Boundary Hydroelectric Project (FERC No. 2144)

Study No. 19

Big Game Study

Final Report

Prepared for
Seattle City Light

Prepared by
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Tetra Tech

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Correction page to Study 19, Big Game Study, as provided by SCL on February 12, 2009

1) p. 2, third bullet, *The Boundary Wildlife Preserve (BWP) (155 acres) and adjoining SCL-owned property (85 acres).*

Subsequent to completion of the final report, SCL discovered a discrepancy between the description of the study area for the "adjoining SCL-owned parcel" and the area that was surveyed during field studies. The BWP was mapped accurately in the study reports and the entire BWP was surveyed as planned; this discrepancy relates only to the "adjoining SCL-owned property."

Terrestrial field crews were working from an incorrect map of the parcel and thus, detailed field surveys took place on only 42 acres of the parcel. Regardless of this error, SCL believes that the conclusions presented in the final study report are still valid.

Additionally, the size of the "adjoining SCL-owned parcel" is 88 acres, not 85 acres.

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1 INTRODUCTION

Study No. 19, the Big Game Study, was conducted in support of the relicensing of the Boundary Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC) No. 2144, as identified in the Revised Study Plan (RSP; SCL 2007) submitted by Seattle City Light (SCL) on February 14, 2007, and approved by the FERC in its Study Plan Determination letter dated March 15, 2007. This report describes the field efforts, analyses, and determination of Project effects and represents the completion of the study.

The target big game species for this study were elk (*Cervus elaphus*), white-tailed deer (*Odocoileus virginianus*), and mule deer (*O. hemionus*). Other big game species addressed in this study include moose (*Alces alces*), black bears (*Ursus americanus*), and mountain lions (*Puma concolor*), which are frequently observed in the Project area. Wolves (*Canis lupus*) and grizzly bears (*Ursus arctos*), which also occur in the Project vicinity, are federally listed species and are therefore addressed separately in the Study 18, Rare, Threatened, and Endangered (RTE) Wildlife Species Final Report (SCL 2009a).

2 STUDY OBJECTIVES

The goal of the Big Game Study was to provide information needed to determine locations of important shoreline segments for big game in terms of habitat, access to water, and suitable crossing sites. The study was also to provide information on potential effects caused by water level fluctuations and Project-related roads to big game and their habitats. Specific objectives of the study were to:

- Document and characterize locations of important big game habitats along Boundary Reservoir.
- Assess the potential effects of reservoir fluctuations on the structure and function of big game habitat and travel/crossing corridors.
- Determine the density and type of roads in the Project vicinity, the contribution of Project-related roads, and potential effects on habitat quality for deer and elk.
- Estimate the amount of big game habitat potentially available in the reservoir fluctuation zone.

3 STUDY AREA

The study area for the Big Game Study extended approximately 18 miles along the Pend Oreille River from the Box Canyon Dam tailrace downstream to the U.S.-Canada border (Figure 3.0-1). Within this linear extent, primary and secondary study areas were defined.

Identification of important shoreline habitats for deer and elk was focused on the area within the Project boundary and was conducted in a "primary study area" that encompassed the following:

- Downstream of Metaline Falls (the lower reservoir)—The reservoir fluctuation zone allowed under the current license (forebay elevation 1,954–1,994 feet NAVD 88 [1,950–1,990 feet NGVD 29])[1,2], and land within the FERC Project boundary (Project area). The Project area includes most Project facilities, the zone 200 horizontal feet (i.e., along the ground surface, perpendicular to the shoreline) beyond the high water level along both reservoir shorelines, and the transmission line right-of-way from the powerhouse to the Bonneville Power Administration interconnection.
- From the Box Canyon Dam tailrace to Metaline Falls (the upper reservoir)—The reservoir fluctuation zone (approximately 1,986–2,020 feet NAVD 88 [1,982–2,016 feet NGVD 29], based on hourly records from 1987 through 2005 at the U.S. Geological Survey [USGS] gage below Box Canyon Dam) and the land within approximately 200 horizontal feet of the high water level (approximately 2,020 feet NAVD 88 [2,016 feet NGVD 29]) along both reservoir shorelines extending to the FERC Project boundary for the Box Canyon Project.[3]
- The Boundary Wildlife Preserve (BWP) (155 acres) and adjoining SCL-owned property (85 acres).

For determining road densities and potential Project-related effects related to roads, a "secondary study area" as defined to include the primary study area and the following:

- From Metaline Falls to Boundary Dam—Between State Route (SR) 31 and the eastern edge of the Project boundary and between County Road 2975 and the western edge of the Project boundary.
- From the Box Canyon Dam tailrace to Metaline Falls—0.5 mile on either side of the primary study area.

The range of water surface elevations recorded during the survey periods for this study is presented below; this range represents typical operating conditions for the period in which data

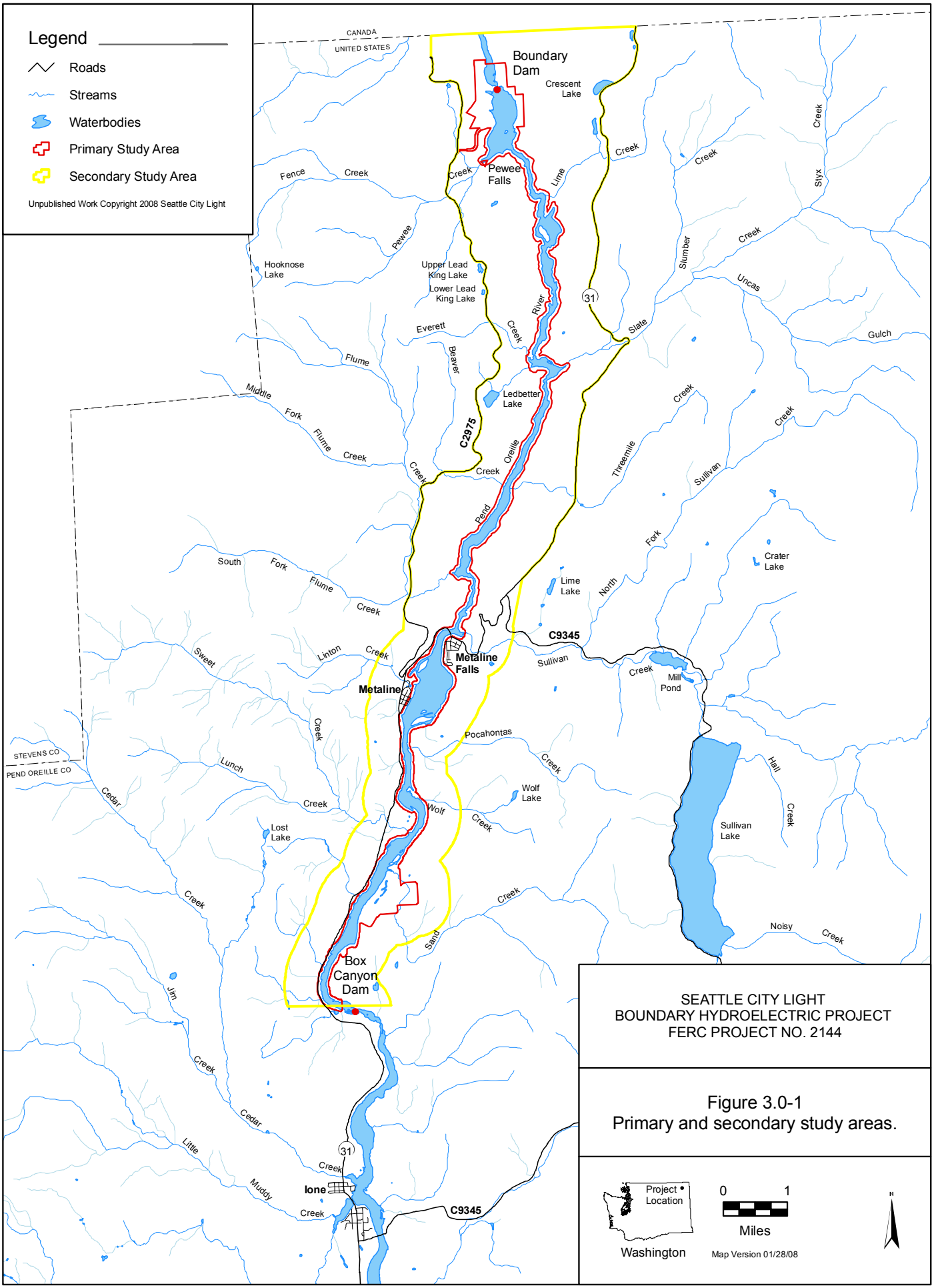
[1]SCL is in the process of converting all Project information from an older elevation datum (National Geodetic Vertical Datum of 1929 [NGVD 29]) to a more recent elevation datum (North American Vertical Datum of 1988 [NAVD 88]). As such, elevations are provided relative to both data throughout this document. The conversion factor between the old and new data is approximately 4 feet (e.g., the crest of the dam is 2,000 feet NGVD 29 and 2,004 feet NAVD 88).

[2] The reservoir fluctuation zone is defined as the area between 1,994 feet and 1,974 feet NAVD 88 (1,990 feet and 1,970 feet NGVD 29). Very infrequently, Project maintenance requires that the reservoir be drawn below this elevation. Between 1987 and 2005 (the period represented by the Project hydrologic record (R2 Resource Consultants, Inc. 2008), drawdowns below 1,974 feet NAVD 88 (1,970 feet NGVD 29) occurred less than 0.25 percent of the time (equivalent to 17.5 days) and drawdowns down to 1,964 feet NAVD (1,960 feet NGVD) or below occurred only 0.02 percent of the time (equivalent to 1.5 days); the lowest recorded forebay elevation within the 19 hydrologic record was 1,957 NAVD 88 (1,953 NGVD 29). The only element of this study that is affected by this definition of the study area is Task 5, Estimate of Potential Big Game Habitat in the Fluctuation Zone.

[3] As indicated in this and other study reports in the Updated Study Report, SCL agreed it is appropriate to study the existing fluctuation range of the reservoir; however, for development of the Preliminary Licensing Proposal (PLP) and License Application, SCL will base its assessment of potential protection, mitigation, and enhancement measures on that portion of the fluctuation zone that is determined to be under the influence of Project operations, versus the effects of inflows and Metaline Falls that are beyond the control of the Project.

were collected. Existing conditions at the time of surveys were considered adequate to acquire all data required for this study:

- From Box Canyon Dam to Metaline Falls—Elevation 1,991–2,009 feet NAVD 88 (1,987–1,995 feet NGVD 29), as measured at the USGS gage 12396500.
- From Metaline Falls to Boundary Dam—Elevation 1,968–1,993 feet NAVD 88 (1,964–1,989 feet NGVD 29), as measured at the SCL gage located in the Boundary forebay.


Legend
Roads
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Primary Study Area
Secondary Study Area
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CANADA
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Boundary Dam
Crescent Lake
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Hooknose Lake
Upper Lead King Lake
Lower Lead King Lake
Ledbetter Lake
Lime Lake
Crater Lake
Wolf Lake
Lost Lake
Sullivan Lake
Mill Pond
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PEND OREILLE CO
Fence Creek
Pewee Creek
Lime Creek
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Slumber Creek
Uncas Creek
Slate Creek
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Everett Creek
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Flume Creek
Middle Fork Flume Creek
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Sweet Creek
Oreille River
Pend Oreille
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Sullivan Creek
North Fork Sullivan Creek
Pocahontas Creek
Hall Creek
Noisy Creek
Lunch Creek
Cedar Creek
Jim Creek
Sand Creek
Little Muddy Creek
Project Location
Washington
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BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure 3.0-1
Primary and secondary study areas.

4 METHODS

The Big Game Study included six tasks:

- Task 1: Compile existing information
- Task 2: Map and characterize shoreline conditions
- Task 3: Assess big game use in shoreline segments
- Task 4: Calculate road densities and estimate road use
- Task 5: Estimate potential big game habitat in the fluctuation zone
- Task 6: Document and assess effects

The methodologies for these tasks are described in detail below.

4.1. Compile Existing Information

Available information on the extent and distribution of big game habitat in the primary study area was reviewed and summarized and site-specific habitat management actions implemented by land management agencies were identified. The primary information sources were wildlife biologists with local offices of the Washington Department of Fish and Wildlife (WDFW; Steve Zender) and the U.S. Forest Service (USFS; Michael Borysewicz); local residents (Rich Sargent, Ryan McNee) and SCL staff (Skip Luhr) knowledgeable about big game use of the study area; the Selkirk Elk Herd Management Plan (Zender and Hickman 2001); the 2003–2009 Game Management Plan (WDFW 2003); and WDFW's Priority Habitats and Species (PHS) database (winter range).

4.2. Map and Characterize Shoreline Conditions

The purpose of mapping and characterizing shoreline conditions was to determine the distribution and extent of suitable habitat for big game and the locations where they can access and cross the reservoir. Habitat suitability for big game is limited by slope; further, its use as cover and/or forage is dependent on plant species composition and structure. Based on the results of big game studies conducted in neighboring parts of British Columbia and Idaho (Unsworth et al. 1998; Boulanger et al. 2000; Poole et al. 2000a, b; D'Eon and Serrouya 2001; Poole and Park 2001a, b; Poole and Mowat 2001), slope thresholds (effective slope) were defined as less than 75 percent for mule deer and less than 60 percent for elk and white-tailed deer. Habitats that provide hiding cover, thermal cover, and forage, as defined by vegetation/land cover types, are described below.

- **Hiding Cover**—For all three species, hiding cover was defined as enough visual cover to hide 90 percent of a deer or elk viewed at 200 feet (Thomas et al. 1979). Cover types that provide hiding cover include all conifer, shrubland, riparian tree and shrub, and palustrine tree and shrub types.
- **Thermal Cover**—For elk, thermal cover was defined as conifer forest stands at least 30 acres in size with greater than 70 percent canopy coverage, and trees greater than or equal to 40 feet tall (Thomas et al. 1979). For deer, winter thermal cover consists of evergreen stands at least 3 acres in size with 60 percent canopy closure, and trees greater than 5 feet in height (USFS 1988). Providing thermal cover for elk

adequately meets thermal cover needs for deer. All stands classified as big game thermal cover also provided hiding cover. This is because most of the conifer forest in the study area is approximately 80 years old and has a shrub layer that represents suitable hiding cover. There were no older age class conifer stands that would provide thermal cover only.

- **Forage Habitat**—Foraging areas include all open vegetated areas that do not qualify as hiding or thermal cover (Thomas et al. 1979). This includes all the grass and sedge meadows at the BWP, the reed canarygrass stands on the upper reservoir islands, and the small sedge-dominated seeps along the edges of the lower reservoir. It is recognized that riparian shrub stands and the shrub understory of conifer stands provide browse for wintering big game, but these vegetation types are classified as hiding cover for this study.

Non-habitats included unvegetated areas such as rock and developments, and vegetated slopes too steep to be effectively used by big game.

Suitable big game habitats were mapped by combining existing Geographic Information System (GIS) data layers on vegetation/land cover types (see Pre-Application Document [PAD; SCL 2006], Section 4.6), shorelines (PAD [SCL 2006], Section 4.3.4), topography, and roads. These data were then overlain on the ortho-photographic data layer to create a map base that was used to delineate homogenous polygons representing hiding cover, thermal cover, forage habitats, and non-habitats for deer and elk.

Locations of big game trails perpendicular or parallel to the reservoir shoreline were identified in the field (see Section 4.3) and either delineated directly onto the maps or recorded using a Global Positioning System (GPS) unit and described in field notes. Trail locations, combined with the topographic data layer, were used to indicate the sites where big game could access and cross the reservoir. A list of dominant shrubs, forbs, and sedges/grasses found in shoreline habitats was obtained from researchers conducting Study 16, Inventory of Riparian Trees and Shrubs (SCL 2009b; Appendix 1); plant species were evaluated for their palatability to big game.

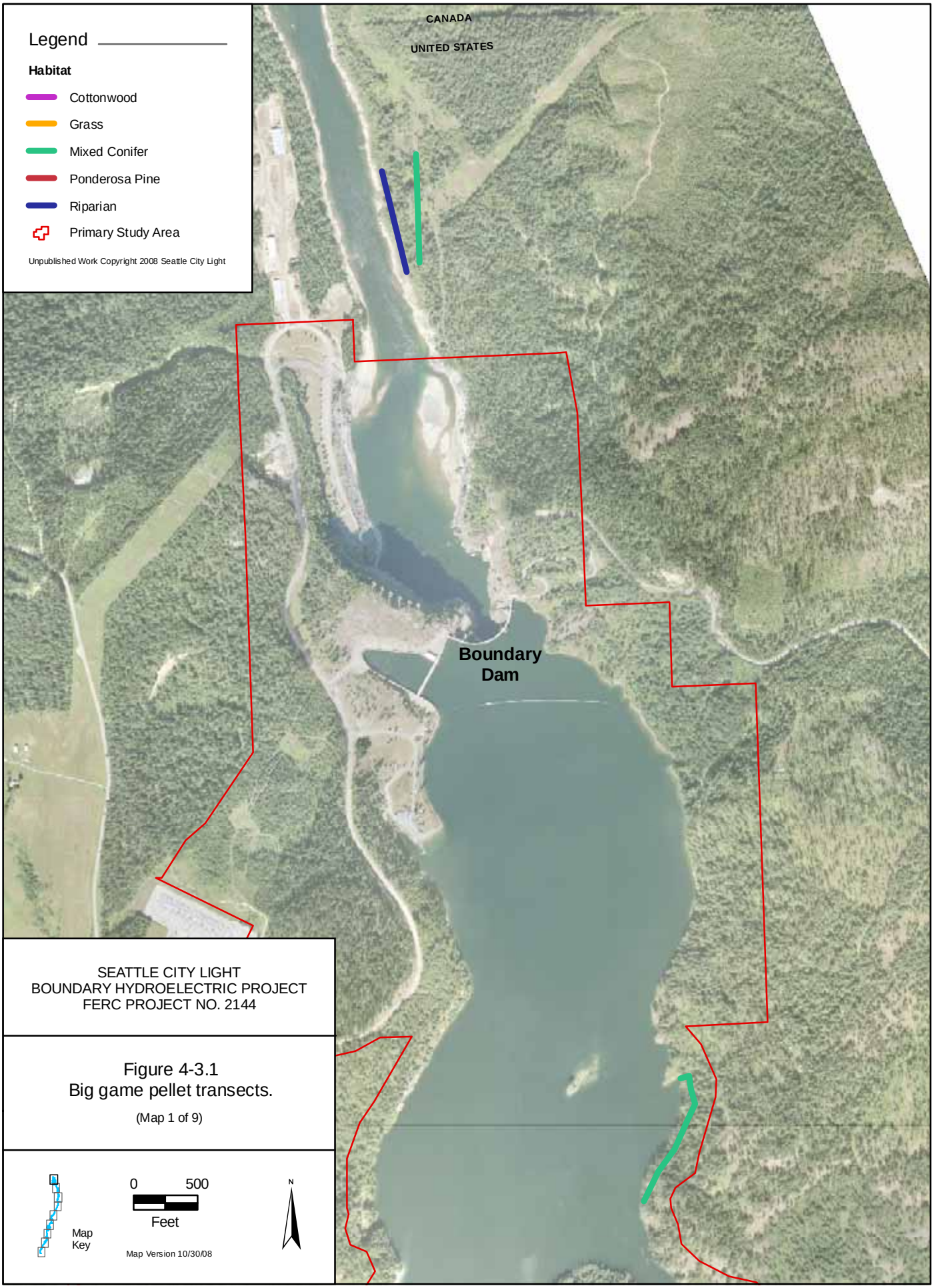
4.3. Assess Big Game Use in Shoreline Segments

Two methods were used to assess relative big game use of the reservoir shoreline: 1) interviewing SCL staff at the Project, relicensing study team members, local agency biologists, and local residents familiar with the reservoir to identify areas where big game have been routinely observed (see Section 4.1); and 2) field surveys. Big game occurring along the reservoir were counted during all 20 boat-based terrestrial wildlife surveys and during 6 walking surveys of the BWP, conducted between April 2007 and September 2008. The GPS location of each sighting was mapped. Reports of incidental big game sightings were solicited from researchers conducting other relicensing field efforts, especially crews conducting winter fish surveys.

