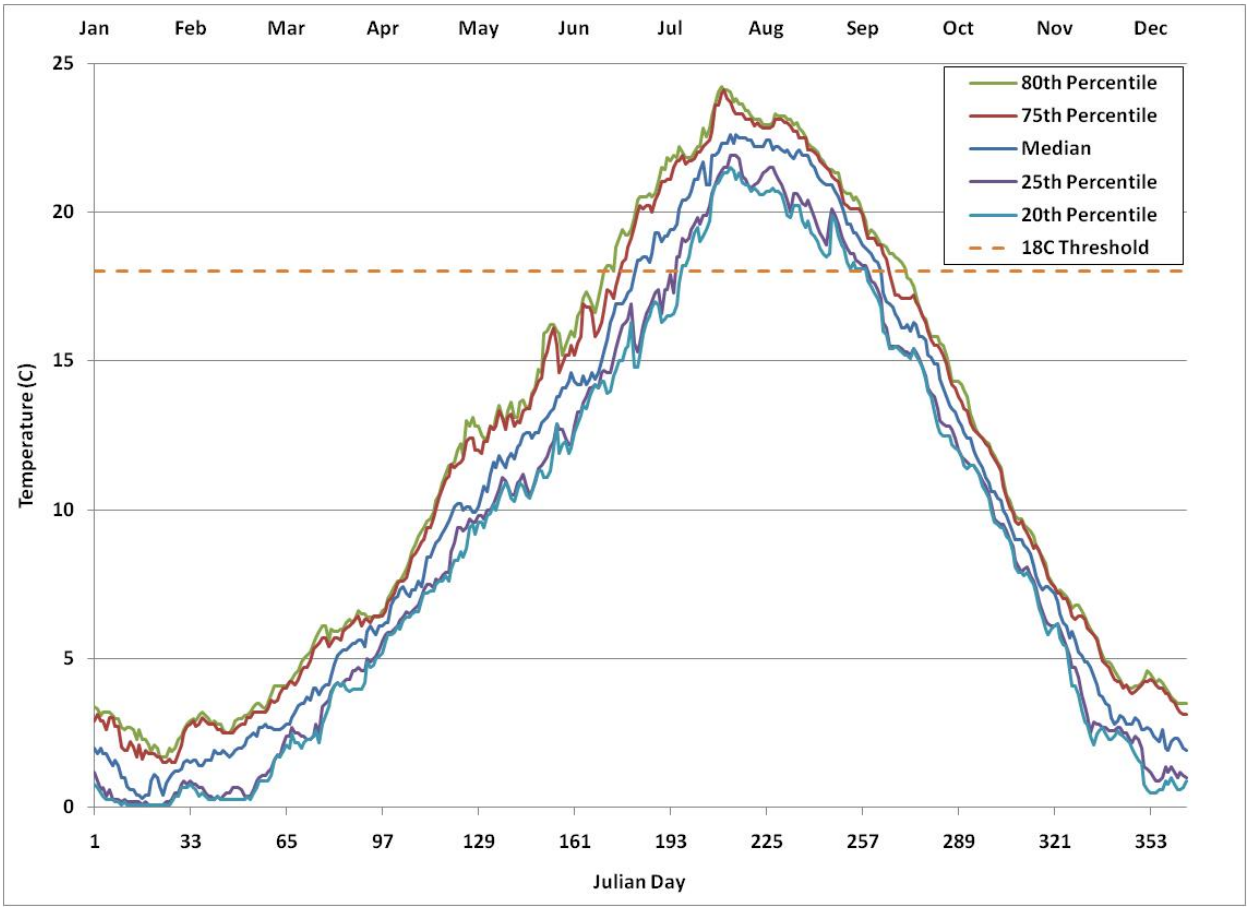


Figure 2.3-1. Median, 75th, and 80th percentile of average daily temperature at USGS gage 12398600 located at the international boundary for water years 1974 through 2007.

Observations of bull trout near Albeni Falls Dam (Geist et al. 2004; Dupont and Horner 2003), cutthroat trout, mountain whitefish, and triploid rainbow trout in Boundary Reservoir (SCL 2009b), and brown trout in Box Canyon Reservoir (Garrett and Bennett 1995) suggest that salmonids use thermal refugia when mainstem river temperatures begin to exceed 18 ˚C. Bull trout were captured and observed via snorkeling below Albeni Falls near a culvert that provided a thermal refuge (Geist et al. 2004). Geist et al. (2004) reported at the time of capture that river temperatures ranged from 18.0 to 23.1 ˚C, while the plume created by inflow from the culvert ranged from 11.8 to 15.0 ˚C, depending on the day and depth.

Seasonal use of the Pend Oreille River by bull trout is evident from the studies completed by DuPont et al. (2007), DuPont and Horner (2003), Geist et al. (2004), and Scholz et al. (2005), but use patterns throughout the year are uncertain, particularly in Boundary Reservoir where few bull trout have been observed and only a single observation from July 2009 is available from a radio-tracked individual. Few bull trout currently use the mainstem Pend Oreille River downstream of Albeni Falls for rearing, and it is possible that the bull trout observed in the mainstem river may originate in the Priest River, Lake Pend Oreille, or their tributaries (Scholz et al. 2005).

During 2003 and 2004 at least 13 bull trout were captured or observed at several locations in the upper reaches of Box Canyon Reservoir, with most of these found in a localized area near a culvert releasing cool spring water (Scholz et al. 2005). Scholz et al. (2005) reported that two radio-tagged bull trout captured downstream of Albeni Falls Dam and released above the dam moved rapidly into Lake Pend Oreille. In addition, six of the seven radio-tagged bull trout tracked in 2003 below Albeni Falls Dam moved upstream towards the dam (Geist et al. 2004). All six bull trout tagged after spawning in the East River, a tributary to Priest River, migrated down the Priest River then migrated upstream in the Pend Oreille River to overwinter in either the river or Lake Pend Oreille (DuPont et al. 2007). Three of the six bull trout returned to the East River by July 1 of the following year for spawning. As noted above, a radio-tagged bull trout captured in Lake Pend Oreille near Memaloose Island and released at the Newport Boat ramp in Box Canyon Reservoir was detected in the Canyon Reach during July 2009 (Olson, J., personal communication, August 4, 2009). Scholz et al. (2005) indicated that bull trout were historically present in the Box Canyon reach and implied that it was reasonable to assume that at least some of them originated in local tributaries because of documented bull trout observations in four tributaries to Box Canyon Reservoir. The degree to which tributaries above or below Albeni Falls Dam historically contributed to bull trout use in the mainstem Pend Oreille River downstream of Albeni Falls is unknown. Regardless of their source, bull trout numbers declined rapidly after construction of Albeni Falls Dam in 1952 (USFWS 2000).

Bull trout mature at five to six years of age during spawning migrations to their natal streams (Scholz et al. 2005). Bull trout are iteroparous and repeat spawning annually or in alternate years. In the Salmo River, which has its confluence with the Pend Oreille River at RM 12.7 (approximately 4.3 miles downstream of Boundary Dam), bull trout spawning migrations begin in June through early August, spawning peaks during early September, and post-spawning migration to overwintering habitat is completed by the end of November (Baxter and Nellestijn 2000; DuPont et al. 2007). Baxter and Nellestijn (2000) consider the Salmo River bull trout population to have a primarily fluvial life history pattern, whereas DuPont et al. (2007) suggested that many bull trout from the East River display an allacustrine behavior pattern, meaning that

spawning areas are in the outlets to lacustrine (lake) rearing areas. The behavior pattern observed by DuPont et al. (2007) is a unique form of allacustrine behavior because both downstream and upstream movements are needed between rearing and spawning areas.Few bull trout from the Salmo River are known to enter Seven Mile Reservoir. However, one Salmo River bull trout was captured, and another detected via telemetry, in the Boundary Dam tailrace in 2008, suggesting that some remnant of an adfluvial life history pattern may still be present in the population.

Bull trout spawning sites are characterized by low-gradient, uniform flow, and gravel substrate between 0.6 and 5 centimeters (0.2 - 2.0 inches) in diameter (Wydoski and Whitney 2003; Fraley and Shepard 1989). Groundwater influence and proximity to cover are also reported as important factors in spawning site selection (Fraley and Shepard 1989). Studies conducted throughout the species' range indicate that spawning occurs in water from 0.75 to 2.0 feet deep (Wydoski and Whitney 2003; Fraley and Shepard 1989) and often occurs in reaches fed by streams or near other sources of cold groundwater (Pratt 1992).

Bull trout require a long period of time from egg deposition until emergence. Rieman and McIntyre (1993) indicate that optimum incubation temperatures are between 2 and 4 ºC. The alevins remain in the streambed, absorbing the yolk sac, for an additional 65 to 90 days after hatching (Pratt 1992). Emergence from the streambed occurs in late winter/early spring (Pratt 1992). High levels of fine sediment in spawning substrates reduce embryo survival, but the extent to which this affects bull trout populations is not entirely known (Rieman and McIntyre 1993). Long winter incubation periods for native char embryos and alevins make them particularly vulnerable to increases in fine sediments (USFWS 1998).

Scholz et al. (2005) summarized the available information on juvenile bull trout migratory behavior. They concluded that most migratory bull trout outmigrate from tributaries at age 2 to 3 and at a size of 170 to 300 millimeters (6.7 - 11.8 inches). The juvenile outmigration from tributaries to Lake Pend Oreille peaks during May, but information from other areas (i.e., Flathead River, Metolius River, Mill Creek) shows that some juveniles also outmigrate in early to late summer.

Bull trout are typically thought to occur in steeper gradient, more upstream stream reaches than other salmonid species. Adult bull trout have a greater ability to navigate waterfalls and cascades that impede the upstream migration of many other salmonid species. Rather than exhibiting unusual leaping abilities, bull trout have been observed to seek out channel margins and bypass falls during high flow events or to burrow through logjams to ascend to upstream reaches. Bull trout can also exhibit a patchy distribution, where they are found in only some tributaries or reaches within a watershed (Watson and Hillman 1997; Baxter 1995). Bull trout may occur in greater densities in these higher gradient reaches to avoid higher water temperatures in downstream reaches, and possibly because of an inability to compete effectively with other salmonid species (Stolz and Schnell 1991).

The WDFW lists the following factors as limiting for bull trout: stream temperatures that exceed the normal spawning and incubation temperature range, lack of spawning and rearing habitat, and a high percentage of fine sediment in spawning gravels (WDFW 1998). Because of their

close association with the bottom, native char, including bull trout, are sensitive to changes in the streambed (Fraley and Shepard 1989; USFWS 1998). Bull trout readily interbreed with non-native brook trout (*Salvelinus fontinalis*), which results in the production of infertile hybrids, thus reducing the potential ecological fitness of bull trout. Brook trout may also exclude bull trout from suitable habitat (USFWS 1998). Finally, bull trout are easily caught, making them highly susceptible to fishing pressure. Any increase in the accessibility of a population to fishing pressure may negatively impact that population (Fraley and Shepard 1989; USFWS 1998).

The NWU Recovery Team for bull trout has designated the Pend Oreille River and its tributaries from Albeni Falls Dam to the U.S.-Canada border as a core area. To develop recovery criteria, the NWU Recovery Team used professional judgment, knowledge of the NWU, and guidance from Rieman and McIntyre (1993) and Rieman and Allendorf (2001). The guidance (Rieman and McIntyre 1993) included the suggestion that fish in core areas with less than five interconnected local populations are at increased risk of extirpation, while fish in core areas with five to 10 local populations are at intermediate risk, and those with more than 10 local populations are at diminished risk. Furthermore, Rieman and Allendorf (2001) suggested that local effective population sizes of more than 50 adults and core area effective populations greater than 1,000 adults minimize adverse genetic effects to the population.

Although there is at most one tributary (LeClerc Creek) within the Pend Oreille River Core Area that may have some bull trout reproduction, nine tributaries were identified by the NWU Recovery Team as having the potential to sustain local bull trout populations and were assigned numeric recovery goals for adult migratory fish with an overall core area recovery goal of 1,575 - 2,625 fish. Two of these tributaries drain into Boundary Reservoir, Slate and Sullivan creeks, which have goals of 25 - 75 fish and 600 - 850 fish, respectively. The remaining seven, Cedar Creek; Ruby Creek, LeClerc Creek, Mill Creek, Tacoma Creek, Calispell Creek, and Indian Creek, drain into Box Canyon Reservoir. Of the Box Canyon tributaries, LeClerc Creek has the largest goal of 400 to 500 adult fish. Detailed population or habitat information used as the basis for including or excluding specific tributaries as local populations is not available or identified in USFWS (2002), nor is there a specific plan for establishing bull trout populations where there currently are none. However, the NWU Recovery Team indicated that artificial propagation might be needed to achieve recovery within 25 years.

The NWU Recovery Team stated that recovery in the NWU was contingent upon reconnecting the Pend Oreille River with the Lower Clark Fork River Subunit that lies upstream of the Pend Oreille Core Area and Albeni Falls Dam (RM 86.9). Albeni Falls Dam impounds the upper 18 miles of the Pend Oreille River and portions of Lake Pend Oreille, the Priest River, and the Clark Fork River (to Cabinet Gorge Dam). The Priest River is located about 5 miles upstream of Albeni Falls Dam. The USFWS Biological Opinion (USFWS 2000) concluded that completion of Albeni Falls Dam was responsible for the "abrupt decline" of bull trout in the Pend Oreille River.

2.3.1. Reservoir and Delta Habitat Conditions

2.3.1.1. Spawning and Incubation

Bull trout are not known to spawn in Boundary Reservoir, the Project tailrace, or tributary deltas that could be affected by Project operations. Scholz et al. (2005) describe bull trout spawning habitat as small tributaries with sufficient cover and upwelling. Consequently, it is not anticipated that bull trout would spawn in Boundary Reservoir. During the relicensing process, state, federal, and tribal RPs agreed that spawning and fry life history stages do not occur in Boundary Reservoir or tailrace and, therefore, did not require modeling (SCL 2008b).

2.3.1.2. Sub-Adult Rearing

Juvenile bull trout typically rear in natal streams for two to three years and outmigrate at a length of about 170 to 300 millimeters (6.7 - 11.8 inches) (Scholz et al. 2005). Bull trout become sexually mature at five to seven years of age before returning to upstream areas to spawn. To assess juvenile bull trout habitat use as part of the relicensing process, juveniles were considered to be 55 to 150 millimeters (2.2 - 5.9 inches) in length, and adults were larger. Juvenile bull trout of this size would generally remain in tributaries rather than migrating to the mainstem Pend Oreille River. Nevertheless, potential juvenile bull trout habitat in Boundary Reservoir was assessed during relicensing.

As part of the relicensing process, habitat suitability index (HSI) information for bull trout and its congener, Dolly Varden trout (*Salvelinus malma*), was reviewed. Dolly Varden trout was used as a surrogate species for bull trout because HSI information for bull trout is very rare. HSI data are scaled between 0 and 1, where 1 represents optimal habitat conditions and 0 represents wholly unsuitable conditions. HSI data are usually depicted graphically as a continuous line chart for depth and velocity or a categorical histogram for substrate.

Depth suitability during the middle of the year (early spring through mid-fall; April through October) is generally highest at depths of 0.75 to 4 feet, but suitability declines in deeper waters, with bull trout generally found to depths of up to 20 feet. During winter (November - March), optimal suitability can occur in somewhat deeper water, from about 2.0 to 10 feet, but similar to the summer rearing season, bull trout generally remain at depths above 20 feet.

Optimal water velocities for bull trout are up to about 1.0 foot per second during the winter and 1.5 feet per second (fps) during the middle of the year. Suitability declines rapidly during the winter, with bull trout generally remaining in velocities less than 2.0 fps. In contrast, waters up to 4.0 fps are somewhat suitable during the mid-year rearing period because swimming capacity is greater at higher water temperatures.

Juvenile bull trout have a high propensity for cover, particularly at night (McPhail and Baxter 1996). Large woody debris (LWD) and coarse substrate such as large cobbles and boulders have the highest suitability (1.0) during mid-year and over-wintering periods. Aquatic vegetation has relatively high suitability during mid-year (0.75) but has relatively low suitability during winter. Submerged terrestrial vegetation may occasionally be used during periods of overbank flows.

During winter, areas with no cover have a suitability of 0, meaning that some form cover is required for an area to be used by a juvenile bull trout at this time of year.

Aquatic habitat modeling was used to provide an index of the amount of physical habitat that might be available to bull trout based on the suitability of available water depths, water velocities, and substrate types under existing conditions. For comparability between reaches, the index calculated was weighted useable area (WUA) per foot of river reach. The model suggested that during average flow years the Forebay and Canyon Reaches have a relatively low density (35 square feet or less of monthly minimum WUA per foot of river) of potentially suitable habitat for bull trout juveniles, particularly during the fall and spring months when water surface elevations fluctuate more frequently and over a greater range than during summer (Figure 2.3-2). Monthly minimum WUA density was slightly higher for the Tailrace Reach (36 to 45 square feet per foot of river) and substantially higher for the Upper Reservoir Reach (60 to 158 square feet per foot of river). Because of its greater length, the Upper Reservoir Reach provides the most available potential habitat for juvenile bull trout. Given the overall lack of observations of bull trout less than 150 millimeters (5.9 inches) in length in any of the Project reaches, it is apparent that some factor other than physical habitat is limiting bull trout use of the Project area.

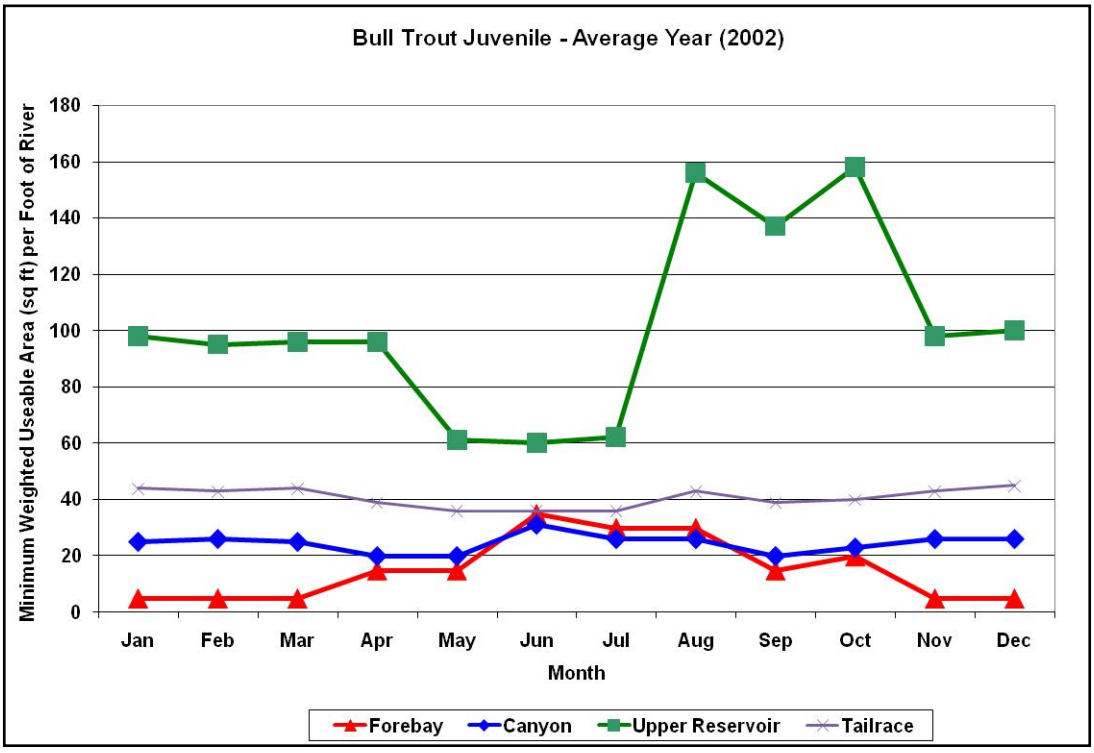


Figure 2.3-2. Monthly WUA minima for juvenile bull trout during an average flow year under existing conditions.

2.3.1.3. Adult Habitat

Adult bull trout (assumed > 150 millimeters [6 inches]) habitat suitability has a broader range than that of juveniles. Based on available HSI information, optimal suitability occurs at depth ranges from 2 to 30 feet during the mid-year rearing period and at depths of 5 to 30 feet in winter. Suitability is less in deeper waters (i.e., 0.2 at 50 feet) year-round, but all depths in Boundary Reservoir are somewhat suitable for adult bull trout. Tracking of bull trout in Lake Pend Oreille by Bassista et al. (2005) suggests that deep water may have a higher suitability than the available HSI information indicates. The five bull trout outfitted with acoustic tags in the Bassista et al. study used benthic areas during spring at a mean depth of 75 feet. During summer, bull trout mostly used benthic areas (66 percent of observations), but were also found in nearshore (25 percent of observations) and pelagic areas. During the fall and winter, observations were only made of two bull trout that were at depths of 26 to 203 feet.

Optimal velocities are 0.20 to 2.25 fps during the mid-year rearing period. Bull trout adults are generally not found at velocities greater than 5.25 fps. During winter, suitable velocities are less than during the mid-year rearing period; optimal velocities are 0.00 to 1.00 fps, and bull trout are generally not found at velocities greater than 4.0 fps during winter. The suitability of different cover types for adult bull trout is the same as for juveniles.

The Aquatic Habitat Model indicated that about three times the density of WUA was available for adult bull trout than for juvenile bull trout under existing conditions, primarily as a result of the higher suitability of deeper and faster water. For an average flow year, the density of WUA was similar for the Upper Reservoir, Canyon, and Tailrace reaches between November and March at about 100 to 160 square feet per foot of river (Figure 2.3-3). In contrast, the Forebay Reach was substantially higher at about 300 square feet per foot of river throughout the year. Between April and October the Upper Reservoir WUA density was more similar to the Forebay Reach. Similar to juvenile bull trout, the relatively few observations of bull trout greater than 150 millimeters (5.9 inches) in length in any of the Project reaches suggests that some factor other than physical habitat is limiting bull trout use of the Project area.

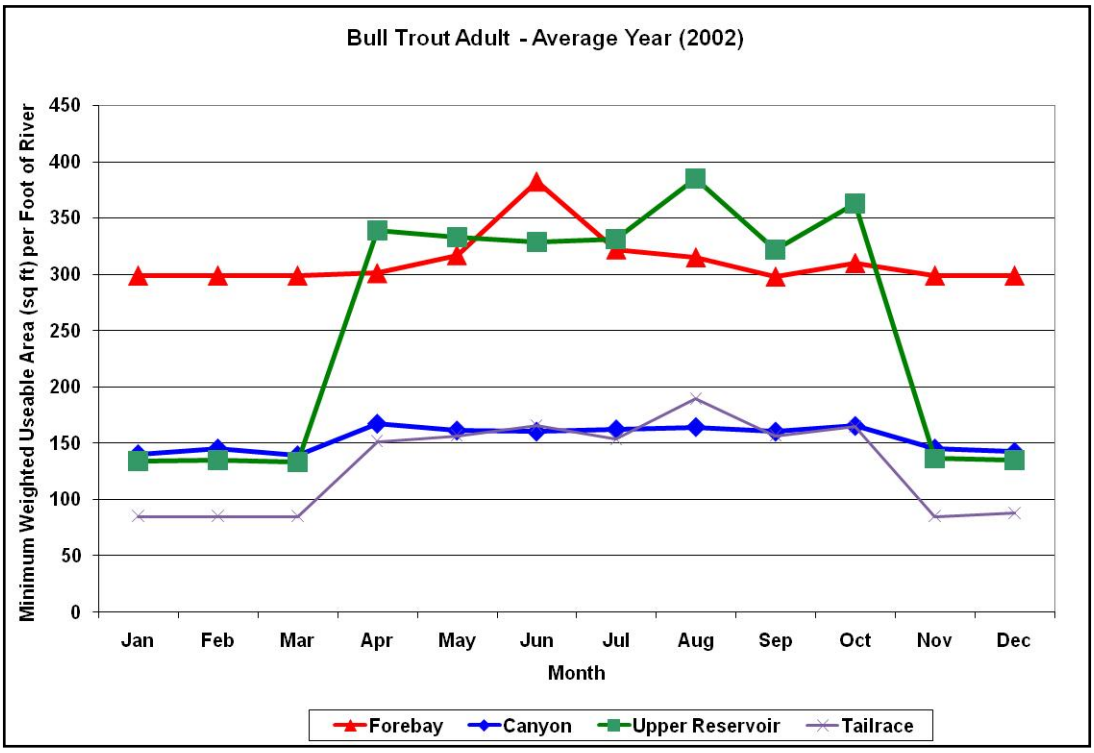


Figure 2.3-3. Monthly WUA minima for adult bull trout during an average flow year under existing conditions.

2.3.1.4. Delta Habitat

Tributary deltas are transition areas between the tributaries and reservoir that, depending upon their physical characteristics, provide a variety of ecological functions. Fish may congregate at the tributary confluence to feed on aquatic organisms transported downstream in the tributary flow, may use the deltas as temperature refugia, or may stage in delta habitats prior to spawning runs. Fry and juvenile fish may rear in complex habitats associated with the deltas, and the influx of tributary water may provide protection from dewatering associated with reservoir water surface elevation fluctuations. Portions of tributary deltas are present in the varial zone of Boundary Reservoir, and therefore are affected by fluctuations in water surface elevation. The fluctuations in elevation associated with Project operations change portions of the deltas from stream habitat to lacustrine habitat as the water surface rises and then back to stream habitat as the water surface falls.

