TR-10 NORTHERN SPOTTED OWL HABITAT ANALYSIS DRAFT REPORT

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

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Initial Study Report

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List of Acronyms and Abbreviations

CBI.....Conservation Biology Institute
City Light.....Seattle City Light
dbh.....diameter at breast height
DNR.....Department of Natural Resources (Washington State)
ESA.....Endangered Species Act
FERC.....Federal Energy Regulatory Commission
FR.....Federal Register
ft.....feet
GIS.....Geographic Information System
ISR.....Initial Study Report
LiDAR.....Light Detection and Ranging
NPS.....National Park Service
NRF.....nesting, roosting, and foraging
NSO.....northern spotted owl
NWFP.....Northwest Forest Plan
PHoDAR.....Photogrammetric Detection and Ranging
Project.....Skagit River Hydroelectric Project
RLNRA.....Ross Lake National Recreation Area
ROW.....right-of-way
RS-FRIS.....Remote-Sensing Forestry Inventory System
RSP.....Revised Study Plan
SR.....State Route
USFWS.....U.S. Fish and Wildlife Service
WAC.....Washington Administrative Code

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1.0 INTRODUCTION

The TR-10 Northern Spotted Owl Habitat Analysis (NSO Habitat Analysis) is being conducted in support of the relicensing of the Skagit River Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC) No. 553, as identified in the Revised Study Plan (RSP) submitted by Seattle City Light (City Light) on April 7, 2021 (City Light 2021). On June 9, 2021, City Light filed a "Notice of Certain Agreements on Study Plans for the Skagit Relicensing" (June 9, 2021 Notice)[1] that detailed additional modifications to the RSP agreed to between City Light and supporting licensing participants (which include the Swinomish Indian Tribal Community, Upper Skagit Indian Tribe, National Marine Fisheries Service, National Park Service [NPS], U.S. Fish and Wildlife Service [USFWS], Washington State Department of Ecology, and Washington Department of Fish and Wildlife). The June 9, 2021 Notice proposed no changes to the NSO Habitat Analysis as described in the RSP.

In its July 16, 2021 Study Plan Determination, FERC approved the NSO Habitat Analysis without modification.

This study is complete and a draft report of the study efforts is being filed with FERC as part of City Light's Initial Study Report (ISR).

1.1 Background and Existing Information

The northern spotted owl (*Strix occidentalis caurina*) is federally-listed as threatened under the Endangered Species Act (ESA) and State-listed as endangered in Washington State. Northern spotted owls (NSO) in the Western Cascades primarily utilize late successional mature and old-growth forests or forests with old growth characteristics, such as large diameter coniferous trees, snags, downed wood, and a closed canopy with multiple canopy layers (Davis et al. 2016; Buchanan 2016). Preferred nesting and roosting habitat includes multi-story forest containing a diversity of tree species, moderate to dense canopy cover (> 60 percent) dominated by large trees with a high incidence of cavities or broken tops, sufficient open space below the canopy for flight, and an accumulation of woody debris on the ground (USFWS 2011). NSO usually nest in tree and snag cavities or in broken tops of large trees. They less frequently nest in mistletoe clumps and abandoned raptor and raven nests (Zeiner et al. 1990). Foraging habitat for NSO is similar to nesting and roosting habitat, though it can encompass a more diverse range of forest types, such as younger forests with some component of residual large diameter conifer trees and snags (Forsman et al. 2015; North et al. 1999; Sovern et al. 2015). NSO are territorial, although home ranges of adjacent pairs can overlap. The size of the home range varies with geography and differences in local prey species. Along the Cascade Range, the estimated average home range size is 2,955 acres with flying squirrels as the predominant prey item (Hamer et al. 2001; USFWS 2011). A minimum habitat patch size required for NSO nesting, roosting, or foraging habitat has not been established or documented.

Critical habitat for NSO was designated in 1992, and has been revised numerous times, most recently in 2021 (86 Federal Register [FR] 62606).[2] This updated critical habitat all falls within

[1] Referred to by FERC in its July 16, 2021 Study Plan Determination as the "updated RSP."

[2] Endangered and threatened wildlife and plants; designation of revised critical habitat for the northern spotted owl. Federal Register Volume 86, Number 215: 62606-62666.

National Forest boundaries and does not extend into National Park or Recreation Area. The designated critical habitat overlaps the Project Boundary in only one location—the southernmost tip of Ross Lake's Ruby Arm, and it stops at the boundary of Ross Lake National Recreation Area (RLNRA).

NSO detection data within and immediately surrounding the Project area is limited (Hoffman et al. 2015). Survey efforts began in the early 1980s and have sporadically continued since that time (Siegel et al. 2012). A baseline NSO inventory was conducted by the North Cascades National Park Complex in the mid-1990s, with 11 NSO activity centers detected, including 6 pairs (Kuntz and Christopherson 1996). Additional surveys were conducted by the Institute of Bird Populations between 2007 and 2010 (Siegel et al. 2012). These included follow-up surveys at the NSO activity centers identified during the baseline inventory and additional surveys in the vicinity of reservoirs. The study indicated locations of five historical spotted owl activity centers, all 1 mile or farther from Project reservoirs:

- Deer Lick > 2.5 miles from Ross Lake;
- Big Beaver Boundary > 6 miles from Ross Lake;
- Pyramid Lake 1 mile from Diablo Lake/Colonial Creek Campground;
- Newhalem Creek > 2 miles from Newhalem; and
- Little Devil/Stout Creek > 3 miles from Newhalem.

Surveys at each of these locations in 2009 and 2010 by Siegel et al. (2012) yielded an NSO response only at Newhalem Creek in 2009 (but not in 2010); much of the Newhalem Creek drainage was subsequently burned in the 2015 Goodell Fire.

An NSO habitat suitability model was originally created by the Northwest Forest Plan's (NWFP) Effectiveness Monitoring Program in 2005 using data from NSO territories throughout the Pacific Northwest for the purposes of assessing trends of NSO populations and their habitat (Davis and Lint 2005). The first iterations of the NWFP Model produced vegetation maps as described in the RSP. An analysis of the original NWFP Model was conducted for North Cascades National Park, comparing model results to known NSO nest sites in the Park (Wilkerson and Siegel 2007). The analysis concluded that the NWFP Model performed relatively well for the Park and the NWFP Model could be used as a reliable tool for land management decisions within the Park. However, the NWFP Model has since been updated based on the latest science and species location data, refining the variables used for analysis to include: (1) diameter diversity index; (2) canopy cover of all conifers; (3) stand height; (4) mean conifer diameter; (5) density of large conifers; (6) stand age; and (7) forest species composition (Davis et al. 2016).

While the updated NWFP Model has been used to map suitable NSO habitat in its range and at regional scales, it has not been accurately applied at the local scale in the Skagit River watershed due to the lack of locally available NSO habitat and detection data. The NWFP Model only attempts to predict potential nesting and roosting habitat, and, while it does include "highly suitable," "suitable," and a third category of "marginal" habitat, it does not include foraging habitat in its predictions. Therefore, a more detailed and refined map of suitable NSO habitat was necessary.

2.0 STUDY GOALS AND OBJECTIVES

The goal of this study is to identify and map potentially suitable NSO nesting, roosting, and foraging (NRF) habitat within and near (i.e., within 0.5 mile) the Project Boundary. Objectives include:

- Develop an NSO NRF Habitat Suitability Model with variables, thresholds, and data scale applicable to the study area;
- Predict the distribution and extent of potentially suitable NSO NRF habitat in and near the study area; and
- Create maps and data layers that could be used to characterize baseline conditions for the NSO in and near the Project, assess potential ongoing Project effects, and, if warranted, inform conservation measures under a new license.

3.0 STUDY AREA

The study area for the NSO Habitat Analysis is 142,088.8 acres. The study area consists of land within the Project Boundary and the surrounding area within 0.5 mile of the Project Boundary, as shown in Figure 3.0-1. To organize the results of the study, the study area was divided into the following six segments, as described below, and shown in Figure 3.0-1:

- Reservoir Segment
  - **Ross Lake National Recreation Area:** This study area segment occurs within the upper Skagit River basin and the Project Boundary within the RLNRA, including the transmission line rights-of-way (ROW), to the confluence of Bacon Creek with the Skagit River. For reporting purposes, this segment is further divided into the following sub-segments:
    - Ross Lake exclusive of Big Beaver Valley;
    - Big Beaver Valley;
    - Diablo Lake; including the approximately 3.6 miles of the transmission line ROW from the Ross Powerhouse to the Diablo Powerhouse;
    - Gorge Lake, including the approximately 3.5 miles of the transmission line ROW from the Diablo Powerhouse to the southern end of Gorge Lake; and
    - An approximately 8.5-mile corridor between Gorge Lake and Bacon Creek that includes the transmission line ROW and the Skagit River.
- Transmission Line ROW Segments
  - **Bacon Creek to Sauk River Crossing:** This study area segment occurs primarily within the upper Skagit River basin and includes the 14.3 miles of transmission line ROW from Bacon Creek to the Sauk River crossing. The lower approximately 2.5 miles of this segment occurs within the Sauk River basin.
  - **Sauk River Crossing to Oso:** This study area segment includes the 25.6 miles of transmission line ROW from the Sauk River transmission line crossing to the community of Oso. The eastern part of this segment is located in the Sauk River basin from the Sauk River crossing to near Darrington. The western portion of this segment, from Darrington to Oso, is located in the Stillaguamish River basin.
  - **Oso to State Route (SR) 528:** This study area segment includes the 17.5 miles of transmission line ROW from Oso to SR 528. The northern portion of this segment is located within the Stillaguamish River basin, and the southern portion of this segment is located within the Snohomish River basin.
  - **SR 528 to Bothell Substation:** This study area segment is located primarily within the Snohomish River basin and includes the 14.4 miles of transmission line ROW from SR 528 to the Bothell substation. The lower approximately 1.5 miles of this segment is located in the Lake Washington basin.

- Mitigation Lands Segment
  - **Western Mitigation Lands:** This study area segment includes all fish and wildlife mitigation lands within the study area not already captured in ROW segments as represented in Figure 3.0-1.

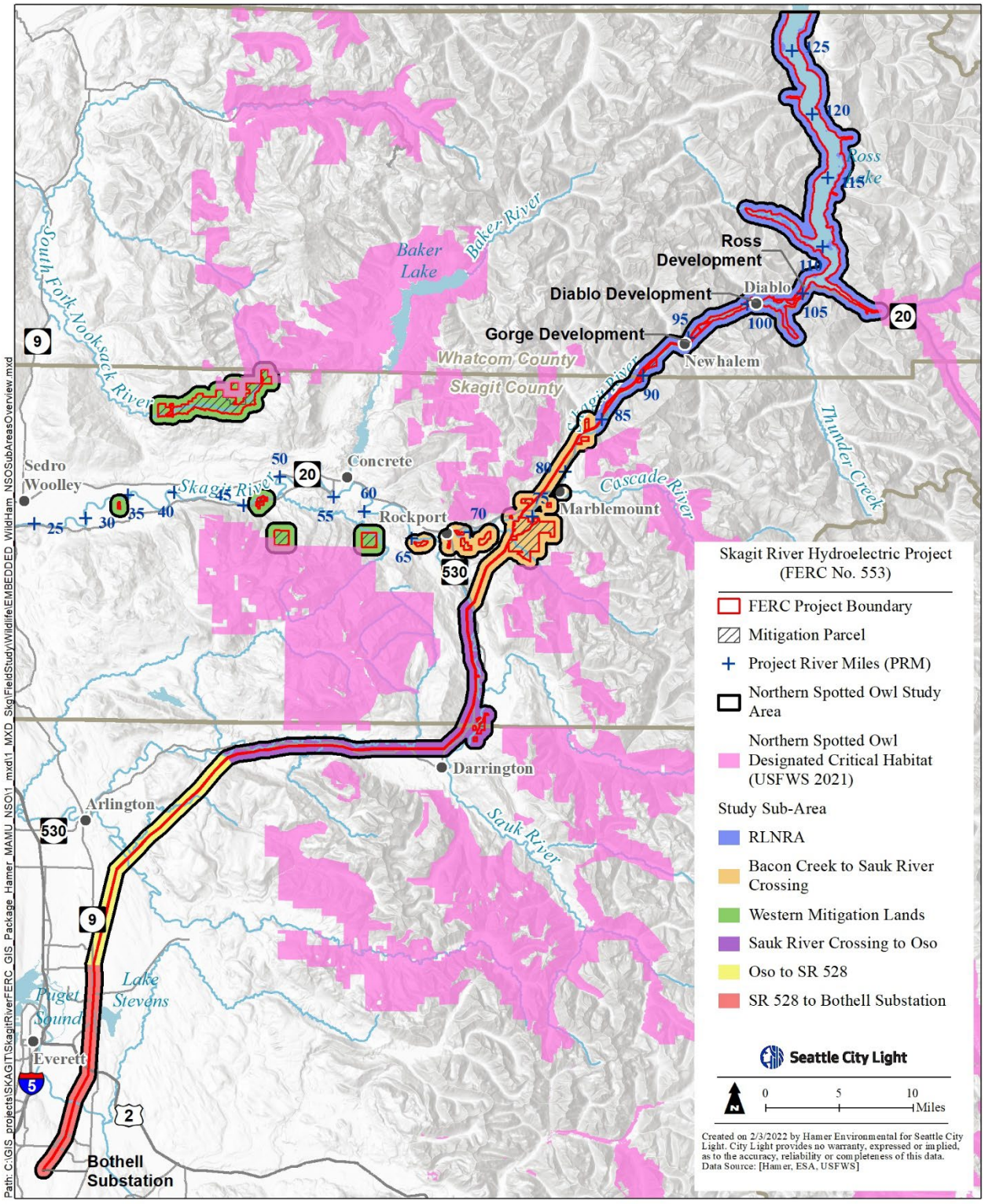

Figure 3.0-1. Study area segments for NSO NRF habitat analysis.

4.0 METHODS

Methods used to develop a map of potentially suitable NSO NRF habitat included the following steps: (1) review relevant scientific literature and models of suitable NSO NRF habitat to inform model criteria and approach; (2) identify and map habitat components for the study area using a Geographic Information System (GIS); and (3) develop a system of criteria to identify potentially suitable and potentially highly suitable NSO NRF habitat, referred to as the NSO NRF Habitat Suitability Model. The general steps for conducting the study are detailed below.