To assess the relative habitat use by three big game groups (deer, elk, and moose) in the primary study area, pellet group count surveys were conducted in April and May 2008. Strip transects were used to quantify pellet group densities in representative habitats. Twenty-seven transects (Figure 4.3-1) were established in five major habitat types of the primary study area: ponderosa

pine, mixed conifer, black cottonwood, riparian scrub-shrub, and grassland (including reed canarygrass). The greatest number of transects (10) were in the mixed conifer habitats and the least (3) in the cottonwood and shrubby riparian habitats, reflecting the relative dominance of these vegetation communities in the primary study area. Transects varied in length from 150 to 800 meters (492 and 2,625 feet), and were either 5 or 10 meters (16 and 33 feet) wide depending on which was the more effective viewing distance based on the density of ground cover vegetation. In total, over 60,000 square meters (15 acres) of big game habitat were surveyed. Pellet group densities were expressed as groups per 1,000 square meters, and quantified by species group (deer, elk, moose), and all species combined. Mule and white-tailed deer pellet groups were not separated by species because of the difficulty in distinguishing between their pellets in the field.

Although not a part of this study, trail cameras were deployed at eight locations on SCL lands in 2008 in an effort to detect study area use by RTE mammals. Data derived from the trail cameras are presented in this report as appropriate to augment the results of the field surveys.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CANADA
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BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
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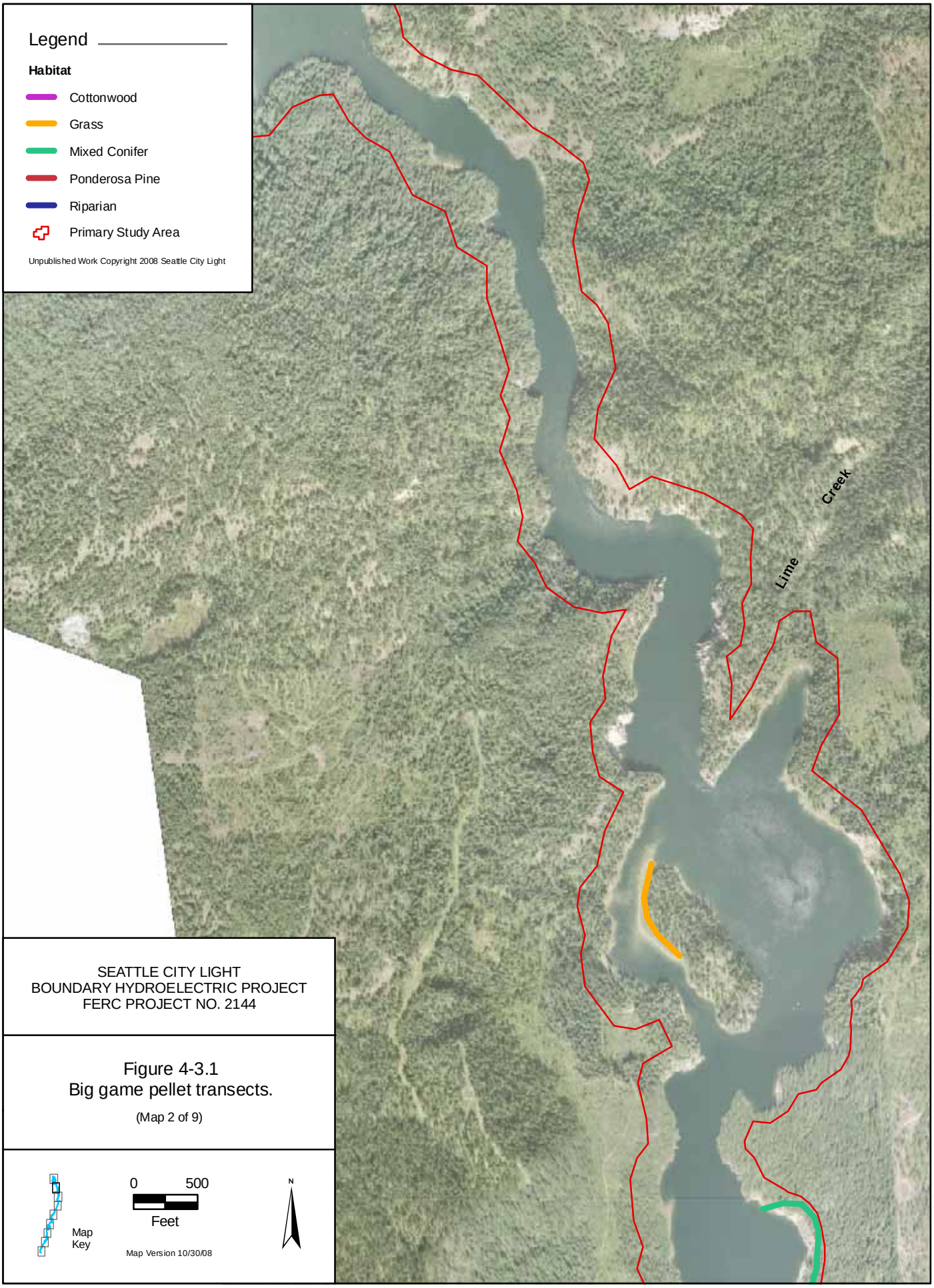
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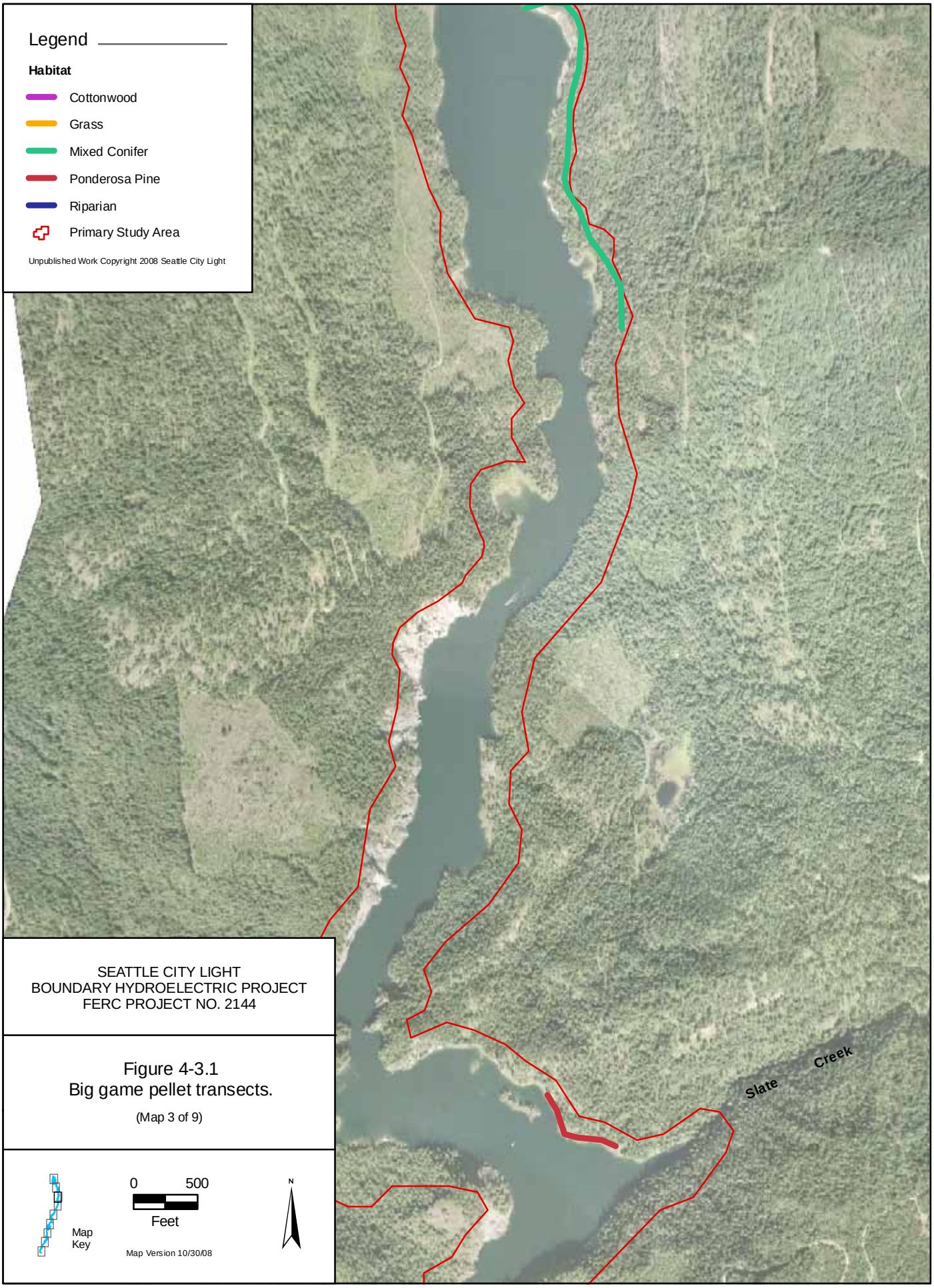
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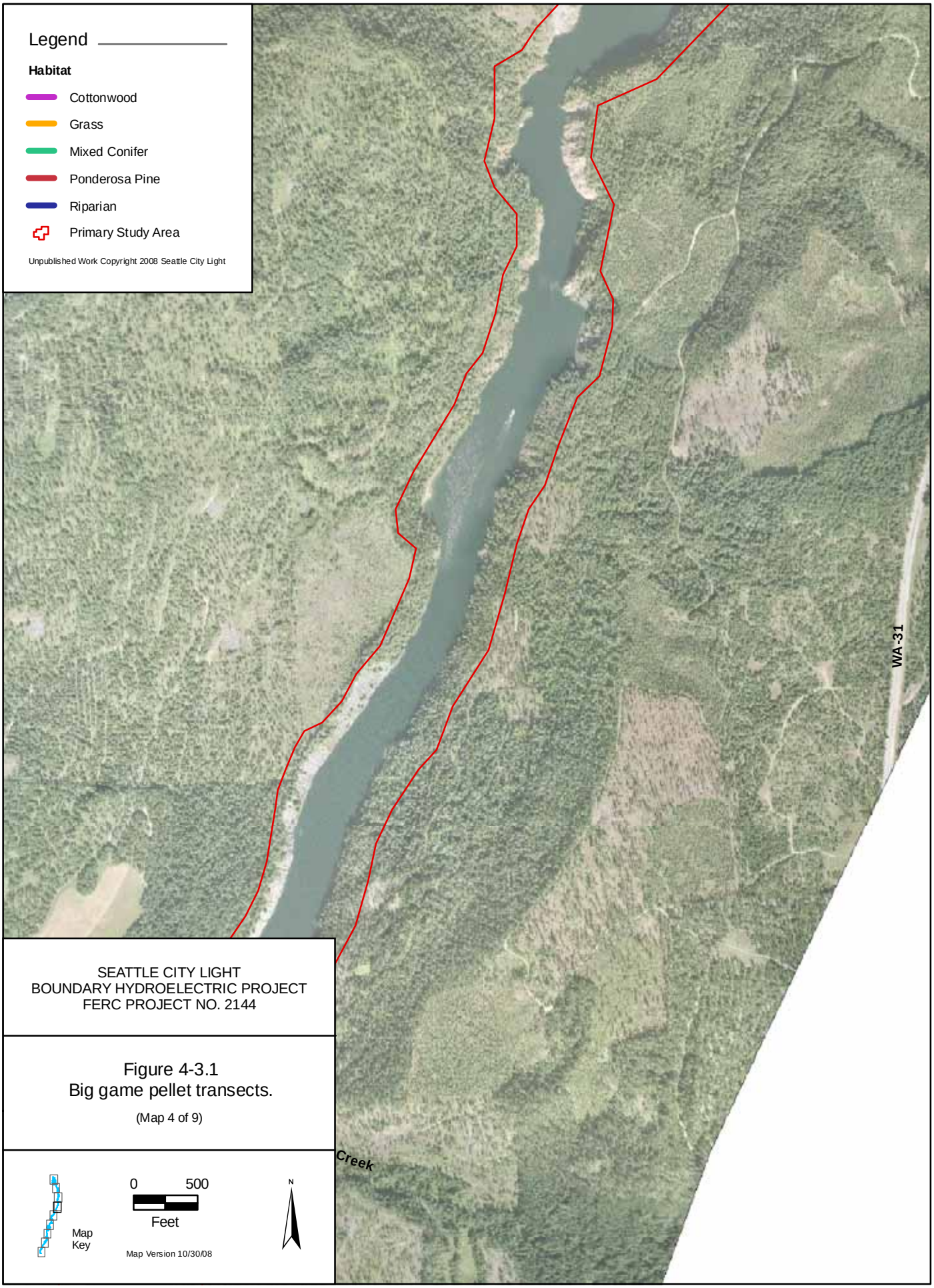
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BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
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(Map 4 of 9)
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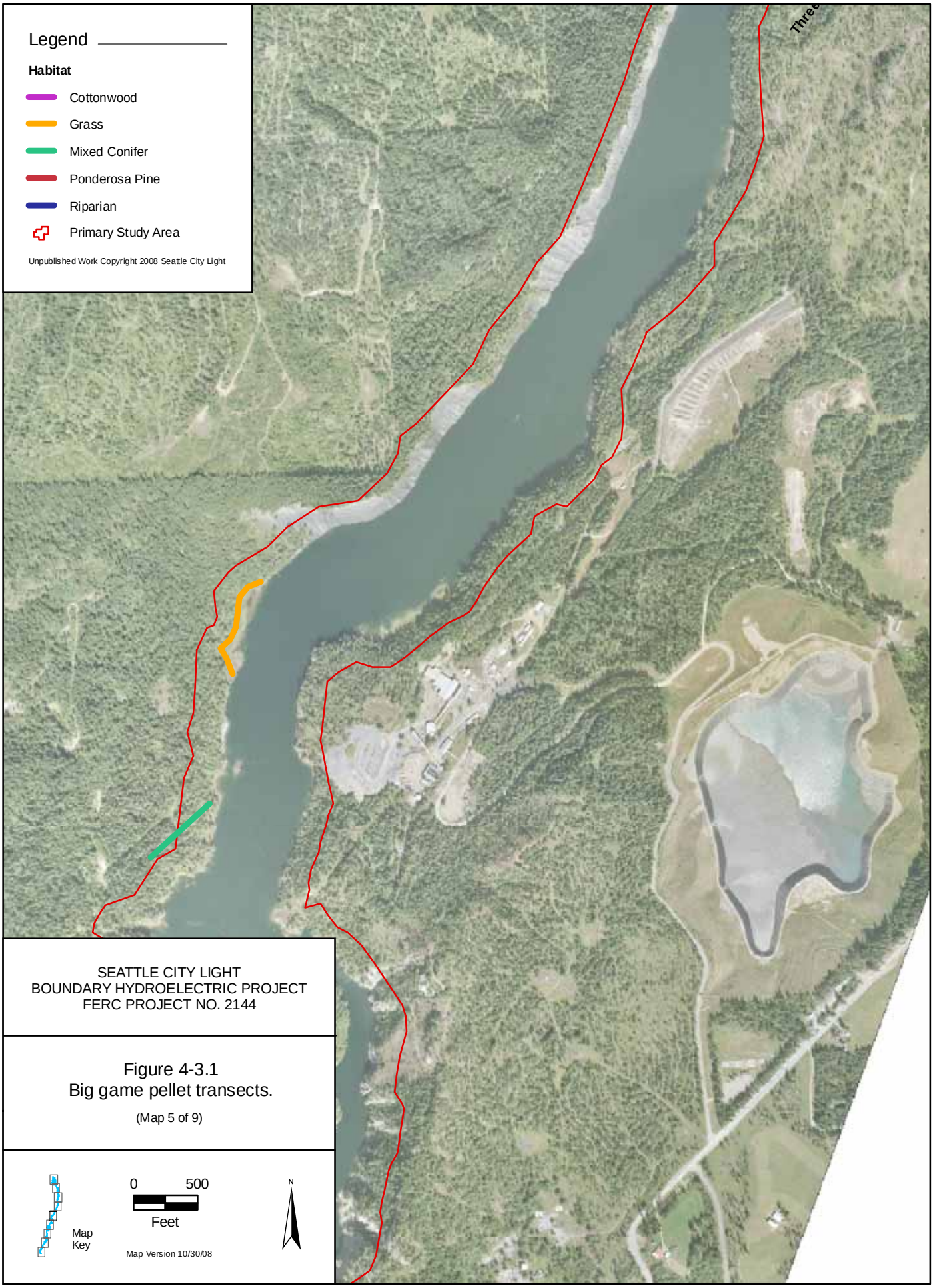
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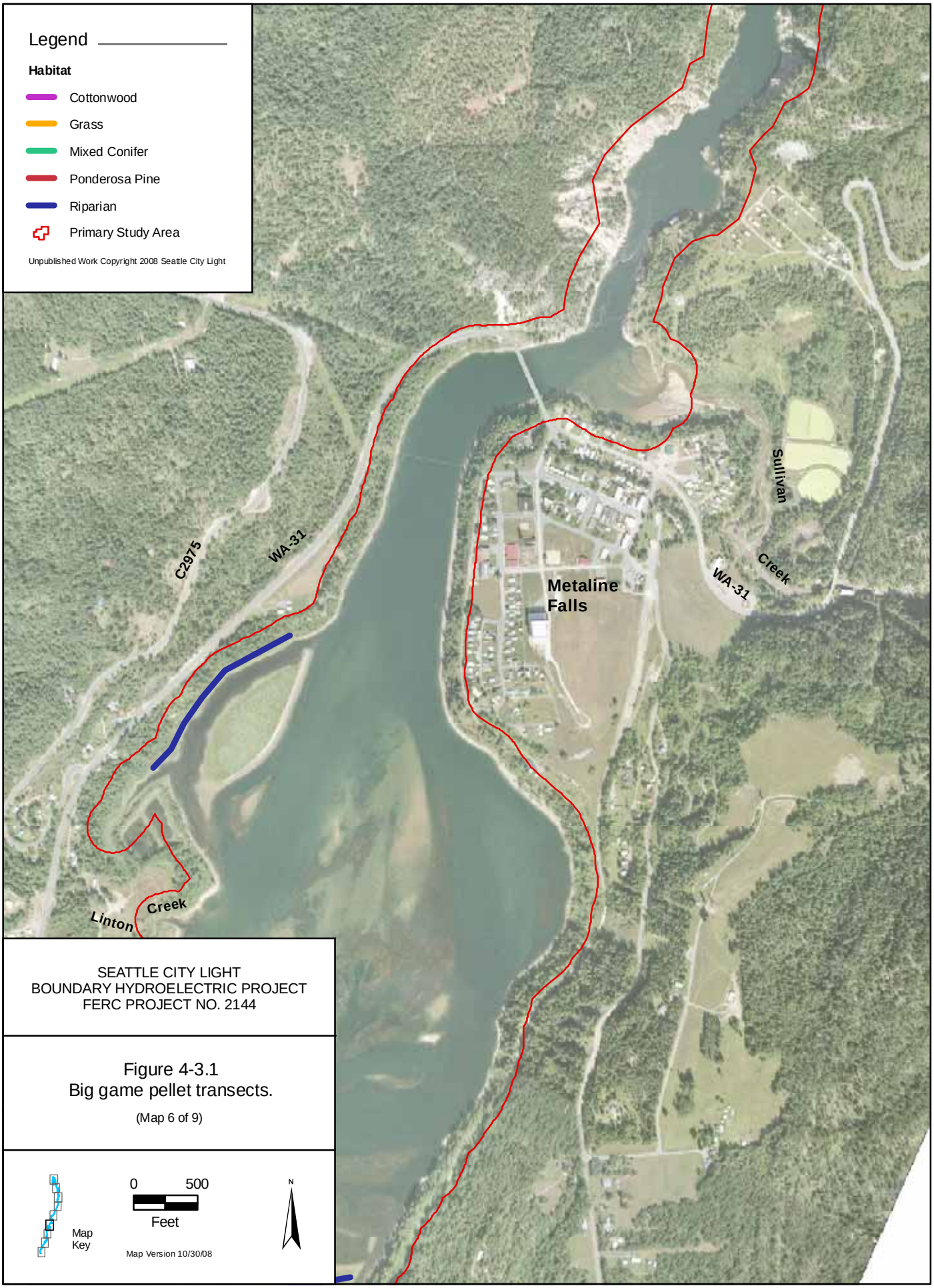
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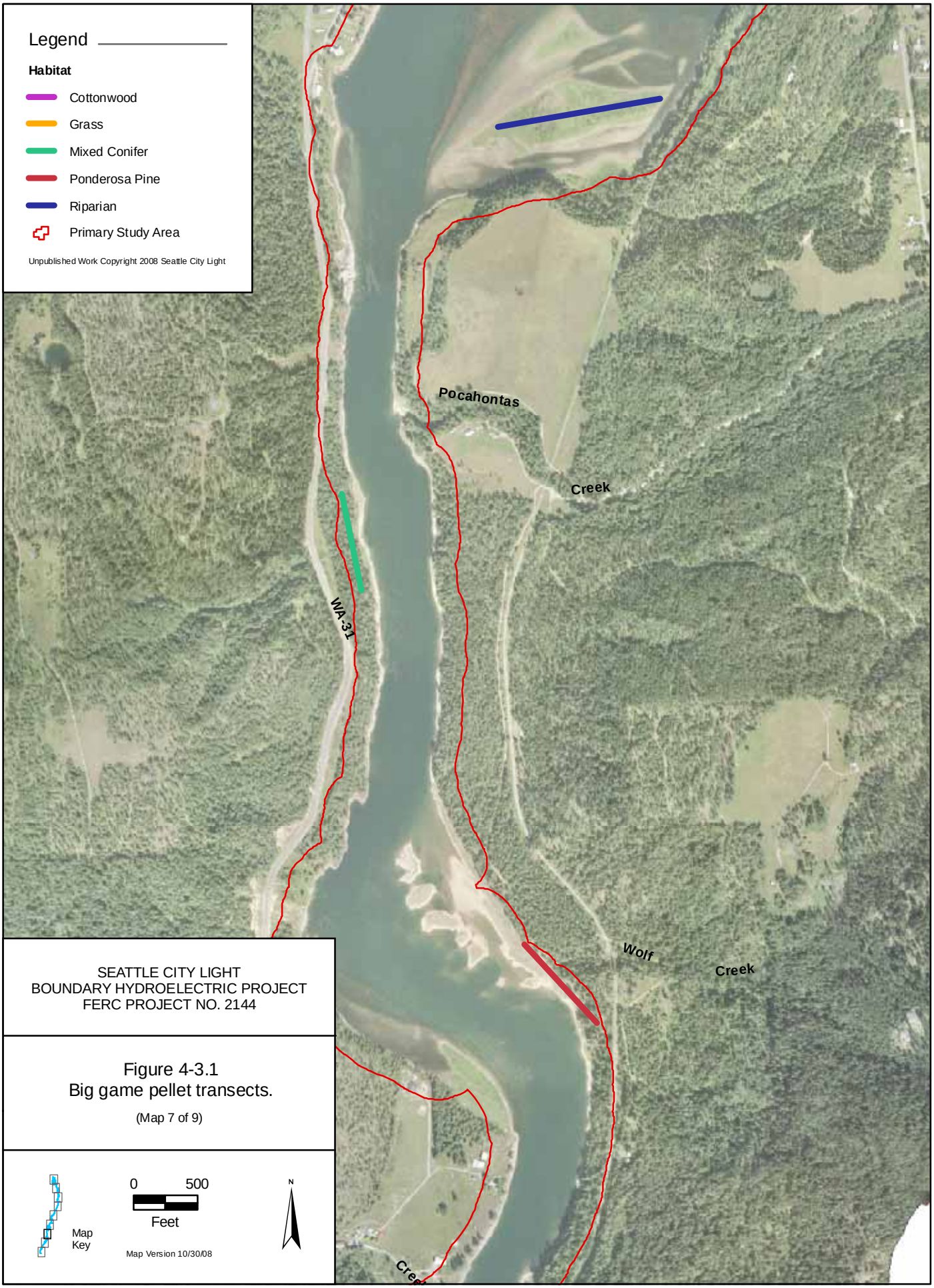
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SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
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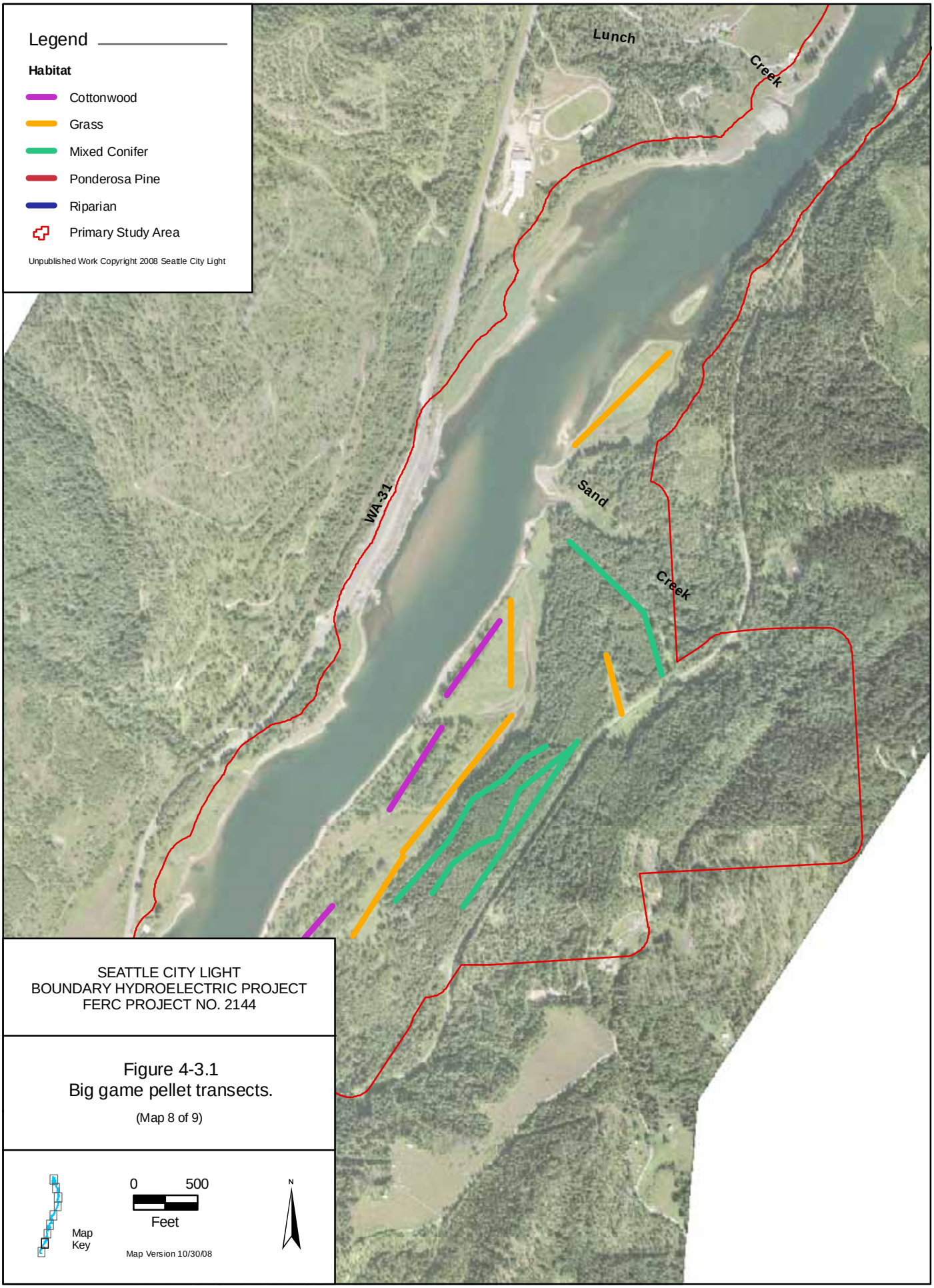
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BOUNDARY HYDROELECTRIC PROJECT
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(Map 8 of 9)
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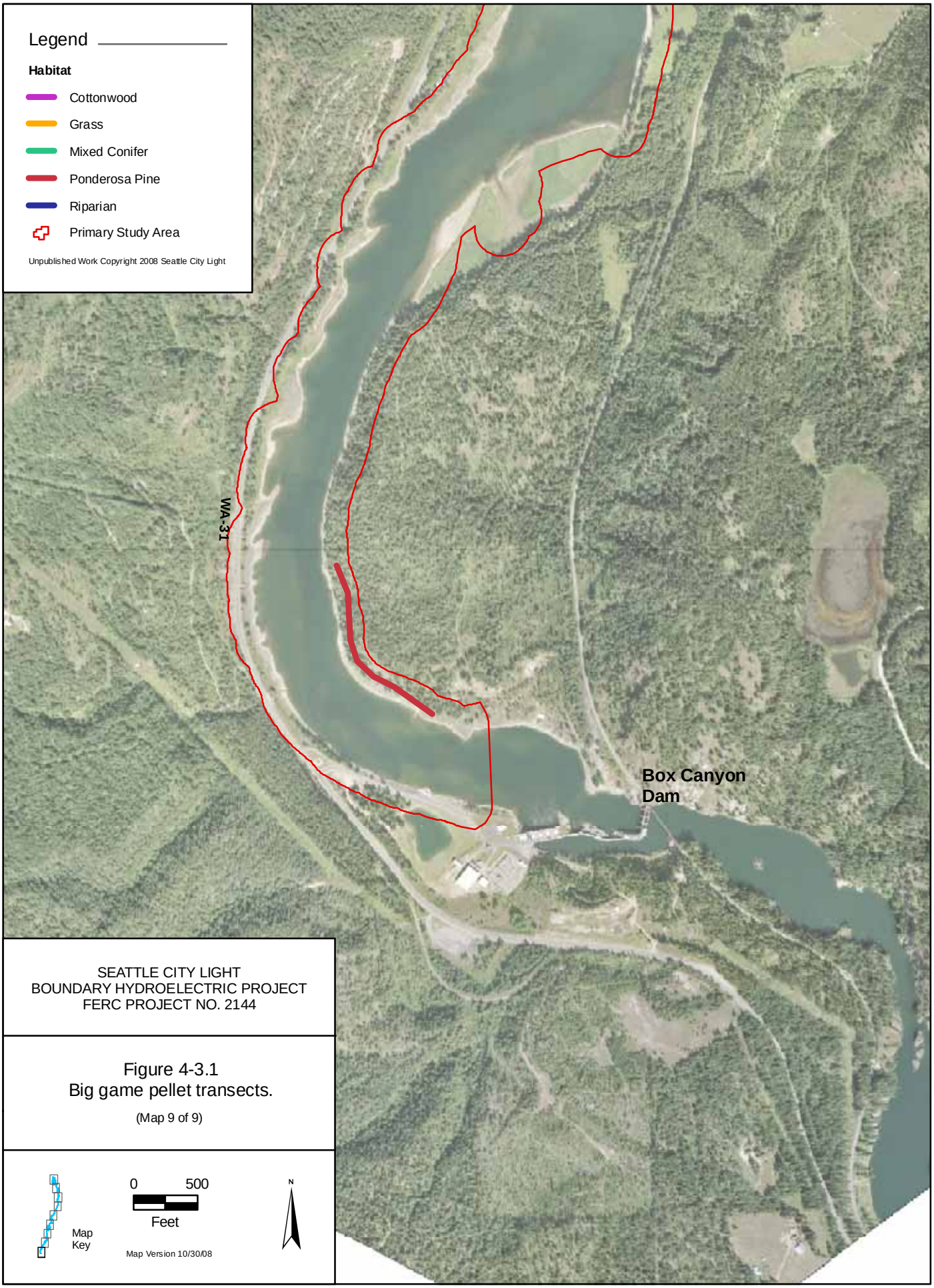
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Dam
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure 4-3.1
Big game pellet transects.
(Map 9 of 9)
Map
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4.4. Calculate Road Densities and Estimate Use