As described previously, there are 28 tributaries that drain into Boundary Reservoir, including 13 unnamed drainages. Most of the tributaries are very small, and some do not contain measurable surface flow during late summer months (Table 2.3-2). Following a screening process that included both desktop geographic information system (GIS) and field assessments, habitat modeling analysis was limited to only those tributary deltas with substantial potential salmonid fish habitat (Sediment Transport and Boundary Reservoir Tributary Delta Habitats Study Final

Report [Sediment Transport and Delta Habitats]; SCL 2009a). Habitat modeling occurred on seven tributary deltas including Slate Creek, Flume Creek, Sullivan Creek, Linton Creek, Pocahontas Creek, Sweet Creek, and Sand Creek. The physical habitat modeling of major tributary deltas translated hourly fluctuations in Boundary Reservoir water surface elevation under existing operations (estimated from the hydraulic routing model) into estimates of a habitat quality rating (HQR) for native salmonids, including bull trout. The HQR model was applied to three historical river flow conditions to evaluate representative tributary delta habitat for wet, dry, and average years. Existing Project operations include a voluntary restriction of forebay water surface elevations at or above 1,984 feet NAVD 88 from 6:00 am through 8:00 pm to facilitate recreational access and use during the period from Memorial Day to Labor Day. From 8:00 pm through 6:00 am of the same period, forebay water surface elevations are voluntarily maintained at or above elevation 1,982 feet NAVD 88. However, because this measure is voluntary, deviations from this pattern have occurred at times.

The HQR (measured in square feet) was calculated as the product of two components: the area of lacustrine and riverine habitat (Figure 2.3-4) weighted by the respective riverine or lacustrine HSI scores. HSI values were calculated for individual representative tributary delta areas for three life stages (i.e., adult, juvenile, and fry) of "generic" native salmonids using the species-habitat relationships developed for cutthroat trout by Hickman and Raleigh (1982). The riverine HSI modeled three or four of the following parameters depending on life stage: thalweg depth, percent cover, percent cobble/boulder substrate, percent pool, pool quality (size and depth), and percent fines. The lacustrine HSI model relied on three water quality parameters: water temperature, dissolved oxygen, and pH. To aid in interpretation of the model results, the HQR values for lacustrine habitat and for riverine habitat for various salmonid life stages were plotted on hourly and cumulative bases over the course of representative wet, dry, and average years. Details of the HQR modeling are provided in the Sediment Transport and Delta Habitats Final Report (SCL 2009a).

The use of a cutthroat trout model to represent native salmonid habitat results in an imperfect representation of bull trout habitat in delta areas because bull trout suitability is more restricted for a number of habitat factors, such as water temperature, and broader for other factors, such as depth and velocity. Nevertheless, the HQR model is useful as an index for describing the relative importance of the different tributaries to native salmonids and for understanding how Project operations may affect habitat conditions.

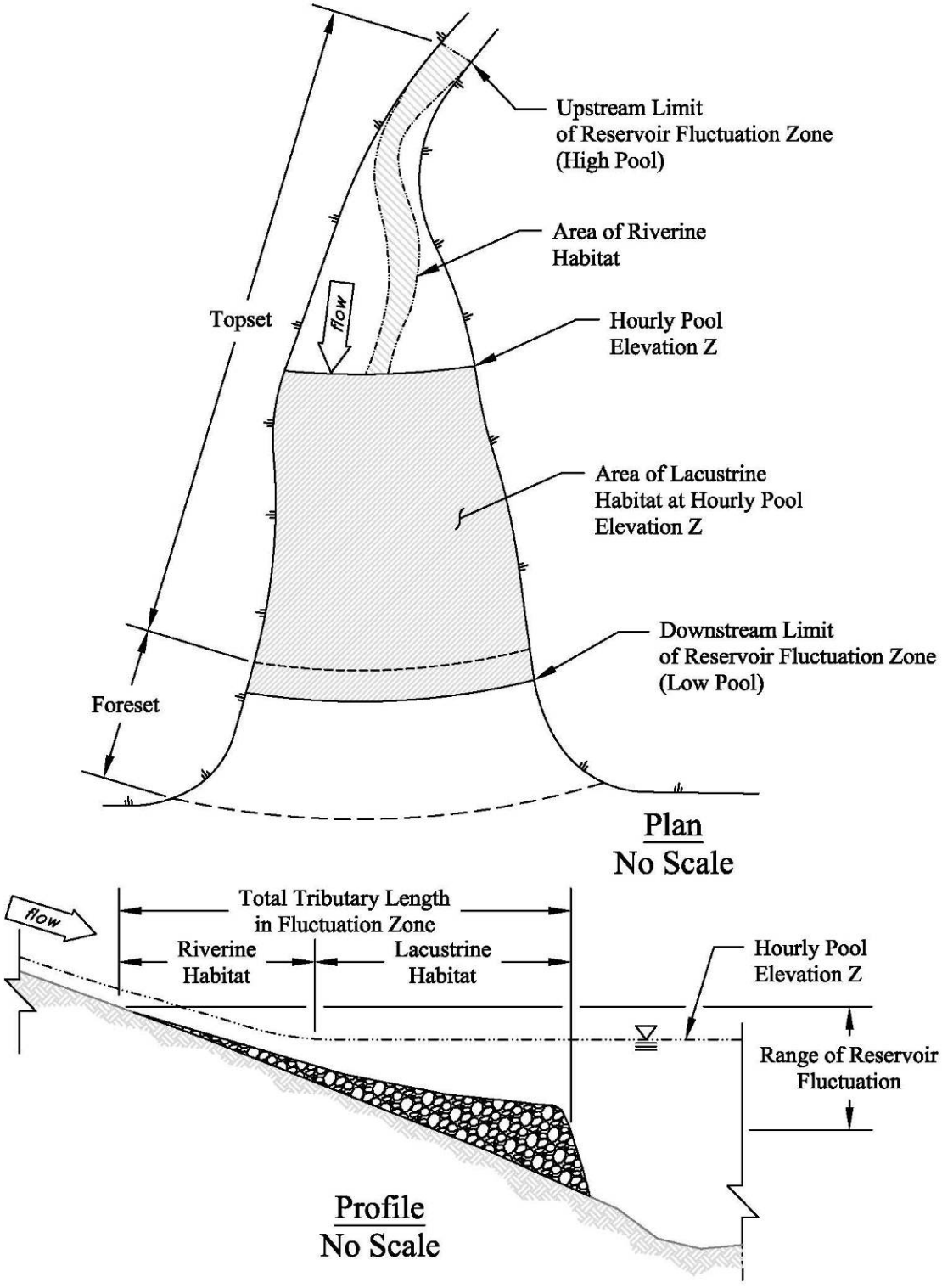


Figure 2.3-4. Conceptual model for determination of riverine and inundated habitat, example high pool and low pool conditions.

Results of the Hickman and Raleigh (1982) riverine model indicate that the Slate Creek delta had the highest HSI scores for each of the three different life stages of trout (Table 2.3-4). Flume Creek and Sullivan Creek (during periods of regulated flow) deltas had the next highest HSI values for the three different life stages of trout. The Pocahontas Creek and Sand Creek deltas were rated as unsuitable because of their dry channels (and associated zero depth of thalweg) at the time of the late summer surveys. For low-flow periods, the suitability is still low in both these creeks for adult salmonids at an HSI of 0.1.

Table 2.3-4. List of tributaries, their calculated Habitat Suitability Indices, and their relative ranking for generic "salmonid" adult, juvenile, and fry life stages in the tributary delta areas of Boundary Reservoir derived from the Hickman and Raleigh (1982) riverine model.

Tributary Name	Adult "Salmonid"		Juvenile "Salmonid"		"Salmonid" Fry	
	HSI	Rank	HSI	Rank	HSI	Rank
Slate Cr.	0.924	1	0.923	1	0.877	1
Flume Cr.	0.820	3	0.900	2	0.739	2
Sullivan Cr. (low flow)	0.703	4	0.340	6	0.340	6
Sullivan Cr. (regulated flow)	0.840	2	0.823	3	0.673	3
Linton Cr.	0.300	5	0.300	7	0.000	8
Pocahontas Cr. (dry)	0.000	9	0.000	9	0.000	8
Pocahontas Cr. (low flow)	0.100	6	0.300	7	0.589	5
Sweet Cr.	0.100	6	0.577	5	0.600	4
Sand Cr. (dry)	0.000	9	0.000	9	0.000	8
Sand Cr. (low flow)	0.100	6	0.703	4	0.160	7

Note:
HSI – Habitat Suitability Index, 0 indicates unsuitable habitat whereas 1 indicates optimal habitat

The Hickman and Raleigh (1982) lacustrine model for salmonid habitat in the shallow water areas of the deltas during periods of inundation suggests a range of habitat quality throughout the year (Table 2.3-5). The model output was driven primarily by the variability in average monthly water temperature (range 1.2 ºC to 22.6 ºC). Monitoring data suggested that dissolved oxygen (DO) and pH were relatively stable over the year, with values generally greater than 8.0 mg/L and between 8.0 and 9.0, respectively. Consequently, DO and pH values (8.54 mg/L and 8.79, respectively) and suitabilities (0.15 and 0.65, respectively) were not varied over the year as part of HSI calculations. During the month with the greatest average water temperature (i.e., August), water temperature (22.6 °C) exceeds the maximum suitable value (22.0 °C) and the resulting HSI is zero (unsuitable habitat). Conversely, in May and October when the average monthly water temperature is between 11.5 and 15 °C, pH becomes the limiting factor and the HSI values approach 0.90. Rieman and McIntyre (1993) report that bull trout populations are

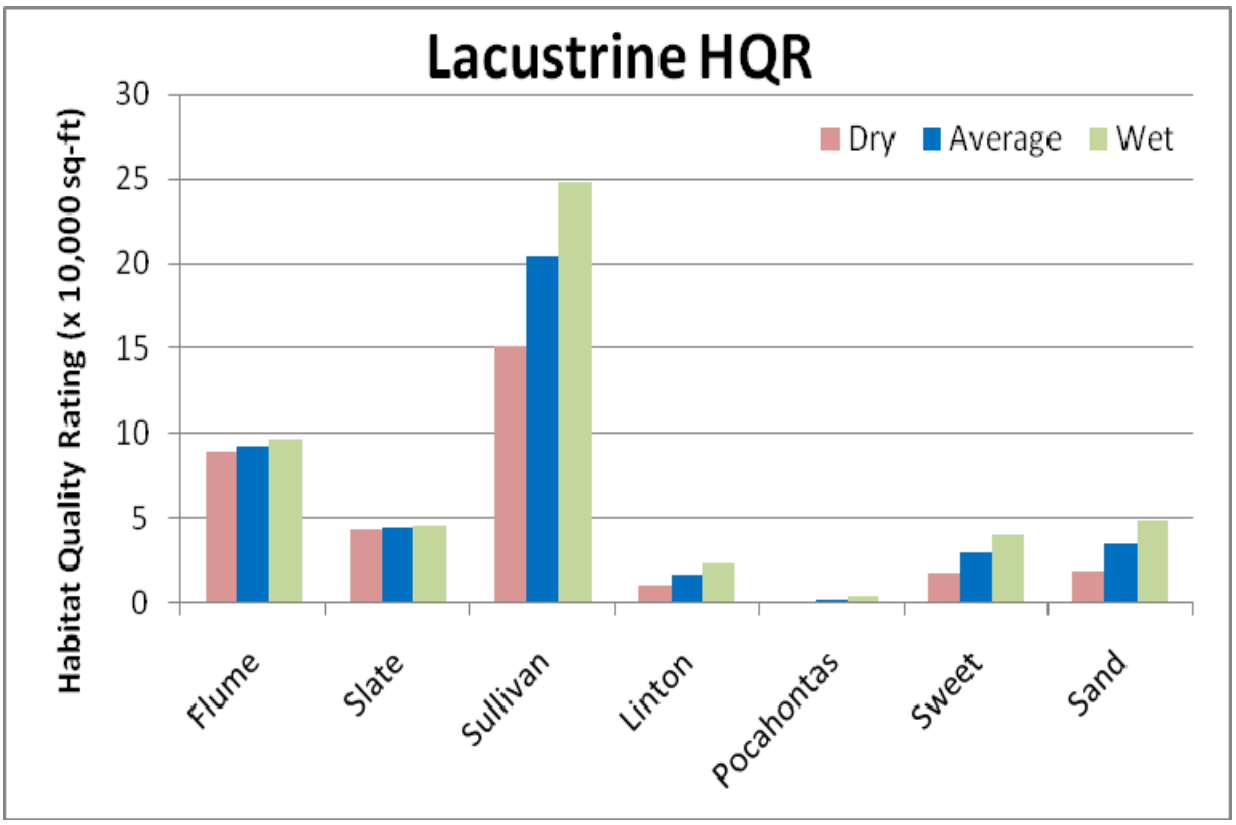
limited to areas with temperatures less than 15 ºC. Consequently, the Hickman and Raleigh (1982) model likely overestimates the suitability of lacustrine habitat for bull trout during the summer months. As temperature fluctuates between the unsuitable values in August and the near optimal values in May, June, and October, the HSI values change accordingly. Because of the influence of the potential presence of thermal plumes at the tributary mouths, the suitability for a reduced portion of the lacustrine area may be greater than 0.00 during times when water temperatures are unsuitable for salmonids.

Table 2.3-5. Boundary Reservoir average monthly temperature values, their associated suitability, and final reservoir Habitat Suitability Index using Hickman and Raleigh's (1982) lacustrine model.

Month	Temperature (ºC)		HSI
	Value	Suitability	
January	1.2	0.15	0.15
February	1.9	0.24	0.24
March	3.9	0.48	0.67
April	7.5	0.83	0.81
May	11.7	1.00	0.86
June	15.3	0.99	0.86
July	21.3	0.16	0.16
August	22.6	0.00	0.00
September	18.9	0.66	0.75
October	13.0	1.00	0.86
November	6.7	0.77	0.79
December	2.4	0.30	0.30

Deltas for two of the tributaries, Slate Creek and Flume Creek, are expected to expand over a 50-year period because these tributaries are located in inlets and protected from sediment-mobilizing mainstem current velocities. Consequently, HQR values are expected to increase over the next 50 years for Slate and Flume creeks. In contrast, the other five modeled tributary deltas are currently in equilibrium, with sediment delivered from the tributaries mobilized and redistributed farther downstream in the mainstem of the river during high flows.

A number of patterns are apparent from the results of the HQR modeling. Each of the modeled tributary deltas had minimum lacustrine HQRs of 0 because water temperatures during August were considered unsuitable. With the exception of Slate, Sullivan, and Sweet creeks, minimum fry, juvenile, and adult riverine HQR values were also 0 under all year types, but different factors were limiting at different tributaries. Average lacustrine HQR values increased from dry, to average, to wet year conditions (Figure 2.3-5). Although not displayed, maximum lacustrine HQR values demonstrated a similar pattern to average HQR values.



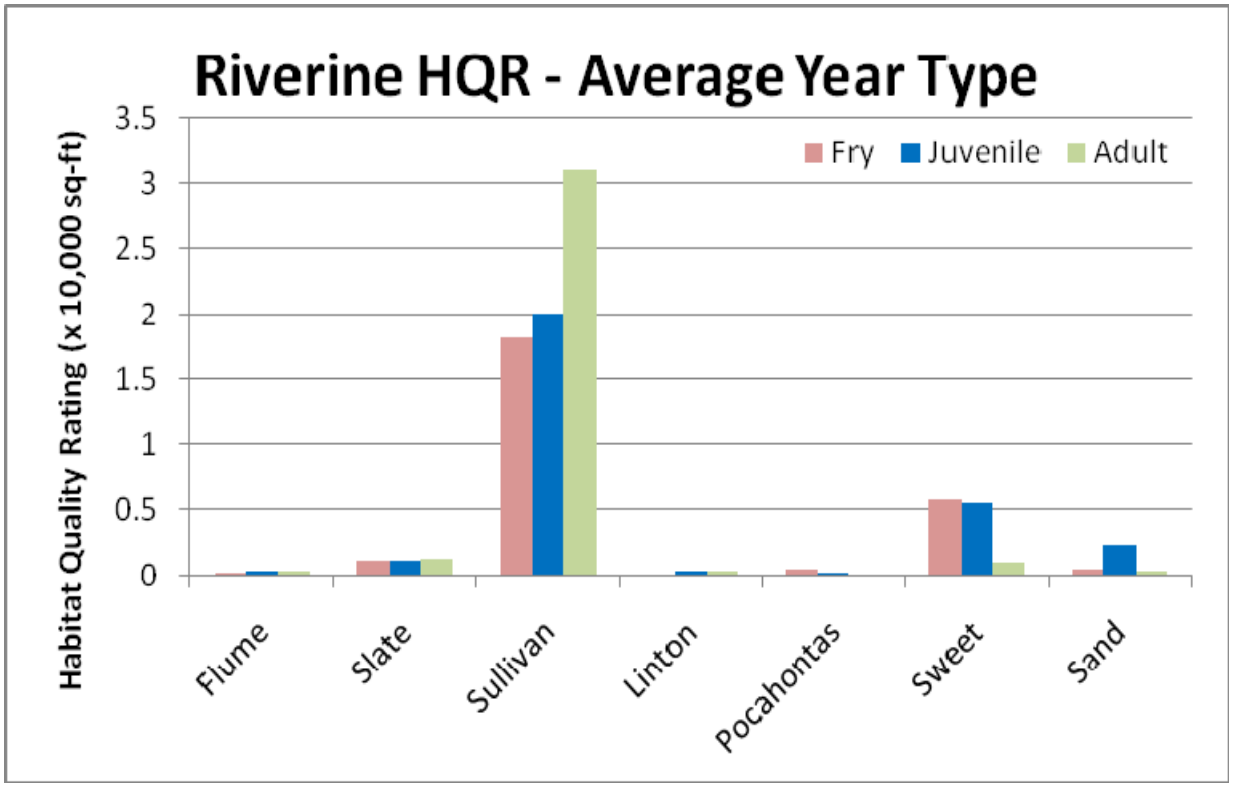


Figure 2.3-5. Average lacustrine and riverine HQR values. HQR values for Slate and Flume creeks are for delta conditions expected during Years 1-17 of the 50-year evaluation period.

The lacustrine HQR results followed the same general pattern for all tributaries, which is a function of water temperature. In the months of April and October, when temperature is within the optimal range, the HQR values peak. Between these two maximums, HQR values rise and fall as water temperatures warm (prior to April), become unsuitably hot (April to October), and then cool (after October). In the wet (1997) and average (2002) years, the lacustrine HQR values reach a maximum at each delta during high mainstem flows because reservoir water surface elevations exceed the upper extent of the delta. Under these high flow conditions, the delta is fully inundated, including areas at higher elevations than the delta, so the lacustrine area is held constant at the maximum. Under these same conditions, the riverine HQR values go to zero because no free-flowing stream habitat exists on the delta.

The Sullivan Creek delta, with average HQRs of 20.4×10^5 square feet and 2.0×10^5 square feet for lacustrine and riverine juvenile habitat, respectively, supplies substantially more lacustrine and riverine habitat than any of the other tributaries. Average lacustrine HQR values are about an order of magnitude higher than riverine HQR values. From highest to lowest based on lacustrine HQR values, key tributaries can be ranked as follows: Sullivan, Flume, Slate, Sand, Sweet, Linton, and Pocahontas creeks. Rankings based on riverine HQR values for the average flow year were as follows: Sullivan, Sweet, Slate, and Sand creeks. Flume, Linton, and Pocahontas creeks had nearly negligible suitability, with HQR values all less than 600 square feet of HQR. Load following operations and the associated diurnal fluctuations in water surface elevations can change the physical characteristics of thermal plumes at tributary deltas. Modeling of the areal extents of thermal plumes for Flume, Sullivan, Linton, and Sweet creeks during representative wet, dry, and average flow years under existing conditions suggested:

- For Flume Creek the modeled plume areas ranged from a low of about 10,000 square feet in to a high of about 20,000 square feet with little difference between the three representative years.
- The Sullivan Creek thermal plume area varied from 0 to 180,000 square feet. Mean plume areas ranged from about 70,000 square feet in the dry year to 100,000 square feet in the wet and average years. During the dry year mainstem water surface elevation dropped below the foreset slope elevation for seven hours during September, resulting in the disappearance of the plume.
- The area of the Linton Creek thermal plume typically varies from over 1,000 square feet up to 10,000 square feet. During the dry year, the modeled plume area dropped below 1,000 square feet during approximately the same period as the Sullivan Creek plume minimum.
- The modeled thermal plume area at Sweet Creek typically varied from over 2,000 to about 10,000 square feet. Similar to Sullivan Creek, plume areas of zero were modeled for a total of 25 hours during the dry year as the mainstem water surface elevation fell below the delta foreset slope.
- Complete disappearance of plume areas requires a combination of low Project inflow and unusually low forebay water surface elevations, which are uncommon events.
- The results of the modeling indicate that there are small differences between the estimated areas of thermal plumes between wet, dry, and average years. In general,

the thermal plume areas are very similar for the wet and average years and tend to be slightly smaller overall during the dry years.

In summary, water temperatures are a major contributor to the riverine HQR values, which are likely overestimates of suitability for bull trout during the summer because of the more restrictive temperature requirements of bull trout compared to the cutthroat trout criteria used in the HQR model. Riverine HQR values for bull trout would likely be zero, or near zero, during the months of July, August, and September. As previously mentioned, temperature modeling has demonstrated that the Project does not increase water temperatures relative to natural conditions. Consequently, the low suitability of the reservoir for bull trout during the summer would occur even in the absence of the Project.

2.3.2. Habitat Connectivity

As described in more detail in Section 2.1 of this document, Boundary Dam is situated in a narrow canyon at RM 17.0 on the Pend Oreille River. The dam is 340 feet high and was built without fish passage facilities. Anadromous fish access to the upper Columbia River basin, including access to the Pend Oreille River, was blocked in 1942 by construction of Grand Coulee Dam 164 miles downstream. At the time of the construction of Boundary Dam, the importance of habitat connectivity for non-anadromous salmonids was not recognized; consequently, fish passage was not considered during its design. Bull trout that might migrate downstream and pass through Project turbines or spillways may be directly injured or killed, or indirectly impacted if they are made temporarily more vulnerable to predation due to disorientation and stress following passage. All upstream movement of bull trout is blocked at Boundary Dam.

Passage barriers are an isolating mechanism for local fish populations. Types of barriers are waterfalls, landslides, water withdrawals, road crossings, and dams. A local population that lives above a barrier can only contribute individuals (and their genes) in a downstream direction. If a local population upstream of a passage barrier is extirpated, then there is virtually no opportunity for the local population to become re-established unless other local populations are present farther upstream or there is human intervention. The likelihood of re-establishing local populations is greatly enhanced if upstream populations include migratory life history forms, which are more likely to disperse. Nelson et al. (2002) reported that the migratory form of bull trout is in decline in the Bitteroot drainage and other locations, even though resident forms remain. Baxter (1999) has come to a similar conclusion for bull trout in the Salmo River drainage. Nelson et al. (2002) suggested that the loss of the migratory form in some areas increases the risk that local populations could go extinct.

Passage barriers may isolate local populations, but they can also prevent the spread of non-native species such as brook trout, which are considered a threat to native salmonids (Andonaegui 2003). Most of the tributaries to Boundary Reservoir have been stocked with non-native salmonid species such as brook trout, brown trout, and rainbow trout. However, Lost Creek and at least two subwatersheds, the NF Sullivan Creek and Lunch Creek, have apparently been unaffected by non-native species. High gradients and three culverts that are potential passage barriers have been identified in the lower reaches of Lost Creek. Fish distribution maps from the USFS (2005) identify cutthroat trout as the only species present in the lower reaches of Lost Creek. The cutthroat trout population in NF Sullivan Creek has been isolated by the presence of

a low head dam that supplies domestic water to the city of Metaline Falls. Surveys in Lunch Creek, a tributary to Sweet Creek, have also collected only cutthroat trout (R2 Resource Consultants 1998a, McLellan 2001). McLellan (2001) suggested high gradients in the lower reaches of Lunch Creek may have slowed or prevented the expansion of brook trout from Sweet Creek.

2.3.2.1. Upstream Fish Passage

As indicated above, the Project does not have upstream fish passage facilities. Consequently any bull trout that survive entrainment through the Albeni Falls, Box Canyon, and Boundary projects are currently prevented from migrating back upstream to their natal streams for spawning. Also, any bull trout from the Salmo River would be prevented from moving upstream past Boundary Dam. These fish are consequently prevented from potentially contributing genetic material to upstream populations and using upstream habitat for foraging. During relicensing studies, three bull trout were captured in the Boundary Dam tailrace, one of which was identified from genetic analysis of tissue samples to be from the Salmo River population, whereas the other two were assigned to populations from tributaries to Lake Pend Oreille, confirming that some bull trout survive downstream passage through all three projects. In addition, radio tracking of a bull trout tagged in the Salmo River indicated that one individual moved into the Boundary Tailrace Reach for several days during the late fall of 2008, then moved back downstream.