4.1 Literature Review

A literature review identified habitat parameters to support the development of an NSO NRF Habitat Suitability Model. The resources reviewed included, but were not limited to, state and federal agency reports and management plans, peer-reviewed published literature, and NPS survey data. Sources reviewed or consulted for this study included:

- Draft periodic status review for the Northern Spotted Owl in Washington (Buchanan 2016).
- Conservation Biology Institute (CBI) North Cascades Old Growth Mapping (CBI 2020).
- Northwest Forest Plan—the first 10 years (1994-2003): status and trends of northern spotted owl populations and habitat (Davis and Lint 2005).
- Northwest Forest Plan—the first 20 years (1994-2013): status and trends of northern spotted owl habitats (Davis et al. 2016).
- Overestimation of fire risk in the Northern Spotted Owl Recovery Plan (Hanson et al. 2009).
- Assessing forest canopies and understory illumination: canopy closure, canopy cover and other measures (Jennings et al. 1999).
- Distribution, numbers, and site characteristics of spotted owls and barred owls in the Cascade Mountains of Washington (Pearson and Livezey 2003).
- Seattle City Light Skagit River LiDAR (2018).
- Surveying for spotted owls in the Upper Skagit watershed of North Cascades National Park Complex, 2009-2010. Natural Resource Technical Report NPS/NOCA/NRTR—2012/597. (Siegel et al. 2012).
- Synthesis of science to inform land management within the Northwest Forest Plan area (Spies et al. 2018).
- A conservation strategy for the northern spotted owl: a report of the Interagency Scientific Committee to address the conservation of the northern spotted owl (Thomas et al. 1990).
- Washington State Department of Natural Resources (DNR) Remote-Sensing Forestry Inventory System (RS-FRIS) GIS data (2017) and associated documentation (Gould and Ricklefs 2021).
- Washington State Legislature. Washington Administrative Codes (WAC), Title 222, Chapter 222-16, Section 222-16-085.

- Nest trees of northern spotted owls *(Strix occidentalis caurina*) in Washington and Oregon, USA (Wilk et al. 2018).
- Interpreting the Northwest Forest Plan's Northern Spotted Owl habitat suitability model for use in North Cascades National Park. The Institute for Bird Populations, Point Reyes Station, CA (Wilkerson and Siegel 2007).
- U.S. Geological Survey (USGS) Western Washington 3DEP LiDAR (2016/2017).

4.2 Identify and Map Potentially Suitable and Highly Suitable NSO NRF Habitat

City Light considered suitable NSO habitat to be NRF habitat. The NSO NRF Habitat Suitability Model for this study was therefore designed to create a conservative and localized model that predicts potentially suitable and potentially highly suitable NRF habitat, using some of the variables utilized by the NWFP Model. Like the NWFP Model (Davis 2016), this NSO NRF Habitat Suitability Model uses data on canopy cover, tree height, density of large conifers, and stand age. However, values for these components were set lower than the NWFP model, based on synthesized findings in other scientific literature, in order to better capture younger forest as potential foraging habitat. Like the NWFP Model, the NSO NRF Habitat Suitability Model describes potential habitat as "suitable" or "highly suitable." However, the NWFP Model includes an additional category of "marginal" habitat and seeks only to indicate areas with nesting and roosting potential, while the NSO NRF Habitat Suitability Model outputs are inclusive of potentially suitable and potentially highly suitable foraging habitat as well. The NSO NRF Habitat Suitability Model did not use diameter diversity index or mean conifer diameter as used in the NWFP. Although all these variables can be indicative of NSO habitat, adequate data were unavailable at the appropriate scale for this study.

4.2.1 Suitable and Highly Suitable NSO NRF Habitat Components

4.2.1.1 Suitable Habitat

For the purposes of this study, and based on the literature review, suitable NSO NRF habitat was determined to be defined by landscapes with the following components (various references; see Table 4.2-1):

- Presence of conifers;
- Canopy cover of 60 percent or greater;
- Stand age of 80 years or older;
- Maximum tree height of 85 feet (ft) or higher; and
- 5 or more large conifers (> 30 inches diameter at breast height [dbh]) per acre.

4.2.1.2 Highly Suitable Habitat

For the purposes of this study, and based on the literature review, highly suitable NSO NRF habitat was determined to be defined by landscapes with the following components (various references; see Table 4.2-1):

- Presence of conifers;
- Canopy cover of 70 percent or greater;
- Stand age of 125 years or older;
- Maximum tree height of 110 ft or higher; and
- 8 or more large conifers (> 30 inches dbh) per acre.

Since the same data layers were used to model both potentially suitable and potentially highly suitable habitat, with only thresholds altered, all areas that meet the criteria for highly suitable habitat also qualify as suitable.

4.2.2 NSO NRF Habitat Suitability Model Approach

A binary site suitability analysis was selected to ensure all minimum habitat criteria were being met and to create an output that clearly indicates what is suitable and what is not. The binary analysis was performed twice using canopy cover, stand age, maximum tree height, and large conifers per acre raster layers, to first capture suitable habitat and then highly suitable habitat. All raster data layers were created by Washington DNR from remotely sensed (Light Detection and Ranging [LiDAR] and Photogrammetric Detection and Ranging [PHoDAR]) data collected in 2017 at 1/10-acre (66-ft²) resolution (Washington DNR 2017; Gould and Ricklefs 2021). An additional vector layer created from the combined results of the TR-01 Vegetation Mapping Study (City Light 2022) and existing vegetation data from NPS's North Cascades National Park (vegetation layer) was used to further distinguish areas of potential habitat by extracting only areas where conifer trees are present. Justification for threshold values for habitat components in this model is provided in Table 4.2-1.The results of this model identify forests that are potentially suitable or highly suitable NRF habitat, but do not predict NSO use.

Table 4.2-1. NSO NRF Habitat Suitability Model (potentially suitable and potentially highly suitable NRF habitat components).

Habitat Component	Suitable[1]	Highly Suitable	Justification
Canopy Cover	≥ 60 %	≥ 70 %	Thomas and Jennings consider forests with 60 to 80% canopy cover to be highly suitable habitat. Spies suggests > 60% as suitable and > 70% as highly suitable, with similar numbers outlined in Davis and the Washington Forest Practices Rules (Davis 2016; Jennings 1999; Spies 2018; Thomas 1990; WAC 222-16-085).
Stand Age	≥ 80 years	≥ 125 years	Thomas considers stands 80 to 100 years old to be marginal and Davis suggests marginal habitat has an average stand age of 102 (with a standard deviation of 83). Spies describes suitable as ≥ 125 years and highly suitable as ≥ 150 years as highly suitable, while Pearson and Livezey recorded multiple NSO site centers in stands ages 80 to 179 years in Washington State (Davis 2016; Pearson and Livezey 2003; Spies 2018; Thomas 1990).
Maximum Tree Height	≥ 85 ft	≥ 110 ft	Washington Forest Practices Rules suggest anything over 85 ft in Washington State is suitable, whereas Davis indicates anything 110 ft and taller is highly suitable (Davis 2016; WAC 222-16-085).
Density of Large Conifers > 30 inches dbh	≥ 5 trees per acre	≥ 8 trees per acre	Habitat component and criteria were chosen based on the NWFP Model thresholds (10 and 16 trees per acre, respectively) and adjusted specifically for this project (Davis 2016).
Presence of Conifers	Yes	Yes	NSO nest almost exclusively in coniferous trees in Washington State (Buchanan 2016; Hanson 1993; Spies 2018; WAC 222-16-085; Wilk et al. 2018).

1 Suitable habitat contains all highly suitable habitat.

Given the NSO NRF habitat requirements, the binary suitability analyses allowed the raster data layers to be analyzed simultaneously, creating two model outputs that selected only areas where thresholds for all habitat components were met. An example of the modeling process is shown for a small portion of the study area in Figure 4.2-1. For suitable NRF habitat, output of the model identifies forests where canopy cover is 60 percent or greater (Figure 4.2-1[A]), stand age is 80 years or older (Figure 4.2-1[B]), maximum tree height is 85 ft or higher (Figure 4.2-1[C]), with 5 or more large conifers (> 30 inches dbh) per acre (Figure 4.2-1[D]). The final model step overlays the vegetation layer to remove areas where conifers are not present (Figure 4.2-1[E]) to identify areas where all suitable habitat component thresholds were met (Figure 4.2-1[F]). For highly suitable NRF habitat, output of the model indicates areas where canopy cover is 70 percent or greater (Figure 4.2-1[A]), stand age is 125 years or older (Figure 4.2-1[B]), maximum tree height is 110 ft or higher (Figure 4.2-1[C]), with 8 or more large conifers (> 30 inches dbh) per acre (Figure 4.2-1[D]). The final model step overlays the vegetation layer to remove areas where conifers are not present (Figure 4.2-1[E]) to identify areas where all highly suitable habitat component thresholds were met (Figure 4.2-1[F]).

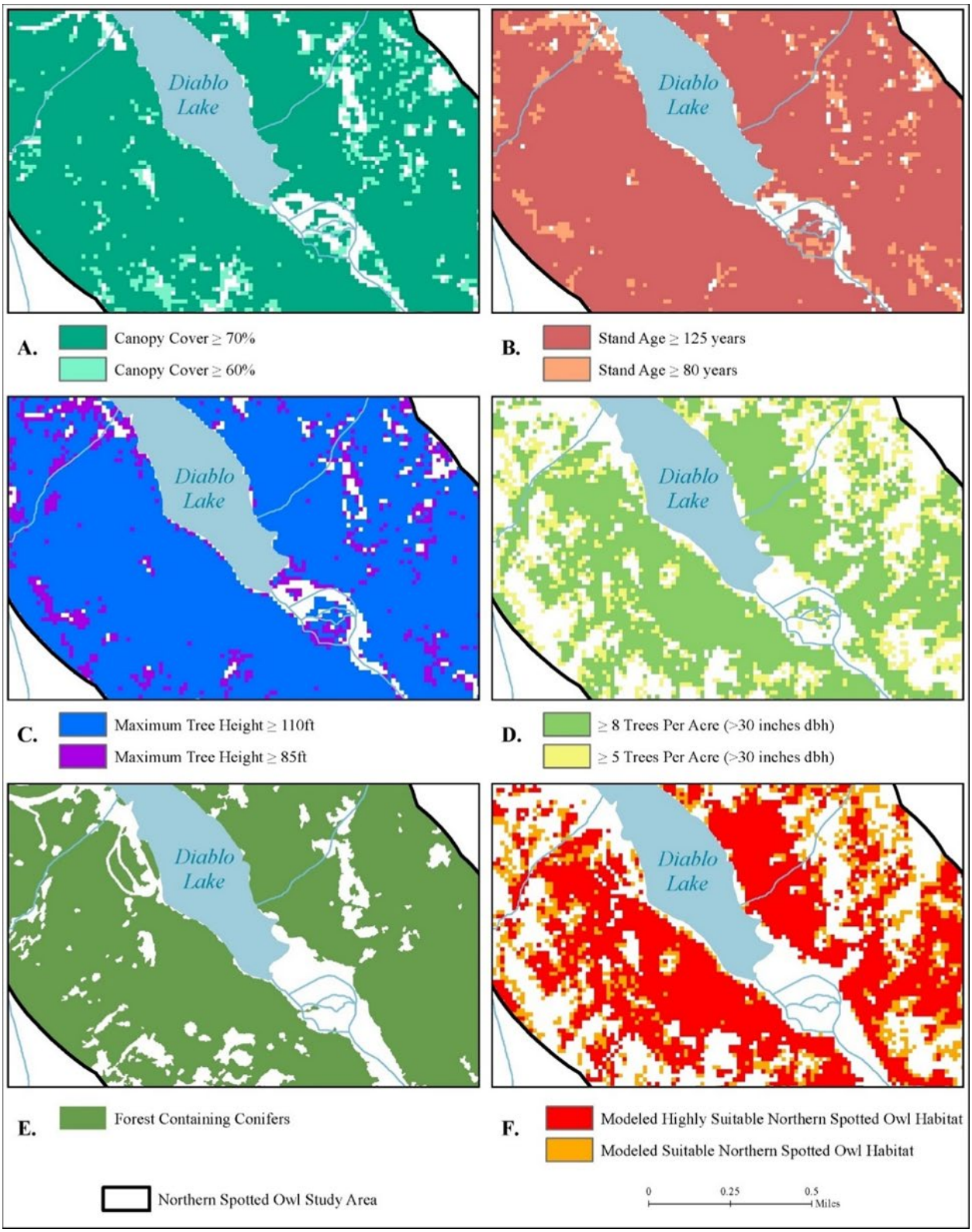

Figure 4.2-1. NSO NRF Habitat Suitability Model input components (A-E) and model output (F) sample showing suitable and highly suitable NRF habitat.

5.0 RESULTS

5.1 Summary of NSO NRF Habitat Suitability Model

A review of scientific literature informed justification of all model components and thresholds as seen in Table 4.2-1.

Modeled suitable and modeled highly suitable NRF habitat for NSO is shown in Attachment A of this study report and is summarized in the tables below. The results of this study are organized by study area segment and sub-segment. The results of this model identify areas of potentially suitable and potentially highly suitable NSO NRF habitat but do not predict NSO presence or use.

5.1.1 Modeled Suitable NSO NRF Habitat

The NSO NRF Habitat Suitability Model identified 13,634.9 acres (9.6 percent of the total study area) as suitable NSO NRF habitat (Table 5.1-1).

Table 5.1-1. Modeled suitable NSO NRF habitat area in the study area by segment.

Study Area Segment[1]	Modeled Suitable Habitat			Total Segment Area (acres)
	Area (acres)	Percent of Segment	Area Within Project Boundary[2] (acres)	
RLNRA	9,797.2	17.5%	1619.9	56,117.6
Bacon Creek to Sauk River Crossing	1,237.6	5.0%	41.5	24,520.3
Western Mitigation Lands	1,152.3	5.8%	278.2	20,016.0
Sauk River Crossing to Oso	1,325.2	6.8%	2.7	19,628.0
Oso to SR 528	120.6	1.0%	0.2	11,694.5
SR 528 to Bothell Substation	2.0	0%	0	10,112.5
Total	**13,634.9**	**9.6%**	**1942.5**	**142,088.8**

1 See Figure 3.0-1 for map of study area segments.
2 Area within Project Boundary includes fish and wildlife mitigation lands.

The RLNRA study area segment contains the most potentially suitable habitat. The 9,797.2 acres of modeled suitable NSO NRF habitat in the RLNRA represents 71.8 percent of the total amount in the study area and are distributed within the five sub-segments (Table 5.1-2). While the Ross Lake sub-segment has the greatest acreage of modeled suitable habitat in the study area, it represents only 17.5 percent of the area of this segment. Conversely, nearly 30 percent of the Diablo Lake subsection contains modeled suitable NSO habitat.

Table 5.1-2. Modeled suitable NSO NRF habitat in the study area by sub-segment.

RLNRA Sub-Segment[1]	Modeled Suitable Habitat			Total Sub-Segment Area (acres)
	Area (acres)	Percent of Sub-Segment	Area Within Project Boundary[2] (acres)	
Ross Lake (excluding Big Beaver Valley)	5,875.3	17.4%	1025.3	33,843.6
Big Beaver Valley	1,095.8	22.5%	419.4	4,866.0
Diablo Lake	1,541.9	28.9%	103.5	5,340.8
Gorge Lake	481.6	14.9%	56.5	3,226.0
Gorge Lake to Bacon Creek	802.6	9.1%	15.2	8,841.1
Total	**9,797.2**	**17.5%**	**1619.9**	**56,117.6**

1 See Figure 3.0-1 for map of study area segments.
2 Area within Project Boundary includes fish and wildlife mitigation lands.