Because of the linear shape and limited extent of the primary study area, road densities were calculated for a larger, secondary study area (which incorporated the primary study area; see Section 3). To calculate road densities and estimate use of roads in the secondary study area, the following tasks were conducted:

- The USFS GIS road layer was reviewed and updated based on field analysis (driving or walking all roads accessible to vehicles).
- Using the updated USFS maps, road densities were calculated for the overall secondary study area and for six sub-areas: east and west sides of the reservoir upstream (southeast and southwest) and downstream (east-central and west-central) of Metaline Falls and east and west side (northeast and northwest) to the Pend Oreille River from Boundary Dam to the U.S.-Canada border (see Figure 5.4-1).
- Road ownership and the list of Project-related roads were obtained from Study 22, Land and Roads Study Revised Final Report (SCL 2009c).
- The contribution of Project-related roads to the overall and sub-area densities was estimated.
- Road use information was incorporated from Study 22, and additional field data were collected (i.e., winter snowmobile use).
- The potential effects of road densities on big game populations were assessed using USFS models.

Potential effects of roads in the secondary study area on big game were assessed using the Thomas et al. (1979) habitat effectiveness model. The RSP suggested applying the Wisdom et al. (2005) model, but it was determined that the detailed road use information required for this model was not available. Roads negatively influence the optimal use of available habitat by deer and elk, and the Thomas et al. (1979) model, adapted from Perry and Overly (1977), quantifies this relationship. Based on this model, as little as one mile of main or secondary road per square mile of habitat results in a significant decline in elk use. Significant declines in deer use occur when densities are greater than three miles of road (all types) per square mile of habitat. The Thomas et al. (1979) model does not require traffic volume data (e.g., vehicles per day), but rather classifies roads into main, secondary, and primitive, and assumes that traffic volume decreases as road quality decreases. Main roads are at least one and one-half lanes wide and regularly maintained (paved or oiled); secondary roads are one and one-half lanes wide, are somewhat improved, and are not maintained regularly; and primitive roads are single-lane roads, are unimproved, and are seldom maintained. In general, all paved and oiled roads in the secondary study area were considered main roads, unoiled USFS arterial roads were considered secondary, and old mining and/or timber harvest roads still passable (or at least frequently used by off-road vehicles [ORVs]) were considered primitive. The specific contribution of Project-related roads to decreased habitat effectiveness in the secondary study area was also assessed.

Use of the secondary study area by snowmobiles was also investigated to determine the disturbance risk to wintering big game. This task involved interviewing USFS personnel with knowledge on the location and extent of snowmobile use on local federal lands and surveying the junctures of seasonally-closed roads during the winter for snowmobile tracks.

4.5. Estimate Potential Big Game Habitat in the Fluctuation Zone

Estimating the amount of big game habitat that could potentially develop in the fluctuation zone if the Project were operated at lower water surface elevations required using different approaches for the upper reservoir versus the lower reservoir. Different approaches were needed because there are major differences in topography, bathymetry, and the effect of Project operations on water surface elevations between the upper and lower reservoirs.

- **Upper Reservoir**—The amount of big game forage habitat that could potentially establish (primarily riparian grasslands) along the upper reservoir was estimated from the potential goose nesting habitat identified in Study 15, Waterfowl/Waterbirds Study Final Report (SCL 2009d). The amount of big game hiding cover that could potentially develop (represented by riparian deciduous tree and shrub habitats) was estimated from the results of Study 16 (SCL 2009b). It was considered unlikely that thermal cover would develop along the upper reservoir because seasonal high flows frequently scour vegetation from the shorelines and would limit the development of conifer stands below the normal full pool elevation.

  Study 15 used the 19-year hydrologic record to determine that the median pool elevation at the forebay during the spring was approximately 1,990 feet NAVD 88 (1,986 feet NGVD 29). The median value was used as it represents the lowest elevation along the reservoir where vegetation has established. The Hydraulic Routing Model (HRM) was used to identify the corresponding water surface elevations along the upper reservoir when the forebay was at approximately 1,985 feet and 1,980 feet NAVD 88 (1,981 and 1,976 feet NGVD 29, respectively) (see Study 16, Section 4.3 for more detail on the differences between water surface elevations between the forebay and upper reservoir). The amount of riparian grassland acreage in each of these increments was then calculated and used in this study to represent potential increases in foraging habitat. A similar exercise was conducted as part of Study 16 to estimate potential riparian shrub and tree acreage and was used to estimate the net change in big game hiding cover associated with operating the reservoir at lower levels. The only difference is that for Study 16, the analysis began at the existing vegetation line at each riparian shrub or tree stand, regardless of the elevation. For both studies it was assumed that riparian tree, shrub, and grassland habitats would not develop on cobble substrates. Because the topography of land adjacent to the upper reservoir is low to moderate, it was also assumed that none of the area below the full pool elevation has slopes greater than 60 percent (the habitat ineffectiveness threshold for white-tailed deer and elk).

- **Lower Reservoir**—To estimate the location and extent of big game habitat that could potentially develop in the lower reservoir fluctuation zone, bathymetric contour data were used to delineate the fluctuation zone between elevations 1,990 and 1,970 feet NAVD 88 (1,986 and 1,966 feet NGVD 29) into four 5-foot increments (recognizing that big game habitat already exists at many locations at elevations between 1,994 and 1,990 NAVD 88 [1,990 and 1,986 feet NGVD 29). Vegetation cover type and bathymetric data layers were then combined to create a base layer for delineating the

habitat that could develop in each 5-foot increment. It was assumed that existing shoreline vegetation (above 1,990 feet NAVD 88 [1,986 feet NGVD 29]) would expand into the fluctuation zone if the reservoir were operated at lower levels during the growing season and if there were no significant changes in topography or substrate (this assumption was applied as these data are lacking for the fluctuation zone downstream of Metaline Falls). Each vegetation type was then extended into the fluctuation zone and designated as hiding cover, thermal cover, forage, or non-habitat. It was also assumed that all conifer stands could, at some point in the future, develop into both hiding and thermal cover and that all riparian shrub stands would eventually provide hiding cover for big game. Non-habitat was defined as cliffs, slopes greater than 60 percent (elk and white-tailed deer) or 75 percent (mule deer) (see Section 4.2), and rocky areas unlikely to support substantial amounts of forage. Finally, the amount of effective hiding cover, thermal cover, and foraging habitat that might develop in the lower reservoir fluctuation zone was calculated for each 5-foot increment.