2.3.2.2. Downstream Fish Passage Facilities

There are no downstream passage facilities at Boundary Dam; consequently, any bull trout that is entrained is at risk of injury or death. This section discusses two components important for understanding the effects of Boundary Dam on bull trout moving downstream in the Pend Oreille River. The first component is the level of risk of mortality as a result of passage through the Project's turbines or as a result of spill once a fish is entrained. The second component is an understanding of the risk of entrainment occurring.

2.3.2.2.1. Passage Survival

A desktop analysis of passage survival was conducted during the relicensing process (R2 Resource Consultants 2006). Results of the desktop analysis were presented to RPS, who agreed that studies to determine Project-specific survival rates would not be necessary as part of relicensing because the desktop analysis likely depicted a reasonable representation of what an empirical study would show. The desktop analysis assessed the likely range of mortality to salmonids, depending upon the entrainment route (turbine, spillway, or sluiceway) and fish size (Table 2.3-6).

Table 2.3-6. Estimated mortality through Boundary Dam for different pathways and fish size.

Pathway	Percent Mortality by Fish Length		
	100 mm	**250 mm**	**600 mm**
Turbines 51- 54	6 – 15	13 – 33	26 – 65
Turbines 55 and 56	5 – 12	11 – 28	23 – 59
Spillways	50 - 80	35 - 65	20 - 50
Sluiceways	40 - 70	25 - 55	10 - 40

Turbine mortality rates were estimated using a predictive equation for Francis turbines developed by the U.S. Department of Energy's Advanced Hydro Turbine System Program (AHTSP), which was based on hundreds of turbine mortality studies and consideration of specific turbine characteristics (Franke et al. 1997). Strike and shear are the major factors that are addressed by the predictive equation method. The equation calculates the probability that a fish of a given size is likely to be near or come in contact with components of the turbine and the shear zone, which occurs in very close proximity to the surfaces of the turbine where water is moving at high velocity over the surface of the steel. The predictive equation uses turbine size, rotational speed, head, number of buckets (or vanes), flow, mechanical efficiency, and the length of the fish entrained to estimate the probability that a fish of a given size would come near to or in contact with a structural element as it passes through the turbine.

A number of field and laboratory studies were reviewed to understand the effects of spillway passage on fish and potential associated mortality levels (Hamilton 1955; R2 Resource Consultants, Inc. 1998b; PNNL 2000; Normandeau Associates 2002). Based on this review, the following conclusions were made concerning the mortality of fish passing through the spill flow at Boundary Dam.

- *Extremely low spill flow rates where the flow passes down or plunges onto the rock and does not reach the open water of the tailrace*: Near 100 percent mortality for fish of all sizes is likely.
- *Relatively low spill flow rates, but high enough that the majority of the flow reaches the plunge pool*: If roughly half the flow dissipates into mist before reaching the tailrace, and half the fish leave the flow and freefall in air to the tailrace, then small fish (approximately 100 mm) would likely experience a 60-70 percent mortality rate. Small fish that remain in the jet would likely experience near 100 percent mortality due to exposure to shear, while small fish that leave the jet and freefall to the tailrace would likely experience low mortality. The larger salmonids (approximately 600 mm) are expected to experience similar or slightly lower mortality rates of 40-50 percent, but for the opposite reasons: fish that leave the jet would be expected to experience very high mortality while those that remain in the jet would likely experience lower mortality due to a greater resistance to shear forces.
- *Larger spill flows where the large majority of the flow remains in a coherent jet to the tailrace*: If fish do not impact the bottom of the plunge pool, which seems reasonable because the plunge pool exceeds 75 feet in depth, the major source of mortality would

likely be due to the shear effects on fish near the periphery of the jet. The greater the magnitude of the spill the more likely the fish will be in the body of the flow and not exposed to the peripheral shear effects, so there is a range of mortality probability with decreasing estimated mortality associated with increasing spill flow rates. For smaller fish this range is estimated to be about 50-80 percent, which would be similar to the results of field studies at Upper Baker Dam, which has similar spillway characteristics (Hamilton 1955), whereas for larger fish the mortality could be as low as 20-40 percent.

Boundary Dam includes seven sluiceways located at about mid-height (crest elevation 1,795 feet NAVD 88) of the dam that discharge into the plunge pool below the dam. The sluiceways are generally used to supplement the spill flow during extreme high-flow events. Given the flow capacity and the dimensions of the sluiceway outlet, the velocity of the flow exiting the sluiceway would be approximately 100 fps, and the impact velocity of the jet upon entry into the plunge pool should be about 115 fps, with a trajectory approximately 30 degrees downward from horizontal. The flow exiting the sluiceways should be fairly well confined as a jet, and given that the tailwater is less than 50 feet below the invert of the sluiceway when the river flow is above approximately 125,000 cfs (typical conditions when sluice gates are in use under current operations), the jet should remain fairly well confined all the way to the tailwater. This will result in a greater percentage of the entrained fish remaining in the body of the flow and not exposed to the shear conditions on the periphery of the jet as it enters the tailwater. Additionally, the closer to horizontal trajectory upon entry into the tailwater should reduce the likelihood of striking the bottom of the plunge pool. These two conditions imply that the mortality of entrained fish in the sluiceway flow should be somewhat lower than that estimated for spill flow of the same magnitude.

Some level of mortality or injury to bull trout entrained at Boundary Dam is unavoidable, and the analysis above suggests midpoint mortality rates would range from 35 to 43 percent for turbine or spillway passage. Collection of two healthy bull trout in the Tailrace Reach that originated in tributaries to Lake Pend Oreille confirms that some bull trout survive entrainment. The relatively low number of observations of bull trout in Boundary Reservoir since the early 1980s, despite intensive sampling in 2000, 2007, and 2008, suggests that the overall incidence of bull trout entrainment mortality at Boundary Dam is low.

2.3.2.2.2. Entrainment

During 2007 and 2008, SCL conducted hydroacoustic and fyke net sampling at Boundary Dam to estimate the number, size, and species, of fish that may be entrained, and the timing of entrainment, in the Project turbine intakes and spillways. The limited frequency, duration of use, and flow conditions associated with the use of the sluiceways, and the discontinued use of the skimmer gate, reduce the need to quantify the number of fish potentially entrained through these pathways.

Hydroacoustic data collection was initiated at Boundary Dam on May 2, 2007 using split-beam target tracking techniques. Transducers were mounted above each turbine intake and aimed down to monitor the water column immediately upstream of each turbine intake opening. In addition, to monitor targets passing through the spillways during spill events, transducers were

deployed at each spill bay. All entrained target detections were weighted for unsampled time and space, and the resulting estimates represent total hourly target passage at each turbine intake or spillway.

Fyke nets were initially deployed in the Unit 54 draft tube gatewell downstream of the turbine unit in October 2007. Substantial testing and net modifications were needed; consequently, routine fyke net sampling was not initiated until February 16, 2008. Fyke netting has generally occurred each weekend for a 24-hour period since April 1, 2008. The fyke net array consists of two frames of eight net panels each, and is designed to screen the entire draft tube downstream of turbine Unit 54.

The fyke netting procedures involved shutting down Unit 54, deploying the two net frames in the draft tube, restarting the turbine, sampling for a fixed period, and then stopping the unit again and retrieving the net frames. All routine fyke net tests to date have been conducted at a 90 MW unit loading. Sampling could not occur at flows higher than 90 MW without excessive net damage, and lower flows are not representative of typical operating loads (maximum Unit 54 output is 150 MW). Hydroacoustic data indicate that flows associated with 90-MW loadings entrained targets at rates generally consistent with higher loadings. Operations data from 2007 indicated that loadings less than 80 MW only occurred during about 7 percent of the operating hours at Unit 54, so using 90 MW was selected as the standard loading for fyke net tests. The typical duration of individual fyke net tests within each 24-hour sampling period was approximately three hours, although individual tests varied from about one to four hours in duration. The duration was selected to ensure the integrity of the captured fish. In general, three to four individual fyke net tests could be completed within each weekly 24-hour sampling period. While fishing the fyke nets, the hydroacoustic system was switched to sample continuously at Unit 54 to maximize temporal sampling coverage.

The fyke net deployment was designed to provide complete net sampling coverage across the Unit 54 draft tube. However, the very high flow rates and variable hydraulic conditions encountered by the nets can result in incomplete sampling due to net damage, potential gaps between the nets and frame, and other factors. To establish measures of fish capture efficiency, neutrally-buoyant targets (NBT), i.e., radishes, carrots, and potatoes, were introduced in the Unit 54 penstock at the head gates during most fyke net tests. It was assumed that NBT targets distributed within the draft tube in a similar manner as fish, and had the same net retention characteristics as fish with lengths greater than 4 inches (equivalent to the minimum size fish included in the hydroacoustic target estimates). The capture efficiency tests indicated that a mean of 63.4 percent of released NBTs were collected in the fyke nets. Live fish tests using triploid rainbow trout were also undertaken to verify that NBT's were suitable fish surrogates. The spatial distribution among the individual fyke nets and capture percentages were found to be statistically equivalent. Other important assumptions were that the calibration of hydroacoustic sampling numbers with fyke net sampling numbers at Unit 54 could be used for other turbine units, could be used to draw conclusions regarding the species mix and size of fish vulnerable to entrainment by the spillways, and could be used to estimate the magnitude of entrainment Project-wide. The FERC-approved study plan recognized that if discrepancies were identified between hydroacoustics and fyke net sampling results, fyke net results would be expected to

provide a better estimate of fish entrainment, by species, size, and number, than that provided by hydroacoustics sampling.

Hydroacoustic and fyke net data collected concurrently between March 2008 and February 2009 indicated that fish entrainment is occurring at the Project. Details of the methods and results of the entrainment study are provided in SCL (2009c, Fish Entrainment and Habitat Connectivity Study Final Report). Periodic statistical comparisons between the hydroacoustic and fyke net entrainment results were planned, and subsequently conducted, in order to identify potential sampling biases of each method and select an approach that was judged to provide the best estimates of entrainment. A one-to-one correspondence between the fyke net and hydroacoustic estimates was not observed over the concurrent sampling period, suggesting that both hydroacoustic and fyke net sampling were providing imperfect estimates of absolute fish entrainment. Consistent with the approach outlined in the Revised Study Plan (RSP; SCL 2007), a fish entrainment estimator combining the sampling strengths of both methods was selected. Consequently, the results of the two techniques were combined using statistical methods derived by Dr. John Skalski of the University of Washington. The hydroacoustic sampling, which provided a continuous measure of relative entrainment at all operating turbines and spill gates, was used to scale the fish entrainment rates measured by the fyke net sampling at Unit 54. Fish entrainment rates measured at Unit 54 by the weekly fyke net sampling were extrapolated to all operating downstream passage routes (turbines and spill gates) on a monthly basis, based on the proportions of relative hydroacoustic passage observed at each location for the period.

Monthly fish passage over the March 2008 through February 2009 monitoring period increased steadily from March through July 2008, reaching a peak in July, with 13,278 fish estimated to have passed downstream through the dam during that month (Figure 2.3-6). A marked decrease in total Project entrainment was observed in August, followed by a slight increase in September. Beginning in October 2008 Project entrainment rates decreased sharply and remained low over the winter months through the end of sampling on March 1, 2009. A total of 54,597 ± 5,176 fish (90 percent confidence interval) were estimated to have been entrained through all operating turbines and spill gates at the Project over the one-year period between March 2008 and February 2009.

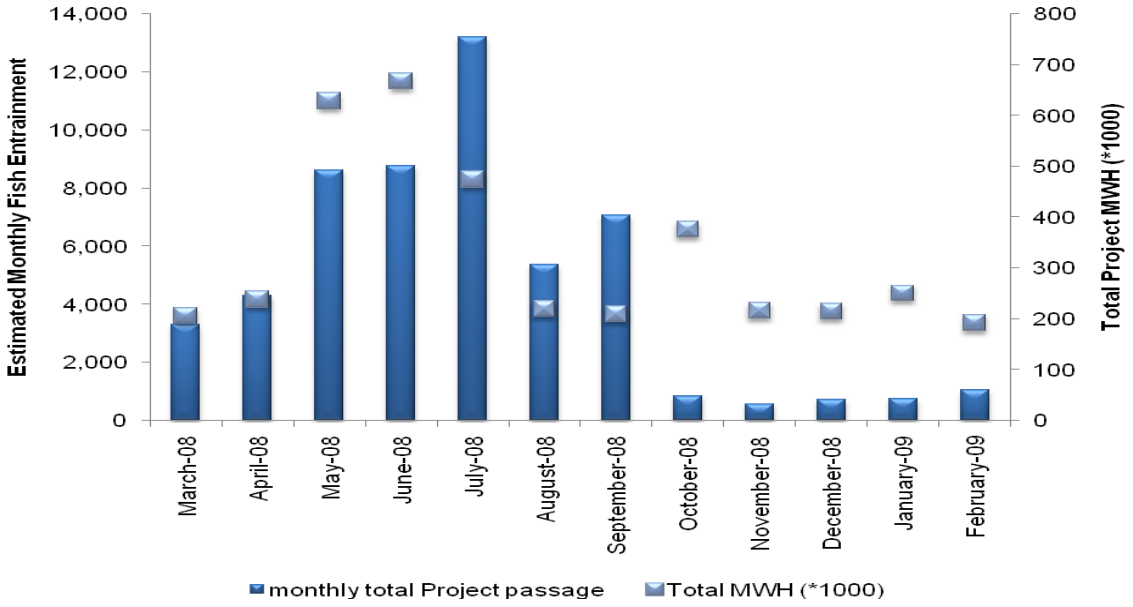


Figure 2.3-6. Estimated total Project fish entrainment through all operating turbines and spill gates on a monthly basis for the March 2008 to February 2009 sampling period.

Suckers, pumpkinseed, and yellow perch dominated the fyke net sampling in the draft tube of turbine Unit 54 between February and October 2008 (Figure 2.3-7). No native salmonids were captured. The fyke net catch over the same approximate period was generally consistent with the composition of catch from electrofishing and gillnetting in the Forebay Reach. Notable exceptions were the higher proportions of burbot, pumpkinseed, and kokanee in the fyke net catch, which may indicate the suitability of habitat or their behavior patterns near to or downstream of the trashrack make them more vulnerable to entrainment than their representation in the catch from elsewhere in the Forebay Reach would suggest. During November 2008 through March 1, 2009 an additional 30 fish representing six species were captured by fyke net in the draft tube of turbine Unit 54, but no comparable data are available from the forebay during the same period. During that period, burbot (37 percent), black crappie (30 percent), and pumpkinseed (13 percent) dominated the fyke net catch. Kokanee (10 percent) were captured during November and December, and yellow perch (7 percent) and sucker (3 percent) were captured during the February through March 1 period. The catch during this period tends to support the hypothesis that burbot, pumpkinseed, and kokanee may be more vulnerable to entrainment than other species.

The length-frequency of fish captured by fyke net in the Unit 54 draft tube demonstrated two distinct size modes, one centered at about 100 millimeters (3.9 inches) and the other at about 340 millimeters (13.4 inches) (Figure 2.3-8). Examination of the length-frequency histograms for individual fish species indicated that the smaller group of fish sizes consisted primarily of pumpkinseed (50-140 millimeters [2-5.5 inches]) and yellow perch (80-190 millimeters [3.1-7.5 inches]), but also included some salmonids (90-200 millimeters [3.5-7.9 inches]), while the larger group of fish sizes consisted primarily of suckers (270-400 millimeters [10.6-15.7 inches])

and a few salmonids (220-390 millimeters [8.7-15.4 inches]). Fish larger than 400 millimeters (15.7 inches) were suckers and burbot.

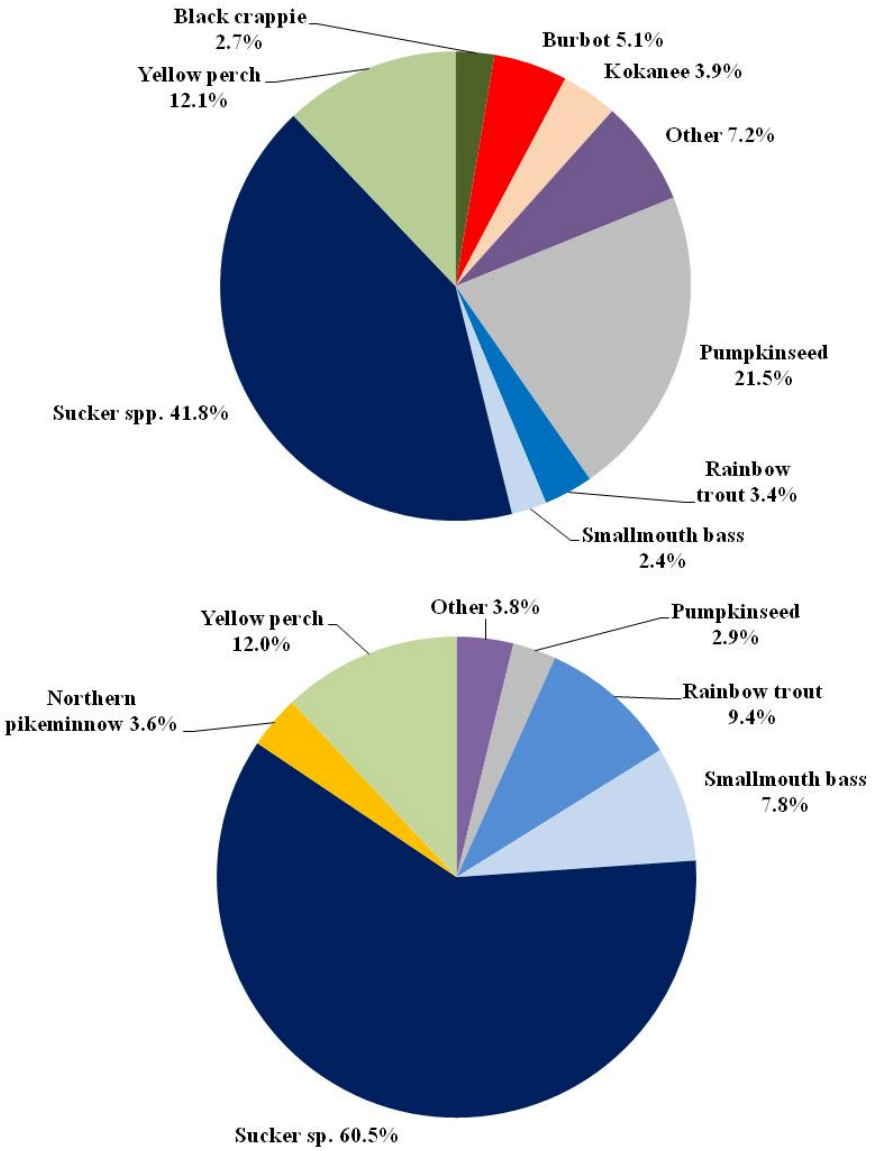


Figure 2.3-7. Species composition resulting from 414 fish captured from fyke net sampling in the turbine draft tube of Unit 54, February through October 2008 (top) and 4,018 fish captured at standard sampling sites in the forebay from March 2007 through September 2008 (bottom).

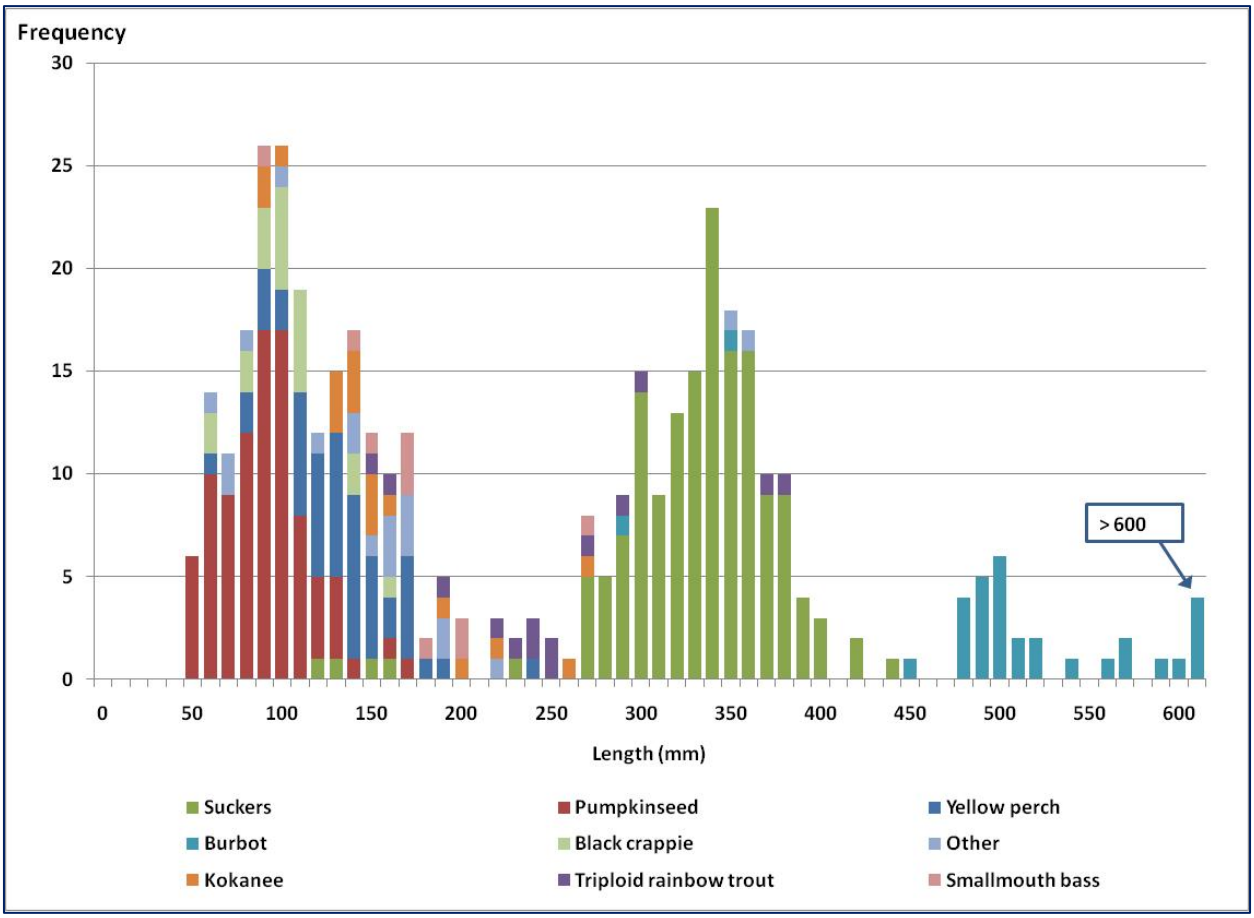


Figure 2.3-8. Length-frequency of fish, by species, captured by fyke net sampling in the Unit 54 draft tube during the period February 16, 2008 through March 1, 2009.

The length-frequency of fish captured by fyke net at Boundary Dam is consistent with the findings of FERC (1995) and Stone and Webster (1992), i.e., that small fish less than 4 inches to moderate size fish up to 6 inches generally account for 75 percent or more of entrained fish at low-head dams dominated by a non-salmonid fish community. Boundary Dam is different from the dams in the review studies in that it is a high-head project. However, many of the physical factors, primarily water velocities (0.7 to 7.2 fps in FERC 1995), are similar.

FERC (1995) and Coutant and Whitney (2000) indicated the life history traits and behavior of the fish species found in an impoundment, including the non-salmonids, are important factors affecting a species potential for being entrained. For example, schooling fish tend to be entrained on an episodic basis and non-salmonid fish that tend to use littoral habitat may have higher entrainment at turbine units that are closer to the shore. Juvenile or larval fish that have a planktonic life history are likely to have higher entrainment levels than those that are benthic or use backwaters. Species that have seasonal movements for spawning or other specific habitat traits may have higher levels of entrainment during these movement periods. Another factor that could affect entrainment levels are a species' depth preference and the depth of turbine intakes.

These authors also noted that entrainment levels may increase during periods with very cold water when fish may succumb to extreme lethargy and torpor.

The available information suggests that any bull trout in the vicinity of the dam would be vulnerable to entrainment at Boundary Dam, but their low overall abundance in Boundary Reservoir and forebay suggests entrainment of bull trout is extremely rare. Genetic testing of two bull trout captured in the Tailrace Reach during fall 2008 indicated they had originated in tributaries to Lake Pend Oreille. Relicensing fish surveys showed an increased incidence of triploid rainbow trout and radio-tagged cutthroat trout in the Tailrace Reach following release in Boundary Reservoir during 2008 compared to 2007. In addition, the catch of walleye, which are relatively common in Box Canyon Reservoir, was substantially higher in Boundary Reservoir during 2008 than 2007. Taken together, this information suggests that during high flow years, such as the spring of 2008, the risk of entrainment may increase relative to normal or low flow years and may have been a factor that contributed to the entrainment of the two bull trout from Lake Pend Oreille that were observed in the Boundary Dam tailrace during late 2008. DuPont et al. (2007) observed that all six bull trout tracked during fall 2002 to fall 2003 migrated from the East River down the Priest River, then turned upstream upon reaching the Pend Oreille River and none turned downstream towards Albeni Falls Dam. Although strong conclusions cannot be drawn from the small sample size in DuPont et al. (2007), which suggests that few post-spawning bull trout from the Priest River drainage move downstream of Albeni Falls Dam, it is interesting that springtime flows during 2003 were relatively low and perhaps did not influence migration patterns as much as higher flows might have.