Across the study area, 320.7 acres of modeled suitable habitat were within the fish and wildlife mitigation properties (excluding the study area buffer). The Pressentin property contains a large amount of modeled NSO NRF habitat with 187.5 (29.4 percent) of its 367 acres being potentially suitable (Table 5.1-3).

Table 5.1-3. Modeled suitable NSO NRF habitat in fish and wildlife mitigation land properties (not including study area buffer).

Mitigation Land Property	Modeled Suitable Habitat		Total Mitigation Land Property Area (acres)	Study Area Segment Where Located[1]
	Area (acres)	Percent of Mitigation Land		
Newhalem Ponds	1.5	1.3%	111.1	RLNRA
County Line Ponds	0.2	0.4%	56.3	RLNRA
Bacon Creek	3.8	3.2%	118.8	Bacon Ck to Sauk River Crossing
B & W Road 1	2.8	3.5%	79.4	Bacon Ck to Sauk River Crossing
B & W Road 2	0.1	0.9%	10.9	Bacon Ck to Sauk River Crossing
Corkindale Creek	0.4	0.3%	142.6	Bacon Ck to Sauk River Crossing
South Marble 40	6.4	15.6%	41.1	Bacon Ck to Sauk River Crossing
Bogert and Tam	0	-	17.0	Bacon Ck to Sauk River Crossing
O'Brien Slough	0	-	47.2	Bacon Ck to Sauk River Crossing
Illabot North	0	-	725.9	Bacon Ck to Sauk River Crossing
Illabot South	26.8	1.1%	2521.8	Bacon Ck to Sauk River Crossing
Barnaby Slough	0	-	225.5	Bacon Ck to Sauk River Crossing
False Lucas Slough	0	-	203.6	Bacon Ck to Sauk River Crossing
Johnson	0	-	7.5	Bacon Ck to Sauk River Crossing
Napoleon Slough	0	-	61.6	Bacon Ck to Sauk River Crossing
McLeod	0	-	126.0	Bacon Ck to Sauk River Crossing
Nooksack	63.6	1.7%	3854.1	Western Mitigation Lands
Bear Lake	0	-	154.9	Western Mitigation Lands
Nooksack West	5.1	1.3%	388.9	Western Mitigation Lands

Mitigation Land Property	Modeled Suitable Habitat		Total Mitigation Land Property Area (acres)	Study Area Segment Where Located[1]
	Area (acres)	Percent of Mitigation Land		
Savage Slough	0.1	0%	211.1	Western Mitigation Lands
Day Creek Slough	0	-	38.4	Western Mitigation Lands
Pressentin	187.5	29.4%	637.0	Western Mitigation Lands
Finney Creek	21.9	3.4%	641.5	Western Mitigation Lands
North Sauk	0	-	45.6	Sauk River Crossing to Oso
Sauk Island	0	-	21.3	Sauk River Crossing to Oso
North Everett Creek	0.2	0.1%	173.8	Sauk River Crossing to Oso
Everett Creek	0.3	0.8%	38.5	Sauk River Crossing to Oso
Dan Creek	0	-	42.1	Sauk River Crossing to Oso
Total	**320.7**	**3.0%**	**10,743.5**	

1 See Figure 3.0-1 for map of study area segments.

Large contiguous patches of modeled suitable habitat can be found throughout the study area. The largest patch (1,169.7 acres) is in the RLNRA on the east side of Ross Lake between May Creek and the north end of Ruby Arm. The ten largest patches found throughout the study area are described in Table 5.1-4.

Table 5.1-4. Ten largest contiguous patches of modeled suitable NSO NRF habitat in the study area.

Study Area Segment	Location Description	Size of Modeled Suitable Habitat Patch (acres)	Page(s) in Attachment A Mapbook
RLNRA	East side of Ross Lake near Canadian Border	233.0	1
RLNRA	East side of Ross Lake between May Creek and north end of Ruby Arm	1169.7	4, 6
RLNRA	North side of Ruby Arm	266.4	7, 8
RLNRA	North of Diablo Lake	186.7	7, 10
RLNRA	Tip of Thunder Arm on northeast side	254.6	9
RLNRA	Tip of Thunder Arm on southwest side	245.9	9
RLNRA	North of Diablo Lake near Diablo Lake Resort and Buster Brown Flats	186.7	7, 10
Bacon Creek to Sauk River Crossing	In the 0.5-mile buffer just outside and northeast of Illabot South mitigation parcel	257.5	15, 16
Bacon Creek to Sauk River Crossing	In the 0.5-mile buffer just outside and southeast of Illabot South mitigation parcel	189.2	15, 16
Western Mitigation Lands	In the 0.5-mile buffer just northeast of Nooksack mitigation parcel	193.9	22, 23

5.1.2 Modeled Highly Suitable NSO NRF Habitat

The NSO NRF Habitat Suitability Model found that 6,736.8 acres (4.7 percent of the total study area) is highly suitable NSO NRF habitat (Table 5.1-5).

Table 5.1-5. Modeled highly suitable NSO NRF habitat area in the study area by segment.

Study Area Segment[1]	Modeled Highly Suitable Habitat			Total Segment Area (acres)
	Area (acres)	Percent of Segment	Area Within Project Boundary[2] (acres)	
RLNRA	5,405.7	9.6%	961.3	56,117.6
Bacon Creek to Sauk River Crossing	547.9	2.2%	11.9	24,520.3
Western Mitigation Lands	412.7	2.1%	84.0	20,016.0
Sauk River Crossing to Oso	350.1	1.8%	0.2	19,628.0
Oso to SR 528	20.3	0.2%	0	11,694.5
SR 528 to Bothell Substation	0.1	0%	0	10,112.5
Total	**6,736.8**	**4.7%**	**1057.4**	**142,088.8**

1 See Figure 3.0-1 for map of study area segments.
2 Area within Project Boundary includes fish and wildlife mitigation lands.

The RLNRA study area segment contains the most potentially highly suitable habitat. The 5,405.7 acres of modeled highly suitable NSO NRF habitat, represents 80.2 percent of all the modeled highly suitable habitat in the study area and are distributed within the five sub-segments (Table 5.1-6). While the Ross Lake sub-segment has the greatest acreage of modeled highly suitable habitat (3,090 acres) in the study area, it represents only 9.1 percent of the area of this subsection. Proportionately, the Diablo Lake subsection has a greater amount.

Table 5.1-6. Modeled highly suitable NSO NRF habitat area in the RLNRA by sub-segment.

RLNRA Sub-Segment[1]	Modeled Highly Suitable Habitat			Total Sub-Segment Area (acres)
	Area (acres)	Percent of Sub-Segment	Area Within Project Boundary[2] (acres)	
Ross Lake (excluding Big Beaver Valley)	3090.2	9.1%	550.4	33,843.6
Big Beaver Valley	688.0	14.1%	304.6	4,866.0
Diablo Lake	959.2	18.0%	65.7	5,340.8
Gorge Lake	231.1	7.2%	32.9	3,226.0
Gorge Lake to Bacon Creek	437.2	4.9%	7.7	8,841.1
Total	**5,405.7**	**9.6%**	**961.3**	**56,117.6**

1 See Figure 3.0-1 for map of study area segments.
2 Area within Project Boundary includes fish and wildlife mitigation lands.

Across the study area, 96.4 acres of modeled suitable habitat were within the fish and wildlife mitigation properties (excluding the study area buffer). The Pressentin property contains a large amount of modeled NSO NRF habitat with 77 acres (12.1 percent) of its 367 acres being potentially suitable (Table 5.1-7).

Table 5.1-7. Modeled highly suitable NSO NRF habitat in fish and wildlife mitigation land properties (not including study area buffer).

Mitigation Land Property	Modeled Highly Suitable Habitat		Total Mitigation Land Property Area (acres)	Study Area Segment Where Located[1]
	Area (acres)	Percent of Mitigation Land		
Newhalem Ponds	0.9	0.8	111.1	RLNRA
County Line Ponds	0	-	56.3	RLNRA
Bacon Creek	1.7	1.4	118.8	Bacon Ck to Sauk River Crossing
B & W Road 1	1.2	1.5	79.4	Bacon Ck to Sauk River Crossing
B & W Road 2	0	-	10.9	Bacon Ck to Sauk River Crossing
Corkindale Creek	0	-	142.6	Bacon Ck to Sauk River Crossing
South Marble 40	2.8	6.8	41.1	Bacon Ck to Sauk River Crossing
Bogert and Tam	0	-	17.0	Bacon Ck to Sauk River Crossing
O'Brien Slough	0	-	47.2	Bacon Ck to Sauk River Crossing
Illabot North	0	-	725.9	Bacon Ck to Sauk River Crossing
Illabot South	5.8	0.2	2521.8	Bacon Ck to Sauk River Crossing
Barnaby Slough	0	-	225.5	Bacon Ck to Sauk River Crossing
False Lucas Slough	0	-	203.6	Bacon Ck to Sauk River Crossing
Johnson	0	-	7.5	Bacon Ck to Sauk River Crossing
Napoleon Slough	0	-	61.6	Bacon Ck to Sauk River Crossing
McLeod	0	-	126.0	Bacon Ck to Sauk River Crossing
Nooksack	0	0.1	3854.1	Western Mitigation Lands
Bear Lake	0	-	154.9	Western Mitigation Lands
Nooksack West	1.9	0.5	388.9	Western Mitigation Lands
Savage Slough	0	-	211.1	Western Mitigation Lands
Day Creek Slough	0	-	38.4	Western Mitigation Lands
Pressentin	77.0	12.1	637.0	Western Mitigation Lands
Finney Creek	1.9	0.3	641.5	Western Mitigation Lands
North Sauk	0	-	45.6	Sauk River Crossing to Oso
Sauk Island	0	-	21.3	Sauk River Crossing to Oso
North Everett Creek	0	-	173.8	Sauk River Crossing to Oso
Everett Creek	0	-	38.5	Sauk River Crossing to Oso
Dan Creek	0	-	42.1	Sauk River Crossing to Oso
Total	**96.4**	**0.9%**	**10,743.5**	

1 See Figure 3.0-1 for map of study area segments.

Large contiguous patches of modeled highly suitable habitat can be found throughout the study area. The largest patch (402.2 acres) is in the RLNRA on the east side of Ross Lake just north of Roland Point. The ten largest patches found throughout the study area are described in Table 5.1-8.

Table 5.1-8. Ten largest contiguous patches of modeled highly suitable NSO NRF habitat in the study area.

Study Area Segment	Location Description	Size of Modeled Suitable Habitat Patch (acres)	Page(s) in Attachment A Mapbook
RLNRA	East side of Ross Lake near Canadian Border	95.8	1
RLNRA	East side of Ross Lake just north of Little Jackass Mountain	83.2	1
RLNRA	East side of Ross Lake just north of Roland Point across from Big Beaver Campground	402.2	4, 6
RLNRA	Big Beaver Valley on north side of the creek	92.1	5
RLNRA	East side of Ross Lake just south of Roland Point and down to Cougar Island	311.1	6
RLNRA	North of Diablo Lake near Diablo Lake Resort and Buster Brown Flats	69.9	7, 10
RLNRA	Tip of Thunder Arm on northeast side	153.1	9
RLNRA	Tip of Thunder Arm on southwest side	189.5	9
Bacon Creek to Sauk River Crossing	In the 0.5-mile buffer just outside and northeast of Illabot South mitigation parcel	67.6	15, 16
Sauk River Crossing to Oso	West of ROW and just north of elbow bend near north of Darrington	84.4	27

6.0 DISCUSSION AND FINDINGS

6.1 Comparison to Existing Models and Detection Data

The results of the modeling effort suggest that the amount of potential suitable NSO NRF habitat in the Project vicinity is relatively low. The model outputs indicate that within the 142,088.8-acre study area, 9.6 percent is potentially suitable habitat for NSOs, and only 4.7 percent is potentially highly suitable habitat. As would be expected, the RLNRA (which is the largest segment of the study area) also has the greatest amount of suitable NSO habitat, with 71.8 percent of the modeled suitable NSO habitat and 80.2 percent of the modeled highly suitable habitat being found in the RLNRA. While the model outputs indicate areas of potentially suitable and potentially highly suitable NSO NRF habitat, they do not predict or determine NSO presence or habitat use.

Upon completion of the two binary site suitability analyses, the model outputs of "suitable" and "highly suitable" NSO NRF habitat were qualitatively compared to the NWFP Habitat Model GIS layer (uses same data as Davis et al., 2011 and 2015), showing "unsuitable," "marginal," "suitable," and "highly suitable" habitat. During this visual comparison, the two models showed similar patterns across the study area. The NSO NRF Habitat Suitability Model output layers overlap with the suitable and highly suitable habitat from the NWFP Model layer as well as some of the marginal category. This indicates that the NSO NRF Habitat Suitability Model was effective at identifying potential nesting and roosting habitat and some of the lower quality habitat possibly used for foraging. Although there were some instances of the NSO NRF Habitat Suitability Model capturing areas labeled as "unsuitable" by the NWFP, this was infrequent and appears to be a result of the difference in data used and the coarse resolution of the NWFP Model output.

The outputs of the NSO NRF Habitat Suitability Model were also compared to the Federal Registry's GIS layer showing NSO critical habitat (86 FR 62606). This critical habitat layer overlaps with very little of the NSO study area; however, in the few places it does, several of them contained suitable or highly suitable habitat from the NSO NRF Habitat Suitability Model. While NSO designated critical habitat only overlaps with the Project Boundary in a single small area on Ross Lake's Ruby Arm, it overlaps with the buffer portion of the NSO study area in that location and in a few other places (as seen in Figure 3.0-1). A substantial patch of critical habitat can be found in the buffer around the Bear Lake and Nooksack mitigation lands; however, none falls within the Project Boundary, and the habitat is limited to the National Forest Boundary. Critical habitat can similarly be found in the buffer south of the Pressentin and Finney Creek mitigation lands. Very small patches of critical habitat can be found in the buffer area southeast of the B&W Road 1 and 2 mitigation lands, near Marblemount southwest of the Corkindale Creek mitigation land, and near the southernmost tip of the Illabot South mitigation land. Based on review of the critical habitat GIS data and methodology, it appears these areas of overlap are minimal due to the fact that critical habitat was not designated within the National Park or Recreation Area boundaries.

While there is some documentation of NSO activity centers near the Project vicinity, all documented NSO activity centers are 1 mile or more away from Project reservoirs, and, therefore, outside the entire NSO study area, which prevents comparison of observational data to the outputs of the NSO NRF Habitat Suitability Model.

As the NSO NRF Habitat Suitability Model variables and thresholds were designed to create a conservative model, and resulting outputs were found to be in good agreement with existing data and models, field verification via habitat assessment plots as described in the RSP was deemed unnecessary at this time.