4.6. Effects Assessment

The effects assessment describes observed and potential Project and non-Project effects on big game species currently utilizing the primary study area and the habitats on which they depend. Information used to conduct this assessment was taken from Study 1, Erosion Study Final Report (SCL 2009e); Study 21, Recreation Resource Study Final Report (SCL 2009f); and the 19-year hydrologic record (R2 Resource Consultants, Inc. 2008).

5 RESULTS

This section presents the results of the study efforts by task. Field data sheets and logs from big game and pellet-group count surveys are available upon request.

5.1. Compile Existing Information

Information from USFS and WDFW biologists indicates that in general, white-tailed deer dominate the Pend Oreille Valley and are the species most commonly harvested during the annual fall hunt. The west side of the Boundary Reservoir is managed as white-tailed deer winter range (USFS 1988). Based on local reports (Sargent 2008), observations of white-tailed deer along the lower reservoir are relatively rare in the winter but are common during the summer. Local reports (Sargent 2008; Luhr 2008) also suggest that while mule deer are pursued during the hunting season, they occur primarily at higher elevations well outside of the secondary study area.

Elk were largely eliminated from eastern Washington by the late 1800s but then reintroduced into Pend Oreille County in 1932 and again in the 1970s. By 2003, the population known as the Selkirk Herd had grown to about 1,450 individuals (WDFW 2003), some of which can be found in the primary and secondary study areas. In the past two decades, the herd has expanded into new territory to the south but has not increased in size in northern Pend Oreille County (Zender and Hickman 2001). Although the east side of Boundary Reservoir, south of Metaline Falls, is managed as elk winter range, it is thought that the quality and quantity of winter browse and

spring foraging areas may be limiting population size in the northern half (Zender and Hickman 2001).

Recent increases in the local moose population indicate that they may be found just about anywhere in the Project vicinity, including the primary study area (Borysewicz 2008). Locals (Sargent 2008) reported seeing moose in the BWP (primary study area) and along Slate Creek (secondary study area). Also, moose are regularly observed foraging at a wetland (locally referred to as "the Swamp") west of the lower reservoir, just outside of the secondary study area.

Black bears and mountain lions are often reported in the primary and secondary study areas, and populations in northeastern Washington are considered stable (WDFW 2008).

5.2. Map and Characterize Shoreline Conditions

Characterizing shoreline conditions for big game along Boundary Reservoir was done by identifying and mapping suitable habitat and the locations of trails and reservoir crossing opportunities. The results of these efforts are described below.

5.2.1. Habitat Mapping

The extent and distribution of hiding and thermal cover and forage habitats in the 1,562-acre (exclusive of the reservoir area) primary study area are strongly influenced by the age of most of the conifer forest stands and the topography that typifies the lower reservoir shorelines. Over one-third of the primary study area does not provide habitat for deer or elk because of steep slopes or lack of vegetation (Table 5.2-1). Along the lower reservoir, non-habitat is typified by cliffs, rocky outcroppings, and slopes effectively too steep for big game use. This is especially true along the Canyon Reach, which extends from Metaline Falls to the downstream end of Z Canyon (Project river mile [PRM] 26.8 to 18.0), where the average slope is greater than 100 percent. Steep slopes also characterize non-habitat along the upper reservoir, along with housing developments, mud flats, gravel bars, and rip-rap.

- **Thermal Cover**—A major fire in 1926 burned most of the primary study area, leaving only a few large legacy trees and older forest stands (Borysewicz 2008). Most of the regenerated mixed conifer stands, now about 80 years old, have only recently developed into thermal cover for deer, defined as conifer stands of 3 acres or more and with greater than or equal to 60 percent crown closure (USFS 1988), but are yet to develop into thermal cover for elk, defined as canopy closures greater than 70 percent (Thomas et al. 1979). The ponderosa pine (*Pinus ponderosa*) dominated stands in the primary study area do not have the requisite canopy cover to provide thermal cover for any big game species, but may reach the requisites for deer within the next decade. Overall, there are 473 acres of thermal cover for elk and white-tailed deer and 589 acres for mule deer in the primary study area (30 and 38 percent respectively) (Table 5.2-1).

- **Hiding Cover**—All of the stands that represent thermal cover in the primary study area also contain a layer of shrubs and small trees in the understory dense enough to provide hiding cover, and were therefore also classified as such. An additional 243

acres of hiding cover for elk and white-tailed deer and 263 acres for mule deer are provided by open ponderosa pine stands with understories of tall shrubs, Sitka alder stands, and riparian tree (especially black cottonwood [*Populus balsamifera* ssp. *trichocarpa*]) and shrub stands (Table 5.2-1). Overall, 54 percent of the primary study area represents hiding cover for mule deer and 46 percent for elk and white-tailed deer.

In general, as the mixed conifer forest matures, thermal cover effectiveness will increase as forest canopies continue to develop. However, associated understories, and their effectiveness as hiding cover, will decline with increased shading.

Table 5.2-1. Acres of big game habitat types in the 1,562-acre primary study area (habitat type definitions per the Colville National Forest Plan [USFS 1988]).

Species Reservoir area	**Habitat Type (acres)**			
	Foraging	**Hiding[1]**	**Thermal[2] and Hiding**	**Non-habitat[3]**
Mule Deer				
Lower Reservoir	92	48	382	361
Upper Reservoir	87	216	207	171
Total	**179**	**263**	**589**	**531**
White-tailed Deer and Elk				
Lower Reservoir	72	38	306	466
Upper Reservoir	70	205	167	238
Total	**142**	**243**	**473**	**704**

Notes:
1 Hiding cover is defined as dense vegetation or topography that would hide at least 90% of a standing animal at a distance of 200 feet.
2 Thermal cover is defined as conifer forest stands of at least 3 acres with at least 60% canopy closure. At this stage of forest succession, all thermal cover stands in the study area include a shrub understory that provides adequate hiding cover.
3 Non-habitat includes rock, bare ground, developed areas, and slopes greater than 60% for white-tailed deer and elk and greater than 75% for mule deer.

- **Forage Habitat**—Open habitats that provide forage for elk and white-tailed deer are very limited along Boundary Reservoir, representing only 142 acres (9 percent) of the primary study area (Table 5.2-1). Because mule deer will use steeper slopes (up to 75 percent) than elk and white-tailed deer, more forage habitat is available for this species. The amount of forage for the primary study area for all big game species is distributed nearly equally between the upper and lower reservoirs.

  Overall, the cover to forage ratio for the primary study area is 83:17 (for all three species), which contrasts with the management objective of a 50:50 ratio for the Colville National Forest (USFS 1988). The cover to forage ratio is nearly the same for the upper and lower reservoirs, although much of the habitat classified as hiding cover in the upper reservoir (Table 5.2-1) consists of riparian shrub communities that

provide browse for deer and moose, especially wintering white-tailed deer, but not elk. In addition to the relatively small amount of big game forage in the primary study area, the quality of some of this habitat is generally low (see Appendix 2 for a review of the palatability of forage species found in the primary study area). Although classified as forage habitat, the wetter riparian grasslands along the upper reservoir, such as the areas dominated by reed canarygrass (*Phalaris arundinacea*) and common tansy (*Tanacetum vulgare*), are of low palatability and probably do not serve as important forage species for elk. By contrast, the drier meadows of the BWP contain a substantial cover of sedges that are preferred by elk, and offer higher quality forage habitat. The drier, open slopes (and many of the open ponderosa pine stands classified as hiding cover) along the reservoir support beaked hazelnut (*Corylus cornuta*) and common snowberry (*Symphoricarpos albus),* all winter forage for white-tailed deer. Field observations and pellet group counts confirmed the importance of these drier sites for deer and elk.

Along the lower reservoir, there are few vegetated open areas and many of these sites are steep slopes with sparse grass and shrub cover. There are a few narrow strips of shoreline habitat (less than 2 acres total) dominated by sedges (*Carex* spp.) and forbs, important forage for elk. Field observations reflect the importance of these sites to big game; for example, deer were frequently observed foraging on the forbs and sedges along the edge of the cove at PRM 20.9, and large numbers of elk pellet groups were counted at a sedge meadow at PRM 25.4.

In conclusion, there is very little high-quality foraging habitat in the primary study area, which is consistent with Zender and Hickman's (2001) observation that poor quality foraging habitat is limiting elk populations in northern Pend Oreille County. Appendix 1 provides the locations and a list of the dominant plant species at the 36 forage sites in the primary study area.

5.2.2. Trails and Reservoir Crossing Locations

Established game trails indicate where big game access the reservoir or travel along the shorelines. Trails may also be indicative of locations where big game routinely cross the reservoir. When viewed from a landscape perspective, these trails may form part of an important travel corridor through the secondary study area. A map of the locations of trails recorded along the reservoir shoreline is provided as Figure 5.2-1. In the primary study area downstream of Metaline Falls, 74 big game trails were recorded; these are located virtually anywhere the topography allowed access to the reservoir and along the reservoir edges. Conversely, along the upper reservoir, fewer established trails were recorded, presumably because big game movement is not constrained by topography. Big game appear to be moving more diffusely through the landscape and parallel to the reservoir within the primary study area above Metaline Falls.

To target specific locations where big game can access and cross Boundary Reservoir, trails that appeared to align on opposite sides of the reservoir were mapped. Along the upper reservoir, these "matching" trails suggest that big game regularly cross the reservoir upstream of Metaline Falls in three locations: near the Box Canyon lower gaging station (PRM 33.4); near Wolf Creek PRM 30.2); and near Pocahontas Creek (PRM 29.3) (Figure 5.2-1). Two white-tailed deer bucks

were observed crossing the reservoir at the latter location. Anecdotal evidence from locals (Sargent 2008) and other relicensing study researchers indicates that big game, including elk and moose, regularly cross the river to and from the BWP, although there is little evidence of trails due to the flat topography and cobble substrate on the shorelines. Ten potential crossing sites (Figure 5.2-1), each affording easy access to and from both sides of the river, were identified along the lower reservoir, indicating that the steep terrain in the Canyon Reach is relatively permeable (one crossing per river mile). However, observations of deer, elk, and moose crossing the lower reservoir in 2007 and 2008 suggest that although these animals may take an easily traveled route down to the water, they seem to cross without regard for the exit opportunities on the opposite side. Except for locations with rocky cliffs, none of the shoreline appears to be too treacherous to impede the ability of big game to exit the river.

All stream drainages entering the reservoir likely serve as travel corridors for dispersing big game. However, incidental sightings of big game, wolves (unverified), and a lynx during the 2007/2008 study period; local knowledge of big game movement patterns (Luhr 2008; Sargent 2008); and grizzly bear radio-tracking data (Borysewicz 2008) suggest a few drainages are particularly important. Along the lower reservoir, big game appear to be moving between Slate Creek and Everett Creek (mule deer, elk, moose, lynx, and possible grizzly bear) and between Threemile Creek and Beaver Creek (elk moving between calving meadows), and are probably using Lime Creek and Flume Creek to access the reservoir (elk and possibly wolves). The river shoreline (especially on the east side) may provide a travel corridor for big game moving between the Boundary Dam tailrace and Canada. Trail cameras deployed adjacent to the tailrace recorded several mule deer, white-tailed deer, elk, and a black bear. Along the upper reservoir, Pocahontas and Wolf creeks provide travel corridors for deer, and the Sand Creek drainage provides a travel corridor for elk using the BWP.

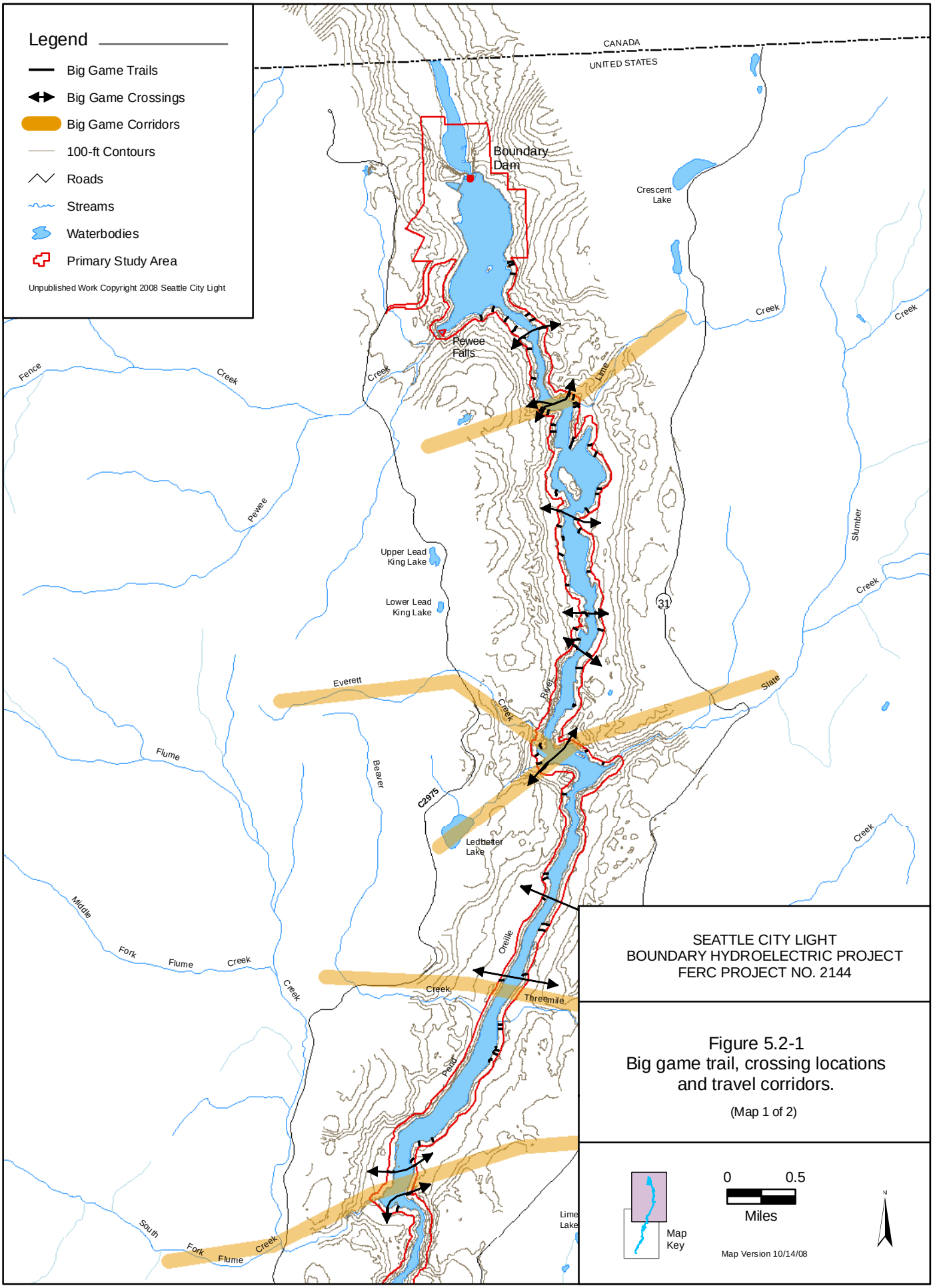
Legend
Big Game Trails
Big Game Crossings
Big Game Corridors
100-ft Contours
Roads
Streams
Waterbodies
Primary Study Area
Unpublished Work Copyright 2008 Seattle City Light
CANADA
UNITED STATES
Boundary Dam
Crescent Lake
Pewee Falls
Fence Creek
Pewee Creek
Lime Creek
Upper Lead King Lake
Lower Lead King Lake
Slumber Creek
Everett Creek
Slate Creek
Flume Creek
Beaver Creek
C2975
Ledbetter Lake
Middle Fork Flume Creek
Orville Creek
Threemile Creek
Pend Oreille
South Fork Flume Creek
Lime Lake
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
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Figure 5.2-1
Big game trail, crossing locations and travel corridors.
(Map 1 of 2)
Map Key
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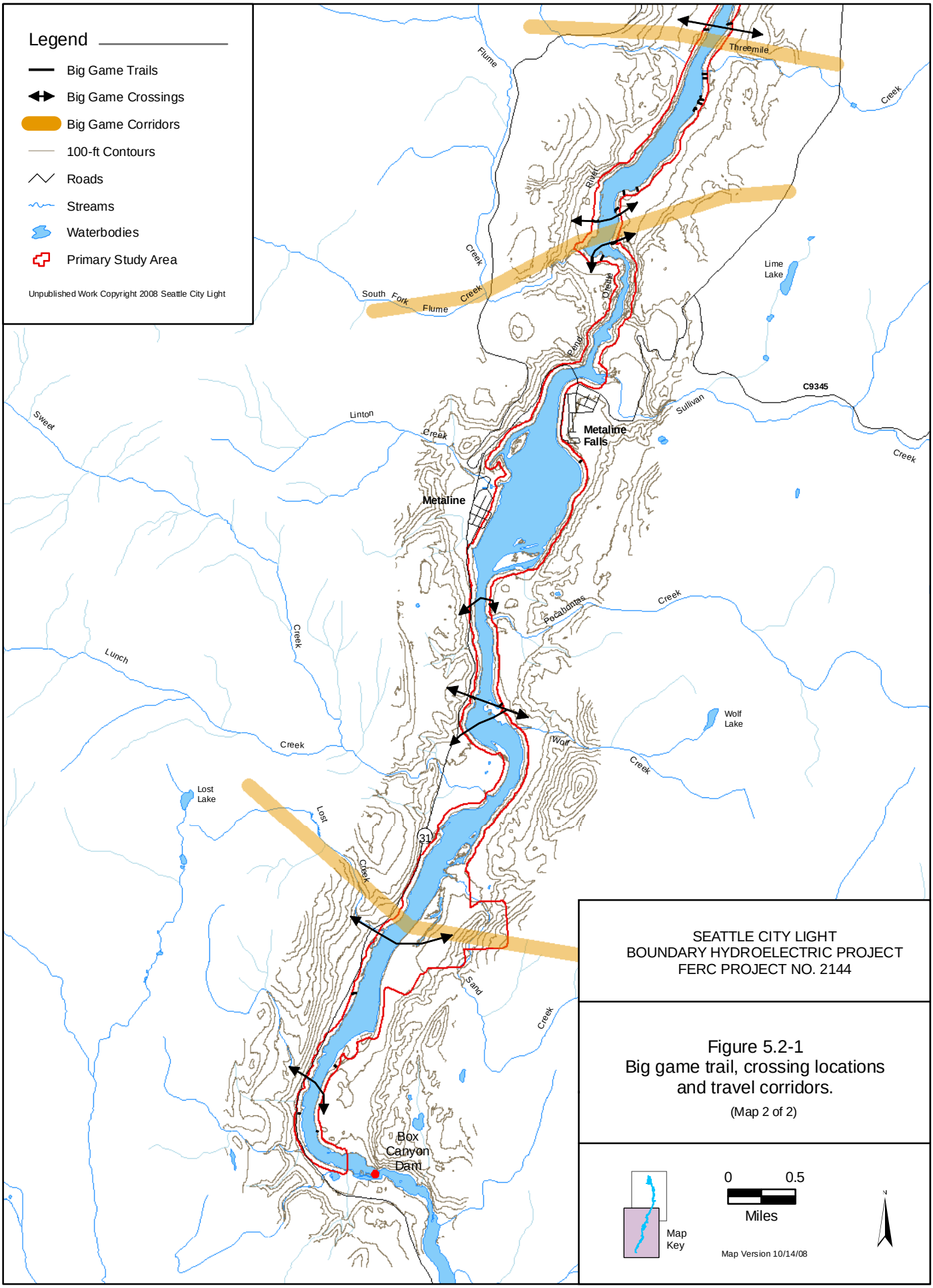
Miles
Map Version 10/14/08


Legend
Big Game Trails
Big Game Crossings
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100-ft Contours
Roads
Streams
Waterbodies
Primary Study Area
Unpublished Work Copyright 2008 Seattle City Light
Threemile
Creek
Flume
River
Creek
South Fork
Flume
Creek
Creek
Lime
Lake
C9345
Sullivan
Creek
Linton
Creek
Sweet
Metaline
Falls
Metaline
Pocahontas
Creek
Creek
Lunch
Creek
Wolf
Lake
Wolf
Creek
Lost
Lake
Lost
Creek
31
Sand
Creek
Box
Canyon
Dam
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure 5.2-1
Big game trail, crossing locations
and travel corridors.
(Map 2 of 2)
Map
Key
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Miles
Map Version 10/14/08

5.3. Assess Big Game Use in Shoreline Segments

Of the six big game species known to occur in the Project vicinity, only three—mule deer, white-tailed deer, and elk—were observed during the 20 wildlife surveys conducted in the primary study area. Sightings or evidence of other big game species—bears, moose, and mountain lions—were made incidentally during other survey efforts.