2.3.3. Water Quality

2.3.3.1. Total Dissolved Gas

Supersaturation of gases in water has the potential to adversely affect fish by forming bubbles in tissues as the dissolved gases come out of solution (Weitkamp et al. 2003). Ecology standards require that waters remain below 110 percent total dissolved gas (TDG) supersaturation (Ecology 2006). At higher flows, the Project forebay TDG level is closely linked to upstream project TDG levels from Box Canyon and Albeni Falls dams. Spill from these upstream projects causes relatively high forebay TDG at flows near and slightly above the Project power plant capacity (56,000 cfs) (Evaluation of Total Dissolved Gas and Potential Abatement Measures Final Report [TDG Evaluation], SCL 2009a). The Boundary Dam tailrace TDG begins to increase slightly over the forebay level for flows above approximately 70,000 cfs. At flows greater than approximately 80,000 cfs, the incoming TDG levels decrease, due to removal of the spillway gates at Box Canyon Dam and corresponding elimination of overflow plunging into the tailwater at upstream projects at higher river flows (TDG Evaluation, SCL 2009a). Analysis of historic data indicates that, with the Project power plant operational changes initiated in 2003 (unit sequencing), TDG exceeds the regulatory limit in the Project tailrace for flows between approximately 70,000 cfs and 108,300 cfs (which corresponds to spill flows of approximately 15,000 cfs to 53,300 cfs). These flow conditions correspond to an occurrence of approximately 7.4 days per year based on the 1987 through 2005 period of record (TDG Evaluation, SCL 2009a). For flows equal to or greater than 108,300 cfs, i.e., the 7Q10 river flow, the TDG standard of 110 percent is not enforced.

The available information suggests that any bull trout residing in the Boundary Reservoir or tailrace during periods of high flow could be at risk of gas bubble trauma from TDG supersaturation. TDG levels in Boundary Reservoir result from operations at Albeni Falls and Box Canyon dams and are unaffected by Project operations. As noted above, under some conditions, high TDG conditions entering the Boundary Dam forebay, which result from upstream projects, may be exacerbated as water passes through or over Boundary Dam. Consequently, Project operations contribute to TDG conditions in the Boundary Dam tailrace at times (see Section 4.5.2.2.3 of Exhibit E of the License Application for discussion of TDG exceedances in the Boundary Dam tailrace). Fish sampling during 2007 and 2008 resulted in no observations of fish with gas bubble trauma in the Boundary tailrace. Because of the species' benthic orientation and preference for deeper water, the risk to bull trout of contracting gas bubble disease is likely lower than that for other salmonid species that prefer shallower water or are more surface oriented.

2.3.3.2. Temperature

High water temperatures can affect salmonids by altering the timing of adult and juvenile migrations and may contribute to stress-related mortality or reduced growth. While migrating bull trout may exhibit a short-term tolerance for high water temperatures (KCDNR 2000), juvenile bull trout are particularly sensitive to changes in water temperature and are typically found in the coldest stream reaches within a basin. Researchers studying tributaries to Lake Pend Oreille found the highest densities of juvenile bull trout at sites with summer maximum temperatures between 11 ˚C and 14 ˚C (Saffel and Scarnecchia 1995). Based on a review of bull trout temperature studies, including those cited by the Environmental Protection Agency (EPA) in support of EPA standards, Hillman and Essig (1998) concluded that optimal water temperatures for juvenile bull trout growth and rearing range from 12 ˚C to 14 ˚C. Spawning activity begins when water temperatures drop below 9 ˚C in the fall and water temperatures consistently below 6 ˚C are needed for egg development.

Water temperatures in Boundary Reservoir are cold in winter and warm in summer. The range of water temperature recorded at 15-minute intervals between May 2007 and September 2008 was 37.9 to 77.4 ˚F (3.3 to 25.2 º˚C) and averaged 57.0 ˚F (13.9 ˚C). Although it does not occur every year, the Forebay Reach was observed to ice-over for a period during the winters of 2007 and 2008. Temperatures in excess of 68 ºF (20 ˚C) commonly occur during the months of July and August. Vertical profiles of water temperature taken monthly at seven locations in Boundary Reservoir suggested it is vertically mixed. Water temperature modeling (CE-QUAL-W2) conducted in support of the application for Clean Water Act Section 401 certification and the Interstate TMDL process demonstrated that for all temperatures above 21 ˚C, which occur more than 70 percent of the critical time during July and August, the natural condition (without the influence of Box Canyon or Albeni Falls dams) is predicted to be above the existing condition. (see Section 4.5.2.2.2 of Exhibit E of the License Application for greater detail regarding the results of temperature modeling).

Water temperatures in Boundary Reservoir often exceed the suitable range for bull trout, as they would in the absence of the Project. During periods of high water temperatures in excess of 18 ˚C, bull trout that do not locate cool water refugia near mouths of tributaries or by entering tributary streams are likely to be adversely affected by the warm water temperatures in the

reservoir. Fish passage through the tributary deltas is a function of reservoir pool level, channel morphology, and tributary inflow. During the summer months, it is unlikely that fish could enter any of the tributaries except Sullivan, Slate, Linton, Flume, and Sweet creeks because of the lack of flow or presence of natural barriers near the tributary confluences.

Coolwater refugia at tributary deltas are generally very small, and, as described previously, their size is affected by fluctuations in water surface elevations. Other coolwater refugia may exist in Boundary Reservoir at groundwater seeps, but the location, size, and number of seeps are unknown. Competition for space at thermal refugia may be a factor adversely affecting any bull trout. Thermal refugia are used by triploid rainbow trout, westslope cutthroat trout, and mountain whitefish, as observed during relicensing studies in 2007 and 2008. In particular, numerous triploid trout, on the order 100 to 150 fish, were observed congregating at the Sweet Creek delta during August of 2007. Many anglers are aware of this behavioral pattern and target their effort towards cool water refugia during warm water periods. Consequently, any bull trout also using these refugia may be at a higher risk of accidental capture by anglers.

WDFW has decided to phase out the release of rainbow trout in the Pend Oreille River. Releases by SCL of triploid trout into Boundary Reservoir are to be reduced during 2009 and cease thereafter (see Section 2.1.4.6 of Exhibit E of the License Application). Releases to Box Canyon Reservoir are scheduled to halt after 2010. Among other things, WDFW cited the potential for competition with native salmonids at coolwater plumes, high entrainment rates past downstream dams, and low capture rates as rationale for halting future releases.

2.3.3.3. Dissolved Oxygen

Dissolved oxygen (DO) is strongly influenced by, and inversely related to, water temperature. Consequently, high water temperatures can adversely affect the ability of water to retain DO. DO levels can also be affected by plant and animal respiration and the amount of mixing in the water column. DO monitoring indicated that Boundary Reservoir is generally above the state standard of 8.0 mg/L, but several exceedances were recorded for July and August of 2008 within deeper portions of the Canyon (Station V5) and Forebay Reach (Station V5), and at a shallow water site near the City of Metaline (Station V2). In addition, observations indicated that DO decreased about 1.0 mg/L from the surface to the deepest measurement between July through October, 2008, and these decreases were more prevalent at the Forebay Reach station (V6). The Water Quality Constituent and Productivity Study (SCL 2009a) concluded that the small DO deficit produced by a low respiration rate indicated incomplete mixing in the water column, despite the uniform temperature profiles, and that the presence of Boundary Dam was affecting the amount of mixing in the northern portion of the Reservoir. If bull trout were to use the northern portion of Boundary Reservoir during late summer periods they could be adversely affected by the DO levels less than 8 mg/L that were measured in waters greater than 20 feet during July and greater than 40 feet during August 2007.

Macrophyte beds, primarily of Eurasian watermilfoil, *Potamogeton* species, and coontail have the potential for a localized diurnal effect on DO levels as a result of photosynthesis and respiration, but site-specific studies in Boundary Reservoir during 2007 suggested the local effects in the beds did not adversely affect overall DO levels in the reservoir. Macrophytes consume carbon dioxide and produce oxygen during daylight hours while photosynthesis occurs,

but during hours of darkness consume oxygen during respiration. Together these result in maximum DO levels during the day and minimum levels (DO depression) at night. Monitoring of DO levels upstream, downstream, and within a macrophyte bed (Site M6) demonstrated low variability at the upstream and downstream locations, despite high variability within the macrophyte bed (Evaluation of the Relationship of pH and DO to Macrophytes in Boundary Reservoir Study Final Report [pH, DO, and Macrophytes], SCL 2009a). During periods of high photosynthesis, monitoring indicated that DO levels at night frequently dropped below 8 mg/L, with the lowest DO level recorded at 2.7 mg/L during August at the station across from the City of Metaline (pH, DO, and Macrophytes, SCL 2009a). Vertical profiles taken in the middle of the shallow old channel (about 29 feet deep at typical summertime water surface elevations) across from the City of Metaline during August demonstrated DO levels at or less than 8 mg/L throughout the water column.

The EPA (1986) reports that DO levels less than 8 mg/L for salmonids, other than embryos, result in some level of impairment, with slight impairment occurring below 6 mg/L, and the limit to avoid acute mortality at 3 mg/L. Except in macrophyte beds, measurements in Boundary Reservoir were greater than 7.0 mg/L and most were above 7.6 mg/L, and exceedances of Ecology's DO standard were uncommon, both spatially and temporally, in 2007 and 2008 (pH, DO, and Macrophytes and Water Quality Constituent and Productivity, SCL 2009a). Despite some indications of low DO levels near to and within macrophyte beds, DO generally remains above state standards and suitable for bull trout. For example, during the same period (August 16) that low DO levels were measured at Station V2, measurements at Station V3, downstream of Metaline Falls, demonstrated DO levels of 8.8 to 9.1 mg/L throughout August (Water Quality Constituent and Productivity, SCL 2009a).

2.3.3.4. Turbidity

Water quality sampling between May 2007 and March 2008 indicated turbidity levels were well below the Washington State Standard of more than 5 nephelometric turbidity units (NTUs) over background when background is 50 NTUs or less (Ecology 2006). The turbidity values (range 0.3 to 4.5 NTUs) measured were less than 5 NTUs during the sample period in Boundary Reservoir; therefore, there were no exceedances of the numeric standard for turbidity. Pelagic and littoral turbidity measurements were similar throughout the reservoir, but with a decreasing trend from May to November. The higher turbidity measurements seen in May and June compared to the rest of the year were due to higher inflows during spring. The seasonal pattern was probably due to several factors, such as higher inorganic particulate matter from runoff in spring, higher phytoplankton abundance (chlorophyll *a*) at the time, and greater water residence and, hence, settling time during the summer. The higher value in March occurred prior to spring runoff and was probably due to high chlorophyll *a*. Based upon the available information, turbidity in Boundary Reservoir is not expected to have an adverse effect on bull trout.

2.3.4. Ecosystem Functions

2.3.4.1. Gravel Transport

The nature and quality of salmonid habitat in rivers is determined, in part, by the transport and instream storage of sediments recruited from upland areas (Spence et al. 1996). In free-flowing

river channels, coarse, gravel-sized sediment is primarily transported downstream during moderate to high flows and is stored within the channel bed and banks during intervening low-flow periods. Suitably-sized gravel is particularly important for bull trout spawning habitat. As indicated previously, bull trout are not known to, and not anticipated to, spawn in the mainstem Pend Oreille River or in the lower reaches of tributaries or their deltas. Instead, spawning habitat would be located in upstream reaches of tributary streams that would not be affected by the Project. Consequently, mainstem gravel transport and distribution is not important to maintaining bull trout spawning habitat. However, sediment transport and deposition are important for shaping the morphology of the river and consequently the quality and quantity of rearing or overwintering habitat for bull trout.

The Pend Oreille River between Boundary Dam and Box Canyon Dam has two distinct segments in terms of sediment transport. The section from the Boundary Dam upstream to Metaline Falls, consisting of the Forebay and Canyon reaches, is a depositional environment created as a result of the inundation from Boundary Dam. Upstream of Metaline Falls, in the Upper Reservoir Reach, the Pend Oreille River is at times influenced by a backwater effect from Boundary Dam, but it often experiences riverine conditions, particularly when forebay water surface elevations are low or inflows are high.

The Pend Oreille River character has also been greatly influenced by past glaciation. As the continental ice that covered the study area melted northward, widespread deposition of glacial sediments occurred in the Pend Oreille River valley. The melting ice also modified the flow direction of the river (from a historic southern path to the present northward direction), and with this change, rapid down-cutting commenced through the glacial deposits. In areas with resistant bedrock, control points such as Metaline Falls formed, resulting in deeply carved canyons downstream and broad, low gradient valleys upstream. The high energy portion of the Pend Oreille River, the Canyon Reach below Metaline Falls, has been inundated by Boundary Dam. The Upper Reservoir Reach was a low energy environment even prior to hydraulic influence from Boundary Dam, and, therefore, its capacity to transport coarse sediment is, and was historically, limited, and the larger gravels and cobbles forming its bed are only mobilized at high flows and are not transported in large quantities relative to the volume of water conveyed by the mainstem.

Considering the size of the Pend Oreille River watershed above the study area, the supply of sediment delivered to the study area is small. This disparity results from much of the contributing watershed passing through lakes and reservoirs that effectively trap sediment before entering the study area. The total drainage area contributing runoff to the study area is approximately 25,650 square miles; however, the portion of this area considered to contribute bedload-sized sediment (sand and larger) is approximately 1,001 square miles (Sediment Transport and Tributary Delta Habitats, SCL 2009a).

These factors combine to create a river that is not exceedingly dynamic in terms of its sediment transport response. The results of the mainstem sediment transport model support this statement in that the only appreciable change in the system predicted by the model was continued deposition below Metaline Falls, primarily in the Forebay Reach. The bed elevation changes and

volume of deposition in the Upper Reservoir Reach over the potential 50-year term of a future license are estimated to be relatively minor.

Additional aspects of sediment transport and river response of the Pend Oreille River are:

- The low sediment supply to the study area coupled with the low energy river system upstream of Metaline Falls creates a coarse pavement layer along the channel bed. The pavement layer limits the supply of sediment from the river bed and protects the underlying materials from channel degradation, even though the supply of sediment to the reach is small.
- The operation of Box Canyon Dam, located at the upstream extent of Boundary Reservoir, limits the supply of bed material to the Upper Reservoir Reach to flow rates that exceed 80,000 cfs. The hydraulic influence of the Boundary Dam affects the transport of sediment through the Boundary Reservoir; however, the effect of Project operations on sediment transport is negligible. The Project ceases to operate in a load following mode when flows into the reservoir exceed the turbine capacity (55,000 cfs). In general, most sediment is transported at flows approaching or greater than the "channel forming" flow (the estimated 2-year recurrence interval peak flow magnitude is 85,800 - 107,000 cfs). The operation of the Box Canyon Dam can create a temporary deficit of coarse sediments if the peak flows do not reach 80,000 cfs for an extended period of years because the leaves at the dam will not be lifted to release the temporarily stored bed load.
- The Tailrace Reach is even less dynamic than the reaches upstream of Boundary Dam because it is more heavily armored with large material and nearly all the inflowing sediment supply is trapped in Boundary reservoir, except for silts and clays and a small amount of sand.

Based on sediment transport modeling (HEC-6T) conducted during relicensing (Sediment Transport and Delta Habitat, SCL 2009a) the following was concluded:

- The morphology of the mainstem Pend Oreille River from Box Canyon Dam to the Canada Border was predicted to not substantially change over the 50-year term of a new license, except as a result of sediment accumulation in the Boundary Dam forebay. The predicted increase in channel bed elevation in the forebay is up to 20 feet, which is approximately 10 percent of the 200-foot average depth of this reach.
- The gradations of the mainstem channel substrates are not predicted to vary considerably from existing gradations over the 50-year term of a new license, except for localized areas of deposition. The Upper Reservoir Reach substrate is predicted to remain dominated by coarse gravels and cobbles, the Canyon Reach is predicted to continue to be dominated by boulders and bedrock (with sand and finer materials occurring in depositional areas), the deposition of silts and clays is predicted to continue in the Forebay Reach, and boulders are predicted to continue dominating channel substrate in the Tailrace Reach.
- Annual high flows that have the greatest capacity to mobilize and transport sediment typically exceed turbine capacity at the Project except during dry years. When flows

exceed turbine capacity, the Project ceases to be operated in a load-following mode and the hydraulic influence of Project operations becomes negligible.

- The simulated channel morphology over the period of a new license is so similar to the existing morphology that no significant responses on the morphology (and associated delta habitats) of tributary deltas were predicted. For example, there was no significant sediment accumulation modeled in the mainstem at the confluence of a tributary delta that could cause sediment delivered from the tributary to pile up and change the morphology of the delta.
- Downstream of Metaline Falls, the backwater from Boundary Dam has inundated the Canyon and Forebay reaches and greatly reduced the ability for sediment to be transported, creating a depositional environment. However, sediment deposition was estimated to be approximately 4,500 acre-feet over the 39-year period from 1967 to 2006. This relatively small amount is a result of two factors:
    - The supply of sediment to the Boundary Reservoir is small; and
    - Because of the relatively small storage volume of the reservoir compared with inflow, the Project passes over 99 percent of clay, and approximately 75 percent of silt, although nearly all bedload is trapped.

The available information and modeling suggests that the morphology of the riverbed and the sediment size distribution in the Action Area are unlikely to substantially change from the current condition. The Tailrace Reach will continue to be limited in the availability of gravel as a result of deposition behind Boundary Dam. However, general life history information suggests that bull trout are unlikely to use the tailrace for spawning (Pratt 1992). Consequently, the adverse effects of reduced gravel levels in the Boundary Dam tailrace are expected to be minimal for bull trout.

2.3.4.2. Woody Debris Transport

LWD can be an important component of aquatic habitat in both riverine and reservoir habitats (Bjornn and Reiser 1991; Northcote and Atagi 1997). LWD provides habitat complexity, cover, and substrate for fish and macroinvertebrates and has been identified as an important component of bull trout habitat (Baxter 1997). As LWD decomposes, it may also provide nutrients to the water column and sediments (Harmon et al. 1986). LWD in reservoirs can be divided into three categories, each with a distinct biological function, based upon wood location: (1) submerged LWD; (2) floating LWD; and (3) shoreline LWD.

No generally recognized criteria for LWD size and distribution in Pacific Northwest reservoirs are available. For rivers and streams east of the Cascade Mountains, the USFWS and National Oceanic and Atmospheric Administration (NOAA) Fisheries consider streams with more than 20 pieces of LWD greater than 12 inches in diameter and 35 feet in length to be "properly functioning" (NMFS 1996). However, the physical processes affected by LWD in reservoirs and large rivers similar in form to the Pend Oreille River are likely to be different than the relatively small streams reported in the literature. Nevertheless it is reasonable to assume that larger wood has a greater likelihood of being stable and a higher potential to create water velocity breaks, fish

cover, complex habitat structure, and surface area for the production of periphyton and macroinvertebrates that prefer woody substrate over rock substrate.

The Project affects the abundance, distribution, and quality of LWD as a component of aquatic habitat within the reservoir and downstream of Boundary Dam. Fluctuations in Boundary Reservoir water surface elevations may affect wood recruitment indirectly by affecting the establishment of new riparian stands adjacent to the varial zone (Inventory of Riparian Trees and Shrubs Final Report [Riparian Study], SCL 2009a). Wood recruitment mechanisms adjacent to lakes or reservoirs are primarily windthrow, senescence, or mass wasting events. Recruitment may also occur by transport from tributaries or passage over Box Canyon Dam during periods of spill, but the sizes of most of the tributaries draining to Boundary Reservoir are too small to result in transport of large wood pieces that could provide substantial habitat structure.

The increase in wood collected at the trashrack during the 2008 high flow year compared to 2007 suggests that peak flows are an important factor for the redistribution of LWD within the Pend Oreille River (Table 2.3-7). If LWD is delivered to Boundary Reservoir from tributaries or Box Canyon Reservoir, a portion could eventually become stranded on the floodplain or gravel bars and, when inundated during periods of high water surface elevations, could serve as littoral habitat for aquatic invertebrates and fish. As reservoir levels recede, some of the non-anchored pieces could float off of these areas and into the main portion of the reservoir.

Table 2.3-7. Summary of large woody debris collected at the Boundary Dam during 2007 and 2008.

	Diameter at Large End	5 to 17 ft	17 to 50 ft	Greater than 50 ft	Total	Number with Root Wads
March 22 and July 29, 2007	4 to 12 in	130	36	2	168	17
	12 to 24 in	10	19	6	35	15
	24 to 32 in	1	1	2	4	2
	> 32 in	0	0	1	1	1
	Total	141	56	11	208	35
June 2 – 17, 2008	4 to 12 in	1084	194	23	1301	109
	12 to 24 in	82	41	23	146	12
	24 to 32 in	3	6	5	14	5
	> 32 in	3	1	0	4	2
	Total	1172	242	51	1465	128

Source: LWD Management Study Final Report, SCL 2008c.

Reservoir fluctuations can affect the portion of time that a given piece of wood provides habitat. LWD that is stranded on mid-channel bars or along the shoreline during peak runoff periods may be at elevations above the water's surface during other parts of the year. Other pieces of wood may be located within the pool fluctuation (varial) zone affected by Project operations and may intermittently provide aquatic habitat.

Removal of LWD at the Project trashrack results in the potential depletion of shoreline wood farther downstream at Seven Mile Reservoir or Waneta Reservoir. Consequently, LWD removal

at Boundary Dam primarily affects bull trout habitat outside of the Action Area, and outside the Pend Oreille River Core Area; only about one mile of the Pend Oreille River is located between Boundary Dam and the U.S.-Canada border. Similarly, removal of wood at Albeni Falls Dam and Box Canyon Dam depletes the amount of wood that enters Boundary Reservoir and could potentially contribute to bull trout habitat.

As described previously, mapping conducted during 2007 demonstrated that LWD was distributed in concentrated areas throughout the reservoir, and some of these areas have remained stable since 2005. Throughout the reservoir 1,531 pieces of LWD were counted, which had a total volume of 63,350 ft^3. The LWD counted was primarily along the shoreline because submerged wood was difficult to observe. However, some of the LWD would be submerged for part of the year, depending on the flow from Box Canyon and operation of the Project. The volume and number of pieces of shoreline LWD per mile of reservoir was highest in the Canyon Reach (118 pieces/mile), lowest in the Upper Reach (53 pieces/mile), and intermediate in the Forebay Reach (80 pieces/mile). Stumps accounted for 141 pieces (about 8 percent) of the LWD counted along the shoreline, which resulted from timber harvest when the reservoir was created. The number of stumps counted in the inventory is considered an underestimate, because additional stumps were likely submerged and not visible during the survey. Floating wood generally ends up at the trash rack and is removed from the reservoir (LWD Management Study, SCL 2008c).

LWD mapping indicates that wood in the largest diameter category (i.e., greater than 32 inches) is extremely rare (about 0.4 percent if the numerical total and 1.3 percent of the volume), and wood in the largest length category is numerically low (399 pieces, 26 percent of total) but provides the most wood volume (40,717 ft^3, 64 percent of total). Records of LWD removal at Boundary Dam indicated that the proportions in the largest length and diameter categories were transported during 2007 and 2008 are also very low, so their removal reduces even further the amount of a rare resource that could potentially benefit aquatic habitat in the Pend Oreille River. Notably, 164 pieces of LWD greater than 12 inches in diameter were removed at Boundary Dam during 2008, which is about 29 percent of the LWD standing crop of those size categories that were counted along the shoreline during 2007. Consequently, LWD removal at Boundary Dam, particularly during high flow years, appears to potentially have a substantial effect on the number and volume of large woody debris over the one-mile reach between Boundary Dam and the U.S.-Canada Border in the Pend Oreille River.

Mass wasting events along the reservoir shoreline can result in the recruitment of new LWD to the system. However, areas with chronic erosion problems will not grow new trees. An erosion study conducted as part of relicensing inventoried 132 erosion sites along 15.5 miles of reservoir shoreline using GIS and aerial photos (Erosion Study Final Report, SCL 2009a). Trees and LWD were observed at only a few locations. Consequently, little high value LWD was available for recruitment. Of inventoried erosion sites, 60 were visited with RPs to evaluate site-specific effects and the potential need for erosion control measures. Of these, only one of the sites that warranted consideration for erosion control measures, near Sullivan Creek (site 26E112), was identified as having a substantive effect on riparian habitat. Overall, Project-related mass wasting along the reservoir shoreline is considered to have a minor effect on LWD that could contribute to aquatic habitat.