6.2 Limitations and Updates of the NSO NRF Habitat Suitability Model

Habitat suitability models are only as accurate as the data that drives them. For study areas such as this, where much of the terrain is difficult to access, on the ground data can be limited. To minimize this limitation, the NSO NRF Habitat Suitability Model used data layers from Washington DNR, derived from a combination of on-the-ground and remote sensing data collected by Washington DNR in 2017.

The NSO NRF Habitat Suitability Model used Washington DNR data collected in 2017 and released as Version 3. This dataset and its raster layers are typically updated every two years by the Washington DNR, though the Version 4 data has been delayed and were unavailable at the time of this modeling effort. Data for Version 4 were collected in 2019 and 2020.

7.0 VARIANCES FROM FERC-APPROVED STUDY PLAN AND PROPOSED MODIFICATIONS

There were two variances from the study plan, though neither adversely affected the quality of the study. The methodology described in the RSP included using LiDAR imagery collected specifically for the Project to be used in the development of the potentially suitable NRF habitat layer. The LiDAR-derived canopy height model created for the Project had several gaps within the NSO study area, including a substantial area on the southern tip of Thunder Arm. The LiDAR model is also at an extremely high resolution (3 ft). Use of these data resulted in outputs that were extremely patchy and, due to the binary nature of the model (a pixel must meet all criteria to be selected), under-selected suitable habitat across the study area. Further attempts were made to aggregate the LiDAR prior to running the binary suitability analysis along with lower resolution layers. After comparing these outputs using the Project-specific LiDAR canopy height model or the maximum tree height layer available from Washington DNR, the Washington DNR layer was determined to be the more complete and more suitable height layer to use for this modeling effort. The DNR layer thus better enabled the intent and objectives of the study plan to be met.

The RSP also called for using CBI's data layer for mapped old growth and late seral forests in the North Cascades (CBI 2020). After careful consideration, it was determined that the CBI layer was unable to provide the specific stand age information needed to both identify and differentiate between suitable and highly suitable NSO NRF habitat in the study area. Instead, the model used a stand age layer made available by Washington DNR, which is more informative and more recent than that available from CBI. Again, the DNR layer better enabled the intent and objectives of this study plan to be met.

This study has met the goals and objectives stated in the RSP and presented in Section 2.0 of this study report.

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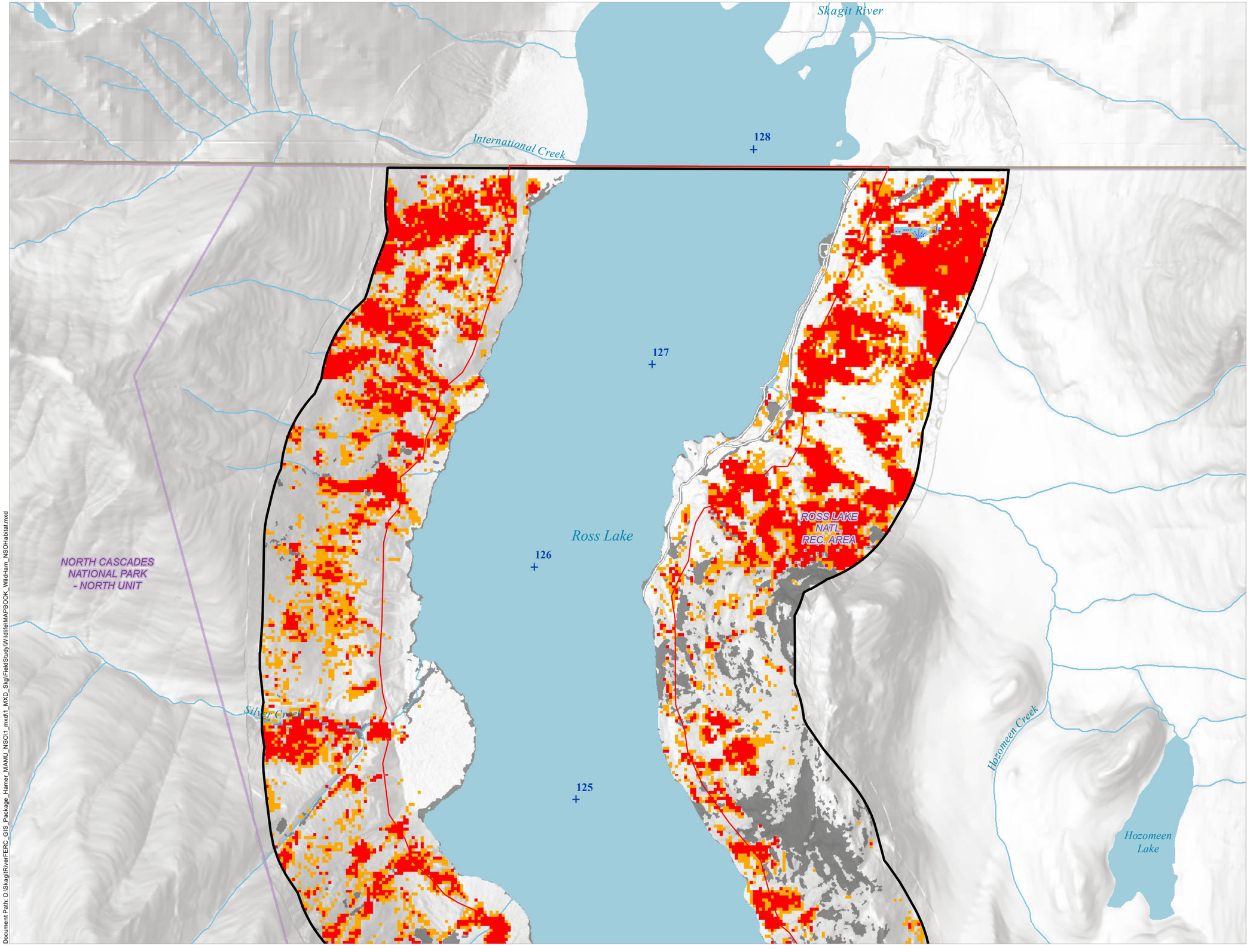
NORTHERN SPOTTED OWL HABITAT ANALYSIS DRAFT REPORT

ATTACHMENT A

MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK



TR-10 MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK

- FERC Project Boundary
- \+ Project River Miles (PRM)
- National Park / National Recreation Area Boundary
- Northern Spotted Owl Study Area
- Non-forested Area
- Modeled Highly Suitable Northern Spotted Owl Habitat
- Modeled Suitable Northern Spotted Owl Habitat

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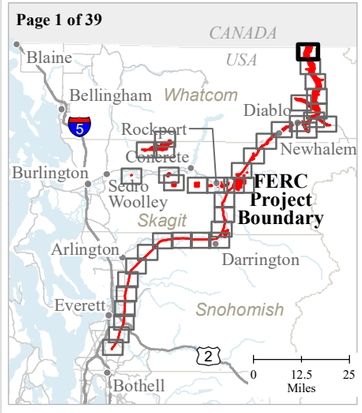

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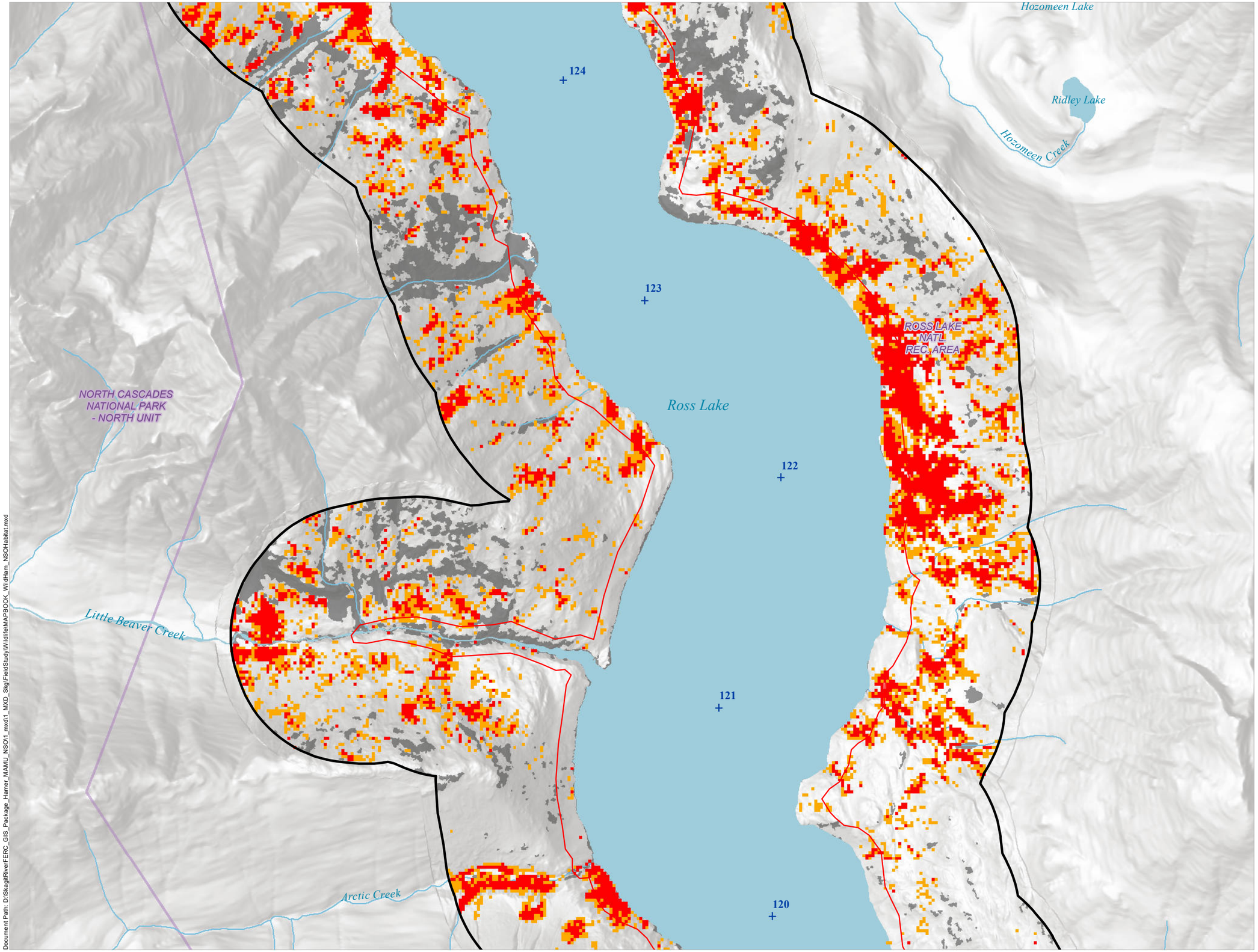

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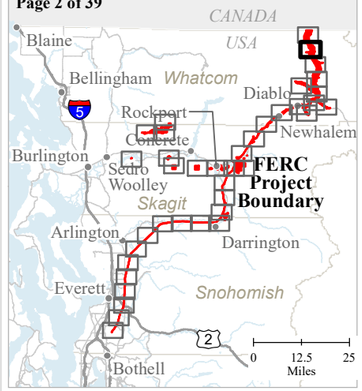

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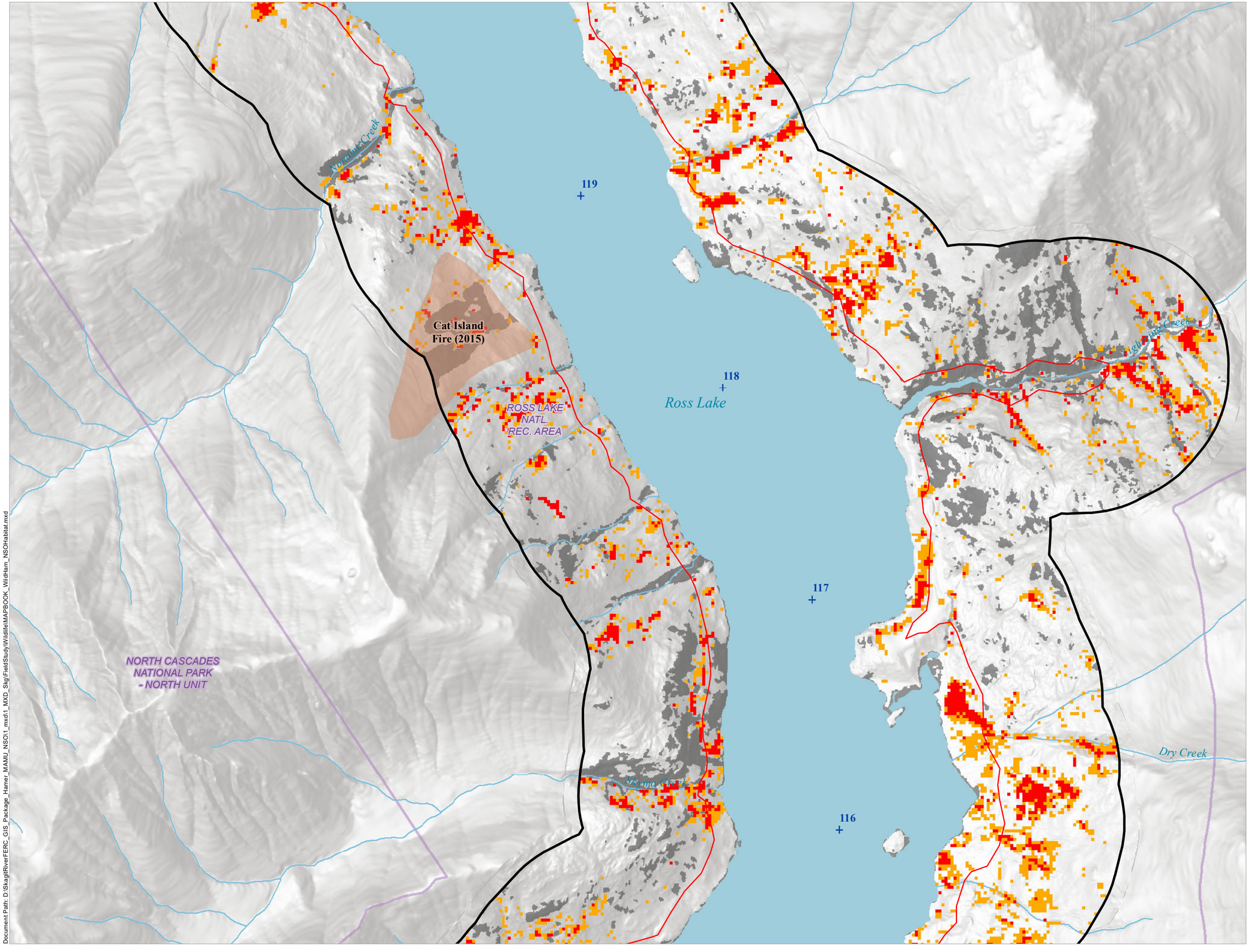