5.3.1. Deer and Elk Observations

In all, there were 59 observations of white-tailed deer, 66 of mule deer, and 3 of elk recorded in the primary study area during wildlife surveys conducted between April 2007 and September 2008 (Table 5.3-1, Figure 5.3-1). No big game were recorded during November or December 2007.

- **Mule Deer—**No mule deer were observed in the primary study area during any of the wildlife surveys conducted between June and December 2007, and June and September 2008. The only summer observations of this species were of 3 animals incidentally recorded on trail cameras (lower reservoir and tailrace) in August 2008. Mule deer were most frequently observed north of Metaline Falls between February and June, although a small group wintered south of Metaline Falls in 2008. Everett Island and a small cove at PRM 20.9 appeared to be especially attractive to mule deer. Relatively large numbers of wintering mule deer were incidentally recorded along the reservoir during a February 20, 2008, fish survey at Everett Island (3), the cove at PRM 20.9 (11), Lime Creek (5), Slate Creek (3), and Sullivan Creek (8). The 16 deer observed along the three creeks were in open conifer stands on southern aspect slopes. The locations and timing of mule deer in the primary study area were consistent with statements by Luhr (2008) and Borysewicz (2008) that this species generally inhabits the higher country east of the secondary study area during summer and fall, and moves into the Pend Oreille River canyon during the winter and spring.

- **White-tailed Deer**—White-tailed deer were observed throughout the primary study area during the summer months, but were mostly concentrated in the ponderosa pine stands along the upper reservoir during the winter and spring. Eight white-tailed deer were also recorded in February 2008 at the mouth of Sullivan Creek. White-tailed deer appear to use the Canyon Reach only during the summer. However, both mule and white-tailed deer (and elk) were recorded on trail cameras during the summer in the Boundary tailrace area.

Table 5.3-1. Number of individuals of each big game species seen in primary study area during wildlife surveys, spring 2007 through fall 2008.

Species	Wildlife Survey Number[1]																					
	1	**2**	**3**	**4**	**5**[2]	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**[2]	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
White-tailed deer	2	5	2	3	0	1	4	1	10	1	0	0	0	5	0	2	0	13	7	2	0	1
Mule deer	2	7	4	0	0	0	0	0	0	0	0	0	0	0	5	9	15	12	9	3	0	0
Elk	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0

Notes

1 Survey dates: **2007** 1—April 20-21; 2—May 9-10; 3—May 30-31; 4—June 14-15; 5—June 25-29; 6—July 10-11; 7—July 25-26; 8—Aug 13 & 16; 9—Sep 7-8; 10—Oct 11-12 ;11—Nov 13; 12—Nov 28; 13—Dec 27; **2008** 14—Jan 17 15—Feb 27; 16—Mar 11; 17—Mar 25-26; 18—April 22-26, 19 – May 12-13; 20–June 18; 21—July 16-17; 22—Sep 16.

2 Wildlife surveys 5 and 13 were not boat-based surveys along the reservoir; therefore, they did not target big game species.

- **Elk**—Only 3 elk were observed during the 20 wildlife surveys but incidental sightings from other relicensing studies, local reports, observations of tracks, pellet group counts, and trail camera recordings were sufficient to discern a pattern of elk use in the primary study area. A small group of elk use the BWP, and apparently range along both sides of the reservoir in this area. Another small group resides just north of Metaline where they have damaged local gardens (Sargent 2008). Small groups of elk winter in the vicinity of Deadman's Eddy and near the mouth of Slate Creek; a few elk spend the summer near Boundary Dam and are regularly seen by SCL personnel. Two independent local reports (Luhr 2008; Sargent 2008) described relatively heavy elk use at Van Dyke meadows located at the western edge of the primary study area immediately south of Beaver Creek. Both these reports stated that elk cross the reservoir near Beaver Creek when traveling between Van Dyke meadows and meadows east of SR 31, areas that are both used for feeding and calving. This herd includes 25 to 40 elk (Borysewicz 2008; Luhr 2008; Sargent 2008). Field investigations confirmed a well-used big game trail at Van Dyke meadows, and fisheries biologists photographed 2 elk swimming across the river near Beaver Creek in June 2008. Observations from this study are consistent with those of WDFW and USFS biologists (Zender and Hickman 2001; Borysewicz 2008; Zender 2008) which suggest that small groups of elk (less than 20) inhabit each of the major drainages along Boundary Reservoir, and that fewer than 100 elk seasonally use the secondary study area.

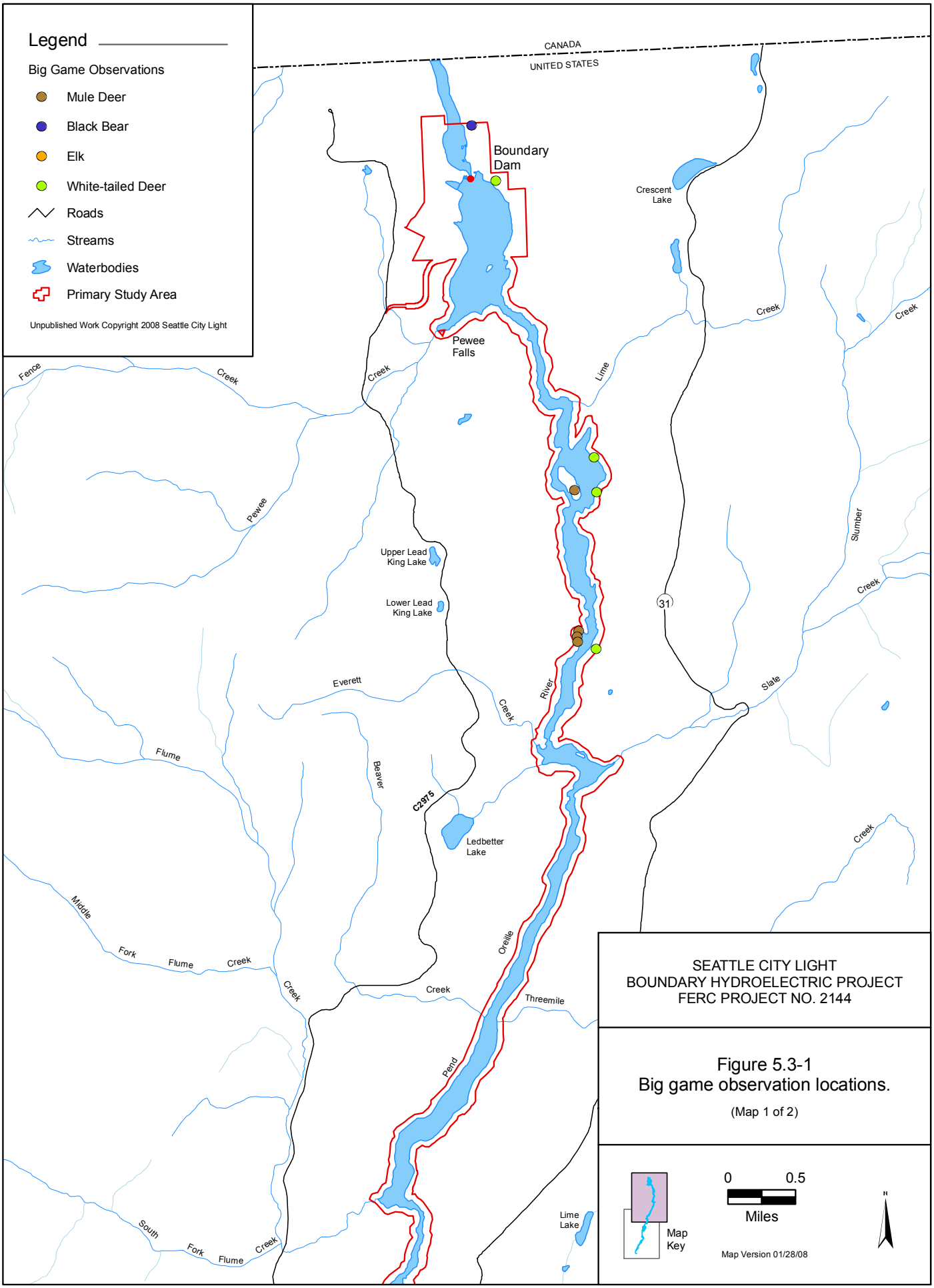
Legend
Big Game Observations
Mule Deer
Black Bear
Elk
White-tailed Deer
Roads
Streams
Waterbodies
Primary Study Area
Unpublished Work Copyright 2008 Seattle City Light
CANADA
UNITED STATES
Boundary Dam
Pewee Falls
Crescent Lake
Upper Lead King Lake
Lower Lead King Lake
Ledbetter Lake
Lime Lake
Fence Creek
Pewee Creek
Lime Creek
Creek
Slumber Creek
Slate Creek
Everett Creek
Beaver Creek
Flume Creek
Middle Fork Flume Creek
South Fork Flume Creek
Threemile Creek
Pend Oreille River
C2975
31
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
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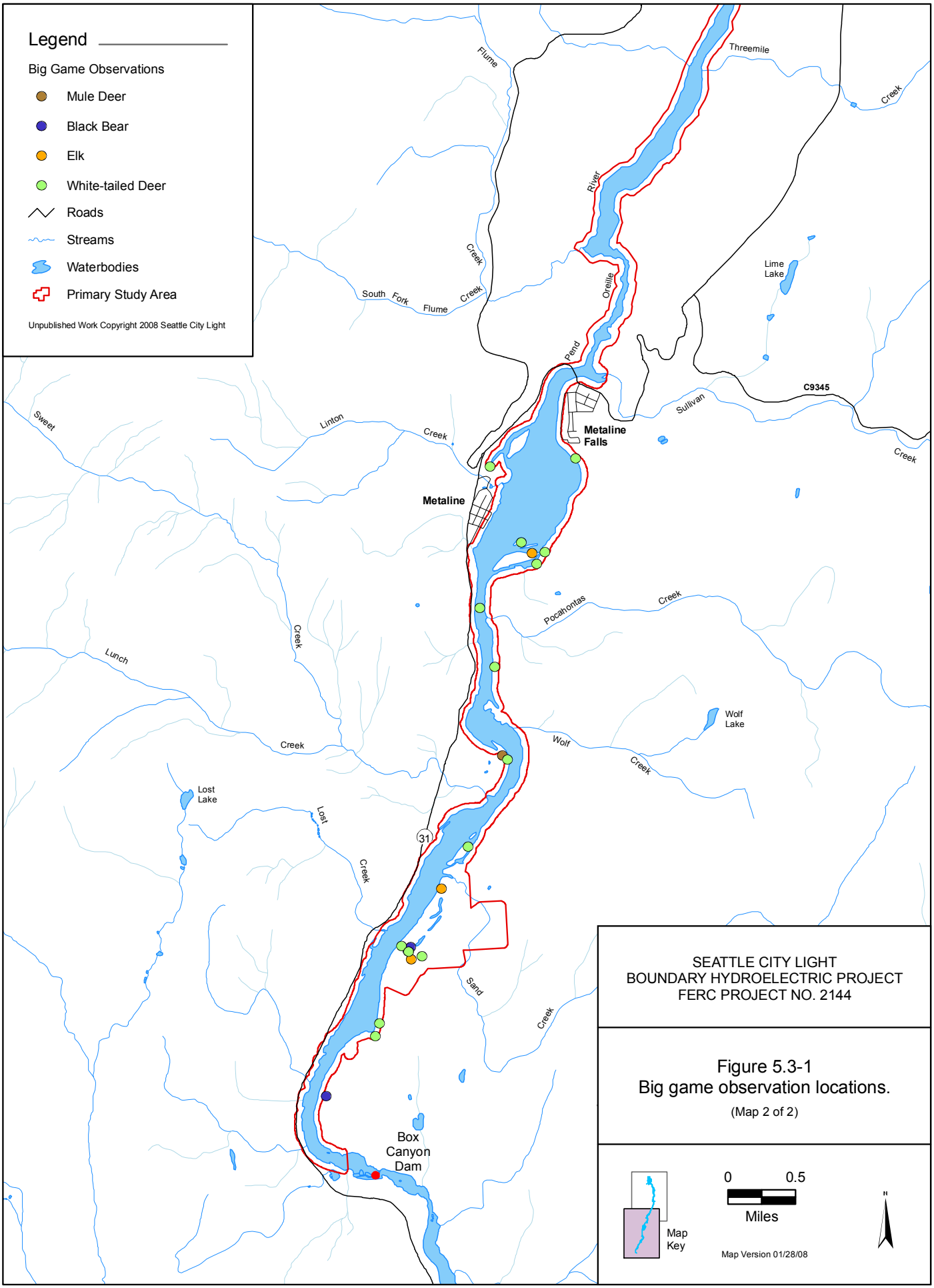
Figure 5.3-1
Big game observation locations.
(Map 1 of 2)
Map Key
0 0.5
Miles
Map Version 01/28/08
N


Legend
Big Game Observations
Mule Deer
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Unpublished Work Copyright 2008 Seattle City Light
Flume
Threemile
Creek
River
Creek
Oreille
Lime
Lake
South Fork
Flume
Creek
Pend
C9345
Sullivan
Sweet
Linton
Creek
Metaline
Falls
Creek
Metaline
Pocahontas
Creek
Creek
Lunch
Wolf
Lake
Creek
Wolf
Creek
Lost
Lake
Lost
Creek
31
Sand
Creek
Box
Canyon
Dam
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure 5.3-1
Big game observation locations.
(Map 2 of 2)
Map
Key
0
0.5
Miles
N
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5.3.2. Pellet Group Count Results

Pellet group counts reflected a pattern of big game use in the primary study area similar to the results from the winter ocular surveys. Pellet group composition was 78 percent deer, 21 percent elk, and 1 percent moose (Table 5.3-2). In comparison, the November 2007 to mid-March 2008 ocular survey results were 89 percent deer and 11 percent elk. On average, the highest densities of pellet groups occurred in the ponderosa pine habitats (22.3 groups per 1,000 square meters), and the lowest in the riparian (3.2 groups per 1,000 square meters) and black cottonwood (3.3 groups per 1,000 square meters) habitats. Grassland habitats dominated by sedges (*Carex* spp.) were highly used, especially by elk, whereas reed canarygrass stands were virtually unused. Deer dominated all habitats except grasslands (Table 5.3-2), which were used more by elk, reflecting differing foraging strategies between the two groups (browser vs. grazer).

Table 5.3-2. Pellet group composition (n = 413 groups) by big game species in five representative habitats.

Habitat	Species		
	Deer	**Elk**	**Moose**
Ponderosa pine	95%	5%	0%
Mixed conifer	88%	10%	2%
Black cottonwood	60%	35%	5%
Riparian scrub-shrub	77%	33%	0%
Grassland	38%	62%	0%
All Habitats	**78%**	**21%**	**1%**

Specific locations with high pellet group densities included the southwest-facing ponderosa pine habitats at the Box Canyon tailrace, Wolf Creek, and Slate Creek, the former two representing important concentration areas for wintering white-tailed deer and the latter used by mule deer and elk. High pellet group densities were also found in the riparian habitat below Boundary Dam, in the upper sedge (*Carex* spp.) meadows at the BWP, and at a narrow strip of sedge-dominated grassland at PRM 25.4. At the latter location, 93 percent of the pellet groups were from elk. Small numbers of elk (two to four) were observed at this site in February and March 2008.

No pellet groups were found in the sedge-dominated habitats at the north end of Everett Island despite heavy winter use of the island by mule deer. These results likely reflect the tendency of mule deer to forage by browsing rather than grazing during the winter (because herbaceous vegetation has either died back or is covered with snow); therefore, use of Everett Island by this species was probably concentrated in areas with shrubs. Few pellet groups were found in dense cottonwood and young-growth mixed conifer stands throughout the primary study area, in the riparian tree and shrub stands along the upper reservoir, or in the reed canarygrass-dominated meadows.

5.3.3. Other Big Game Observations

Although the other three big game species known to occur in the Project vicinity—moose, black bear, and mountain lion—were not observed during the 2007 and 2008 wildlife surveys, these species were seen in or near the primary study area by other researchers. Tracks and other signs of these three species were also recorded in the primary study area.

- **Moose**—Two moose were photographed crossing the lower reservoir near Slate Creek in June 2008, and enough pellet groups were noted in the Slate Creek drainage during a general wildlife survey to suggest the drainage is important to moose. Moose pellet groups and tracks were also regularly observed during spring wildlife surveys at the BWP, and two moose were observed swimming across the river to the BWP in August 2008.
- **Black Bear**—A small brown-phase black bear (reported as a grizzly bear cub but photo-verified as a black bear) was reported in the spring of 2007 near the security gate to Boundary Dam by the security guards and a non-wildlife survey crew. Non-wildlife survey crews also reported sighting single black bears on two occasions: eating apples at the BWP; and on the east bank of the river below Box Canyon Dam (Figure 5.3-1). Further, various bear sightings occurred on the road leading to Monument Bar, outside of the primary study area, but within the secondary study area. Bear tracks were recorded at the BWP and below Boundary Dam in the tailrace area (east bank); at the latter location, tracks of a sow and cubs were noted in July 2007. Finally, a trail camera in the Boundary tailrace area recorded a black bear in August 2008 (Figure 5.3-1).
- **Mountain Lion**—Mountain lions were not visually recorded in 2007 or 2008, but tracks (including those of females with cubs) and deer-kills were noted along the lower reservoir (in the Canyon Reach) during the winter of 2007/2008.

5.4. Calculate Road Densities and Estimate Use

Within the 26.5 square mile secondary study area, there are 118.3 miles of road, of which 9.5 miles (8.1 percent) are Project-related. Most roads are primitive USFS roads (65.6 miles) or main paved highways and county roads (39.2 miles). The sub-area with the greatest road density (east-central) is located east of the river between Metaline Falls and Boundary Dam (Table 5.4-1, Figure 5.4-1). The presence of SR 31 and numerous primitive roads associated with past timber and mining activity account for the higher road densities in this sub-area. Other sub-areas that have relatively high road densities include the southwest sub-area, which is narrow and heavily influenced by SR 31, and the northwest sub-area, which is associated with the Boundary Dam maintenance facilities.

Overall, the road densities in the secondary study area are not high enough to greatly influence deer use of available habitat. Results of the Thomas et al. (1979) model indicate that 73 to 94 percent of the habitat effectiveness for deer is maintained in all six sub-areas (Table 5.4-1). Elk are more sensitive to the presence of roads, particularly main and secondary roads, which is reflected in the modeling results. Habitat effectiveness for elk is less than 70 percent in all sub-areas, and is 40 percent overall. Habitat effectiveness is especially low in the northwest, east-central, and southwest sub-areas where main road densities are highest. The high road densities in the northwest sub-area are a result of its small size relative to the number of roads associated

with the dam and maintenance facilities. Nearly 90 percent of the roads in this sub-area are Project-related. The east-central and southeast sub-areas are affected by the presence of SR 31 and paved and unpaved roads associated with past timber harvest, mines (past and present), schools, and motels just outside of the city limits of Metaline Falls.