Overall, the Project has a small effect on LWD resources through the removal of LWD at Boundary Dam and by limiting the potential development of new riparian stands of trees. The degree to which bull trout would use LWD resources in the reservoir and tailrace is uncertain. Bull trout are strongly associated with LWD and large substrate while occupying streams (Pratt 1992), but little information is available concerning microhabitat features used in lakes and reservoirs. Tracking by Bassista et al. (2005) of five bull trout outfitted with acoustic tags in Lake Pend Oreille indicated that bull trout used benthic areas during the spring at locations an average of 500 feet offshore at a mean depth of 75 feet. During summer bull trout mostly used benthic areas (66 percent of observations), but were also found in nearshore (25 percent of observations) and pelagic areas. During the fall and winter, observations were only made on two bull trout that were at depths of 26 to 203 feet; most observations were in nearshore benthic areas and the remainder were in the pelagic zone. Based on the observations by Bassista et al. (2005), bull trout are not likely to substantially use LWD along reservoir shorelines, but could perhaps use sunken LWD or submerged stumps. Consequently, the small effect on LWD resources by the Project is likely to translate into little to no adverse effects on bull trout.

2.3.4.3. Floodplain Connectivity

Rivers construct and maintain channels such that small and moderate-sized discharges (less than or equal to flows with a 2-year recurrence interval) are contained within the channel, while larger discharges that occur less frequently exceed the channel capacity and overflow onto the floodplain. During floods, water is stored in sloughs and side channels, or seeps into floodplain soils and recharges groundwater storage. This stored groundwater slowly drains back to the channel, providing a source of cool inflow during the summer (Naiman et al. 1992). Low-gradient, unconfined channels migrate back and forth across their floodplains in sinuous patterns in response to differential patterns of bank erosion and sediment deposition. Channel migration may occur as a result of slow, steady erosion of the outside of a meander bend, or it may occur as a sudden shift into an old channel during flood events. As a result of these processes, natural low gradient, alluvial channels typically develop a network of low-flow channels containing numerous gravel bars, side channels, abandoned oxbow lakes, sloughs and wetlands. Such off-channel and mainstem margin habitats are an important component of juvenile salmonid rearing habitat and refuge from high flows.

The formation, availability, and quality of off-channel habitat are currently limited in the Action Area due to natural topographic features, flood control operations associated with upstream projects, and land-use changes. Nearly all of Boundary Reservoir and the Boundary Dam tailrace north of Metaline Falls is confined within steep-walled canyon topography. Consequently, the availability of floodplain habitat in that part of the reservoir is naturally low. In contrast, the Pend Oreille River between Box Canyon Dam and Metaline Falls is somewhat broader with areas where flood flows result in small backwater sloughs and pools that could trap and/or strand fish. Bank hardening has contributed to confinement of the river in some places upstream of Metaline Falls. Significant amounts of riprap are present in the Box Canyon tailrace and some riprap is present near the mouth of Sullivan Creek and along the west bank as a result of bank stabilization to protect roads and homes. Flood storage operations upstream of the Project (e.g., Hungry Horse Dam) have reduced some of the large channel-altering flows that historically threatened people and property but were also responsible for creating new side channels.

Based on sediment transport modeling of Boundary Reservoir, the limited off-channel habitat available is likely to persist without substantial change over the next 50 years (Sediment Transport and Delta Habitats, SCL 2009a). Whether bull trout, if present in the Action Area, would use the available off-channel habitat during portions of the year is unknown. Bull trout tracked by Bassista et al. (2005) in Lake Pend Oreille were always observed at depths greater than 13 feet. If bull trout were to behave similarly in Boundary Reservoir, they would probably not use off-channel habitat, which is shallower than 13 feet deep. Consequently, bull trout use of off-channel habitat in the Action Area is unlikely to be affected by the Project.

2.3.4.4. Non-native Species

Numerous non-native fish species are present in the Action Area and tributaries draining to Boundary Reservoir that could have an adverse effect on bull trout. These include smallmouth and largemouth bass, walleye, northern pike, brook trout, triploid rainbow trout, brown trout, and lake trout. Many of these species are piscivorous and could forage on any young bull trout that are present.

Although the historical fish community is not completely understood, especially with regard to the relative abundance of native species, the current fish community in the mainstem Pend Oreille River is certainly different, in part because of the introduction of non-native species. Most of the introduced species occupy higher trophic levels and are primarily piscivorous in the older age classes. In order of their relative abundance in the mainstem fish community, these relatively large piscivorous non-native species include yellow perch (14.9 percent), smallmouth bass (10.5 percent), brown trout (0.6 percent), largemouth bass (0.4 percent), walleye (0.3 percent), northern pike (0.2 percent), and lake trout (<0.1 percent).

The substantial smallmouth bass population and recently established northern pike population are of particular concern relative to predation risk. The smallmouth bass population is sufficiently robust to support the annual "Bassin Assassin" tournament in the reservoir, which has become increasingly popular over recent years. Radiotelemetry studies indicate that smallmouth bass use the flooded delta area at the mouth of Sullivan Creek during spring high-flow periods when young salmonids would be expected to move downstream and enter the reservoir (SCL 2009b).

Northern pike, which are highly piscivorous and may prey on salmonids, have recently become established in Boundary Reservoir, likely as a result of entrainment from Box Canyon Reservoir. McLellan (2001) conducted extensive sampling in Boundary Reservoir during 1999 but did not capture any northern pike. However, sampling conducted as part of relicensing in 2007 and 2008 resulted in the capture of 35 northern pike up to 910 millimeters (35.8 inches) in length. In addition, numerous young-of-the-year northern pike were captured and observed during 2008 in vegetated areas considered to be suitable for northern pike spawning. The observations over the last few years suggest that the population of northern pike in Boundary Reservoir is increasing in size; however, it is unclear how large a population may be sustained within the reservoir.

The self-reproducing populations of non-native trout are relatively small in the reservoir, but could contribute to crowding in thermal refugia during periods of high mainstem water temperatures. Triploid rainbow trout have been stocked into Boundary Reservoir by SCL to

provided sport fishing opportunities. During the years 2001 to 2008 SCL stocked an average of 7,099 triploid rainbow trout into Boundary Reservoir, with about half of them being stocked in the spring and the other half in the fall. Relicensing studies during 2007 and 2008 indicated that few of the stocked triploid rainbow trout survived the winter in Boundary Reservoir. The primary threat from the stocked triploid rainbow trout to bull trout is crowding in thermal refugia. They also increase the risk of accidental capture by anglers targeting triploid rainbow trout. Triploid rainbow trout diets could overlap with those of bull trout, but the extent to which they could be competing for a common, limited food resource is unknown. As mentioned above, stocking of triploid rainbow trout in Boundary Reservoir will not occur for the foreseeable future after 2009. Consequently, all of the potential adverse effects of triploid trout to bull trout will be avoided in the future.

The higher trophic level native species include northern pikeminnow (6.0 percent), burbot (0.2 percent), cutthroat trout (<0.1 percent), and bull trout (<0.01 percent). Notably, only one of the non-native species (brown trout) relies on the tributaries for a portion of its life history, whereas two of the four native species, both salmonids, rely on tributaries for the spawning and juvenile rearing life stages. The forage base for piscivorous fish species is also substantially altered in the mainstem due in part to the presence of non-native species such as pumpkinseed, black crappie, and tench, which in combination account for nearly 10 percent of the fish community in the mainstem. While the direct effects of non-native fish on native salmonids in Boundary Reservoir are unclear, it is apparent that non-native fish species currently have a much larger role as top level predators in the fish community than native species do.

The relative importance of competition, predation, forage base, and habitat access and availability that are part of the ecological relationships between native species and non-native species are typically complicated, difficult to discern, and poorly understood in the Project area. It is apparent than non-native species are currently much more dominant than native species, particularly in the case of bull trout, in the higher trophic levels. The scientific literature suggests that non-native species have an adverse effect on native salmonids (e.g., Sanderson et al. 2009; Fritts and Pearsons 2004). However, it is unclear to what extent non-native species in the reservoir have contributed to the decline of native salmonids that historically filled higher trophic levels or whether the non-native species are opportunistically filling higher trophic levels vacated by native species whose abundance has been reduced due to other factors. Regardless, an important consideration expressed by some RPs was that non-operational mainstem PM&E measures proposed by SCL in its License Application be beneficial to native salmonids without encouraging the proliferation of non-native fish species (IRA Meeting Summary; March 24-25, 2009).

Productivity in Boundary Reservoir is relatively low (Tributary Productivity, SCL 2009a). Theoretically, the presence of non-native trout in Boundary Reservoir could result in competitive interactions with bull trout for food. However, it is unclear if trout populations are sufficiently large, or food resources sufficiently scarce, for competition for food to be a limiting factor for bull trout.

2.4. Terrestrial Species

Three wildlife species listed as Threatened or Endangered under the ESA can occur in the Project vicinity: Canada lynx, grizzly bear, and woodland caribou. Locations of species occurrences from the Priority Habitat and Species (PHS) database and species observations recorded during SCL's technical studies in 2007 and 2008 are shown in Figure 2.4-1. Table 2.4-1 lists these species and provides a summary of their potential occurrence. No federally listed or proposed Threatened or Endangered plant species are known to occur in the Project vicinity. On February 27, 2009, the USFWS reclassified the gray wolf Rocky Mountain DPS from Threatened to Delisted (73FR10514), and thus this species is not evaluated in this BA.

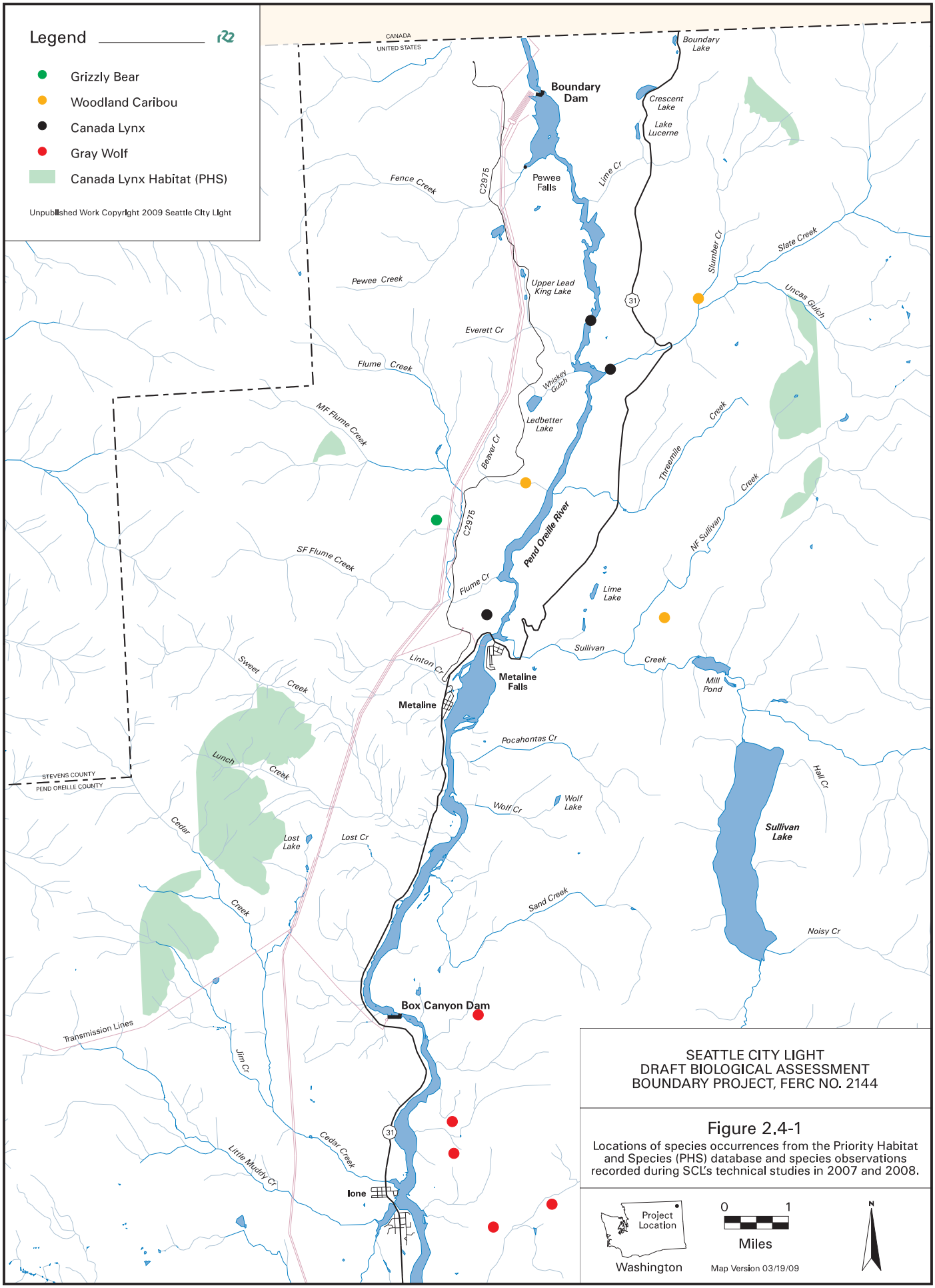

Legend
Grizzly Bear
Woodland Caribou
Canada Lynx
Gray Wolf
Canada Lynx Habitat (PHS)
Unpublished Work Copyright 2009 Seattle City Light
CANADA
UNITED STATES
Boundary Lake
Boundary Dam
Crescent Lake
Lake Lucerne
Pewee Falls
Lime Cr
C2975
Fence Creek
Slumber Cr
Slate Creek
Pewee Creek
Upper Lead King Lake
Uncas Gulch
Everett Cr
Flume Creek
Whiskey Gulch
MF Flume Creek
Ledbetter Lake
Beaver Cr
Threemile Creek
NF Sullivan Creek
Pend Oreille River
SF Flume Creek
Flume Cr
Lime Lake
Sullivan Creek
Linton Cr
Metaline Falls
Mill Pond
Sweet Creek
Metaline
Pocahontas Cr
Lunch Creek
STEVENS COUNTY
PEND OREILLE COUNTY
Wolf Cr
Wolf Lake
Hall Cr
Cedar Creek
Lost Lake
Lost Cr
Sullivan Lake
Sand Creek
Noisy Cr
Box Canyon Dam
Transmission Lines
Jim Cr
Cedar Creek
Little Muddy Cr
Ione
SEATTLE CITY LIGHT
DRAFT BIOLOGICAL ASSESSMENT
BOUNDARY PROJECT, FERC NO. 2144
Figure 2.4-1
Locations of species occurrences from the Priority Habitat and Species (PHS) database and species observations recorded during SCL's technical studies in 2007 and 2008.
Project Location
Washington
0
1
Miles
Map Version 03/19/09
N

Table 2.4-1. Federally-listed Threatened and Endangered terrestrial species that may occur in the Project vicinity.

Scientific/ Common Name	USFWS Status[1]	USFS Status	BLM Status	WDFW Status[2]	Occurrence
Lynx canadensis Canada lynx	FT	None	None	ST	One individual documented swimming across Canyon Reach in 2008.
Rangifer tarandus caribou Woodland caribou	FE	None	None	SE	Documented in Project vicinity. Introduced to Sullivan Creek Drainage in 1996. Periodic sightings over past 25 years.
Ursus arctos Grizzly bear	FT	None	None	SE	Documented in Project vicinity. Periodic sightings over past 10 years.

Notes:
1 FT = federal Threatened species, FE = federal Endangered species,
2 SE = State Endangered, ST = State Threatened.

2.4.1. Canada Lynx

The Canada lynx (*Lynx canadensis*) is a federal and state-listed Threatened species. In northeastern Washington, lynx use remote, high-elevation (> 4,000 feet) forests dominated by mature spruce (*Picea* sp.), subalpine fir (*Abies lasiocarpa*), and thickets of dense lodgepole pine (*Pinus contorta*) that support prey (primarily snowshoe hare [*Lepus americanus*]) populations (Brittell et al. 1989,;Stinson 2001). Only a small amount of the land in the general area (within 5 miles) of the Project vicinity is above elevation 4,000 feet. Lynx habitat quality is believed to be lower in the southern periphery of its range than in the northern taiga, because landscapes are more heterogeneous in terms of topography, climate, and vegetation (Buskirk et al. 2000). Population recruitment and home range sizes of lynx in the United States are similar to those reported during the decline or low phase of snowshoe hare cycles at more northern latitudes (Koehler 1990; Apps 2000). Lynx at the southern periphery of their range may prey on a wider variety of organisms, because of differences in small mammal communities and lower average hare densities compared with northern taiga.

There have been several reported lynx sightings within five miles of the Project according to USFS records (USFS unpublished data, CNF Sullivan Lake Ranger District, Borysewicz 2008). During the 2007-2008 field season, a fisheries study crew observed a lynx swimming across the Canyon Reach of the reservoir south of Monument Bar in a narrow section of the reservoir (about 300 feet wide) (Big Game Study Final Report, SCL 2009a), confirming lynx use in the Project vicinity. This individual was thought to be a dispersing individual, traversing the Project vicinity and heading toward higher elevations and more suitable habitat.

The Project area is not located within a designated Lynx Management Zone (LMZ) established in the Washington State Recovery Plan for Lynx (Stinson 2001). LMZs include regions of the state that should be managed for lynx because they are occupied, or were recently occupied (within the past 30 years), by lynx. These LMZs are to be regularly surveyed to monitor the status of populations

(Stinson 2001), although no status reports or updates have been issued since the 2001 recovery plan (WDFW 2008). The two LMZs closest to the Project are the Salmo Priest LMZ to the east and the Little Pend Oreille LMZ to the west. The LMZs have been divided into Lynx Analysis Units (LAUs), which were established to assess habitat conditions and are useful as survey units for documenting lynx occurrence. The Project is nearest to the Russian and Cedar (to the west) and Slate and Totem (to the east) LAUs. The LAUs are at least 1 mile from the Project area.

Recovery goals in the Washington State Recovery Plan for Lynx (Stinson 2001) include the following:

- Lynx are consistently present during 10 consecutive years in > 75 percent of the LAUs in LMZs.
- Lynx surveys indicate that recruitment from local reproduction regularly occurs.
- Agreements or forest management plans are in place for federal, state, and major private landholdings.

When these goals are met and verified, lynx will be considered for down-listing from state threatened to state sensitive (Stinson 2001).

The USFS signed an agreement with the USFWS on February 7, 2000, to manage habitat specifically for lynx to minimize the impact of the listing on forest management operations and comply with the ESA (USFWS and USFS 2000). While the species is unlikely to regularly inhabit the Project vicinity, individual animals may travel through the area. The USFWS has initiated the five-year review for grizzly bear and Canada lynx (72 FR 19549 19551); however, publication of this document is pending.

2.4.2. Woodland Caribou

The woodland caribou (*Rangifer tarandus caribou*) is a federal and state-listed Endangered species. A small number of woodland caribou occur in the southern Selkirk Mountains, with most of the animals occurring in British Columbia, north of the Project area. Caribou have been transplanted into northeastern Washington and northern Idaho, including some in the upper Sullivan Creek drainage on the Sullivan Lake Ranger District, beginning in the late 1990s (Audet and Allen 1996). During early winter, caribou move to low-elevation, old-growth cedar (*Thuja plicata*)/hemlock (*Tsuga heterophylla*) forests. They then move up to subalpine fir and whitebark pine (*Pinus albicaulis*) stands once snow becomes sufficiently compacted and crusted for caribou to be able to walk on top of it (USFWS 1994). During spring, caribou move downslope to forage in shrubfields, meadows, and open forest stands.

The majority of the caribou population resides in the Salmo-Priest Wilderness Area, more than five miles east of the Project. Areas above elevation 4,000 feet are included in the Selkirk Mountain Woodland Caribou Recovery Area (USFWS 1994).

Specific goals of the Selkirk Mountain Woodland Caribou Recovery Plan include the following:

- Maintain the two existing caribou herds in the Selkirk ecosystem.
- Establish a herd in the western portion of the Selkirk Mountains in Washington.

- Maintain an increasing population as reflected by March aerial surveys (i.e., r>l).
- Secure and enhance at least 179,000 ha (442,317 acres) of suitable and potential caribou habitat in the Selkirk Mountains to support a self-sustaining population.

To date, no updated information has been reported on the progress of management activities toward these goals.

Over the last 25 years, woodland caribou have occasionally been observed in the general vicinity of the town of Metaline Falls and near the West Side Access Road, and have been documented crossing the river north of Metaline (CNF Sullivan Lake Ranger District Wildlife Species Occurrence database, 1996; Borysewicz 2008). Despite these rare observations, the Project vicinity itself lacks the older forests and elevations typically used by this species.

2.4.3. Grizzly Bear

The grizzly bear (*Ursus arctos*) is listed as a threatened species under the ESA and as a Washington state-listed endangered species. The USFWS has determined that the grizzly bear population in the Selkirk area of Idaho and Washington warrants reclassification to Endangered status, but such action has been precluded by work on other higher priority species (FR 64(94):26725-26733, May 17, 1999). The Grizzly Bear Recovery Plan lists human activity, road building, forestry, and mining as adversely affecting the grizzly bear (USFWS 1993). Since 1975, habitat protection measures implemented by federal agencies under the ESA have focused on providing secure habitat for bears that lessens opportunities for human-caused mortality resulting from hunting (i.e., mistaken for black bear [*Ursus americanus*]), poaching, human-bear conflicts, and livestock-bear conflicts.

The boundary of the Selkirk Mountain Grizzly Bear Recovery Area (Highway 31) is approximately 0.75 miles east of the Project area boundary. Thus, the Project area is not within a designated grizzly bear recovery area, although individual grizzly bears that occur outside the recovery area are protected. Populations are estimated to be 40 - 50 animals within the 2,200 square-mile Selkirk Mountain recovery zone (USFWS 2004).

Recovery goals for the Selkirk Mountain grizzly bear population are largely focused on retaining breeding females and reducing the human-caused mortality to zero. These goals are:

- Six females with cubs over a running 6-year average both inside the recovery zone and within a 10-mile area immediately surrounding the recovery zone, including Canada.
- Seven of the 10 bear management units on the U.S. side occupied by females with young from a running 6-year sum of observations.
- Known human-caused mortality not to exceed 4 percent of the population estimate based on the most recent 3-year sum of females with cubs; furthermore, no more than 30 percent of this 4 percent mortality limit shall be females.
- The mortality limits cannot be exceeded during any 2 consecutive years.

The USFWS has initiated the five-year review for grizzly bear and Canada lynx (72 FR 19549 19551); however, publication of this document is pending.

The Colville National Forest (CNF) Forest Plan (USFS 1988) includes grizzly bear management in accordance with the Interagency Grizzly Bear Guidelines (IGBC 1986) and the CNF Guidelines for Management in Occupied Grizzly Bear Habitat. Secure bear habitat is primarily a function of the total and accessible (un-gated) motorized road density. Other guidelines are aimed at reducing bear habituation to recreation sites and other areas of human activity, and reducing direct and indirect bear mortality.

In the early 1990s, Wielgus et al. (1994) estimated densities of 3.65 bears per 100 square miles in the U.S. portion of the Selkirk Grizzly Bear Recovery Zone, whereas the Canadian portion had a density of 6.3 bears per 100 square miles. According to USFS records, grizzly bear sightings have been recorded within the last 10 years on both sides of the reservoir. In 2004, USFS biologists observed a grizzly bear feeding on a deer carcass in the lower Sullivan Creek drainage. Radiotelemetry from 2003 indicated that a grizzly bear may have used Slate Creek as a travel corridor before crossing the reservoir (USFS unpublished data, CNF Sullivan Lake Ranger District, Borysewicz 2008). A local resident reported that grizzly bears are often seen in the spring foraging in the meadows on both sides of Boundary Reservoir south of Metaline Falls in the secondary study area (Luhr 2008). Grizzly bears require spring forage habitats that provide large amounts of succulent, palatable herbaceous plants when they emerge from den sites. In most cases, these habitats are restricted to wetlands and riparian areas. During the summer and fall, berry-producing shrubfields are important. Both spring and summer/fall forage habitats are limited in the portions of the CNF near the Project (USFS 1998). Den sites are associated with high elevations farther to the east near the Salmo-Priest Wilderness Area (USFS 1998).

3 DESCRIPTION OF ACTIONS

3.1. Proposed Project Operation

Under the new FERC license term, SCL proposes to operate the Project as it is currently licensed, but with the formalization of two currently voluntary operational measures: forebay water surface elevation restrictions for summer recreation enhancement and turbine unit sequencing to reduce TDG production during non-spill conditions. The proposed summer forebay water surface elevation restriction is as follows: from Memorial Day weekend (starting Friday evening) through Labor Day weekend (ending Monday evening), forebay water surface elevations will be maintained at or above 1,984 NAVD 88 from 6:00 am through 8:00 pm to facilitate recreational access and use. From 8:00 pm through 6:00 am, forebay water surface elevations will be maintained at or above elevation 1,982 feet NAVD 88. Under SCL's proposed operation, the 1,984- and 1,982-foot NAVD 88 elevations will be license requirements that cannot be violated except for conditions such as equipment failures, maintenance activities, electrical and mechanical device limitations, safety inspections, testing, natural disasters (e.g., lightning), compliance with Western Electricity Coordinating Council (WECC) and North American Electric Reliability Council (NERC) requirements, capacity and energy emergencies, and any event that triggers the Project Emergency Action Plan (EAP).