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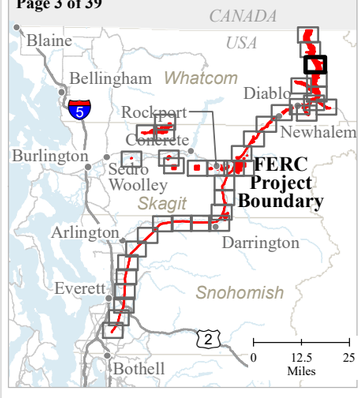

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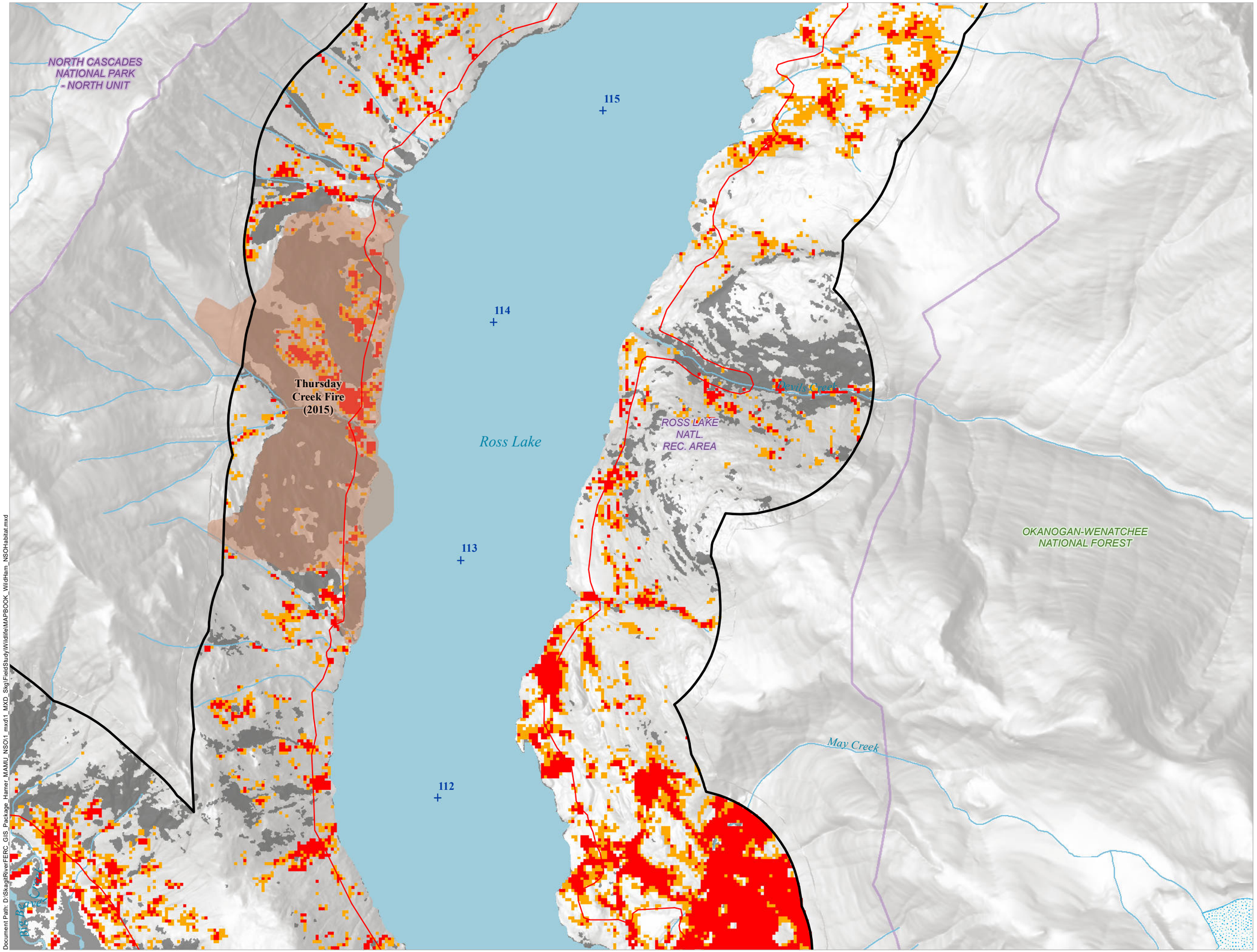

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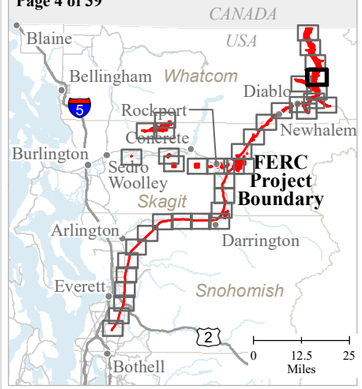

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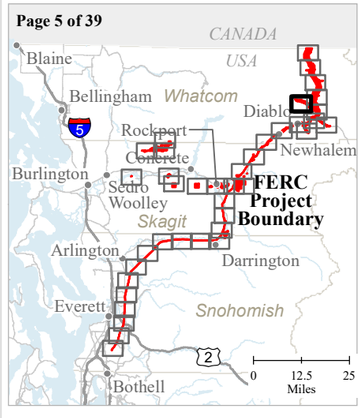

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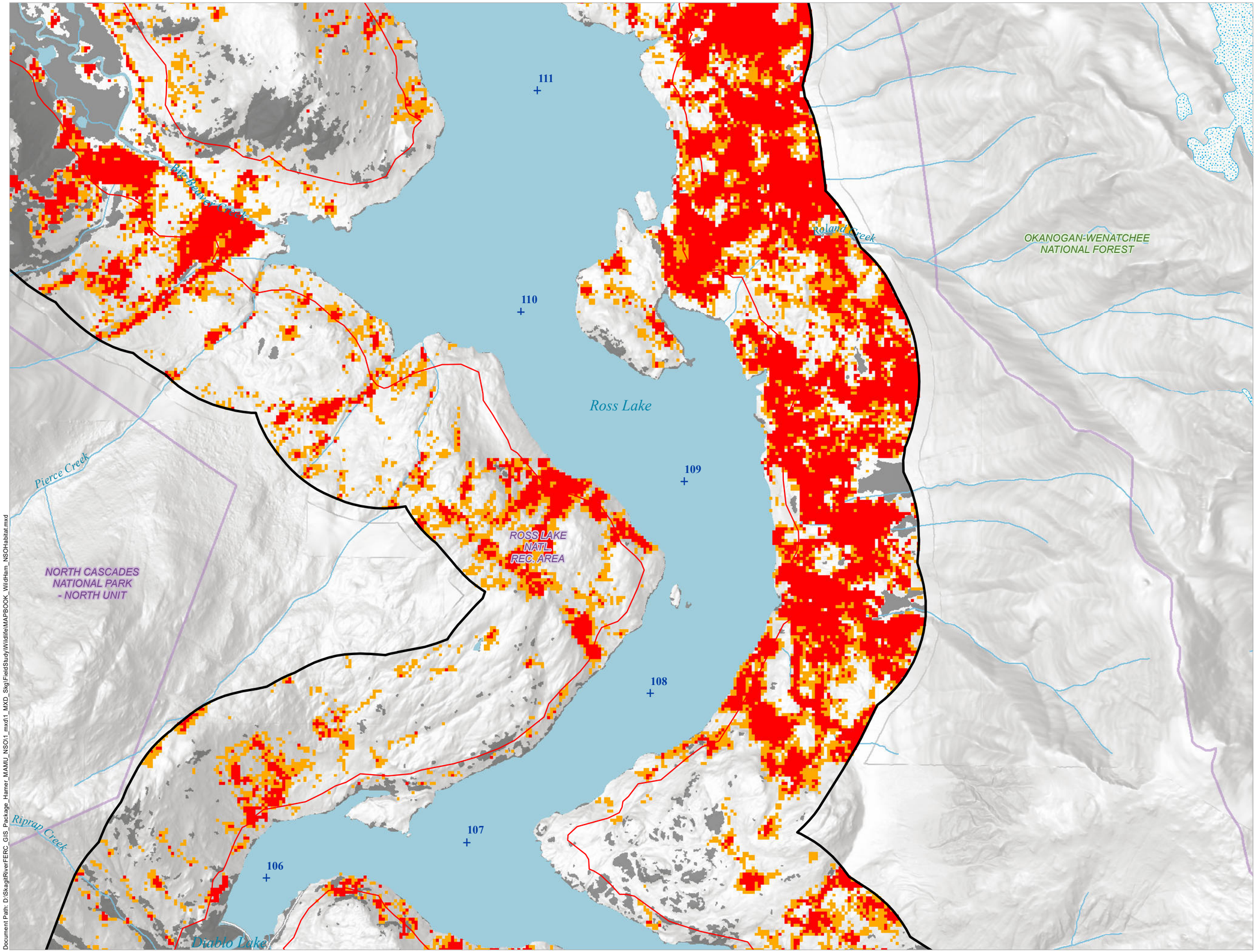

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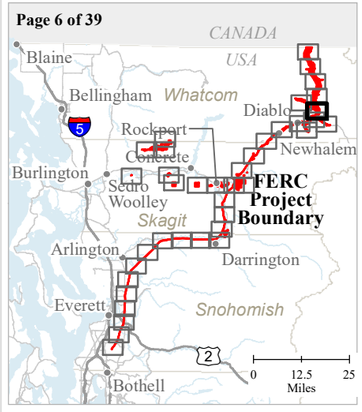
Miles



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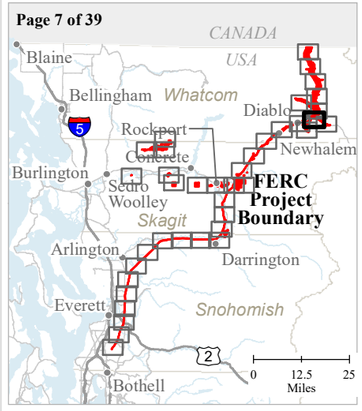
TR-10 MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK

- FERC Project Boundary
- Project River Miles (PRM)
- National Park / National Recreation Area Boundary
- Northern Spotted Owl Study Area
- Non-forested Area
- Modeled Highly Suitable Northern Spotted Owl Habitat
- Modeled Suitable Northern Spotted Owl Habitat

N

0 0.25 0.5
Miles



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TR-10 MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK

- FERC Project Boundary
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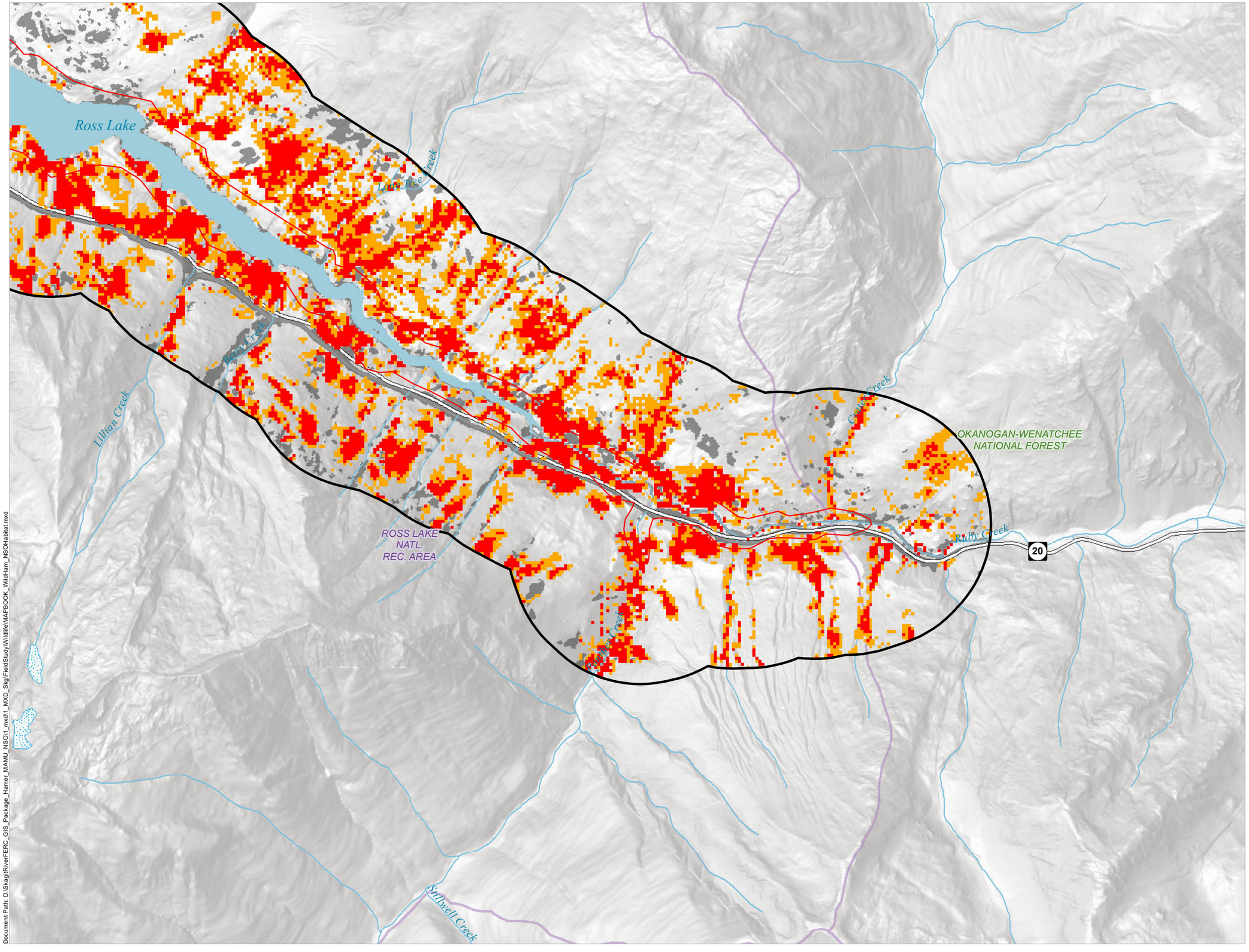
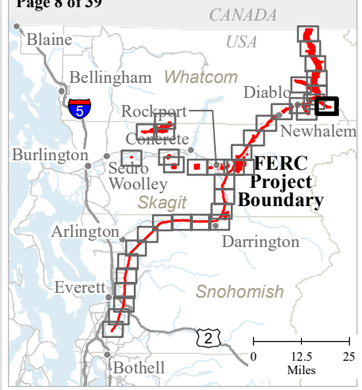
- Northern Spotted Owl Study Area
- Non-forested Area
- Modeled Highly Suitable Northern Spotted Owl Habitat
- Modeled Suitable Northern Spotted Owl Habitat



N

0 0.25 0.5
Miles



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TR-10 MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK

- FERC Project Boundary
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- Non-forested Area
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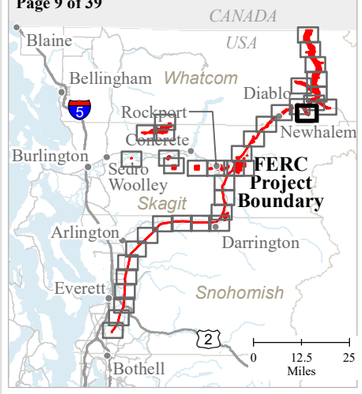
- Modeled Suitable Northern Spotted Owl Habitat

0 0.25 0.5 Miles



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TR-10 MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK

- FERC Project Boundary
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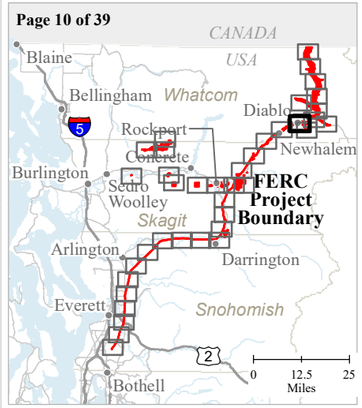
- Modeled Suitable Northern Spotted Owl Habitat

N

0 0.25 0.5
Miles



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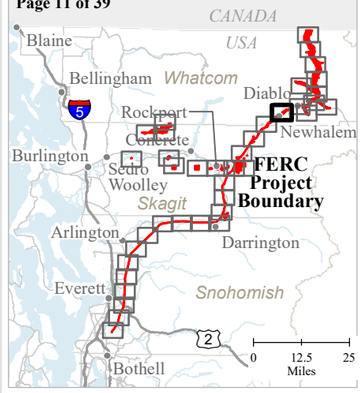
N

0 0.25 0.5
Miles



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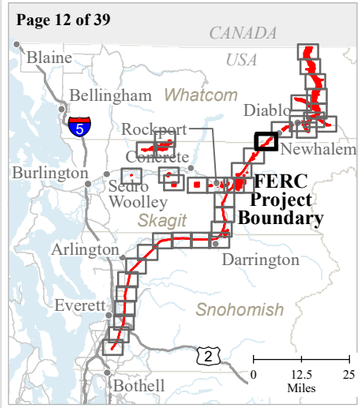
N

0 0.25 0.5
Miles



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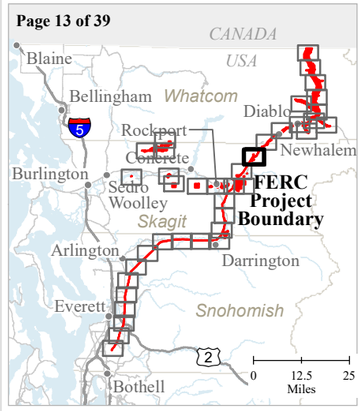
N

0 0.25 0.5
Miles



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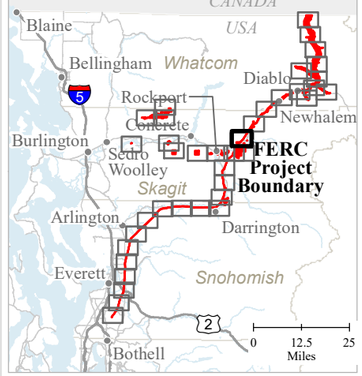
N

0 0.25 0.5
Miles



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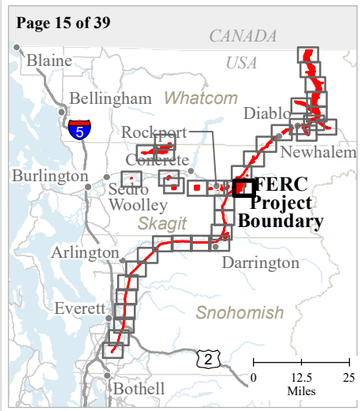
N

0 0.25 0.5
Miles



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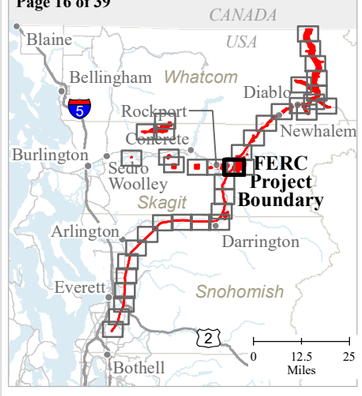
0 0.25 0.5 Miles



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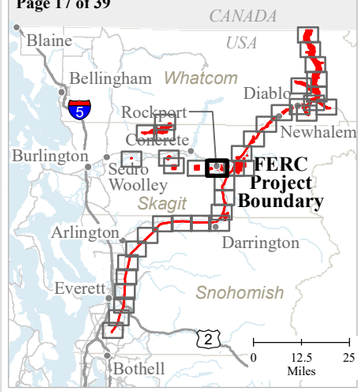
N

0 0.25 0.5
Miles



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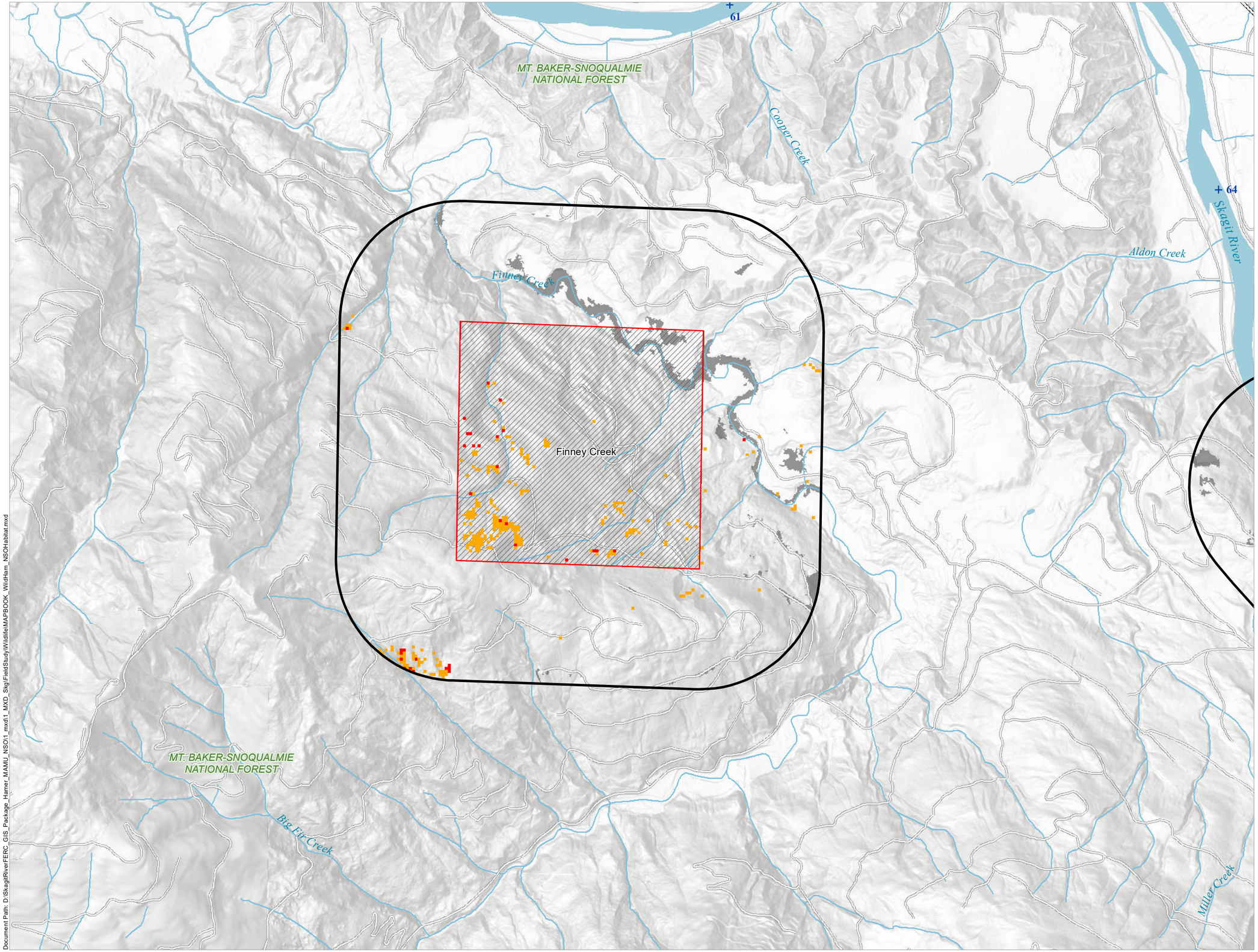
TR-10 MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK



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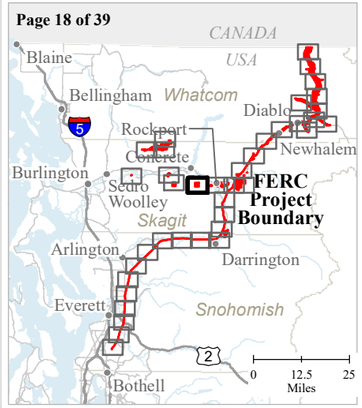
N

0 0.25 0.5
Miles



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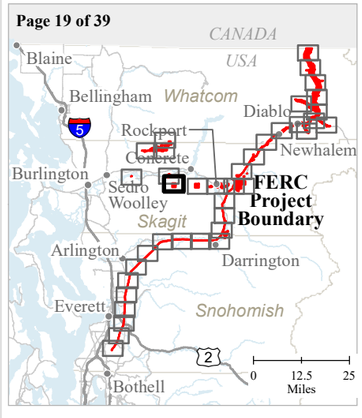
0 0.25 0.5
Miles



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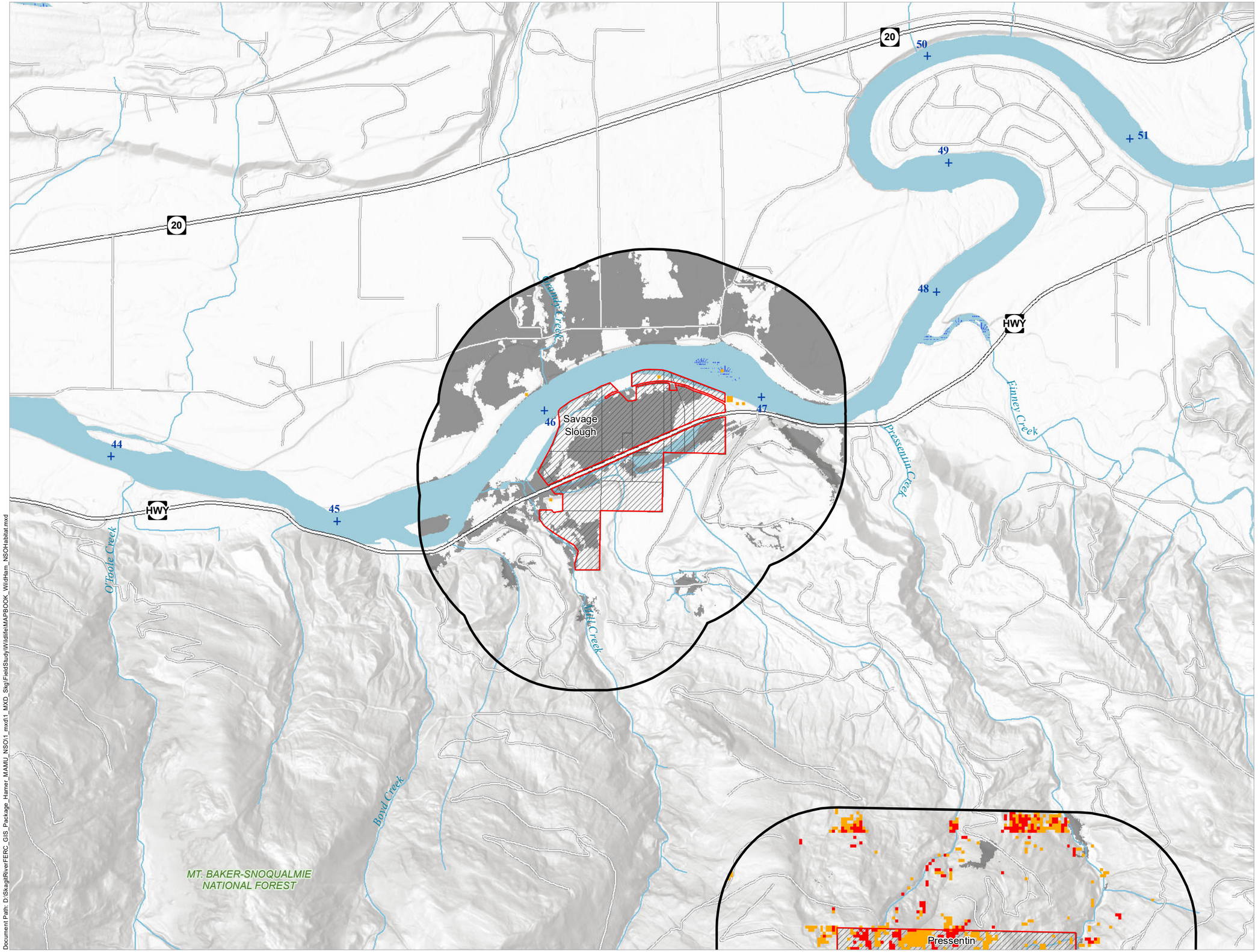
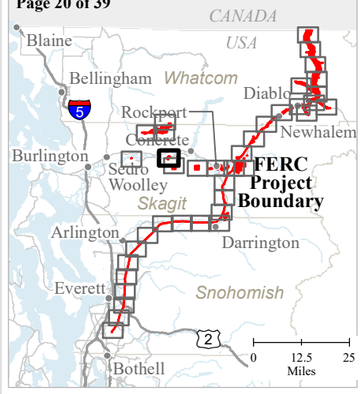