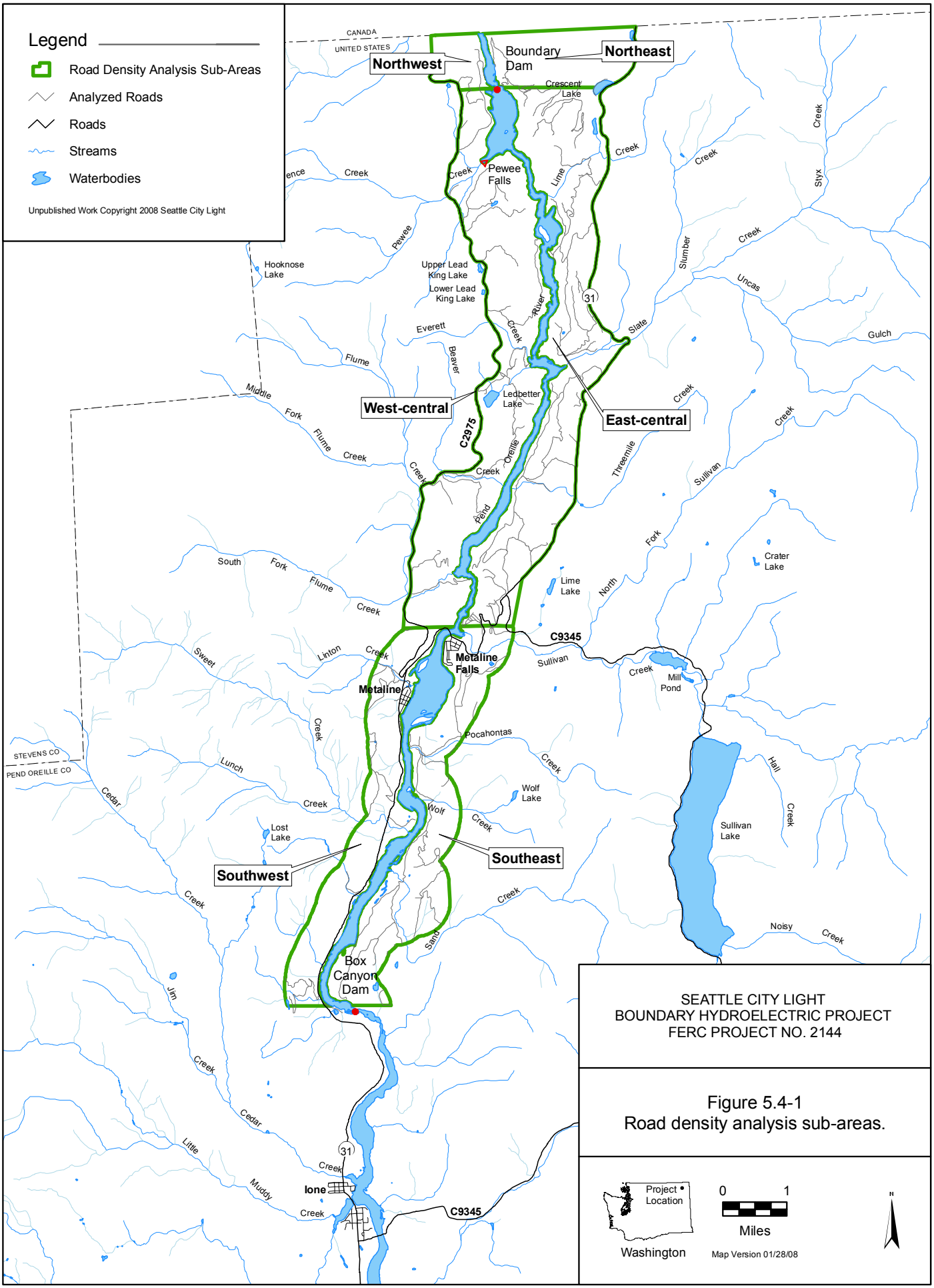
Table 5.4-1. Road densities in the secondary study area and six sub-areas, and approximate habitat effectiveness for deer and elk (from Thomas et al. [1979]).

Sub-area	Road Density (miles of road/square mile)			Habitat Effectiveness[4]	
	Main[1]	Secondary[2]	Primitive[3]	Deer	Elk
Northwest (0.67 mi^2)	1.89	0.35	0.76	89%	35%
West-central (7.54 mi^2)	0.85	0.08	2.43	85%	58%
Southwest (3.94 mi^2)	2.18	0.22	1.88	81%	34%
Northeast (2.02 mi^2)	0.49	0.35	0.78	94%	68%
East-central (7.42 mi^2)	1.04	0.70	3.35	73%	35%
Southeast (4.93 mi^2)	0.55	1.18	2.56	77%	45%
Overall (26.52 mi^2)	**1.06**	**0.51**	**2.47**	**81%**	**40%**

Notes:
1 Main road – at least one and one-half lanes wide and regularly maintained (paved or oiled).
2 Secondary road – one and one-half lanes wide, are somewhat improved, and are not regularly maintained.
3 Primitive road – single-lane roads are unimproved and seldom maintained.
4 Habitat effectiveness – The effectiveness of deer and elk in obtaining optimum use of the maximum area of available habitat; the higher the road density, the lower the habitat effectiveness.

Only 6.2 miles of road occur in the primary study area (2.4 square miles) (see Study 22 [SCL 2009c] for a table and map of the Project-related roads), 40 percent (2.4 miles) of which are Project-related roads. Almost all of the Project-related roads are associated with access to Boundary Dam, the Vista House, and Project maintenance facilities. The remaining roads (all non-Project) in the primary study area include three portions of SR 31 falling within 200 feet of the reservoir (southwest sub-area), and the primitive (abandoned logging roads) roads within the BWP. Very few road segments extend into the primary study area between Metaline Falls and the Boundary forebay.

All highways and paved county and private roads in the secondary study area are assumed to experience regular use. These include SR 31, County Road 2975, the Boundary Dam West-side Access Road and maintenance facilities road network, roads associated with the Pend Oreille Mine, and during the summer, County Road 3990. Relative to these, the network of USFS roads in the east-central sub-area and the logging roads on the BWP receive minor levels of vehicle traffic, mostly ORV use. Additional information on road conditions, level of use, and ownership can be found in the Study 22 Revised Final Report (SCL 2009c).


Legend
Road Density Analysis Sub-Areas
Analyzed Roads
Roads
Streams
Waterbodies
Unpublished Work Copyright 2008 Seattle City Light
CANADA
UNITED STATES
Northwest
Northeast
Boundary Dam
Crescent Lake
Pewee Falls
Hooknose Lake
Upper Lead King Lake
Lower Lead King Lake
Everett
Ledbetter Lake
West-central
East-central
C2975
Oreille
Pend
Middle Fork Flume Creek
South Fork Flume Creek
Lime Lake
Crater Lake
Threemile
Sullivan
Mill Pond
C9345
Metaline
Metaline Falls
Linton
Sweet
Lunch
Cedar
Pocahontas
Wolf Lake
Lost Lake
Southwest
Southeast
Sullivan Lake
Hall
Noisy
Sand
Box Canyon Dam
Jim
Little Muddy
Slate
Uncas
Slumber
Styx
Gulch
Lime
Beaver
River
Fork
North
STEVENS CO
PEND OREILLE CO
31
Ione
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure 5.4-1
Road density analysis sub-areas.
Project Location
Washington
0
1
Miles
Map Version 01/28/08
N

During winter wildlife surveys conducted in December 2007 and February and March 2008, the entire lengths of SR 31 and County Road 2975 that form the borders of the secondary study area were surveyed to document the level of snowmobile use (tracks going into the secondary study area), especially on the USFS roads that are gated and closed to automobiles for the winter. The meadows at the BWP were also surveyed for snowmobile use. During the three surveys, a single snowmobile track was observed on Forest Service Road 172 (south of Slate Creek), and several tracks were noted at the BWP. According to the USFS (Borysewicz 2008), the USFS roads in the secondary study area are infrequently used by snowmobilers, except by mountain lion hunters and a few locals living along SR 31.

5.5. Estimate Potential Big Game Habitat in the Fluctuation Zone

The amount of big game habitat (hiding and thermal cover, and forage) that could develop in the fluctuation zone if the Project were operated at lower water surface elevations is limited by different processes along the upper and lower reservoirs. Flood-related processes, including high flow velocities and water surface elevations, limit the ability of shrubs and trees to establish along the upper reservoir margins by periodically inundating and/or scouring seedlings. Along the lower reservoir, vegetation establishment is limited by topography and substrate. Because potential habitat development was estimated differently for the upper and lower reservoir (see Section 4.5), each is discussed separately below.

5.5.1. Upper Reservoir

The amount of potential habitat for big game that could develop with Boundary forebay water surface elevations at 1,985 and 1,980 feet NAVD 88 (1,981 and 1,976 feet NGVD 29) is based on the results from Studies 15 (SCL 2009d) and 16 (SCL 2009b):

- **Hiding Cover**—Maintaining Boundary forebay water surface elevations at approximately 1,985 feet NAVD 88 (1,981 feet NGVD 29) could potentially result in the development of an additional 5.8 acres of hiding cover for all big game species. Approximately 8.1 acres could develop if the Project were operated at approximately 1,980 feet NAVD 88 (1,976 feet NGVD 29). Most of the net increase in hiding cover would be in red-osier dogwood [*Cornus sericea*] on the island at PRM 28.9 (see Study 16 Final Report [SCL 2009b]).

- **Thermal Cover**—Regardless of how the Project is operated, thermal cover would not be expected to develop in the upper reservoir fluctuation zone because seasonal high flows, which typically scour seedlings, would prevent conifer tree establishment. A review of historic photographs and the lack of stumps in the fluctuation zone upstream of Metaline Falls suggest that conifer trees were not present in this area prior to Project construction, and undoubtedly not in densities qualifying as thermal cover.

- **Forage Habitat**—Study 15 indicated that operating the reservoir at lower water surface elevations would increase the amount of riparian grassland habitat in the upper reservoir on the islands at PRMs 27.7, 31.3, 31.5, and 33.2. New islands likely to be dominated by grasslands would become exposed at PRMs 27.8 and 31.7.

Further, shoreline grassland habitat would expand at PRM 30.4. Overall, it is estimated that operating at a forebay water surface elevation of 1,985 feet NAVD 88 (1,981 feet NGVD 29) would result in a net increase of about 8.5 acres of grassland habitat; an additional 4 acres (12.5 acres total) would be expected at the 1,980-foot NAVD 88 (1,976-foot NGVD 29) level. However, these grasslands would most likely be dominated by reed canarygrass, which is prevalent on the existing islands and shorelines of the upper reservoir. The pellet group study (Section 5.3) indicated that reed canarygrass was virtually unused by big game, suggesting that any new grassland habitats that develop in the upper reservoir would have little value as forage for big game.

5.5.2. Lower Reservoir

The amount of potential habitat for elk, white-tailed deer, and mule deer that could develop with Boundary forebay water surface elevations at 1,985, 1,980, 1,975, and 1,970 feet NAVD 88 (1,981, 1,976, 1,971, and 1,966 feet NGVD 29) is presented in Table 5.5-1 and discussed below.

Hiding Cover— Upland hiding cover associated with conifer stands could potentially increase by a maximum of 14.8 acres for mule deer and 11.5 acres for white-tailed deer and elk (Table 5.5-1). As determined from Study 16 (SCL 2009b), a maximum of 0.6 acre of woody riparian hiding cover would be expected to develop in the fluctuation zone along the lower reservoir. As riparian vegetation expands deeper into the current fluctuation zone, some existing riparian vegetation will desiccate and die as the water table drops.

- **Thermal Cover**—New conifer stands developing in the lower reservoir fluctuation zone would develop first into hiding cover, and then mature into thermal cover over time. Because the only difference between conifer stands that provide hiding cover and thermal cover is temporal, the maximum thermal cover that could potentially develop in the lower reservoir fluctuation zone is 14.8 acres for mule deer and 11.5 acres for white-tailed deer and elk (Table 5.5-1).

- **Forage Habitat**—Forage habitat that could develop in the lower reservoir fluctuation zone includes expansion of the few narrow riparian sedge stands and the open grasslands found on many of the upland slopes. A maximum of approximately 33.6 acres of effective mule deer foraging habitat and 30.1 acres of white-tailed deer and elk foraging habitat could potentially develop in the fluctuation zone (Table 5.5-1).

Table 5.5-1. Incremental and cumulative (in parentheses) increases in big game habitat (acres) potentially developing in the fluctuation zone with lower reservoir water surface elevations (1,990 feet NAVD 88 to 1,970 feet NAVD 88) for mule deer (slopes <75 percent) and elk and white-tailed deer (slopes <60 percent).

Species Habitat Type (acres)	**Increment (feet below 1,990 feet NAVD 88)**			
	-5	**-10**	**-15**	**-20**
Mule Deer				
Woody Riparian Hiding[1]	0.2 (0.2)	0.2 (0.4)	0.2 (0.6)	-0.6 (0.0)
Conifer Thermal and Hiding[2]	5.1 (5.1)	4.6 (9.7)	2.7 (12.4)	2.4 (14.8)
Forage	12.7 (12.7)	9.8 (22.5)	5.9 (28.4)	5.2 (33.6)
Total Mule Deer Habitat Development	**18.0 (18.0)**	**14.6 (32.6)**	**8.8 (41.4)**	**7.0 (48.4)**
Non-Habitat	12.6 (12.6)	12.4 (25.0)	14.0 (39.0)	12.4 (51.4)
White-tailed Deer and Elk				
Woody Riparian Hiding[1]	0.2 (0.2)	0.2 (0.4)	0.2 (0.6)	-0.6 (0.0)
Conifer Thermal and Hiding[2]	4.5 (4.5)	3.7 (8.2)	1.9 (10.1)	1.4 (11.5)
Forage	12.1 (12.1)	8.8 (20.9)	5.0 (25.9)	4.2 (30.1)
Total White-tailed Deer & Elk Habitat Development	**16.8 (16.8)**	**12.7 (29.5)**	**7.1 (36.6)**	**5.0 (41.6)**
Non-Habitat	11.6 (11.6)	11.0 (22.6)	13.1 (35.7)	11.2 (46.9)

Notes:
1 Net change in woody riparian vegetation from results of Study 16 (SCL 2009b).
2 Assumes all conifer stands will eventually provide both hiding and thermal cover.

Overall, operating the Project 20 feet lower than current operations would result in a maximum habitat (hiding, thermal, and forage) gain of about 48.4 acres (9 percent increase) for mule deer and 41.6 acres (10 percent increase) for elk and white-tailed deer over the amount currently available in the primary study area in the lower reservoir (see Section 5.2.1).

5.6. Effects Assessment

The following effects assessment addresses both Project and non-Project-related effects on big game and their habitats.

5.6.1. Project Effects

Potential Project effects on big game include fluctuating water levels, habitat loss from erosion, disturbance related to Project access and maintenance, and disturbance from Project-related recreation. Each type of effect is discussed below.

5.6.1.1. Daily Water-Level Fluctuations

As discussed in the Study 1 Final Report (SCL 2009e) and Study 16 Final Report (SCL 2009b), daily fluctuations in water surface elevations can result in:

- The removal of soil from exposed reservoir shorelines, preventing the establishment of native vegetation in the fluctuation zone;
- Loss of shoreline vegetation due to slumping and undercutting; and
- The creation of steep, eroded banks.

Study 16 concluded that water surface level fluctuations have the potential to limit the establishment and expansion of woody riparian vegetation into the fluctuation zone of the lower reservoir except in sheltered areas such as coves or creek inlets where fine sediment substrates persist and topography is gentle. Daily fluctuations have, therefore, potentially influenced the amount of woody riparian habitat available as hiding cover for deer and elk, especially along the lower reservoir. Along the upper reservoir, while daily water fluctuations likely have some limiting effect on the development of riparian habitat, scouring of vegetation from seasonal high flows appears to be the more dominant limiting factor (see Section 5.6.2.1).

Both Studies 1 and 16 showed, however, that erosion is having only a minimal effect on riparian big game habitat. In the past 40 years, approximately 15 acres of shoreline has been lost to erosion, but not all of this erosion was Project-related. Further, most erosion has occurred on slopes greater than 90 percent, too steep to provide big game habitat (Study 1 Final Report [SCL 2009e]), especially along the lower reservoir where only 1.6 acres of effective big game habitat was estimated lost to Project-related erosion (Table 5.6-1). Along the upper reservoir, the results of Study 1 (in conjunction with the big game models) indicate that Project operations (totally or partially) have been responsible for the loss of about 3 acres of big game forage habitat (mostly low quality reed canarygrass stands) over the last 40 years (Table 5.6-1). However, most of this erosion has since stabilized, and future rates of erosion are expected to be lower than in the past.

Table 5.6-1. Acreage of effective big game habitat potentially lost from erosion due, totally or partially, to Project operations since reservoir construction.

Reservoir	Habitat (acres)			Total (acres)
	Forage	Hiding	Thermal/Hiding	
Lower	0.1	0.9	0.6	1.6
Upper	3.0	<0.1	0.0	3.0
Total	**3.1**	**0.9**	**0.6**	**4.6**

Erosion along both the upper and lower reservoirs is most likely to continue to have some minimal effect on shoreline habitats used by big game, but the rate of erosion is very slow, and is more likely to affect marginal forage habitats.

Based on the results of the trail mapping and the erosion mapping from Study 1, it does not appear that erosion is having a significant effect on river access or crossing locations for big game.

5.6.1.2. Project Maintenance and Operations

Of the 1,562 acres (2.4 square miles) of land in the primary study area, maintenance facilities represent only 29 acres (1.9 percent), and nearly all of these facilities are confined to the immediate vicinity of Boundary Dam. Thus, the actual footprint of Boundary Dam on the landscape is relatively small. Excepting areas that have security fencing, the dam facilities are unlikely to hinder big game movement across the landscape.

Of the 118 miles of road in the secondary study area (26.5 square miles), 9.5 (8 percent) are Project-related, and these roads are contributing to lower habitat effectiveness for elk. Still, effects are localized with virtually all Project-related roads occurring within 1 mile of Boundary Dam, and less than half the roads used by SCL personnel on a daily basis. Further, only about 3 miles of road are paved and can be traveled at speeds high enough to pose a collision risk with big game. Only 1 mile of paved road, the West-side Access Road, is used on a daily basis by SCL staff. Overall, use of Project-related roads by SCL staff has a potentially small, localized effect on local big game populations.

5.6.1.3. Recreation

Although reservoir-based recreation has the potential to disturb big game, most of the deer and elk observations along the reservoir occurred during the winter months or in the early morning or evening hours, when boat-based activity is probably low. The time signature of photographs taken by trail cameras indicated that much of the mule deer and elk summer activity occurred at night. It appears that neither daily nor seasonal use of the primary study area by big game coincides with peak boat activity on the reservoir.

Project-related roads might provide access for hunters, but it is not possible to determine if this results in greater big game mortality from hunting. Most Project-related roads are concentrated near Boundary Dam where access is restricted for security reasons. It is unlikely that Project-related roads measurably contribute to annual big game harvest in the study area.