From Labor Day weekend to Memorial Day weekend, operating the Project as it is currently operated will result in forebay water surface elevations generally fluctuating between 1,994 feet and 1,974 feet NAVD 88. Minimum forebay elevations will often be above 1,980 feet NAVD 88 and will only occasionally be below 1,974 feet NAVD 88. The range of water surface elevations for dry (2001), average (2002), and wet (1997) inflow years is shown in Figures E.2-6 through E.2-8 of Section 2.1.2.3 of this Exhibit E.

To reduce TDG under normal, non-spill operations, SCL will operate Units 55 and 56 above 125 MW and sequence their startup and shutdown so that they are the last units to be brought on line and the first units to be shut down (see Section 4.5.2.2.3, Total Dissolved Gas, of Exhibit E of the License Application for greater detail on the effect of unit sequencing).

Both of the formalized operational measures–forebay water surface elevation restrictions primarily for summer recreation enhancement and turbine unit sequencing to reduce TDG production–will be accomplished by programming and documenting (Numbered Dispatching Memoranda) these measures as administered by SCL's System Control Center.

During the new license term, SCL plans to upgrade equipment at the Boundary Dam power plant (see Section 2.3.2 of Exhibit E of the License Application). Proposed upgrades to the turbines may reduce or eliminate the conditions that in the past have led to TDG production during non-spill operations. When the proposed turbine upgrades are completed, SCL plans to reevaluate the need for the unit sequencing identified above and adjust the approach to, or eliminate, the sequencing restrictions as appropriate.

3.2. Conservation Measures Affecting Aquatic Species

Proposed non-operational PM&Es relevant to bull trout are as follows:

- Gravel Augmentation below Box Canyon Dam
- Channel Modifications for Mainstem Trapping Pools at Project RM 30.3
- Upstream Fish Passage
- Mainstem Large Woody Debris and Tributary Deltas
- Boundary Reservoir Fish Community Monitoring
- Habitat Protection, Riparian Improvement, and Stream Channel Enhancement in Sullivan Creek from RM 0.00 to RM 0.54
- Riparian, Streambank, and Channel Improvements in Sullivan Creek from RM 2.30 to 3.93
- Culvert Replacements in Slate Creek Tributaries Slumber Creek at RM 0.20 and Styx Creek at RM 0.10
- Riparian Planting in Linton Creek RM 0.00 to 0.20
- Channel Improvements in Sweet Creek from RM 0.40 to 0.50
- Riparian Buffer Protection and Enhancement in Sweet Creek from RM 0.00 to 0.50
- Tributary Non-native Trout Suppression
- Native Trout Supplementation Facility
- TDG Abatement Measures

These measures are summarized below and described in more detail in the Fish and Aquatics Management Plan (FAMP), i.e., Attachment E-8 to Exhibit E of the License Application.

3.2.1. Gravel Augmentation Below Box Canyon Dam

SCL proposes to increase mountain whitefish spawning opportunities by augmenting gravel and small cobble by a total area of 4,500 square yards in the upper reservoir between PRM 29.1 and the Box Canyon Dam. Tentative sites have been identified at PRM 33.7 (0.8 mile below Box Canyon Dam) (Figure 3.2-1), but final site selection will be developed in coordination with the Fish and Aquatics Workgroup (FAWG). Average depth of augmented gravel/small cobble will be 1 foot, resulting in a total augmented volume of 1,500 cubic yards. For planning purposes, SCL assumes that 25 percent of the gravel/cobble volume will be replenished every five years. An implementation planning study developed cooperatively with the FAWG within three years following license issuance will be used to identify depth, velocity, and any other criteria used for site selection. The implementation plan will also identify whether boulder weirs or other structures will be needed to help retain the augmented gravel at the proposed sites. Conceptually, large boulders will be placed in horseshoe-shaped clusters for gravel retention. Implementation will occur within two years following completion of the planning phase.

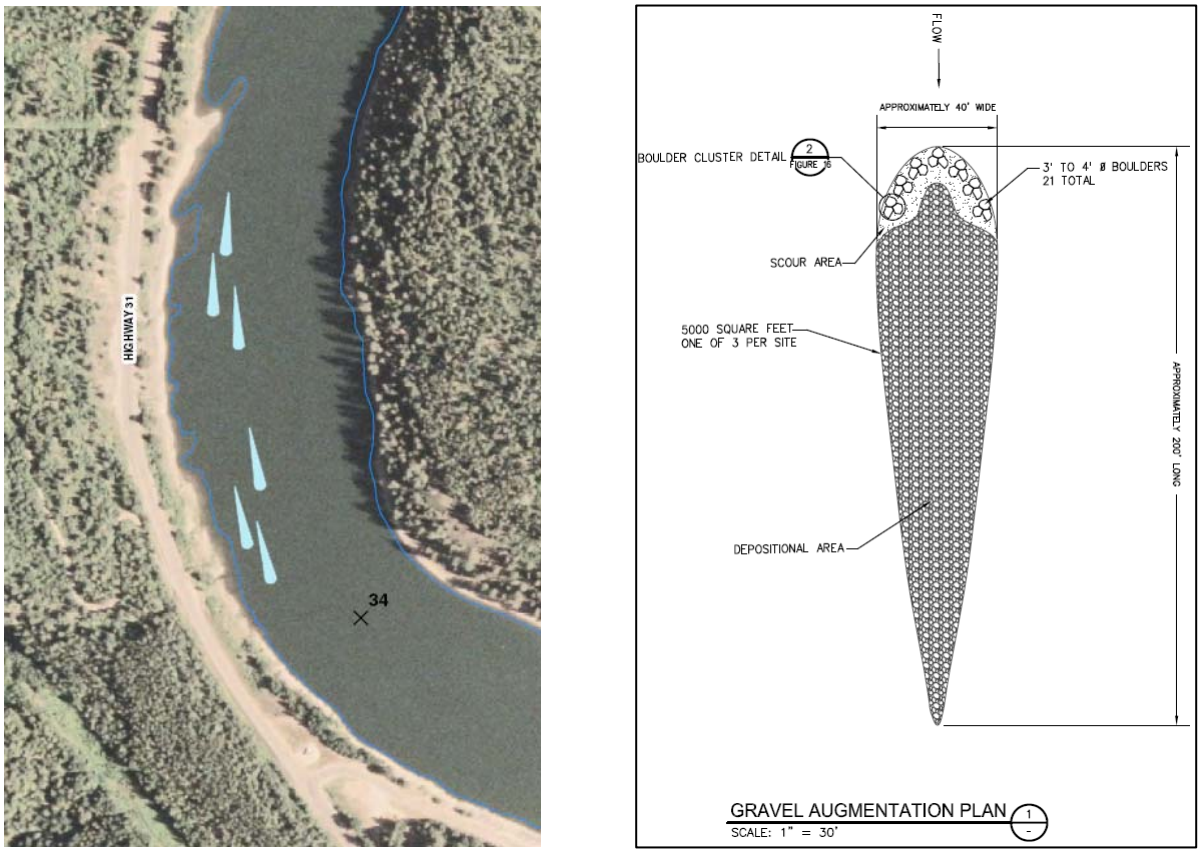


Figure 3.2-1. Tentative location of gravel augmentation near PRM 33.7 (left). Conceptual boulder cluster and augmented gravel (right).

Compliance and effectiveness monitoring will be conducted as described in the FAMP (Attachment E-8 to Exhibit E of the License Application). Compliance monitoring will document implementation and identify the appropriate frequency of gravel replenishment. Egg mats will be used to evaluate effectiveness.

3.2.1.1. Rationale

The available information from relicensing studies suggests that mountain whitefish spawn in the Box Canyon Dam tailrace (SCL 2009d). Standard monthly electrofishing surveys and targeted surveys were conducted specifically to locate staging mountain whitefish congregations and individuals ripe for spawning. In addition, egg mats were also deployed at a number of locations to better understand the timing of mountain whitefish spawning. The catch of gravid and milt-flowing mountain whitefish by boat electrofishing in the Upper Reservoir Reach during these surveys supports the hypothesis that mountain whitefish spawn in the Upper Reservoir Reach during November and December. Furthermore, egg mats successfully collected a small number of eggs believed to be those of mountain whitefish. The addition of high quality spawning substrate in areas with suitable depths and velocities is anticipated to increase the spawning opportunities and success of mountain whitefish in Boundary Reservoir.

3.2.2. Channel Modifications for Mainstem Trapping Pools at Project RM 30.3

SCL proposes to modify four pools (totaling about 67,320 square feet) within the Cobble Sisters area of the reservoir near PRM 30.3. The modifications will include excavation of a 1,800-foot channel to connect three of the trapping pools and using spoils from excavation to fill one of the pools (Figure 3.2-2). The objective of this measure will be to maintain a wetted connection to mainstem flows in the constructed channel under proposed operations. The measure will reduce the current risk to fish of being trapped within pools during periods of declining reservoir water surface elevations.

SCL, in collaboration with the FAWG, will prepare an implementation plan within three years following license issuance. The implementation plan will provide design specifications for the channel excavation and dispersal of spoils based on field surveys at the Cobble Sisters. The design will include drawings that specify the current and planned topography and shape of the site. The thalweg of the excavated channel will be at an elevation of 1,979 feet NAVD 88, which will result in it being wet under all but the most extreme drawdowns, thus allowing fish egress to the mainstem under nearly all flow and operating conditions.

Compliance and effectiveness monitoring will be conducted as described in the FAMP (Attachment E-8 to Exhibit E of the License Application).

Figure 3.2-2. Location of trapping pools (left) and conceptual plan (right) for modification at Cobble Sisters.

3.2.2.1. Rationale

Relicensing studies during 2007 and 2008 suggested that fry and young-of-year fish may become trapped in pools during periods of declining reservoir water surface elevations and under some conditions may suffer injury or mortality during these events. Although nearly all of the trapped fish observed during 2007 and 2008 were non-salmonids, such as suckers, perch, or smallmouth bass fry, these trapping mechanisms could also potentially adversely affect native salmonids if they are present in the trapping areas when water surface elevations decline.

During 2008, the Cobble Sisters area was identified as a location with a high occurrence of trapping (Mainstem Aquatic Habitat Modeling Study Final Report, SCL 2009a). The pools and depressions at the site are the result of aggregate mining that occurred prior to completion of the Project. The excavated depressions have persisted since construction of the Project, which suggests that the area is geomorphically stable. SCL is proposing the excavation of connecting channels at the Cobble Sisters because these habitats are man-made and stable.

3.2.3. Upstream Fish Passage

SCL will develop a trap-and-haul facility that provides upstream passage for native salmonids 3.9 inches and larger because Boundary Dam is too high (340 feet) for a traditional fish ladder facility. Because of the low abundance of native salmonids in the tailrace and the high level of uncertainty regarding the feasibility of implementing a permanent upstream passage solution, SCL is proposing a phased approach to addressing the need for upstream passage. Similar approaches have been used for the recently relicensed Clark Fork River (FERC No. 2058) and Box Canyon (FERC No. 2042) projects. SCL intends to work collaboratively with the FAWG to implement the passage program.

Phase I will last seven years and result in the design and construction, during Years 6 and 7, of a temporary trap-and-haul facility and produce biological information used to determine alternative locations and periods for deploying the temporary facility. Phase II will follow Phase

I and last 10 years. This phase will consist of deploying the temporary facility at the alternative locations and periods identified during Phase I. Phase II will identify the best location(s) for deploying a permanent trap-and-haul facility. For planning purposes, SCL assumes that design and construction of a permanent trap-and-haul facility will occur during Years 16 and 17 following license issuance; however, at any time between Year 13 and Year 16 of Phase II, SCL, in collaboration with the FAWG, could transition to Phase III. Phase III will involve operation of a permanent trap-and-haul facility at a fixed location or a long-term mobile trap-and-haul facility that could be deployed on a seasonal basis and fished at various locations. Greater detail regarding the upstream fish passage PM&E measure is provided in the FAMP (Attachment E-8 to Exhibit E of the License Application).

3.2.3.1. Rationale

Boundary Dam prevents upstream movement of fish, including native salmonids. However, relicensing studies indicate that the abundance of native salmonids in the Tailrace Reach is very low, representing only about 2 percent of the fish community. From March 2007 to December 2008, 29 native salmonids (three bull trout [a fourth bull trout was detected via radio telemetry in 2008], 12 westslope cutthroat, and 23 mountain whitefish) were captured during monthly electrofishing and gillnet sampling in the Boundary Dam tailrace or observed while snorkeling. The available information suggests that the number of native salmonids prevented from accessing habitat upstream of Boundary Dam or contributing to the upstream gene pool is relatively small, and their significance as a proportion of total population is uncertain. Nevertheless, the NWU Recovery Team for bull trout considers passage at hydroelectric projects on the Pend Oreille River a high priority for recovery (USFWS 2002).

3.2.4. Mainstem Large Woody Debris at Tributary Deltas

SCL proposes to enhance tributary delta habitat by providing additional cover for salmonids through placement of engineered LWD jams in the upper delta regions of four tributaries to Boundary Reservoir: Sullivan, Sweet, Slate, and Linton creeks. The upper delta regions were selected to address RP's concerns that measures be located to benefit native salmonids without also encouraging proliferation of non-native fish species. Sullivan Creek will receive two LWD jams and Slate, Sweet, and Linton creeks will each get one LWD jam. LWD jams will be sized based on tributary size: each LWD jam in Slate Creek, Sweet Creek, and Linton Creek will have a target volume of 529 cubic feet (one key piece and 5 large pieces), and jams will have a target size of 1,700 cubic feet for the Sullivan Creek Delta. Each LWD jam will include at least one key piece based on sizes recommended in Fox and Bolton (2007), at least one piece with an attached root wad that could also count as the key piece, and additional LWD pieces to meet the target volume for the LWD jam. LWD jam designs will follow the engineering guidance provided in WDFW (2003) and Saldi-Caromile et al. (2004). SCL assumes that maintenance or replacement structures will be needed every seven years, i.e., up to six full replacements during the new license term for each structure.

A relicensing study also examined the size and amount of woody debris removed at Boundary Dam, which is used as firewood at the Forebay Recreational Area or sold as saw logs by the removal contractor (LWD Management Study, SCL 2008c). SCL proposes that LWD collected at the Boundary Dam trash rack be managed to retain and stockpile wood suitable for this PM&E

measure and other stream enhancement measures to be implemented in the channelized portions of Sullivan Creek and Sweet Creek. Wood to be stockpiled would be a minimum of 12 inches in diameter and 17 feet in length (medium-size categories in Peck et al. 2003). The target size of the site would be sufficient to stockpile approximately 10,000 cubic feet of LWD (approximately 34 logging truck loads). It is unlikely that sufficient sizes and numbers of LWD pieces can be collected at Boundary Dam over the near term to provide all the LWD needed for PM&E measures. Consequently, purchase of LWD from outside sources will likely be needed.

Activities at the Sullivan Creek delta associated with this PM&E measure could be affected by activities required pursuant to the pending surrender proceeding for the Pend Oreille County Public Utility District's (PUD's) Sullivan Lake Hydroelectric Project (FERC No. 2225) license. The Sullivan Lake Project includes Mill Pond Dam. Removal of Mill Pond Dam could adversely affect downstream enhancement projects through short- or long-term changes in sediment supply and LWD recruitment and transport. Consequently, implementation of SCL's proposed PM&E measure in Sullivan Creek will not occur until the disposition of Mill Pond Dam has been determined. Following implementation of SCL's proposed PM&E measure, compliance and effectiveness monitoring will be conducted at each of the tributary delta sites. Greater detail regarding this PM&E measure is provided in the FAMP (Attachment E-8 to Exhibit E of the License Application). If this PM&E measure is approved, SCL will propose any necessary revisions to the Project boundary after the specific locations of the LWD jams and related activities are determined.

3.2.4.1. Rationale

Relicensing studies indicate that native and non-native salmonids use tributary deltas during summer to take advantage of coldwater refugia (SCL 2009b). Deltas also serve as transition areas between the reservoir and tributaries and must be used by fish moving between these two habitat types. Habitat studies indicate there is little LWD (e.g. Figure 3.2-3) or other forms of cover in these tributary deltas (LWD Management Study, SCL 2008c).

Figure 3.2-3. Downstream view of Sweet Creek in the upper delta area (left) and looking upstream at Sullivan Creek during early September, 2007.

3.2.5. Boundary Reservoir Fish Community Monitoring

SCL proposes to conduct fish community surveys in Boundary Reservoir, Boundary Dam tailrace, and selected tributaries at five-year intervals to obtain information on trends in the abundance and species composition of the fish community. Information for Boundary Reservoir will be collected for each of the three major reaches: Forebay, Canyon, and Upper Reservoir. Tributaries to be surveyed include Slate Creek, Flume Creek, Sullivan Creek, Sweet Creek, Linton Creek, and Sand Creek. SCL anticipates that the level of effort and techniques used would be similar to those of McLellan (2001) so that trend data will be comparable across years. At a minimum, the techniques to be used will include electrofishing, gill netting, and snorkeling. A study plan will be prepared in collaboration with the FAWG prior to each field season and a survey completion report prepared within one year following surveys to document compliance with the study plan and PM&E measure.

3.2.5.1. Rationale

Trend information on fish communities in the Project area is important for resource management agencies so they can identify necessary changes in future management direction. For example, McLellan (2001) collected information on the composition of the fish community and species relative abundance in Boundary Reservoir during 2000, and SCL collected similar information during 2007 and 2008 (SCL 2009b). The trend information from these two studies demonstrates the establishment of a northern pike population in Boundary Reservoir. During 2000 McLellan (2001) observed no northern pike, but SCL (2009b) documented both adult and juvenile northern pike in areas considered suitable for spawning. Although northern pike numbers in Boundary Reservoir are considered to be relatively low, a self-reproducing population has been established, and there is the potential for increasing numbers in the future. If predator fish, such as northern pike, proliferate significantly in the Project area, they could become a threat to the already uncommon native salmonids. Trend information could help management agencies in the development of strategies for the recovery of native salmonids and for setting priorities and schedules for implementing these strategies. For example, WDFW could consider harvest regulations aimed at reducing the number of northern pike. Trend information might also be helpful in adaptive management associated with PM&E measures being implemented by SCL as part of the new license.

3.2.6. Habitat Protection, Riparian Improvement, and Stream Channel Enhancement in Sullivan Creek RM 0.00 to RM 0.54

This measure has three components to be implemented between the mouth of Sullivan Creek and RM 0.54 (downstream of the Highway 31 Bridge and the Sullivan Creek Hydroelectric Project boundary). Each of the following components is described separately: habitat protection, riparian planting, and stream channel enhancement. If this PM&E measure is approved, SCL will propose any necessary revisions to the Project boundary after the specific locations of the related activities are determined.

3.2.6.1. Habitat Protection

The objective of this component is to protect up to 54.7 acres within the stream corridor and a 300-foot buffer adjacent to Sullivan Creek from RM 0.00 to 0.54 through a combination of conservation easements or land acquisition (Figure 3.2-4). Protection measures reduce the risk of future adverse effects to existing habitat. SCL owns land adjacent to this reach of Sullivan Creek, of which 29.8 acres lie within the stream corridor or proposed buffer. A variety of state, local, and private entities accounts for the remaining ownership. Protection of non-SCL lands would require willingness of other landowners to enter into conservation agreements or sale of lands within the buffer zone. SCL proposes to place all of its ownership within the buffer under protected status throughout the duration of the new license. In addition, SCL will pursue conservation easements or land acquisitions from willing owners within the buffer zone.

Figure 3.2-4. Sullivan Creek from RM 0.00 to 0.54 with a 300-foot buffer.

3.2.6.2. Riparian Improvement

This component would implement riparian improvement along the left and right banks for up to 3,000 feet of stream, with the objective of improving riparian functions (shade, potential instream large woody debris, and erosion control), improving riparian habitat for wildlife, and

decreasing the presence of invasive plant species. Activities in some sections of the reach will depend on the successful implementation of the habitat protection component involving non-SCL landowners. This measure assumes that improvements will be made to approximately 60 percent of the 13.8-acre area within a 100-foot buffer on each side of the stream, resulting in improvements to approximately 8.3 acres. Current riparian conditions are variable with some portions devoid of riparian trees or brush (i.e., very sparse), some having a moderate density of mixed brush, herbaceous plants, and hardwoods with some conifers intermixed (moderately sparse), and some having a relatively dense hardwood forest cover with some conifers intermixed (sparse). This measure assumes that approximately 3.8 acres of riparian buffer with very sparse existing vegetation will require a high density of plantings, 2.0 acres of riparian buffer will require plantings interspersed among moderately sparse existing vegetation, and 2.5 acres of riparian buffer will require plantings interspersed among sparse existing vegetation. This component assumes approximately 5.5 acres of riparian area is in good condition and does not need improvement. Non-native vegetation found in the PM&E reach will be removed and replaced with native vegetation. Selection of specific plants and planting locations will be determined as part post-licensing planning and design work conducted in collaboration with the FAWG and following WDFW guidelines in Saldi-Caromile et al. (2004). It is anticipated that plants will be a mix of native coniferous and deciduous trees, shrubs, and herbaceous plants or ground cover. Non-native vegetation that has died will be replaced as needed during the three-year period following implementation to meet a minimum 80 percent survival of plantings.

3.2.6.3. Stream Channel Enhancement

The objective of this component will be to improve instream spawning and rearing habitat and channel conditions along 1,450 feet of stream by adding a combination of structural elements, primarily in the form of groins, barbs, porous boulder weirs, boulder clusters, and LWD. Addition of structural elements will contribute to pool formation and retention of LWD and coarse sediment suitable for salmonid spawning. Structural elements along the left bank will help stabilize the stream bank, protecting downstream property owners and decreasing bank erosion. This component assumes up to 100 boulders averaging 3 feet in diameter will be placed in the stream. This component proposes to supplement LWD to approximate the median key piece and total LWD densities estimated as reference conditions for the Douglas fir-Ponderosa Pine Region in Fox and Bolton (2007), which are 1.2 key pieces per 1,000 feet and 52 LWD pieces per 1,000 feet. LWD placement could take place in conjunction with some of the boulder placements for anchoring or increasing structure size. For planning purposes, SCL assumes that one engineered LWD jam will be designed and placed in the reach; the LWD jam will have a target volume of 1,800 cubic feet and will include at least one key piece (minimum volume of 344 cubic feet [Fox and Bolton 2007]), at least one piece with an attached root wad that could also count as the key piece, and additional LWD pieces to meet the target volume for the jam. Other LWD pieces will be placed individually, grouped, or placed in conjunction with boulders to meet the target of 75 pieces of LWD in the reach (existing plus supplemented LWD).

SCL anticipates that LWD may need replenishment because of loss from transport or degradation. Furthermore, SCL anticipates that woody debris structures such will have a five- to 10-year life span and will occasionally need repair or replacement. LWD replenishment will occur on a five-year basis throughout the term of the license to meet minimum LWD target density. SCL commits to replacing each instream LWD structure up to six times over the course

of the license term. Individual boulders and structures built using boulders are not expected to need replacement, but localized scour and other fluvial processes could result in the need for repair or repositioning of boulders.

Activities associated with this PM&E measure could be affected by activities required pursuant to the pending surrender proceeding for the license for the Sullivan Lake Hydroelectric Project, which includes Mill Pond Dam. If Mill Pond Dam is removed, it could adversely affect the effectiveness of any existing downstream enhancement projects through short- or long-term changes in sediment supply and LWD recruitment and transport. Consequently implementation of this component will not occur until the disposition of Mill Pond Dam has been determined. Implementation of this component along some portions of the reach will likely require landowner permission for access or modification of the stream bank on their property.

Compliance and effectiveness monitoring will be performed as part of this PM&E measure and is detailed in the FAMP (Attachment E-8 to Exhibit E of the License Application).

3.2.6.4. Rationale

Sullivan Creek is the largest tributary draining into Boundary Reservoir. Biological surveys conducted during relicensing indicated that the delta region and lower reaches of Sullivan Creek are used for rearing by cutthroat trout, brown trout, and rainbow trout. The delta has also been identified as a location of known mountain whitefish spawning. Although few bull trout have been observed in Sullivan Creek, the lower 0.66 mile of Sullivan Creek is designated as critical habitat by the USFWS.

The presence of the City of Metaline Falls and existing commercial and residential development adjacent to this lower reach of Sullivan Creek suggests there is a relatively high risk of future development compared to USFS lands farther upstream. A channel assessment from RM 0.47 to RM 0.68 was conducted during mid-July 2008. The habitat conditions in the surveyed reach were described as poor for fish migration, rearing, and overwintering. Spawning conditions are poor because appropriate sized gravel is lacking, and during high flows there is a high potential for any redds to be scoured. The bed conditions of the reach have been influenced by suction dredge mining and the Highway 31 Bridge. The dominant bed surface pattern was riffles and rapids. LWD was rare throughout the surveyed reach and primarily present above the water surface at the time of the survey and is consequently only an active component of fish habitat at higher flows. LWD functions relative to channel conditions observed during the survey primarily included bank stability and small pool scour. No LWD jams were present during the July 2008 survey. The riparian zone was described as composed of young (< 40 years) mixed vegetation. Several riparian sections within the PM&E reach are currently not forested and other sections have patches dominated by low brush and herbaceous vegetation (Figure 3.2-5).