0 0.25 0.5 Miles



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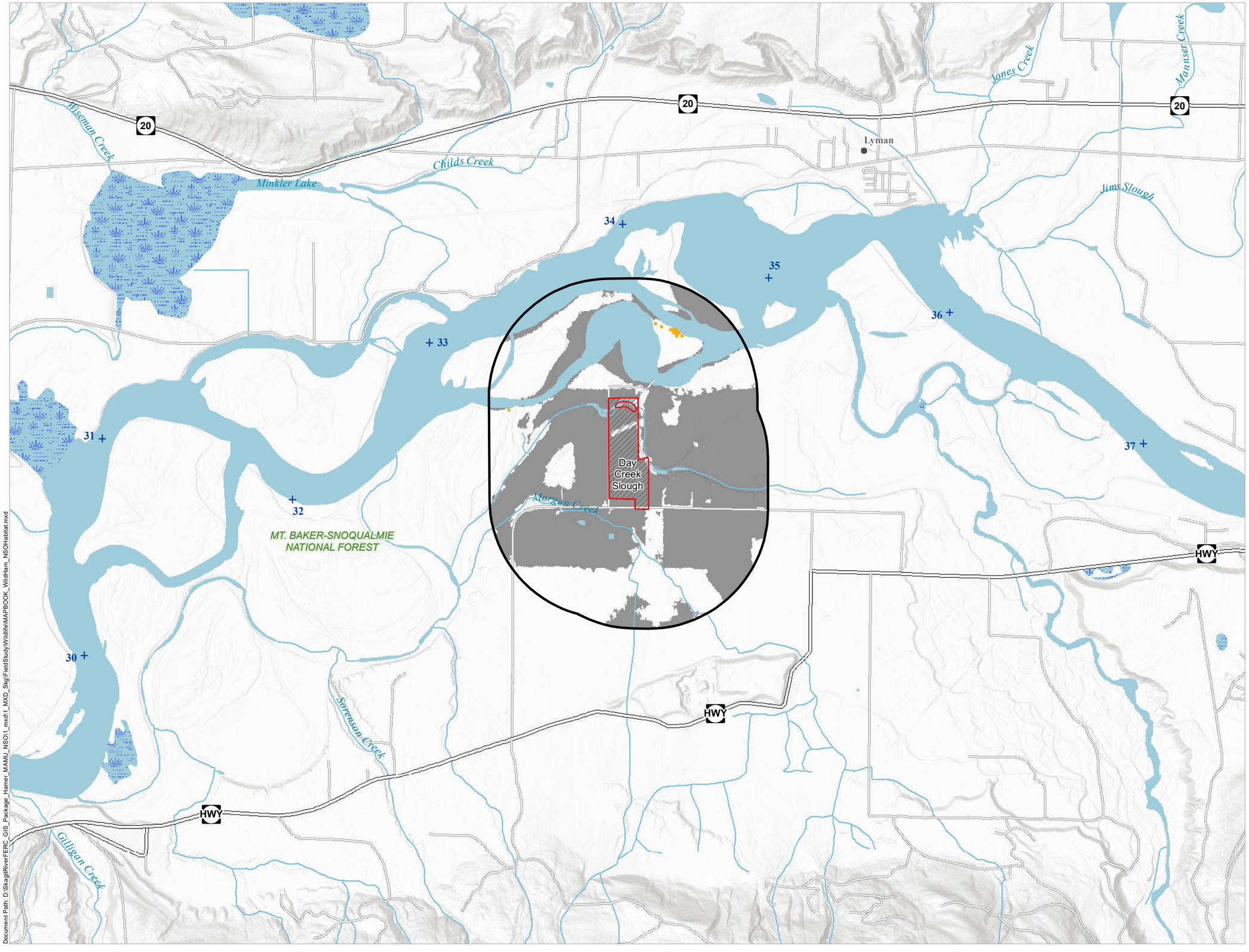

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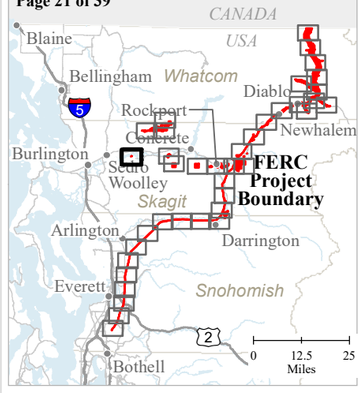

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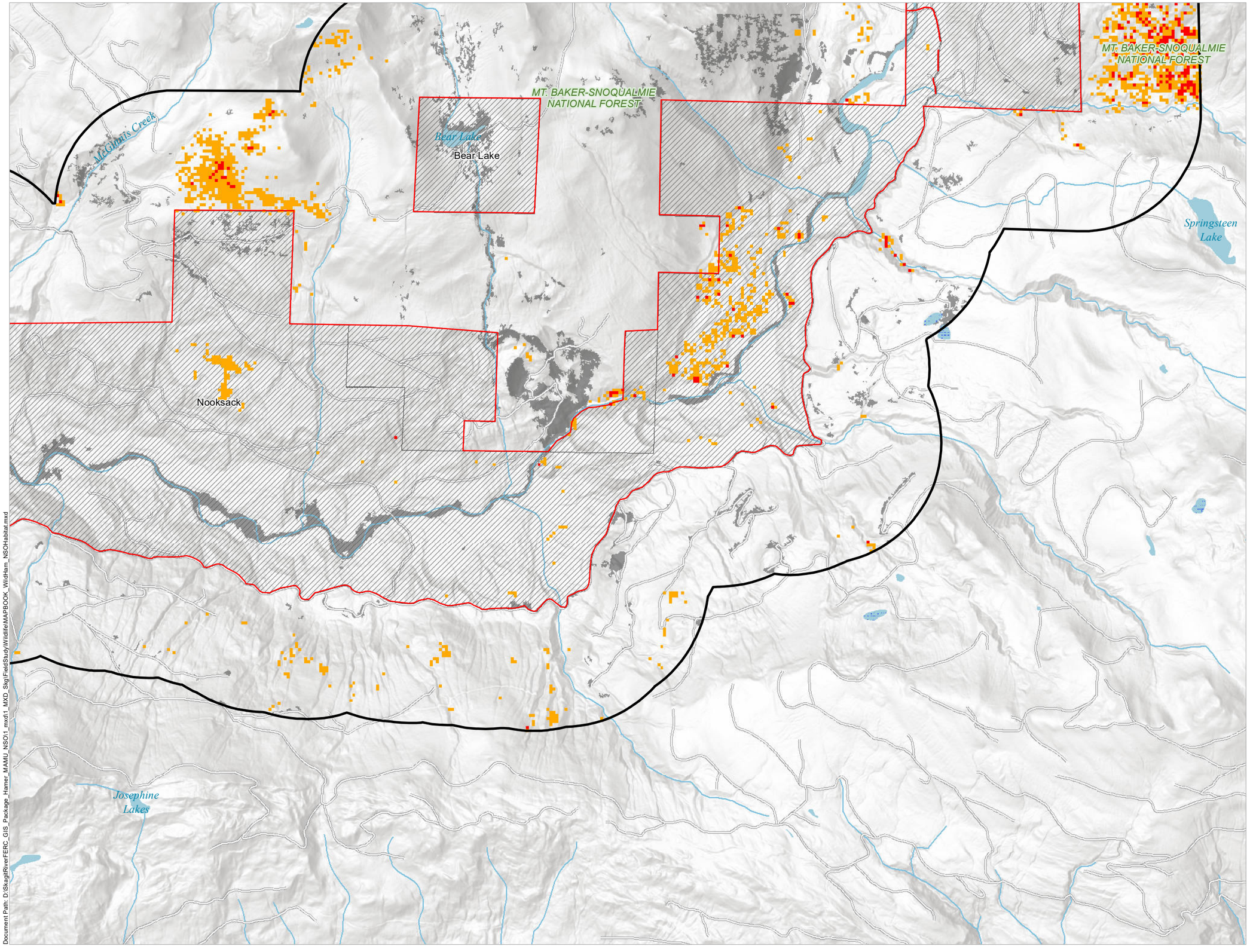

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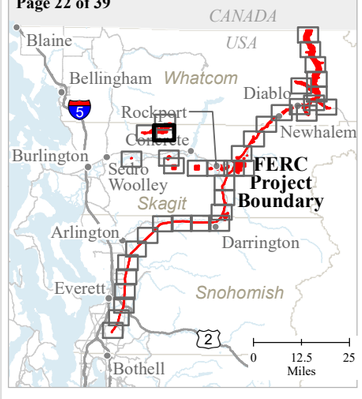
0 0.25 0.5
Miles



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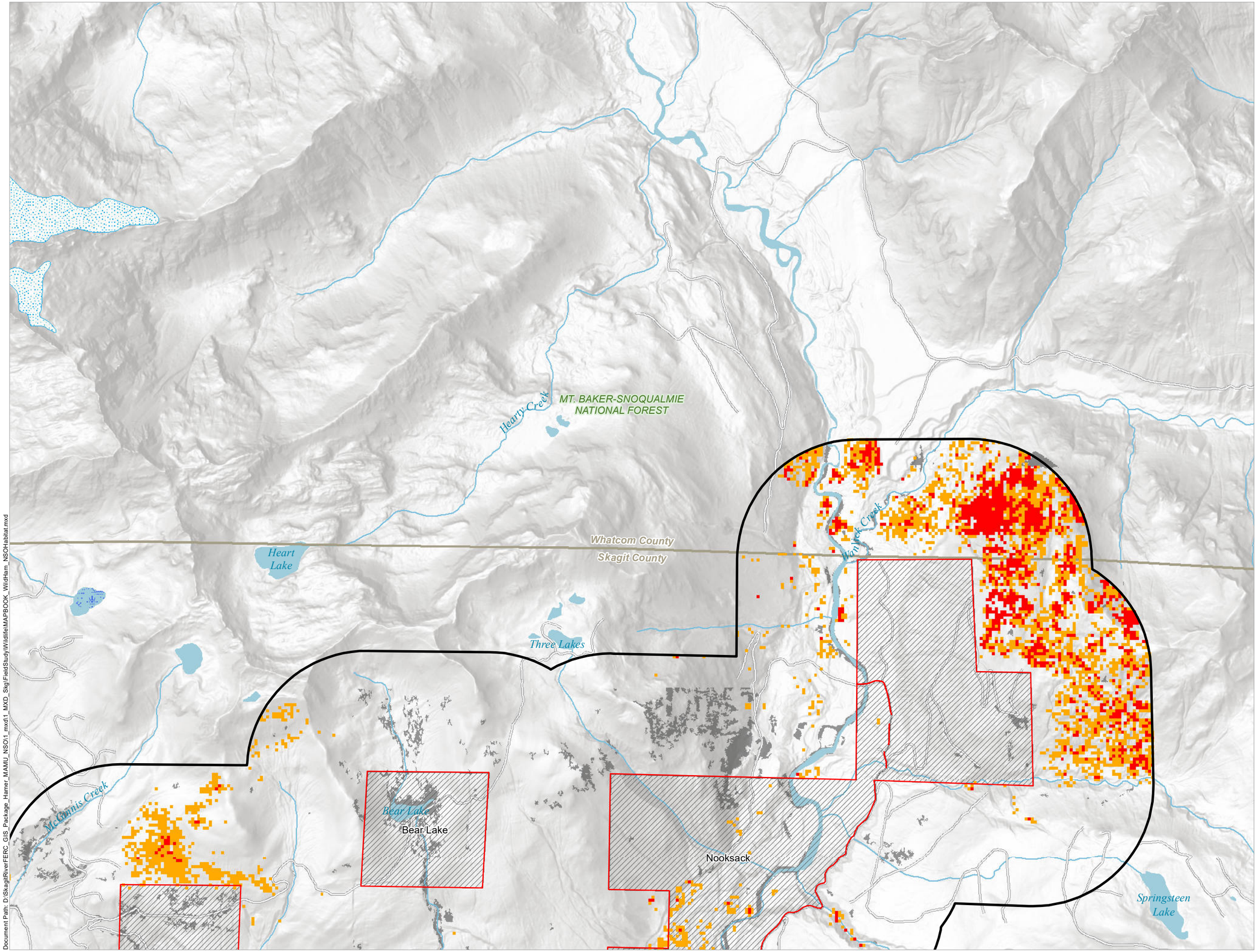

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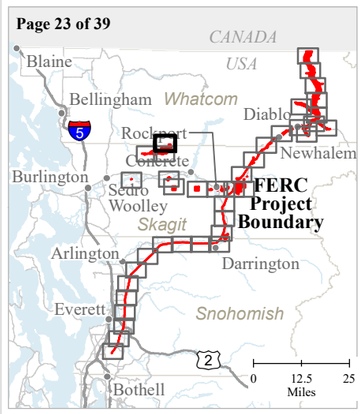
Miles



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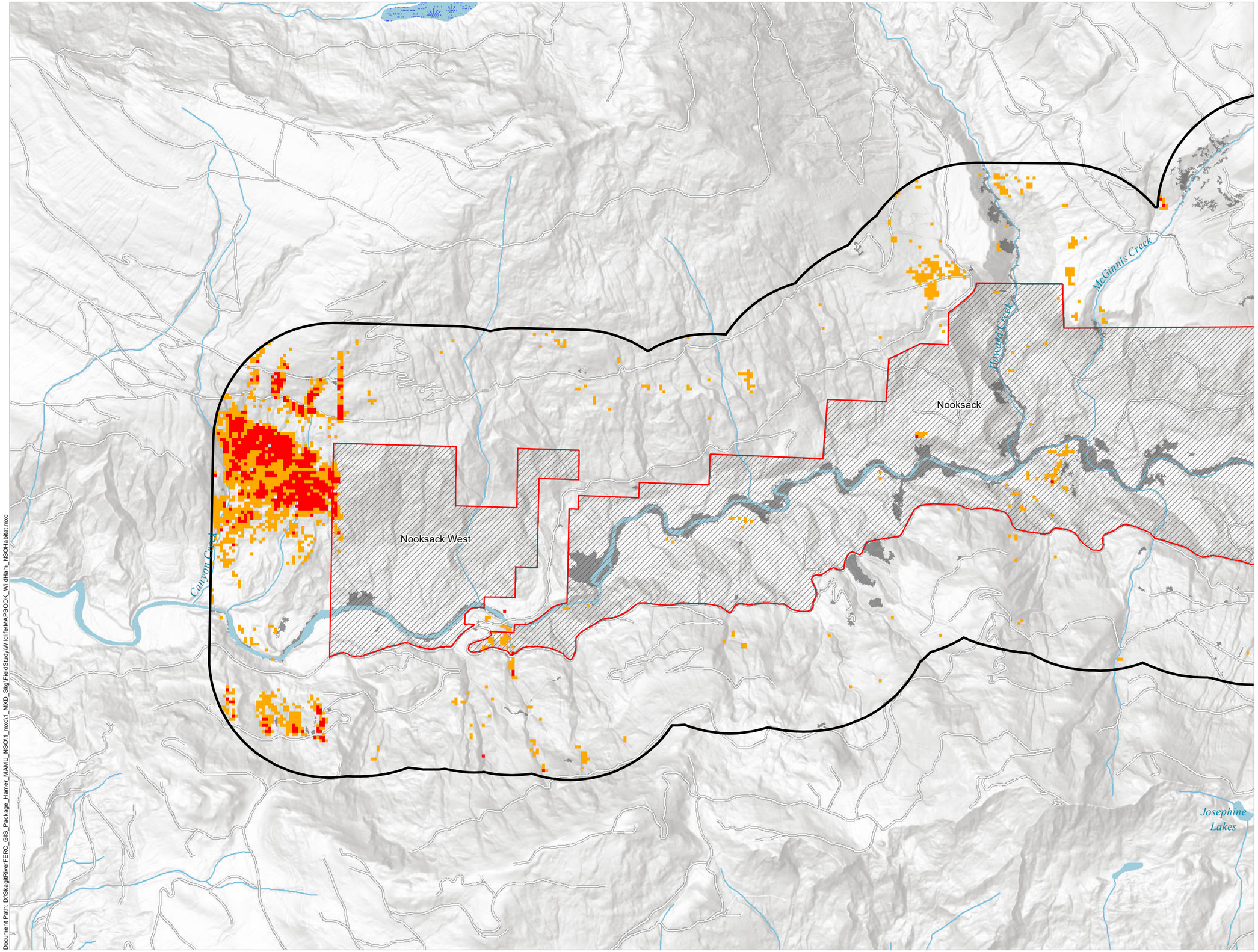