All-terrain vehicle (ATV) and snowmobile use occurs on the meadows of the BWP, although the level and frequency of ATV use in this area is unknown. Elk and white-tailed deer use of the BWP was also noted. Wisdom et al. (2004) studied elk responses to off-road recreation and found pronounced flight responses of elk to ATVs, and Creel et al. (2002) found increased levels of stress hormones in elk as a response to snowmobile activity. Moen et al. (1982) found increased heart rates of white-tailed deer in the presence of snowmobiles with corresponding additive energy expenditure. Thus, off-road recreation activity has the potential to limit the effectiveness of the BWP in providing secure habitat for big game.

5.6.2. Non-Project Effects

Potential non-Project effects on big game include seasonal high flows, flooding, mining, timber harvest, and grazing.

5.6.2.1. Seasonal High Flows

Seasonal high flows can affect big game by flooding and scouring existing vegetation, resulting in a loss of habitat important to big game. Seasonal high flows in the lower reservoir are regulated by Boundary Dam, often at elevations more commonly seen during non-peak conditions. Thus, flooding has little effect on lower reservoir shorelines (see Study 1 [SCL 2009e]). Along the upper reservoir, tree and shrub seedlings can be physically dislodged by high flow velocities and seedlings can be damaged or destroyed by shifting gravel and cobble substrates during high flows. Ice can have a similar scouring effect. Seasonal high flows and ice likely have a significant role in preventing the establishment of riparian communities that could be used by big game upstream of Metaline Falls (see Study 16 [SCL 2009b]).

5.6.2.2. Other Effects

Teck Cominco's Pend Oreille Mine is the only active mine operating in the Project vicinity. There are no known negative impacts from this mine on big game although there are anecdotal reports that deer concentrate around the mine parking lots during the winter, potentially leading to increased road mortality. Timber harvest can affect big game by removing thermal cover, however, there is currently no timber harvesting activity in the primary study area, and there is not likely to be any, at least on USFS lands, in the near future (Borysewicz 2008). Riparian, aquatic, and visual resource buffer regulations (including the Inland Native Fish Strategy on federal lands [e.g., USFS and BLM] and Pend Oreille County forest practices and shoreline protection regulations on private lands [e.g., SCL and Teck Cominco]) would also restrict timber harvesting activity within the primary study area. Grazing can lead to conflicts with big game where cattle compete for forage. Other than a few livestock straying into the tailrace area from Canada, there is currently no livestock grazing in the primary study area.

6 CONCLUSIONS

Key findings of this study include the following:

- White-tailed deer, mule deer, elk, moose, black bears, and mountain lions regularly use the primary study area, and gray wolves and grizzly bears may occasionally use the area.
- During the summer, white-tailed deer are found throughout the primary study area, elk use is limited to a few key areas, and mule deer are largely absent (having moved to higher elevations). During the winter, mule deer and elk move into the Canyon Reach and white-tailed deer concentrate in the ponderosa pine stands along the upper reservoir.
- Approximately one-third of the primary study area does not meet the definition of big game habitat because of steep slopes and rocky terrain.

- Cover (hiding and thermal) is not lacking in the primary study area, but forage is limited. Along the upper reservoir, most of the available grass forage is reed canarygrass, not a preferred big game forage species, whereas much of the hiding cover is composed of shrubs important as food for wintering deer.
- Seventy-four trails and 10 potential high-use crossings located within the Canyon Reach suggest that although the terrain is rugged, the area is permeable (at least one crossing per river mile) to big game, with ample reservoir access and crossing opportunities.
- Pellet group counts indicated that 78 percent of the winter use of the primary study area is by deer, with the highest use in ponderosa pine stands. Further, sedge meadows were primarily used by elk and big game largely avoided the reed canarygrass stands.
- Roads in the secondary study area are managed primarily by the USFS, the state, and the county. Road densities are high enough to significantly reduce habitat effectiveness for elk, but not for deer. Project-related roads account for 8.1 percent of the 118 miles of road in the secondary study area and 40 percent of the primary study area.
- Snowmobile use in the secondary study area is low.
- Potential big game habitat that could develop in the fluctuation zone, if the reservoir were operated at lower levels, is limited by several hydrogeomorphological factors. In the upper reservoir, a dominant factor appears to be seasonal high flows, which scour seedlings and prevent the establishment of trees and shrubs; only unpalatable reed canarygrass forage habitat and approximately 8 acres of red-osier dogwood-dominated hiding cover would be expected to develop in the fluctuation zone. In the lower reservoir, steep rocky slopes and a lack of fine sediment in the fluctuation zone due to Project-related water level fluctuation appear to be the main factors restricting habitat development; an estimated 48.4 acres of additional mule deer habitat (upland cover and forage) and 41.6 acres of elk and white-tailed deer habitat could potentially develop in the fluctuation zone.
- Erosion does not appear to be affecting big game access to the reservoir.
- Project-related recreation is not considered an important disturbance factor to big game because most reservoir boating activity does not coincide with seasonal and daily use periods by big game. However, use of the BWP by ORVs and snowmobiles may be affecting use of the area by big game.
- Seasonal high flows have eroded island grasslands in the upper reservoir, but these areas do not represent important habitats for big game as they are dominated by reed canarygrass. Most other sites that have been eroded have slopes greater than 90 percent, making them too steep to be effective big game habitat.
- No significant effects to big game from mining, timber harvest, or grazing were identified.

7 VARIANCES FROM FERC-APPROVED STUDY PLAN AND PROPOSED MODIFICATIONS

Big game observations were recorded during reservoir-based surveys targeting other species (e.g., waterfowl, RTE wildlife), resulting in more big game survey data than originally proposed in the RSP. In addition, incidental big game sightings were recorded by non-wildlife research teams. The RSP contemplated using the Wisdom et al. (2005) model to investigate the effects of local roads on big game habitat. However, this model requires traffic volume data, partitioned by day and night. Because no traffic data (e.g., number of vehicles per day) are available for the secondary study area, the Thomas et al. (1979) model was used to evaluate the influence of roads on big game habitat effectiveness. The Thomas et al. (1979) model classifies roads based on road quality and assumes traffic volume decreases as road quality decreases. Finally, the suitability of conducting a pellet group count study was evaluated. In consultation with relicensing participants, a modified version of the pellet group count methodology used by Boulanger et al. (2000) was implemented in April 2008.

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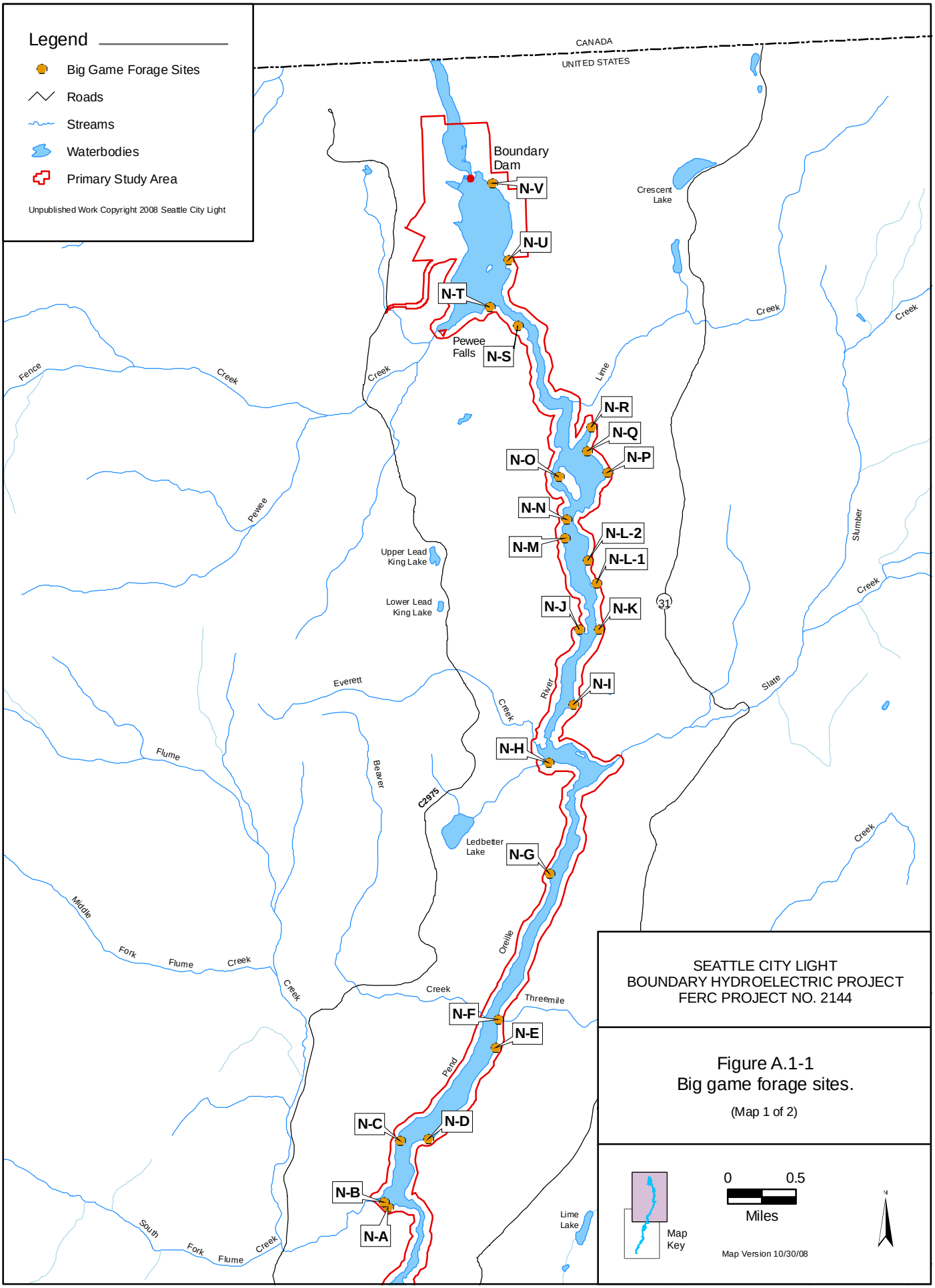
Appendix 1: Plant Species Documented at Mapped Big Game Forage Sites


Legend
Big Game Forage Sites
Roads
Streams
Waterbodies
Primary Study Area
Unpublished Work Copyright 2008 Seattle City Light
CANADA
UNITED STATES
Boundary Dam
N-V
N-U
N-T
Pewee Falls
N-S
N-R
N-Q
N-P
N-O
N-N
N-M
N-L-2
N-L-1
N-K
N-J
N-I
N-H
N-G
N-F
N-E
N-D
N-C
N-B
N-A
Crescent Lake
Upper Lead King Lake
Lower Lead King Lake
Ledbetter Lake
Lime Lake
Fence Creek
Pewee Creek
Lime Creek
Slumber Creek
Everett Creek
Beaver Creek
Flume Creek
Middle Fork Flume Creek
South Fork Flume Creek
Orelle River
Threemile Pond
C2975
31
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure A.1-1
Big game forage sites.
(Map 1 of 2)
Map Key
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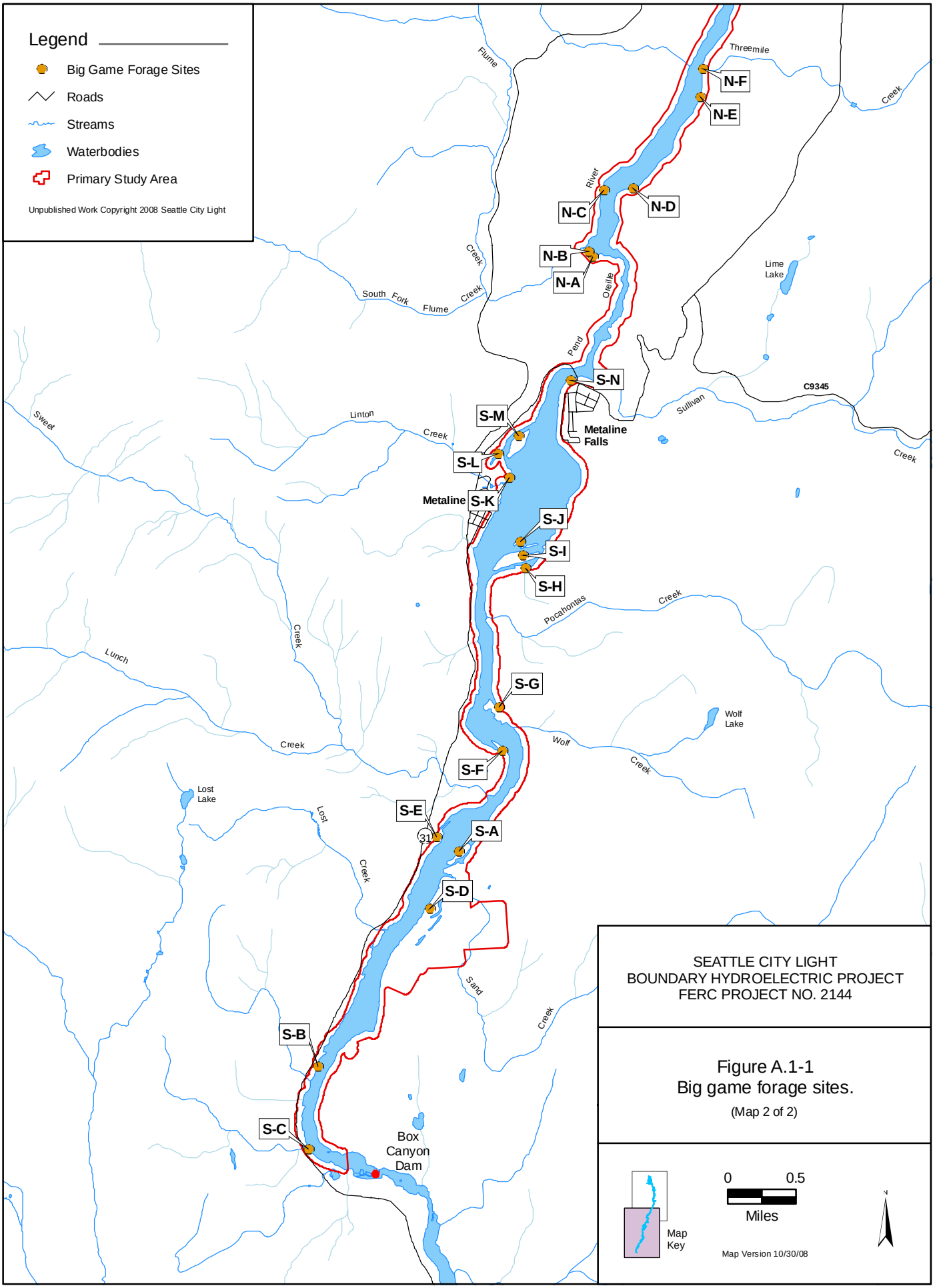
Map Version 10/30/08


Legend
Big Game Forage Sites
Roads
Streams
Waterbodies
Primary Study Area
Unpublished Work Copyright 2008 Seattle City Light
N-F
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S-G
S-F
S-E
S-A
S-D
S-B
S-C
Metaline Falls
Metaline
Box Canyon Dam
Threemile Creek
Flume Creek
South Fork Flume Creek
Pend Oreille River
Lime Lake
C9345
Sullivan Creek
Linton Creek
Sweet Creek
Pocahontas Creek
Lunch Creek
Wolf Lake
Wolf Creek
Lost Lake
Lost Creek
Sand Creek
31
SEATTLE CITY LIGHT
BOUNDARY HYDROELECTRIC PROJECT
FERC PROJECT NO. 2144
Figure A.1-1
Big game forage sites.
(Map 2 of 2)
Map Key
0
0.5
Miles
Map Version 10/30/08

Table A.1-1. Dominant plant species at big game forage sites in the primary study area.

Plot No.	Trees	Shrubs	Forbs	Grass-like Plants
N-A	*Thuja plicata* western redcedar	*Cornus canadensis* bunchberry	*Aralia nudicaulis* wild sarsaparilla	*Carex* spp. sedges
	Pseudotsuga menziesii Douglas-fir	*Linnaea borealis* twinflower	*Clintonia uniflora* queen's cup	*Festuca occidentalis* western fescue
		Corylus cornuta beaked hazelnut		
		Chimaphila umbellata prince's-pine		
N-B	*Thuja plicata* western redcedar	*Corylus cornuta* beaked hazelnut	*Aralia nudicaulis* wild sarsaparilla	*Carex* spp. sedges
	Pseudotsuga menziesii Douglas-fir	*Linnaea borealis* twinflower	*Clintonia uniflora* queen's cup	*Festuca occidentalis* western fescue
	Abies grandis grand fir	*Symphoricarpos albus* common snowberry	*Hypericum perforatum* common St. John's wort	
		Alnus sinuata Sitka alder	*Aster* spp.	
N-C	*Thuja plicata* western redcedar	*Arctostaphylos uva-ursi* Kinnikinnick	*Aster* spp.	
	Pseudotsuga menziesii Douglas-fir	*Corylus cornuta* beaked hazelnut	*Tanacetum vulgare* common tansy	*Carex* spp. sedges
		Berberis aquifolium tall Oregon-grape	*Plantago lanceolata* ribwort	
		Holodiscus discolor oceanspray	*Aster* spp.	
N-D	*Thuja plicata* western redcedar	*Berberis aquifolium* tall Oregon-grape	*Tanacetum vulgare* common tansy	*Carex* spp. sedges
	Pseudotsuga menziesii Douglas-fir	*Shepherdia canadensis* russet buffaloberry	*Plantago lanceolata* ribwort	
	Abies grandis grand fir	*Salix* spp. willow	*Melilotus alba* white sweet-clover	
		Alnus sinuate Sitka alder	*Aster* spp.	
N-E	*Thuja plicata* western redcedar	*Corylus cornuta* beaked hazelnut	*Smilacina stellata* star-flowered false Solomon's seal	*Carex* spp. sedges
	Pseudotsuga menziesii Douglas-fir	*Acer glabrum* Rocky Mountain maple		
	Abies grandis grand fir	*Berberis nervosa* dull Oregon-grape		
	Larix occidentalis western larch	*Linnaea borealis* twinflower		
	Taxus brevifolia western yew			

Table A.1-1, continued…

Plot No.	Trees	Shrubs	Forbs	Grass-like Plants
N-F	*Pseudotsuga menziesii* Douglas-fir	*Arctostaphylos uva-ursi* Kinnikinnick	*Aster* spp.	*Muhlenbergia mexicana* Mexican muhly
	Thuja plicata western redcedar	*Juniperus occidentalis* western juniper		
	Alnus sinuata Sitka alder	*Shepherdia canadensis* russet buffaloberry		
	Betula papyrifera paper birch			
N-G		*Alnus sinuata* Sitka alder	*Plantago lanceolata* ribwort	
		Shepherdia canadensis russet buffaloberry	*Tanacetum vulgare* common tansy	
			Aster spp.	
			Melilotus alba white sweet-clover	
N-H	*Pinus contorta* lodgepole pine	*Alnus sinuata* Sitka alder	*Clintonia uniflora* queen's cup	
	Larix occidentalis western larch	*Shepherdia canadensis* russet buffaloberry	*Aster* spp.	
	Thuja plicata western redcedar	*Vaccinium membranaceum* thinleaf huckleberry	*Fragaria virginiana* wild strawberry	
	Tsuga heterophylla western hemlock	*Arctostaphylos uva-ursi* Kinnikinnick	*Silene oregana* Oregon silene	
		Gautheria ovatifolia western teaberry	*Aralia nudicaulis* wild sarsaparilla	
N-I	*Larix occidentalis* western larch	*Alnus sinuata* Sitka alder		
	Thuja plicata western redcedar			
	Pseudotsuga menziesii Douglas-fir			
N-J		*Alnus sinuata* Sitka alder	*Apocynum androsaemifolium* spreading dogbane	*Phalaris arundinacea* reed canarygrass
		Arctostaphylos uva-ursi Kinnikinnick	*Pteridium aquilinum* western brackenfern	*Carex* spp. sedges
		Rubus parviflorus thimbleberry	*Aster* spp.	