Figure 3.2-5. Sullivan Creek downstream of Highway 31 Bridge.

3.2.7. Riparian, Streambank, and Channel Improvements in Sullivan Creek from RM 2.30 to 3.93

This PM&E measure will enhance Sullivan Creek from approximately 265 feet downstream of the confluence of Sullivan Creek and North Fork Sullivan Creek to the Sullivan Creek Hydroelectric Project boundary downstream of Mill Pond Dam and will focus primarily on streambank and channel enhancement, but will also include a limited amount of riparian planting. The objective will be to deflect water from the right bank to the left bank in areas hydrologically connected to Sullivan Lake Road, decrease bank erosion on the right bank, provide instream structure to promote pool creation and deposition and retention of spawning gravel, decrease the channel width-to-depth ratio, and promote the riparian buffer along the right bank. Non-native vegetation will be removed and planted native vegetation will be replaced as needed to achieve an 80 percent survival rate over the three-year period following implementation of the measure.

Selection of specific structural elements and their placement will be determined as part of post-license planning and design work conducted in collaboration with the FAWG and following WDFW guidelines in Saldi-Caromile et al. (2004). This measure will implement the design and construction of up to seven engineered LWD jams. Each LWD jam will have a target volume of 1,100 cubic feet and include at least one key piece (minimum volume of 344 cubic feet [Fox and Bolton 2007]), at least one piece with an attached root wad that could also count as the key piece, and additional LWD pieces to meet the target volume for the jam. Up to 100 boulders averaging 3 feet in diameter will be placed in the stream, primarily in boulder clusters, but will also be used to anchor LWD pieces.

Activities associated this PM&E measure could be affected by activities required pursuant to the pending surrender proceeding for the license for the Sullivan Lake Hydroelectric Project (FERC No. 2225), which includes Mill Pond Dam. If Mill Pond Dam is removed, it could adversely affect the effectiveness of any existing downstream enhancement projects through short- or long-term changes in sediment supply and LWD recruitment and transport. Consequently implementation of this component will not occur until the disposition of Mill Pond Dam has been determined. Implementation of this component along some portions of the reach will likely require USFS permission for access or modification of the stream bank.

Compliance and effectiveness monitoring will be performed as part of this PM&E measure as detailed in the FAMP (Attachment E-8 to Exhibit E of the License Application). If this PM&E measure is approved, SCL will propose any necessary revisions to the Project boundary after the specific locations of the related activities are determined.

3.2.7.1. Rationale

Two reaches, from RM 2.30 to 2.60 and from RM 2.74 to 3.02, underwent channel assessments as part of relicensing studies (Tributary Productivity, SCL 2009a). Habitat quality was described as low for salmonid spawning in both survey reaches, moderate for migration and rearing habitat in both reaches, and low and moderate, respectively, for overwintering habitat. The reaches were described as being adversely impacted by the presence of Mill Pond Dam, which starves the reach of coarse substrate and LWD, and the presence of Sullivan Lake Road along its right bank, which is hydraulically connected in several locations, limits lateral movement of the channel, and reduces riparian function (Figure 3.2-6). LWD density in the two reaches was lower than regional reference levels reported by Fox and Bolton (2007). No LWD jams were observed in one reach and one LWD jam was observed in the other. Riparian vegetation was described as a mixture of hardwoods and conifers, with the left bank having both young (< 40 years old) and mature (40-80 years old) trees, while the right bank had primarily young vegetation. Channel morphology was described primarily as plane-bed, with few rearing pools available. McLellan (2001) surveyed one site in the reach from North Fork Sullivan Creek to Mill Pond Dam and observed low numbers of cutthroat trout (1 fish, < 1 fish/100 square meters [1,076 square feet]) and rainbow trout (26 fish, 1 fish/100 square meters [1,076 square feet]). Increasing channel structure, decoupling the Sullivan Road from the stream, and enhancing riparian conditions is expected to benefit trout in the stream.

Figure 3.2-6. Section of Sullivan Lake Road hydraulically connected to right bank of Sullivan Creek.

3.2.8. Culvert Replacements in Slate Creek Tributaries Slumber Creek at RM 0.20 and Styx Creek at RM 0.10

Under this PM&E measure culverts at Slumber and Styx creeks (RM 0.20 and 0.10, respectively), will be replaced with new culverts that meet Washington State criteria within four years following license issuance. The objective of the PM&E measure is to provide passage for juvenile, sub-adult, and adult salmonids at all flow levels and provide access to more than 0.3 miles of resident trout habitat available in Slumber Creek and more than 1.9 miles available in Styx Creek. A secondary objective is to improve downstream transport of LWD. As part of culvert replacement, riparian planting will occur as needed in disturbed areas to control erosion and provide shade. Maintenance of the replacement structures will be the responsibility of the USFS.

Compliance monitoring will be implemented as part of this PM&E measure to ensure adequate survival of riparian plantings during the first three years following implementation. Non-native vegetation will be removed and planted native vegetation will be replaced as needed to achieve an 80 percent survival rate over the three-year period following implementation of the measure.

3.2.8.1. Rationale

Slumber Creek and Styx Creek are tributaries to Slate Creek, with their confluences at RM 2.0 and 4.9, respectively. USFS roads cross these tributaries near their mouths (RM 0.20 and 0.10, respectively). During 2008, habitat surveys were conducted upstream and downstream of these culverts for 492 feet in conjunction with evaluation of the culverts (Tributary Productivity, SCL 2009a,). Neither of the culverts was found to meet Washington State criteria for fish passage.

Both tributaries are relatively small with wetted widths less than 7.5 feet, but contain suitable trout habitat over a portion of their lengths (Tributary Productivity, SCL 2009a) that will be available under all flow conditions following replacement.

3.2.9. Riparian Planting in Linton Creek RM 0.00 to 0.20

Linton Creek flows through the town of Metaline and its mouth is located in Metaline Park. This PM&E measure will implement riparian improvement along the left and right banks for up to 655 feet of stream upstream of the mouth of Linton Creek, with the objective of improving riparian functions (e.g., shade, potential instream LWD, leaf and needle litter, erosion control, etc.), improving riparian habitat for wildlife, and decreasing the presence of invasive plant species. The PM&E measure assumes any non-native vegetation found in the PM&E reach within a 100-foot buffer on both sides of the stream (total area approximately 3.0 acres) will be removed. The riparian buffer will be planted with native vegetation. Selection of specific plants and planting locations will be determined as part of post-license planning and design work conducted in collaboration with the FAWG and the City of Metaline and following WDFW guidelines in Saldi-Caromile et al. (2004). It is anticipated that plants will be a mix native coniferous and deciduous trees, shrubs, and herbaceous plants or ground cover. Implementation of this PM&E measure depends on permission from the City of Metaline. If permission is not obtained, the funds allocated to riparian planting along Linton Creek will be allocated to other PM&E measures in collaboration with the FAWG.

Compliance monitoring will be implemented as part of this PM&E measure and non-native vegetation that has died will be replaced as needed to achieve an 80 percent survival rate over the three years following implementation.

3.2.9.1. Rationale

A channel and habitat survey from RM 0.00 to 0.25 (Tributary Productivity, SCL 2009a,) indicated that habitat was predominantly composed of low gradient riffles, with an average channel slope of 2 percent (Figure 3.2-7). Riparian and rearing habitat conditions within the survey reach were found to be poor. SCL (SCL 2009b) observed cutthroat trout, rainbow trout, brown trout, brook trout, pumpkinseed, and largescale sucker using the tributary channel while sampling during July through September 2008. Because Linton Creek is relatively small, with a mean wetted width of 10.6 feet, improvements to the riparian zone will likely provide substantial increased shade within five to ten years and increases in LWD recruitment to the channel over the long-term.

Figure 3.2-7. Riparian and channel conditions in lower Linton Creek.

3.2.10. Channel Improvements in Sweet Creek RM 0.40 to RM 0.50

The objective of this PM&E measure will be to increase channel complexity and gravel retention through LWD placement over a 558-foot reach downstream of the Highway 31 culvert. The bankfull width of Sweet Creek is approximately 33 feet in this reach, making it suitable for placement of channel spanning LWD. Up to 10 channel-spanning structures will be installed. Each structure will have one to three LWD pieces, of which at least one will be a key piece with a minimum volume of 88.2 cubic feet, preferably with a rootwad attached (Fox and Bolton 2007). Selection of the specific location and design of the spanning structures will be determined as part of post-license planning and design work conducted in collaboration with the FAWG and following WDFW guidelines in Saldi-Caromile et al. (2004). The presence of eroding stream banks will be considered during this process, and streambank reshaping could be implemented as part of structure placement to reduce erosion. As part of post-license planning other types of structural elements such as partial-spanning structures, porous boulder weirs, or boulder clusters could be substituted for proposed elements.

The design-life for engineered log structures in streams is anticipated to be five to 10 years; consequently, for planning purposes it is anticipated that maintenance or replacement structures will be needed every seven years during the new license term or up to six full replacements for each structure. If this PM&E measure is approved, SCL will propose any necessary revisions to the Project boundary after the specific locations of the related activities are determined.

Compliance and effectiveness monitoring will be performed as part of this PM&E measure as described in the FAMP (Attachment 8 to the License Application Exhibit E).

3.2.10.1. Rationale

Sweet Creek is the fourth largest tributary draining into Boundary Reservoir, with a drainage area of 11.1 square miles. A series of natural falls begin at RM 0.6 that are a complete upstream passage barrier. The stream also passes through a large box culvert under Highway 31 at RM 0.5. The culvert appears to block transport of LWD based on the buildup of wood and retention of gravel on its upstream side, and streambank erosion is occurring downstream of the culvert (Tributary Productivity, SCL 2009a). The culvert does not meet WDFW criteria for fish passage, but cutthroat trout, mountain whitefish, rainbow trout, brown trout, and brook trout have been observed upstream of the culvert (McLellan 2001), suggesting the culvert is passable under some conditions. Fish habitat and channel surveys conducted from the mouth to the lowermost falls suggest riparian and instream substrate and LWD conditions are relatively good; however, the reach is dominated by riffles and has relatively few pools (Tributary Productivity, SCL 2009a; McLellan 2001). The addition of channel-spanning drop structures should result in more pool habitat for fish using the stream.

3.2.11. Riparian Buffer Protection and Enhancement in Sweet Creek RM 0.00 to RM 0.50

SCL will pursue acquisition or protective land easements for 11.8 acres within a 100-foot buffer (excluding existing roads) on either side of Sweet Creek from the mouth to RM 0.5, which is the location of the Highway 31 culvert (Figure 3.2-8). In addition, SCL proposes to remove non-native vegetation and plant native brush and trees over 3.3 acres within the buffer. The majority of plantings will occur over a 3-acre area near the mouth of Sweet Creek where trees are mostly lacking, but will also include a 0.3-acre area north of the access road near the high school football field. Implementation of the protective portion of this PM&E measure depends on the willingness of current owners (three private owners, the Selkirk School District, Washington State Department of Natural Resources, and Washington Department of Transportation) to sell a portion of their land or enter into easement agreements. Similarly, implementing riparian plantings will require permission from the owners, even if long-term protection could not be provided. If owners are unwilling to sell or provide easements within the 100-foot buffer, then long-term protection will not be provided. If owners do not grant permission for riparian plantings, then funds equal to the cost of these plantings will be allocated to other PM&E measures as determined in collaboration with the FAWG. Compliance and effectiveness monitoring will be performed as part of this PM&E measure and is detailed in the FAMP (Attachment 8 to the License Application Exhibit E),and non-native vegetation that has died will be replaced as needed to achieve an 80 percent survival rate for three years following implementation.

3.2.11.1. Rationale

The coolwater plume at the tributary delta to Sweet Creek has been identified as an important area for salmonids during warm summer months. Bull trout, westslope cutthroat trout, and mountain whitefish have all been observed in lower reaches of Sweet Creek (SCL 2009b). While most of the riparian zone of Sweet Creek downstream of Highway 31is in relatively good condition (Tributary Productivity, SCL 2009a; McLellan 2001), several areas could be improved through riparian planting that would increase future shade and LWD recruitment potential.

Protection of the existing good riparian habitat and improvement of some areas would benefit native salmonids in the stream and would help maintain coolwater temperatures in the tributary delta.

Figure 3.2-8. Riparian buffer area adjacent to Sweet Creek proposed for protection.

3.2.12. Tributary Non-native Trout Suppression

SCL will conduct non-native trout suppression activities over an average of 5.8 miles of stream annually using a single pass of backpack electrofishing equipment. The basis for this amount of stream is the assumption that suppression will occur over 2.4 miles of Sweet Creek, between the barrier falls at RM 0.92 and the fish bearing headwaters except for Lunch Creek, on a three-years on/two-years off cycle. Suppression will also occur over 7.3 miles of Slate Creek, between the barrier chutes and falls at RM 0.75 and the fish bearing headwaters, also with a single-pass of a backpack electrofishing unit on a three-years on/two-years off cycle. SCL selected these two creeks because they have barrier falls that prevent immigration of non-native fish residing downstream, westslope cutthroat trout are present at low to moderate densities, and non-native trout densities appear to be relatively low (McLellan 2001).

The basis of the 5.8-mile average is as follows: suppression activities will be conducted for three years and then discontinued for two years over 2.4 miles of Sweet Creek and 7.3 miles of Slate Creek, for a total of 9.7 miles per year, and 29.1 miles over three years (i.e., 9.7 miles x 3 years = 29.1 miles). Annualized over the five-year on/off cycle, this will yield an average of 5.8 miles per year (29.1 miles ÷ 5 years). As stated above, SCL's commitment is an average of 5.8 miles per year, but the total could be implemented in different ways, including doing the total of 9.7 miles during three out of five years, which follows the recommendations of Peterson et al. (2008). Compliance and effectiveness monitoring will be conducted as part of this PM&E measure is described in more detail in the FAMP (Attachment 8 of the License Application Exhibit E).

3.2.12.1. Rationale

Most of the tributaries to the Pend Oreille River, including Boundary Reservoir, have been stocked with non-native salmonid species such as brook trout, brown trout, and rainbow trout (McLellan 2001). The presence of non-native trout, especially brook trout, has been suggested as a serious threat to native salmonids as a result of interbreeding (with bull trout) and competition for habitat and food resources (Andonaegui 2003). The USFWS (1999) stated in its status review that westslope cutthroat trout are usually found in the cooler upper extents of tributaries, but suggested this use was more likely driven by competition from other trout such as rainbow trout and brook trout that are less tolerant of cooler, higher gradient streams, than by a preference for that habitat type. Cutthroat trout, mountain whitefish, rainbow trout, brown trout, and brook trout have been observed downstream of the series of impassable falls beginning at RM 0.6 in Sweet Creek; however only brook trout and cutthroat trout were observed above the series of falls (McLellan 2001). No brook trout were observed in Lunch Creek or the uppermost reach surveyed in Sweet Creek.

Slate Creek has been identified as a stream important to the recovery of bull trout by the recovery team for the bull trout NWU and reduction of non-native fish species as a priority action (POSRT 2005). Surveys in Slate Creek conducted by McLellan (2001), R2 Resource Consultants (1998a), and the USFS (1998) have documented the presence of eastern brook trout. Rainbow trout have also been documented in Slate Creek downstream of the chute and falls barrier located at RM 0.75, but it is unclear if they are native redband trout or descendents of hatchery rainbow trout stocked in the creek because no genetic tests have been conducted on rainbow trout from Slate Creek. Tests of a small number of rainbow trout captured in Boundary Reservoir suggest that some had genetic characteristics similar to other native inland rainbow stocks, but the small sample size and lack of a baseline genetic library from nearby native redband populations for comparison precluded unequivocal conclusions (Small and Von Bargen 2009).

3.2.13. Native Salmonid Supplementation Facility

SCL will fund the construction and operation of a supplementation hatchery for the production of native salmonids to supplement tributaries draining into Boundary Reservoir. The initial target species will be westslope cutthroat trout, but the facility will be designed to simultaneously propagate two species of fish that could include bull trout, westslope cutthroat trout, redband trout, or mountain whitefish. The target capacity for the hatchery will be up to 45,000 eyed eggs,

fry, or fingerling (3 to 4 inch) fish per year (approximately 1,000 lbs per year if all were reared to fingerling-size). Selection of species, stocks, and lifestages to be produced will be developed in coordination with the FAWG. In addition, the hatchery will have the capacity to sustain the necessary numbers of broodstock fish derived from locally adapted stocks to produce this number of eggs, fry, or fingerlings. Because mature westslope cutthroat trout tend to be small in Boundary Reservoir tributaries (few fish exceed 12 inches; McLellan 2001), SCL estimates broodstock requirements could be 200 to 300 fish, assuming 500 eggs per female. Assuming an average size of 2.2 pounds per fish, broodstock rearing capacity will need to be approximately 440 to 660 pounds.

For planning purposes, it is assumed that the propagation facility will be located at the 40-acre WDFW parcel near Indian Creek that formerly supported the Usk Hatchery. The WDFW currently holds a 7-cfs water right from a natural spring at this location. The water supply could require heating to be appropriate for some species or life stages.

3.2.13.1. Rationale

The larger tributaries to Boundary Reservoir contain a variety of fish species, and most salmonid species in the Project Area occur in the tributaries (SCL 2006; SCL 2009b). Surveys conducted by the USFS, WDFW, and Kalispel Tribe of Indians (Kalispel Tribe) show that the dominant sport fish in tributaries are westslope cutthroat trout, eastern brook trout, rainbow trout, and to a lesser extent brown trout and mountain whitefish (SCL 2006). These surveys documented observations of bull trout (1 dead individual apparently caught by an angler), kokanee, and burbot in Sullivan Creek and bull trout (1 individual) in Sweet Creek. The burbot and kokanee in Sullivan Creek were likely entrained from Sullivan Lake, where substantial sport fisheries exist for both species.

Currently, no self-reproducing bull trout populations occur in any tributaries to Boundary Reservoir. Nevertheless, the Northeast Washington Unit (NWU) recovery team has identified Sullivan and Slate creeks as local bull trout populations under a recovered condition based on habitat survey data and professional judgment (USFWS 2002). The NWU recovery team suggested that artificial propagation of bull trout could be needed to seed currently unoccupied habitat. Westslope cutthroat trout are widely distributed in the Project area, but threatened by the presence of non-native brook trout. Peterson et al. (2004) found the survival of age-0 and age-1 cutthroat trout to the population at mid-elevations (approximately 8,200 to 8,858 feet elevation) was 13 times and 2 times higher, respectively, when brook trout abundance was suppressed. Lower elevations similar to tributaries surrounding the Project (fish bearing waters are generally less than 5,000 feet elevation) were not sampled in Peterson et al. (2004). Suppression of non-native trout in Slate and Sweet creeks is proposed as a PM&E measure (see Section 3.2.112). SCL hypothesizes that supplementation of westslope cutthroat trout in streams can complement brook trout suppression activities and result in higher recruitment to the cutthroat trout population than suppression alone.

3.2.14. Total Dissolved Gas

TDG levels have the potential to adversely affect any bull trout that use the Tailrace Reach during periods of spill. Following issuance of the new license for the Project, SCL will

implement measures identified in its Draft TDG Attainment Plan (Attachment E-4 to Exhibit E of the License Application) that are designed to attain TDG compliance at the Project. SCL will initially evaluate the following three gate alternatives for TDG abatement:

- Throttle Sluice Gates, which involves operation of sluice gates in partially open positions.
- Roughen Sluice Flow, which entails modification of the sluice gate outlets to break up and spread flow.
- Spillway Flow Splitter/Aerator, which entails modifying the spillways to aerate, break up, and spread flow.

The three gate alternatives all involve spilling flow through existing outlets (the seven sluice gates and two spillway gates) into the tailwater plunge pool and rely on reduction in TDG production by spreading the flow and limiting plunging effects of the confined water jets. The historic performance of these outlets at small gate openings indicates the potential for successfully reducing tailwater TDG levels. Reduction of TDG levels would decrease the risk of gas bubble trauma in bull trout in the Boundary Dam tailrace.

Each of the alternative measures could have both beneficial and adverse effects on bull trout. The beneficial effects will be a higher likelihood of attaining TDG compliance levels in the Boundary Dam tailrace. However, the measures could also result in increased injury or mortality of fish entrained through the spillways or sluiceways due to the increased risk of fish strike with the added roughening elements. Fish strikes could result in blunt-force trauma to fish and loss of scales. Spreading the flow and reducing the size of water jets could be beneficial for small fish but adversely affect large fish during their landing in the tailrace. As described above, small fish (approximately 100 mm [3.9 inches]) that leave a water jet and freefall to the tailrace should survive at a higher rate than small fish that experience strong shear forces while plunging in a water jet. In contrast, large fish (approximately 600 mm [23.6 inches]) have low survival if they leave a water jet. Substantial uncertainty surrounds the magnitude of both the potential beneficial and adverse effects of the proposed mitigation measures for TDG resulting in substantial uncertainty regarding the overall net effect to fish, in general, and bull trout in particular.

3.2.15. Operations

As explained in Section 3.1, SCL proposes to operate the Project as it is currently licensed, but with the formalization of two currently voluntary operational measures: forebay water surface elevation restrictions for summer recreation enhancement and turbine unit sequencing to reduce TDG production during non-spill conditions. The proposed summer forebay water surface elevation restriction is as follows: from Memorial Day weekend (starting Friday evening) through Labor Day weekend (ending Monday evening), forebay water surface elevations will be maintained at or above 1,984 NAVD 88 from 6:00 am through 8:00 pm to facilitate recreational access and use. From 8:00 pm through 6:00 am, forebay water surface elevations will be maintained at or above elevation 1,982 feet NAVD 88. Under SCL's proposed operation, the 1,984- and 1,982-foot NAVD 88 elevations will be license requirements that cannot be violated except for conditions such as equipment failures, maintenance activities, electrical and

mechanical device limitations, safety inspections, testing, natural disasters (e.g., lightning), compliance with WECC and NERC requirements, capacity and energy emergencies, and any event that triggers the Project Emergency Action Plan (EAP).

From Labor Day weekend to Memorial Day weekend, operating the Project as it is currently operated will result in forebay water surface elevations generally fluctuating between 1,994 feet and 1,974 feet NAVD 88. Minimum forebay elevations will often be above 1,980 feet NAVD 88 and will only occasionally be below 1,974 feet NAVD 88. The range of water surface elevations for dry (2001), average (2002), and wet (1997) inflow years is shown in Figures E.2-6 through E.2-8 of Section 2.1.2.3 of this Exhibit E.

This proposed forebay water surface elevation restriction is expected to reduce the incidence of fish trapping and stranding and provide a small increase in productivity within the reservoir's varial zone, as compared to the No Action alternative. Under the existing voluntary restrictions, there were times when the forebay was drawn down below the minimum target levels identified above. There were 4 hours of daytime excursions and no nighttime excursions during the representative wet year (1997), 136 hours of daytime and 63 hours of nighttime excursions during the representative dry year (2001), and 9 hours of daytime and no nighttime excursions during the representative average year (2002). While most of the excursions were small (less than 1 foot), there were times when they were fairly large. For example, during 2001 the maximum excursion was 5.7 feet below the target elevation. Under SCL's proposed operation, the 1,984- and 1,982-foot NAVD 88 elevations will be license requirements that cannot be violated, except under the conditions identified above. Consequently, fish and other aquatic organisms will benefit from formalizing the summer pool restrictions, especially during dry years.

3.3. Conservation Measures Affecting Terrestrial Species

Proposed environmental measures that will benefit terrestrial, federally listed Threatened and Endangered species are addressed in SCL's Terrestrial Resources Management Plan (TRMP) (Attachment E-3 to Exhibit E of the License Application) for the Project. If a listed species significantly increases its presence in the Project area during the term of the new license, a joint solution regarding any measures related to that species will be developed between SCL and the Terrestrial Resources Workgroup (TRWG). Other aspects of the TRMP that will benefit federally listed species include standards and best management practices (BMPs) for SCL maintenance activities, management prescriptions for SCL-owned lands within the Project boundary, and incorporation of the 89-acre BWP Addition into the Project boundary, as well as management of these lands for terrestrial resource protection and enhancement.

4 EFFECTS OF ACTION

4.1. Aquatic Species

4.1.1. Direct Effects

The direct potential adverse effects of the Project on bull trout include:

- Fluctuations in reservoir and tributary delta habitat as a result of varying water surface elevation due to load following operations.
- Mortality and injury during entrainment at Boundary Dam.
- Potential for fish trapping or stranding.
- Loss of connectivity with habitat upstream of Boundary Dam.
- Risk of gas bubble trauma resulting from elevated TDG concentrations in the Boundary Dam tailrace.

Each of these effects has been described in detail above and is summarized below.

Fluctuations in reservoir and tributary delta habitat will occur under the proposed Project operations. Based on habitat modeling for bull trout greater than 150 mm (approximately 6 inches), the quantity of bull trout habitat in the reservoir that will be affected by water surface fluctuation is a substantial portion of the total amount of available habitat. However, the amount of suitable habitat that is not affected by water surface fluctuation should be more than sufficient to support the current bull trout population in the Project area. Suitable reservoir habitat based upon depth, velocity, and substrate is not limiting bull trout populations in the Project area.

In contrast, variability associated with coolwater plumes in tributary delta regions during the summer has the potential to be limiting if the number of bull trout using Boundary Reservoir increases over the term of new license. Inter- and intra-specific competition may occur in coolwater plumes, but the relative importance of the Project relative to other factors (e.g., presence and abundance of non-native species, tributary flow magnitudes, etc.) that could affect these interactions is unknown. Relicensing studies also suggest that the shapes of coolwater plumes change depending on mainstem flow and water surface elevations. Westslope cutthroat trout demonstrated active adjustments in delta regions to remain within suitable water temperatures, and bull trout are likely to behave similarly. The need for frequent adjustments in location as a result of fluctuating water surface elevations is likely an intermittent adverse effect, but it is difficult to quantify the magnitude of the effect or determine if these adjustments significantly affect overall fish growth or reproductive fitness, because some level of movement would be normal regardless of water surface level fluctuations.

SCL is partially avoiding the effects of fluctuating water surface elevations by formalizing the summer forebay water surface elevation restriction (see Section 3.1 of this BA), which will slightly reduce potential adverse effects on bull trout relative to what may have occurred under the existing voluntary restriction. Under proposed operations, it is anticipated that monthly juvenile WUA minimums will be the same as under existing conditions, except during dry years when WUA is expected to be slightly higher compared to existing operations during June (Forebay Reach 19 to 30 square feet/foot of river, Canyon Reach 22 to 26 square feet/foot) and July (Forebay Reach 21 to 30 square feet/foot, Canyon reach 24 to 26 square feet/foot). Similarly, physical habitat modeling suggests that monthly adult bull trout WUA minimums will be slightly higher under proposed operations during June (Forebay Reach 316 to 322 square feet/foot of river, Upper Reservoir Reach 379 to 388 square feet/foot, Tailrace Reach 155 to 157 square feet/foot) and July (Upper Reservoir Reach 373 to 388 square feet/foot). The adverse effects of fluctuating water surface elevations on tributary coolwater plumes is also partially mitigated by SCL's PM&E measures that place LWD jams in the deltas of Linton, Sweet, Slate,

and Sullivan Creek; increase LWD levels and place LWD jams in the lower reach of Sullivan Creek; and improve riparian areas in lower Sullivan Creek, Sweet Creek, and Linton Creek. Each of these PM&E measures is designed to improve water quality (temperature) and the quality and quantity of tributary and tributary delta habitat that could be used by bull trout during warm summer months.

The available information suggests that bull trout in the vicinity of Boundary Dam could be vulnerable to entrainment, but their low overall abundance in Boundary Reservoir indicates that entrainment of bull trout is currently extremely rare. If bull trout populations were to become established in Boundary Reservoir tributaries, it is unclear what proportion of the tributary fish would migrate downstream to mainstem habitats. Of those fish that entered Boundary Reservoir, some fish could move downstream, survive interaction with the introduced non-native predators, warm water temperatures, and other impediments to survival associated with the mainstem habitats and enter the Boundary Dam forebay. Some tributary fish might also follow the allacustrine life history pattern reported by Dupont et al. (2007) and migrate upstream towards Lake Pend Oreille. The portion of those fish that move downstream could be exposed to potential entrainment at Boundary Dam and the associated risk of injury or mortality. In addition, if there are future increases in upstream bull trout population sizes and entrainment through Albeni Falls and Box Canyon dams occur, then the numbers of bull trout at risk of entrainment at Boundary Dam could also increase. Increased incidence of triploid rainbow trout, radio-tagged cutthroat trout in the Tailrace Reach, and an increase in the catch of walleye in Boundary Reservoir following the relatively high spring flows of 2008 suggests that during high flow years the risk of entrainment may increase relative to normal or low flow years.

As described in Section 3.2.2, the current level of risk of mortality to bull trout from trapping or stranding in the Action Area is considered low because of the low number of bull trout that have been observed in the past and their large size, which is consistent with life history of bull trout in the region (i.e., juveniles rear in tributary streams for at least several years until they reach 170 - 300 millimeters [6.7 - 11.8 inches] in length). Under SCL's proposal, the potential for trapping and stranding of bull trout should decrease as a result of excavating a channel between trapping pools located in Cobble Sisters area of the Upper Reservoir Reach and filling one pool near the channel margin. The excavated channel will contain water when reservoir surface elevations are above 1,979 feet NAVD 88. However, the proposed mitigation will not reduce the potential for trapping or stranding of any bull trout elsewhere in the Action Area, except perhaps slightly as the result of the summer forebay water surface restriction. Consequently, some small level of risk to bull trout from trapping and stranding will be ongoing under the new license.

As described in Section 3.2.3, a phased approach for implementing upstream fish passage is proposed under the new license. There is uncertainty regarding the effectiveness of the proposed trap-and-haul facility. Furthermore, it is unlikely that the facility will be able to operate year-round because of physical constraints associated with the Boundary Dam tailrace and the temperature and flow regime of the Pend Oreille River, which are independent of the operation of the Project. Even under an optimistic scenario, it is unlikely that all bull trout that survive entrainment at Boundary Dam will be passed back upstream under the proposed mitigation. Consequently, under the new license, upstream connectivity for bull trout is anticipated to improve but may not be fully restored.

As described in Section 3.2.14, SCL is proposing to implement a number of alternatives for attaining TDG compliance at the Project. Attainment of TDG compliance is expected to completely mitigate for potential Project-related TDG effects on bull trout in the Boundary Dam tailrace. However, TDG levels in the Action Area (in the reservoir upstream of the dam) are also the result of upstream operations at Albeni Falls and Box Canyon dams. Consequently, it is not possible for the Project to independently restore TDG levels in the Action Area, i.e., upstream of its area of influence. Mitigation measures designed to reduce TDG levels in Boundary Reservoir may also result in adverse effects to bull trout due to fish strike and increased likelihood that larger fish would not remain within plunging water jets if they were to be passed downstream via spillways or sluiceways.

4.1.2. Indirect, Interdependent, and Interrelated Effects

An analysis of the effects of the proposed action on listed species must determine whether the species in question, in this case bull trout, can be expected to survive with an adequate potential for recovery under the effects of the proposed or continuing action, the environmental baseline, and any interrelated, interdependent and indirect effects. The baseline includes existing Project operations. Interrelated actions are activities that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those which have no independent utility apart from the action being considered. Indirect effects are themselves caused by the action but are removed in space and/or time. The interrelated, interdependent, and indirect effects include:

- Bull trout recovery activities
- Hatchery and harvest practices
- Changes to flood control operations
- Implementation of the license at the Box Canyon Project
- Disposition of the Sullivan Creek Project
- Implementation of the Waneta Project upgrade and resulting operational changes at the Seven Mile Project in British Columbia

4.1.2.1. Bull Trout Recovery Activities

The following plans provide guidance for the management of aquatic resources in the Project area:

- Watershed Management Plan for WRIA 62 (Golder Associates, Inc. 2005)
- The NWPPC Intermountain Province Subbasin Plan (GEI Consultants 2004)
- Draft Bull Trout Recovery Plan (USFWS 2002)
- The Inland Native Fish Strategy (INFISH; USFS 1995)
- The Land and Resource Management Plan for the Colville National Forest (USFS 1988)
- The Clark Fork - Pend Oreille Basin Water Quality Study: A summary of Findings and a Management Plan

- Joint WDFW/Tribal Wild Salmonid Policy (WDFW and Western Washington Treaty Tribes 1998)

A common goal among these plans is the improvement of aquatic habitat and water quality to benefit native salmonids, especially bull trout. A comprehensive list of activities that contribute to the recovery of bull trout in the NWU and Lake Pend Oreille area is not available because of the wide variety of federal, state, tribal, and non-governmental organizations that conduct activities in the region. Some of the major activities that are ongoing or have been recently completed are:

- Mainstem Fish Passage
  - Albeni Falls passage feasibility studies (U.S. Army Corps of Engineers [USACE], Kalispel Natural Resource Department [KNRD])
  - Upstream and downstream passage at Box Canyon Dam (Pend Oreille County PUD)
- Tributary Habitat Restoration, Enhancement, and Passage
  - Box Canyon Project PM&E measures (Pend Oreille County PUD)
  - Kalispel resident fish project (KNRD)
  - Road abandonment and bank stabilization (KNRD)
  - Riparian fencing and planting (WDFW)
  - Tributary passage and screening (KNRD, Ione)
- Bull Trout Research and Monitoring
  - Monitoring in the Priest River sub-basin (USACE and USFWS)
  - Genetic inventory of bull trout in the Pend Oreille sub-basin (KNRD)
  - Kalispel resident fish project (KNRD)
  - Resident fish stock status above Chief Joseph and Grand Coulee Dams (WDFW and KNRD in Project area)
  - Granite Creek watershed assessment (KNRD/POCD)
- Mainstem Pend Oreille River Water Quality
  - Temperature TMDL implementation for the Pend Oreille River (Ecology and stakeholders)
  - Water quality monitoring (KNRD)

Implementation of most of the actions associated with the plans and many of the ongoing activities rely on funding that can vary widely from year to year. For example, many habitat restoration projects in the watershed are coordinated through the Pend Oreille Conservation District and funded by the Washington Salmon Recovery Funding Board (SRFB), which gets its funding from the Pacific Coast Salmon Recovery Fund (PCSRF) and state bonds. However, as of July 2009, future funding of the PCSRF from Congress is in doubt because the House of Representatives did not include it in its budget bill. Statewide biannual (every other year) state contributions have varied from approximately $12 million to $36 million between 2000 and 2008 (Feb 2009 SRFBD Fact Sheet). Similarly, activities conducted by the USFS, the USFWS, and USACE depend on funding allocations from Congress. Because of the variability in annual funding, it is uncertain if or when activities recommended in the various plans, such as the establishment of downstream and upstream passage at Albeni Falls Dam, will be implemented.

Recovery activities to be implemented by organizations regulated by federal and state agencies have more certainty regarding their funding and schedule. For example, as part of the Box Canyon Settlement Agreement the Pend Oreille County PUD has agreed to install downstream passage facilities with the goal of 95 percent fish passage efficiency by 2015 or ten years after issuance of a license from FERC. The PUD has also agreed to restore 164 miles of tributary stream within 25 years.

Taken together, numerous activities that improve habitat, fish passage, and water quality are likely to occur in the watershed and will contribute to the recovery of bull trout during the new Project license term. Consequently, it is likely that the incidence of bull trout using Boundary Reservoir, tailrace, or tributaries will increase, but the magnitude of the increase and whether recovery criteria will be achieved is uncertain.

4.1.2.2. Hatchery and Harvest Practices

WDFW manages fisheries in the Action Area and regulates private and public hatchery releases. WDFW modifies and publishes recreational fishing regulations on an annual basis. Currently, recreational anglers may not target bull trout, but may incidentally catch and release bull trout. Changes in the regulations such as seasons, closed areas, and harvestable sizes and numbers of other trout species could also change the likelihood of the incidental catch of bull trout by reducing or increasing the level of effort expended by anglers.

4.1.2.3. Flood Control Operations

Significant storage reservoirs within the basin include Hungry Horse Reservoir and Flathead Lake in Montana, and Lake Pend Oreille and Priest Lake in Idaho. Other projects along the mainstem Pend Oreille River upstream of the Project include the Box Canyon Project, the Albeni Falls Project, the Cabinet Gorge and Noxon Rapids developments of the Clark Fork River Project in Idaho and Montana, and the Thompson Falls Project (FERC. No. 1869) in Montana. Downstream of Boundary Dam, the Pend Oreille River flows past Seven Mile and Waneta dams, both in Canada, before entering the Columbia River. Because of the basin size and corresponding annual flow, typically no single project has an overriding influence on flows in the river. Potential influence on flows by individual projects is greater during low-flow periods and for those reservoirs having significant storage capacity (Enserch 1994). In addition to the dams listed above, the Sullivan Creek Hydroelectric Project is located on Sullivan Creek, the main tributary to Boundary Reservoir.

The upstream projects have a significant effect on inflows to the Project reservoir. In the absence of upstream impoundments, flows would typically exceed regulated flows from May through July, during the periods when water is stored in upstream projects (SCL 2008a). Regulated flows are typically greater than unimpaired flows from August through April, as stored water is released from upstream projects. Future changes to flood control and other operations at these upstream projects could affect the timing and magnitude of inflows to the Project and, as a result, interact with Project operations to influence water surface elevations in the reservoir.

4.1.2.4. Box Canyon Project

The Pend Oreille County PUD recently received a new license for its Box Canyon Project. Included in the license articles are a number of measures designed to benefit bull trout, such as turbine upgrades, upstream fish passage, and restoration and enhancement of tributary streams. These improvements, if successful, could increase the number of bull trout in Boundary Reservoir or Boundary Dam tailrace.

4.1.2.5. Sullivan Creek Project

The Pend Oreille County PUD is currently working to determine the disposition of the Sullivan Creek Project, which the PUD has decided not to relicense. If there are any interrelated effects of the Sullivan Creek Project negotiations and the Project relicensing, they will be more fully described in future drafts of this BA.

4.1.2.6. Waneta Upgrade and Seven Mile Project Operations

BC Hydro's Seven Mile Project is located 11 river miles downstream of Boundary Dam, and Seven Mile Reservoir at times backs water up to the base of Boundary Dam. The average maximum water surface elevation of Seven Mile Reservoir is approximately 1,734 feet NAVD 88 (BC Hydro 2003). Because of downstream water quality and flow requirements and capacity limitations at the Waneta Project (i.e., the next project downstream of Seven Mile) the Seven Mile Project has operated to reregulate flows from the Project. Upgrades to the capacity at the Waneta Project are anticipated to allow the Seven Mile Project to modify its operations to engage in a greater degree of load following. The specific effects of any operational modifications at the Seven Mile Project on pool levels in the Boundary Dam tailrace are uncertain. However, in general, changes could affect the amount of suitable rearing habitat available to bull trout in the Boundary Dam tailrace and could affect the design and operation of the upstream trap-and-haul facility proposed as mitigation for the Project.

4.2. Terrestrial Species

The three terrestrial threatened or endangered species that could occur in the Project area, Canada lynx, grizzly bear, and woodland caribou, are wide-ranging species, with territories far beyond the size of the Project vicinity. Limited use of the Project area by these species has been observed. The primary terrestrial effects associated with the Project–water fluctuation effects on shoreline habitat, erosion and loss of habitat, and human disturbance–occur on a localized and discrete scale compared to the expansive home ranges of these species. Potential effects that apply to all of the listed species are discussed below, followed by a species-specific discussion.

Streams, rivers, and lakes, represent potential obstacles to unrestricted wildlife movement across the landscape. In undisturbed landscapes, these features are part of the "natural matrix" (Meffe and Carroll 1997) and represent barriers to the movement of some species but not others. Big game species readily cross large rivers by swimming, or on foot under favorable conditions, such as seasonal low flows or periods of ice cover during the winter.

Boundary Reservoir does not represent a barrier to the movement of the large Threatened or Endangered mammals found in the Project vicinity; however, the slope and composition of the shoreline, as well as water currents in the reservoir, influence where these species can cross. This may affect the movement patterns of these large mammals.

Of the 7.25 miles of Project-related roads, only about 2 miles are paved and bordered by mowed lawns; the remaining 5.25 miles are dirt or crushed rock and bordered by native or naturalized vegetation. All of the Project-related roads are fully or partially included in the existing FERC Project boundary; those portions of roads not currently included in the Project boundary, but used exclusively or primarily for Project purposes, are being proposed for inclusion in the Project boundary. Although Project-related roads may contribute to cumulative effects on these wide-ranging species, they do not make up the majority of roads in the vicinity, and as such their effect is small.

4.2.1. Canada Lynx

Canada lynx use of the Project vicinity is presumed to be primarily as a travel corridor between lynx populations on either side of the Pend Oreille River, in the designated LMZs (RTE Wildlife Study, SCL 2009a). Lynx are not directly dependent on resources associated with the river or Project, and are not affected by water fluctuations, vegetation changes in the water fluctuation zone, or erosion. The observation of an individual lynx swimming across the Canyon Reach (RTE Wildlife Study, SCL 2009a) confirms that lynx occasionally use the Project area.

Construction of roads may reduce lynx habitat by removing forest cover. On the other hand, in some instances, along less-traveled roads where vegetation provides good snowshoe hare habitat, lynx may use the roadbed for travel and foraging (Koehler and Brittell 1990). Roads and trails may facilitate snowmobile and other human uses in winter, and snow compaction on roads or trails may allow competing carnivores, such as coyotes (*Canis latrans*) and mountain lions (*Felix concolor*), access to lynx habitat (Buskirk et al. 2000). In the absence of roads and trails, snow depths and snow conditions normally limit the mobility of these other predators during mid winter.

Preliminary information suggests that lynx do not avoid roads (Ruggiero et al. 2000a), except at high traffic volumes (Apps 2000). It is possible that summer use of roads and trails through denning habitat may have negative effects, if lynx are forced to move kittens because of associated human disturbance (Ruggiero et al. 2000b). At this time, there is no compelling evidence to suggest that management of road density is necessary to conserve lynx. However, new road construction continues to occur in many watersheds within lynx habitat, many of which are already highly roaded, and the effects on lynx are largely unknown (Interagency Lynx Biology Team 2000). The primary prey of lynx, snowshoe hare, is commonly available in the Project vicinity (SCL 2006), as are other small animals that lynx are known to prey upon (Squires et al. 2007). Given the lack of suitable habitat and the lack of Project effects on lynx prey base (Stinson 2001), and the minor effect that Project roads contribute to the overall landscape, there are no Project-related effects on lynx.

The determination for Canada lynx is that the Project "May Affect but is Not Likely to Adversely Affect" this species.

4.2.2. Woodland Caribou

There are few records of woodland caribou in the Project vicinity, but this species may use the general area east of the Project for winter forage grounds. Woodland caribou are occasionally known to cross the reservoir south of Metaline Falls, where topography may allow easier access to river crossing points. Because of the steeper terrain around the lower reservoir (below Metaline Falls), big game trails are concentrated in areas that follow topographic features such as drainages. Along the upper reservoir (above Metaline Falls) the terrain is gentler and allows for a more diffuse pattern of big game travel. No impediments to big game travel or to reservoir access were identified during field studies and subsequent analysis (Big Game Study, SCL 2009a). Woodland caribou are likely to use big game trails that other ungulates use, especially in areas of steep topography. In Jasper National Park, woodland caribou generally avoided areas within 1 kilometer (km; 0.6 miles) of campgrounds and up to 750 meters (2,460 feet) from trails; however, displacement distances and intensity of avoidance depended on the level of human use on the nearest trails (Whittington and Mercer 2004). Caribou were noted to avoid areas with 250 meters (820 feet) of linear features such as gravel roads and seismic test corridors (Dyer 1999).

Habitat in the Project vicinity is generally unsuitable for woodland caribou because of its low elevation and lack of older forest habitat; therefore, Project operations are not expected to affect caribou. Project-related roads are not a primary component of the road network in the vicinity and are not expected to hinder the movement of any woodland caribou that may wander into the vicinity. Because Project-related roads represent a minor component of the landscape in the vicinity, the marginal quality of available caribou habitat, and the extremely low use of the vicinity by woodland caribou, there are no Project effects to this species.

The determination for woodland caribou is that the Project "May Affect but is Not Likely to Adversely Affect" this species.

4.2.3. Grizzly Bear

The Grizzly Bear Recovery Plan lists human activity, road building, forestry, and mining as adversely affecting grizzly bears (USFWS 1993). Grizzly bears are not affected by Project operations, but road use has the potential to alter grizzly bear use of the vicinity.

Road density and associated human activity affect grizzly bear movements and can cause significant mortality to bears from road kills and human-bear conflicts (Mace and Jonkel 1980). In southeastern British Columbia, McLellan and Mace (1985) reported that adult bears, on average, used an area extending 100-250 meters (328-820 feet) from open roads significantly less than the area available; use within 100 meters (328 feet) of roads was 40 percent of expected in spring and 50 percent of expected in summer/fall. Kasworm and Manley (1988) reported a similar response of bears to roads in the Cabinet Mountains, Montana; use within 500 meters (547 yards) of open roads was reduced 78 percent from expected in spring and 87 percent in fall. However, bears have readily habituated to high levels of human disturbance, as long as it was predictable and non-lethal (McArthur 1979; Dood et al. 1986).

Aune and Kasworm (1989) found that bears living in the foothills of the Rocky Mountains appeared to accommodate a high level of human activity by adopting a more nocturnal activity

pattern than bears that occupied more remote backcountry areas. Kasworm and Manley (1988) compared habitat use by bears in two areas in the Cabinet Mountains with different road densities and seasonal access. In the areas with 4 km (2.5 miles) of road open only from July 1 to October 15, the average distance of bear use to nearest road prior to July 1 was 0.6 km (0.4 miles). When roads opened, the mean distance of bear activity to roads increased to 1.1 km (0.7 miles). Most importantly, the amount of area avoided by bears after the roads were opened was similar to the maximum distance avoided by bears in the area with a higher open road density and no seasonal closure. Grizzly bears can become habituated to roads and will regularly cross even high-traffic highways, such as Highway 31 through the Project vicinity (Gibeau et al. 2001).

Despite the continued influence of human-caused mortality in the Selkirk Mountain recovery zone, the grizzly bear population appears to be expanding its range, as evidenced by an increase in sightings in areas with few reports of grizzly bears. This range expansion may also be at least partially responsible for the increase in agency removal of bears and other interactions with humans around the periphery of the recovery zone. This grizzly population is still small, and gains in recovery could quickly be reversed (Wakkinen and Kasworm 2004).

Grizzly bears may occasionally use the Project vicinity, but Project operations do not have an effect on the habitat of this wide-ranging species. In addition, the Project area roads represent a minor contribution to the landscape conditions of the vicinity and will not hinder the movement of grizzly bears that may wander through the vicinity. Use of the BWP by snowmobiles and all terrain vehicles (ATVs) could discourage use of this area by bears if they were to wander into this area. In general, because of the low grizzly bear use of the Project area and minimal impacts on habitat from Project operations, there are negligible Project-related effects to this species.

The determination for grizzly bear is that the Project "May Affect but is Not Likely to Adversely Affect" this species.

5 CONCLUSIONS

5.1. Aquatic Species

The determination for bull trout is that the Project “May Affect, is Likely to Adversely Affect” this species because of the potential for injury or mortality to any bull trout that are entrained at Boundary Dam. However, relative to the baseline condition, implementation of proposed Project operations and proposed PM&E measures under the new Project license are anticipated to contribute substantially to the maintenance and enhancement of bull trout populations and habitat within the NWU for bull trout. Formalization of summertime water surface elevation restrictions is expected to provide little benefit to bull trout, because the effects will occur primarily during a time of year when temperatures in the mainstem are naturally too high to allow for bull trout use of the reservoir. However, more stable water surface elevations could result in fewer disturbances to thermal plumes (which could be used by bull trout) located at tributary deltas during the summer months. Several mitigation measures are also anticipated to contribute to bull trout recovery in the Pend Oreille Core Area. In particular, these include improved habitat connectivity as the result of implementing upstream fish passage at Boundary Dam, LWD

enhancement at tributary deltas, excavation of channels connecting trapping pools to the mainstem, and off-site tributary habitat and stream channel improvements. Table 5.1-1 provides a summary diagnostics matrix of the anticipated effects of proposed conservation measures on bull trout.

Table 5.1-1. Summary diagnostics matrix of effects of the proposed conservation measures for the Boundary Project on bull trout (*Salvelinus confluentus*) pending FERC relicensing.

Diagnostics	Distinct Population Segment (DPS) Jeopardy	Effects of the Action			
		Restore	Improve	Maintain	Degrade
Reservoir and tributary delta conditions					
Spawning and Incubation	No			X	
Sub-adult rearing	No		X		
Adult upstream migration	No		X		
Habitat connectivity					
Upstream passage facilities	No		X		
Downstream passage facilities	No			X	
Water quality					
Total dissolved gases	No		X		
Water temperature	No			X	
Turbidity	No			X	
Ecosystem functions					
Gravel transport	No			X	
Woody debris transport	No			X	
Floodplain connectivity	No			X	

5.2. Terrestrial Species

Under the proposed action, there may be negligible effects to Canada lynx, woodland caribou, and grizzly bear from Project-related human use that may alter the way these wide ranging species use terrestrial habitats in the Action Area. All of these species are occasional visitors to the Project vicinity but are not affected by water level fluctuations or the corresponding effects on shoreline vegetation. Use of Project-related roads and use of the BWP by snowmobiles and ATVs may alter habitat use patterns if these species were to wander through the vicinity, but this effect is not considered significant.

Table 5.2-1 summarizes the effect determination for the Threatened and Endangered terrestrial species that may occur in the Project vicinity.

Table 5.2-1. Summary of ESA effect determination for terrestrial wildlife that may occur in the Project vicinity.

Species	No Effect	Not Likely to Adversely Affect	Likely to Adversely Affect
Canada lynx		X	
Woodland caribou		X	
Grizzly bear		X	

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