Table A.1-1, continued…

Plot No.	Trees	Shrubs	Forbs	Grass-like Plants
N-K	*Pseudotsuga menziesii* Douglas-fir	*Corylus cornuta* beaked hazelnut	*Hieracium caespitosum* meadow hawkweed	*Calamagrostis canadensis* bluejoint
	Thuja plicata western redcedar	*Holodiscus discolor* oceanspray	*Antennaria racemosa* raceme pussytoes	
	Larix occidentalis western larch	*Amelanchier alnifolia* Saskatoon serviceberry	*Aster* spp.	
	Abies grandis grand fir	*Rosa woodsii* Woods' rose		
		Berberis spp. Oregon-grape		
		Linnaea borealis twinflower		
N-L-1	*Pseudotsuga menziesii* Douglas-fir	*Alnus sinuata* Sitka alder	*Pteridium aquilinum* western brackenfern	*Phalaris arundinacea* reed canarygrass
	Larix occidentalis western larch	*Rubus parviflorus* thimbleberry	*Hypericum perforatum* common St. John's wort	*Elymus glaucus* blue wildrye
	Abies grandis grand fir	*Symphoricarpos albus* common snowberry	*Clintonia uniflora* queen's cup	*Danthonia spicata* poverty oatgrass
	Pinus contorta lodgepole pine	*Linnaea borealis* twinflower		*Agrostis* spp.
N-L-2	*Abies grandis* grand fir	*Alnus sinuata* Sitka alder	*Hieracium caespitosum* meadow hawkweed	*Agrostis* spp.
	Larix occidentalis western larch	*Rubus parviflorus* thimbleberry	*Aster* spp.	
	Thuja plicata western redcedar	*Linnaea borealis* twinflower	*Fragaria virginiana* wild strawberry	
		Symphoricarpos albus common snowberry	*Viola* spp. violet	
			Pteridium aquilinum western brackenfern	
N-M	*Abies grandis* grand fir	*Alnus sinuata* Sitka alder	*Apocynum androsaemifolium* spreading dogbane	*Bromus ciliatus* fringed brome
	Larix occidentalis western larch	*Spiraea douglasii* western spiraea	*Hypericum perforatum* common St. John's wort	*Phalaris arundinacea* reed canarygrass
	Pinus monticola western white pine	*Rubus parviflorus* thimbleberry	*Solidago gigantea* giant goldenrod	*Agrostis* spp.
	Thuja plicata western redcedar	*Linnaea borealis* twinflower		
		Symphoricarpos albus common snowberry		

Table A.1-1, continued…

Plot No.	Trees	Shrubs	Forbs	Grass-like Plants
N-N	*Thuja plicata* western redcedar	*Shepherdia canadensis* russet buffaloberry	*Hieracium caespitosum* meadow hawkweed	*Agrostis* spp.
	Larix occidentalis western larch	*Acer glabrum* Rocky Mountain maple	*Verbascum thapsus* common mullein	*Poa* spp.
	Pseudotsuga menziesii Douglas-fir	*Juniperus scopulorum* Rocky Mountain juniper	*Solidago gigantea* giant goldenrod	
		Corylus cornuta beaked hazelnut	*Medicago lupulina* black medick	
		Arctostaphylos uva-ursi Kinnikinnick		
N-O	*Larix occidentalis* western larch	*Arctostaphylos uva-ursi* Kinnikinnick	*Melilotus alba* white sweet-clover	*Calamagrostis canadensis* bluejoint
	Thuja plicata western redcedar	*Juniperus scopulorum* Rocky Mountain juniper	*Apocynum androsaemifolium* spreading dogbane	*Carex* spp. sedges
	Pseudotsuga menziesii Douglas-fir	*Shepherdia canadensis* russet buffaloberry		*Agrostis* spp.
	Pinus monticola western white pine	*Corylus cornuta* beaked hazelnut		
N-P	*Pseudotsuga menziesii* Douglas-fir	*Physocarpus malvaceus* mallow ninebark	*Centaurea biebersteinii* spotted knapweed	*Elymus glaucus* blue wildrye
	Pinus ponderosa ponderosa pine	*Corylus cornuta* beaked hazelnut	*Aster* spp.	*Danthonia spicata* poverty oatgrass
	Larix occidentalis western larch	*Arctostaphylos uva-ursi* Kinnikinnick	*Smilacina racemosa* false Solomon's seal	*Festuca occidentalis* western fescue
	Pinus monticola western white pine	*Rosa woodsii* Woods' rose	*Antennaria racemosa* raceme pussytoes	
N-Q	*Thuja plicata* western redcedar	*Shepherdia canadensis* russet buffaloberry	*Aster* spp.	*Carex deweyana* Dewey sedge
	Larix occidentalis western larch	*Alnus sinuata* Sitka alder	*Aralia nudicaulis* wild sarsaparilla	*Bromus ciliatus* fringed brome
	Pinus ponderosa ponderosa pine	*Corylus cornuta* beaked hazelnut	*Smilacina stellata* star-flowered false Solomon's seal	*Elymus glaucus* blue wildrye
	Betula papyrifera paper birch	*Acer glabrum* Rocky Mountain maple	*Melilotus alba* white sweet-clover	*Agrostis* spp.
		Symphoricarpos albus common snowberry		

Table A.1-1, continued…

Plot No.	Trees	Shrubs	Forbs	Grass-like Plants
N-R	*Abies grandis* grand fir	*Alnus sinuata* Sitka alder	*Cirsium arvense* Canada thistle	*Agrostis* spp.
	Thuja plicata western redcedar	*Shepherdia canadensis* russet buffaloberry	*Hypericum perforatum* common St. John's wort	*Poa* spp.
	Pinus ponderosa ponderosa pine	*Symphoricarpos albus* common snowberry	*Aster* spp.	*Phalaris arundinacea* reed canarygrass
	Betula papyrifera paper birch	*Acer glabrum* Rocky Mountain maple	*Angelica arguta* Lyall's angelica	*Carex* spp. sedges
	Larix occidentalis western larch	*Corylus cornuta* beaked hazelnut	*Disporum* sp.	
N-S	*Thuja plicata* western redcedar	*Alnus sinuata* Sitka alder	*Pteridium aquilinum* western brackenfern	*Elymus glaucus* blue wildrye
	Betula papyrifera paper birch	*Corylus cornuta* beaked hazelnut	*Aster* spp.	*Festuca* spp.
	Pseudotsuga menziesii Douglas-fir	*Shepherdia canadensis* russet buffaloberry	*Lycopodium complanatum* groundcedar	*Phalaris arundinacea* reed canarygrass
	Larix occidentalis western larch	*Cornus canadensis* bunchberry	*Fragaria virginiana* wild strawberry	
	Pinus monticola western white pine	*Philadelphus lewisii* Lewis' mock-orange	*Clintonia uniflora* queen's cup	
		Linnaea borealis twinflower		
N-T	*Pseudotsuga menziesii* Douglas-fir	*Alnus sinuata* Sitka alder	*Aster* spp.	*Agrostis* spp.
	Thuja plicata western redcedar	*Corylus cornuta* beaked hazelnut	*Clintonia uniflora* queen's cup	*Luzula parviflora* smallflowered woodrush
	Larix occidentalis western larch	*Arctostaphylos uva-ursi* kinnikinnick	*Fragaria virginiana* wild strawberry	
	Betula papyrifera paper birch	*Shepherdia canadensis* russet buffaloberry	*Pteridium aquilinum* western brackenfern	
		Holodiscus discolor oceanspray		
N-U	*Pseudotsuga menziesii* Douglas-fir	*Corylus cornuta* beaked hazelnut	*Centaurea biebersteinii* spotted knapweed	*Festuca* spp.
	Thuja plicata western redcedar	*Holodiscus discolor* oceanspray	*Aster conspicuus* showy aster	
	Abies grandis grand fir	*Alnus sinuata* Sitka alder	*Antennaria* spp. pussytoes	
		Arctostaphylos uva-ursi Kinnikinnick	*Fragaria virginiana* wild strawberry	
		Philadelphus lewisii Lewis' mock-orange	*Clintonia uniflora* queen's cup	

Table A.1-1, continued…

Plot No.	Trees	Shrubs	Forbs	Grass-like Plants
N-V	*Thuja plicata* western redcedar	*Alnus sinuata* Sitka alder	*Aralia nudicaulis* wild sarsaparilla	*Carex* spp. sedges
	Pseudotsuga menziesii Douglas-fir	*Symphoricarpos albus* common snowberry	*Pteridium aquilinum* western brackenfern	*Elymus glaucus* blue wildrye
	Larix occidentalis western larch	*Rubus parviflorus* thimbleberry	*Aster* spp.	
	Betula papyrifera paper birch	*Corylus cornuta* beaked hazelnut		
		Rosa woodsii Woods' rose		
S-A			*Equisetum* spp. horsetail	*Phalaris arundinacea* reed canarygrass
			Mentha spp. mint	*Carex* spp. sedges
S-B	*Pinus ponderosa* ponderosa pine	*Crataegus douglasii* black hawthorn	*Centaurea biebersteinii* spotted knapweed	
		Symphoricarpos albus common snowberry	*Plantago lanceolata* narrowleaf plantain	
		Rosa woodsii Woods' rose	*Apocynum cannabinum* Indianhemp	
		Salix exigua coyote willow		
S-C	*Alnus incana* mountain alder	*Cornus sericea* red-osier dogwood	*Artemesia* spp. sagebrush	
	Populus balsamifera black cottonwood	*Salix exigua* coyote willow		
		Cornus sericea red-osier dogwood		
S-D	*Populus balsamifera* black cottonwood	*Symphoricarpos albus* common snowberry	*Solidago gigantea* giant goldenrod	*Phalaris arundinacea* reed canarygrass
		Crataegus douglasii black hawthorn	*Artemesia* spp. sagebrush	*Carex vesicaria* blister sedge
			Mentha spp. mint	
			Lysimachia spp. loosestrife	
S-E			*Mentha arvensis* field mint	*Phalaris arundinacea* reed canarygrass
			Equisetum spp. horsetail	*Carex* spp. sedges

Table A.1-1, continued…

Plot No.	Trees	Shrubs	Forbs	Grass-like Plants
S-F			*Potentilla anserina* silverweed	*Phalaris arundinacea* reed canarygrass
			Mentha arvensis field mint	*Carex vesicaria* blister sedge
			Myosotis scirpoides forget-me-not	*Carex vulpinoidea* fox sedge
				Scirpus microcarpus small-flowered bulrush
S-G	*Pinus ponderosa* ponderosa pine	*Salix exigua* coyote willow	*Apocynum cannabinum* Indianhemp	*Agrostis* spp.
	Pseudotsuga menziesii Douglas-fir	*Juniper scopulorum* Rocky Mountain juniper	*Artemisia ludoviciana* white sagebrush	*Phleum pratense* timothy
			Melilotus alba white sweet-clover	*Agropyron* spp.
S-H	*Populus balsamifera* black cottonwood	*Alnus sinuata* Sitka alder	*Mentha arvensis* field mint	*Phalaris arundinacea* reed canarygrass
		Salix exigua coyote willow	*Cirsium arvense* Canada thistle	*Carex* spp. sedges
		Salix sitchensis Sitka willow	*Centaurea biebersteinii* spotted knapweed	
		Cornus sericea red-osier dogwood		
S-I		*Cornus sericea* red-osier dogwood	*Artemisia ludoviciana* white sagebrush	*Carex* spp. sedges
			Cirsium arvense Canada thistle	
			Helenium autumnale common sneezeweed	
			Lysimachia ciliata fringed loosestrife	
			Lysimachia thyrsiflora tufted loosestrife	
S-J		*Cornus sericea* red-osier dogwood	*Lysimachia ciliata* fringed loosestrife	*Phalaris arundinacea* reed canarygrass
			Lysimachia thyrsiflora tufted loosestrife	
			Cirsium arvense Canada thistle	
S-K	*Pinus ponderosa* ponderosa pine	*Cornus sericea* red-osier dogwood	*Melilotus alba* white sweet-clover	*Phalaris arundinacea* reed canarygrass
	Populus balsamifera black cottonwood	*Symphoricarpos albus* common snowberry		
		Crataegus douglasii black hawthorn		
		Amelanchier alnifolia Saskatoon serviceberry		

Table A.1-1, continued…

Plot No.	Trees	Shrubs	Forbs	Grass-like Plants
S-L			*Artemisia ludoviciana* white sagebrush	*Phalaris arundinacea* reed canarygrass
			Lysimachia thyrsiflora tufted loosestrife	
			Lysimachia ciliata fringed loosestrife	
			Cirsium arvense Canada thistle	
			Myosotis scorpioides true forget-me-not	
			Mentha arvensis field mint	
S-M		*Alnus sinuata* Sitka alder	*Spiraea douglasii* western spiraea	*Phalaris arundinacea* reed canarygrass
		Cornus sericea red-osier dogwood		*Scirpus microcarpus* small-flowered bulrush
		Salix lucida shining willow		
S-N	*Thuja plicata* western redcedar	*Cornus sericea* red-osier dogwood	*Tanacetum vulgare* common tansy	*Phalaris arundinacea* reed canarygrass
	Larix occidentalis western larch	*Symphoricarpos albus* common snowberry		
	Pseudotsuga menziesii Douglas-fir	*Shepherdia canadensis* russet buffaloberry		
	Betula papyrifera paper birch			

Appendix 2: Palatability of Forage Species Found in the Primary Study Area

Table A.2-1. Palatability of forage species found in the primary study area.

Common Name	Scientific Name	Palatability for Deer and Elk
agrostis	*Agrostis* spp.	good (elk), fair (deer)[3]
balsam poplar	*Populus balsamifera*	high[8]
beaked hazelnut	*Corylus cornuta*	high[6]
black cottonwood	*Populus trichocarpa*	low to good (good for elk only)[3]
black hawthorn	*Crataegus douglasii*	moderate (livestock)[3]
black medick	*Medicago lupulina*	high (*M. sativa*)[3]
blister sedge	*Carex vesicaria*	commonly grazed by elk[5]
blue wildrye	*Elymus glaucus*	good (elk) poor to good (deer)[3]
bluejoint	*Calamagrostis canadensis*	fair (elk) poor to fair (deer)[3]
bunchberry	*Cornus canadensis*	good[3]
Canada thistle	*Cirsium arvense*	low[3]
common mullein	*Verbascum thapsus*	low[1]
common snowberry	*Symphoricarpos albus*	medium to high[2]
common St. John's-wort	*Hypericum perforatum*	high[3]
common tansy	*Tanacetum vulgare*	low[1]
Douglas-fir	*Pseudotsuga menziesii*	medium (new growth: high)[2]
dull Oregon-grape	*Berberis nervosa*	high (deer)[2]
festuca	*Festuca* spp.	moderate to good (*F. altaica* high)[3]
field mint	*Mentha arvensis*	low[7]
fringed brome	*Bromus ciliatus*	high[3]
giant goldenrod	*Solidago gigantea*	moderate (livestock) (*S. canadensis & missouriensis*)[3]
grand fir	*Abies grandis*	low[3]
gray alder	*Alnus incana*	low to moderate[3]
Indianhemp	*Apocynum cannabinum*	poor[3]
kinnikinnick	*Arctostaphylos uva-ursi*	low[8]
Lewis' mock-orange	*Philadelphus lewisii*	high (deer)[2]
lodgepole pine	*Pinus contorta*	low[8]
mallow ninebark	*Physocarpus malvaceus*	high (deer)[2]
meadow hawkweed	*Hieracium caespitosum*	high (deer)[2]
Mexican muhly	*Muhlenbergia mexicana*	low[7]
coyote willow	*Salix exigua*	high[2]
oceanspray	*Holodiscus discolor*	poor[3]
paper birch	*Betula papyrifera*	low[8]
poa grass	*Poa* spp.	generally high[3]
ponderosa pine	*Pinus ponderosa*	low[3]
poverty oatgrass	*Danthonia spicata*	good (elk) poor (deer)[3]
prince's-pine	*Chimaphila umbellate*	poor to moderate[3]
queen's cup	*Clintonia uniflora*	moderate[3]
raceme pussytoes	*Antennaria racemosa*	moderate to high (deer) (*A. parlinii*)[4]
red-osier dogwood	*Cornus sericea*	high[2]

Table A.2-1, continued…

Common Name	Scientific Name	Palatability for Deer and Elk
reed canarygrass	*Phalaris arundinacea*	low in high-alkaloid ecotypes[10]
Rocky Mountain juniper	*Juniperus scopulorum*	low but used by black-tailed deer[8]
Rocky Mountain maple	*Acer glabrum*	medium[8]
russet buffaloberry	*Shepherdia canadensis*	poor to fair (elk) poor to good (deer)[3]
Saskatoon serviceberry	*Amelanchier alnifolia*	high[2]
shining willow	*Salix lucida*	high[2]
showy aster	*Aster conspicuus*	high[3]
silverweed	*Potentilla anserina*	fair (*P. glandulosa* and *recta*)[3]
Sitka alder	*Alnus sinuata*	low[3]
Sitka willow	*Salix sitchensis*	high[2]
smallflowered woodrush	*Luzula parviflora*	low[9]
spotted knapweed	*Centaurea biebersteinii*	low[3]
spreading dogbane	*Apocynum androsaemifolium*	low[3]
star-flowered false Solomon's seal	*Smilacina stellata*	low[3]
tall Oregon-grape	*Berberis aquifolium*	high (deer)[2]
thimbleberry	*Rubus parviflorus*	high (deer)[2]
thinleaf huckleberry	*Vaccinium membranaceum*	low-moderate (western huckleberry)[3]
timothy	*Phleum pratense*	high (elk)[2]
twinflower	*Linnaea borealis*	high (deer)[2]
western brackenfern	*Pteridium aquilinum*	poor[3]
western fescue	*Festuca occidentalis*	high (elk) (Idaho & rough fescue)[2]
western hemlock	*Tsuga heterophylla*	browsed by deer and elk in the Pacific Northwest[3]
western juniper	*Juniperus occidentalis*	low, can be good for deer (*J. ashei, communis, californica, horizontalis, pinchotii*)[3]
western larch	*Larix occidentalis*	medium[8]
western redcedar	*Thuja plicata*	high (deer)[2]
western spirea	*Spiraea douglasii*	low[3]
western teaberry	*Gautheria ovatifolia*	fair to poor (*G. shallon*)[3]
western white pine	*Pinus monticola*	low[3]
western yew	*Taxus brevifolia*	medium[3]
white sagebrush	*Artemisia ludoviciana*	poor (livestock)[3]
white sweet-clover	*Melilotus alba*	high[2]
wild strawberry	*Fragaria virginiana*	moderate (*F. vesca*)[3]
Wood's rose	*Rosa woodsii*	medium[8]

Notes:

1 CEPEP (Colorado Environmental Pesticide Education Program). 2008. State noxious weed list. Colorado State University, Fort Collins, Colorado, USA. Available online at: http://www.cepep.colostate.edu/noxious.htm

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Table A.2-1, continued…

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6 Link, R. 2004. Living with wildlife: deer. Washington Department of Fish and Wildlife. Olympia, Washington, USA. Available online at: http://wdfw.wa.gov/wlm/living/deer.pdf

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