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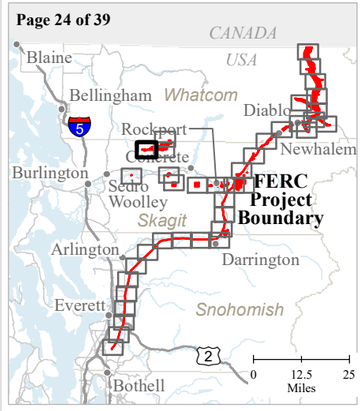

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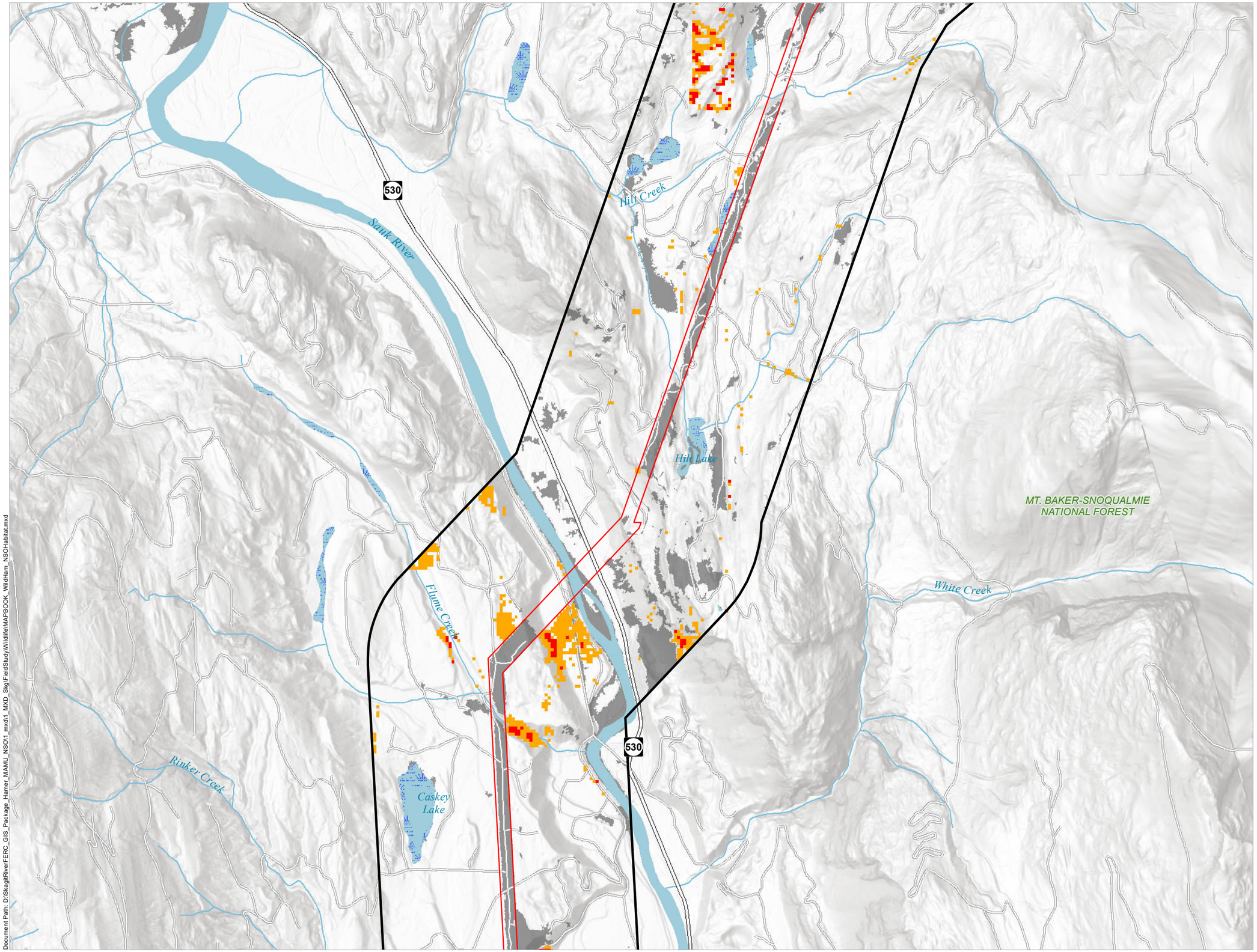
TR-10 MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK

- FERC Project Boundary
- Northern Spotted Owl Study Area
- Non-forested Area
- Modeled Highly Suitable Northern Spotted Owl Habitat
- Modeled Suitable Northern Spotted Owl Habitat



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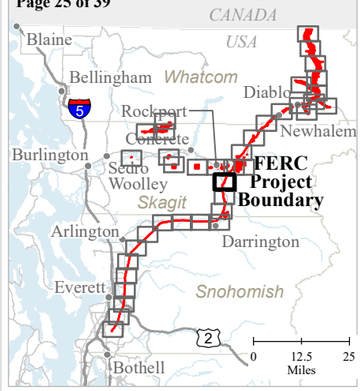

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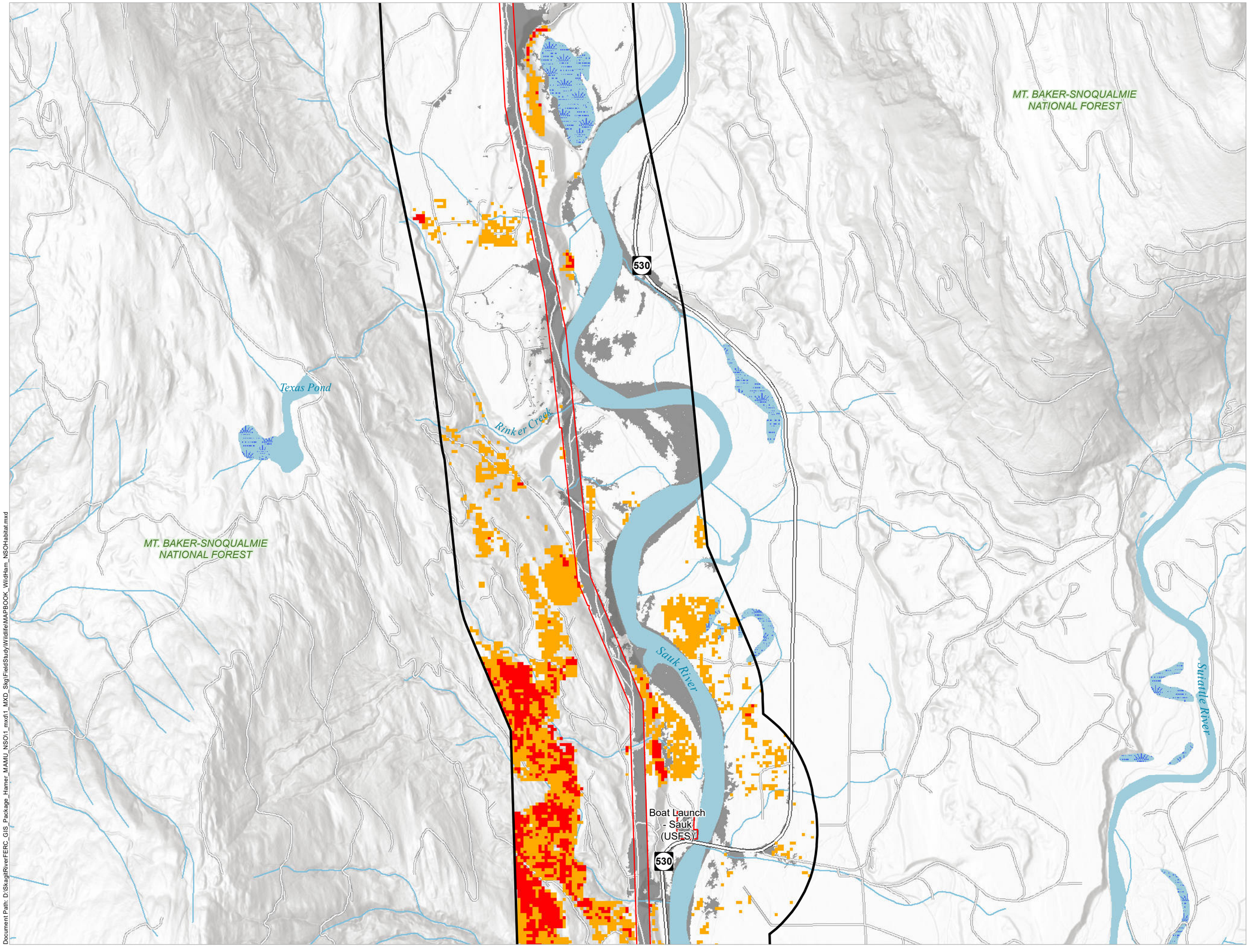

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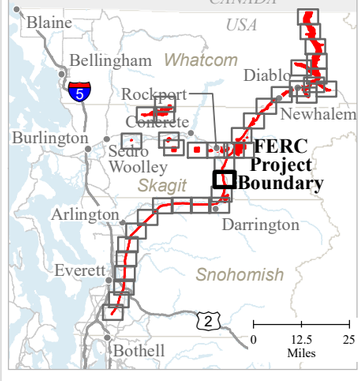
Miles



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TR-10 MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK

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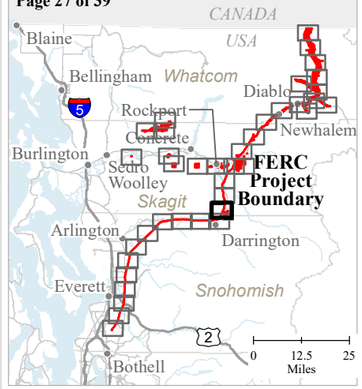

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MT. BAKER-SNOQUALMIE NATIONAL FOREST
Suiattle River
Sauk River
530
North Sauk
Prairie Creek
Skagit County
Snohomish County
Gravel Creek
Everett Creek
North Everett Creek
Dan Creek

TR-10 MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK

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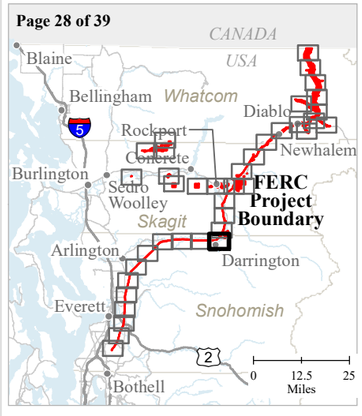

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Skagit County
Snohomish County
Everett Creek
North Everett Creek
Dan Creek
Sauk River
Everett Creek
Dan Creek
530
Three Rivers Mill Pond
530
Darrington
Lost Lake
Kirk Lake
Squire Creek
MT. BAKER-SNOQUALMIE NATIONAL FOREST

TR-10 MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK

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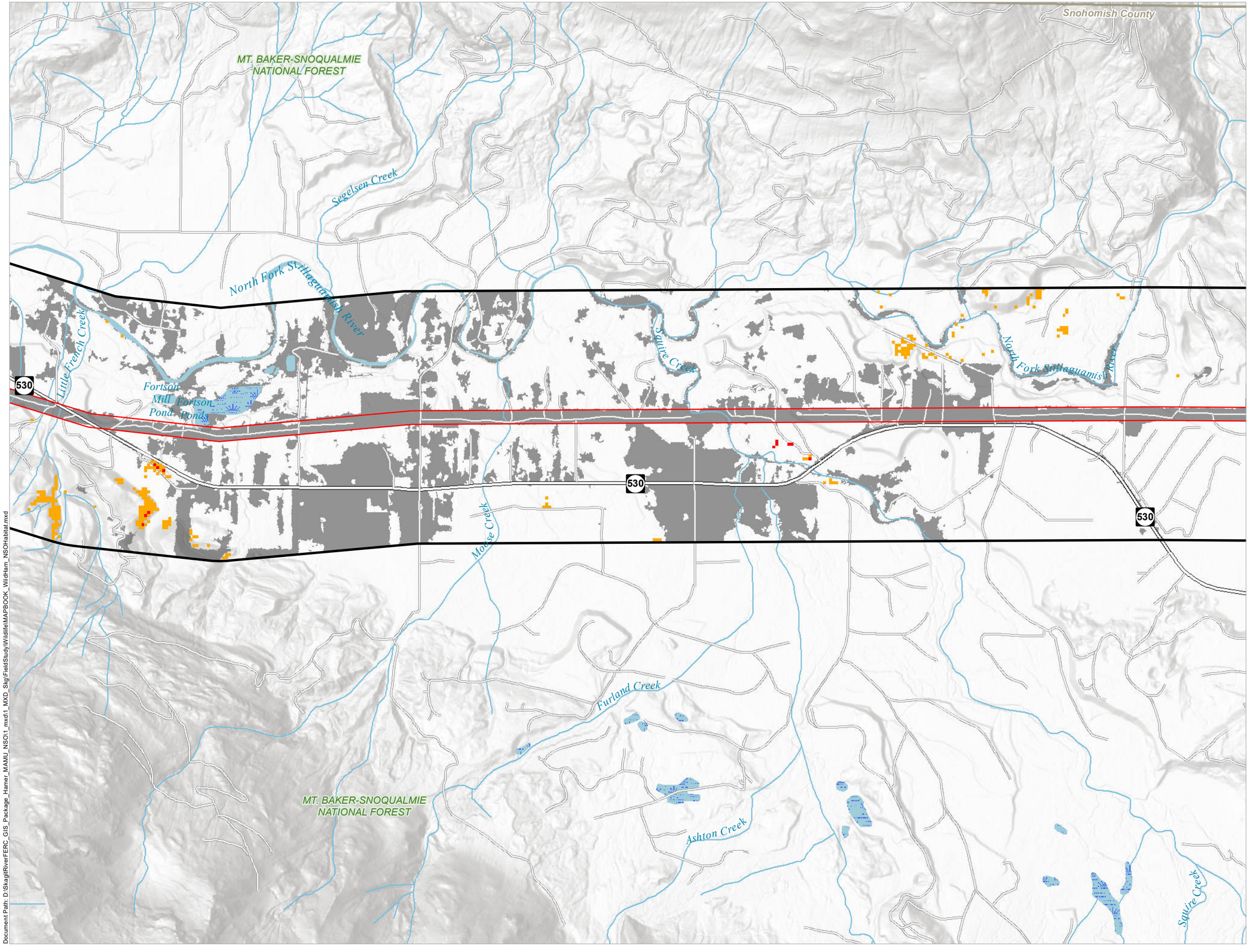

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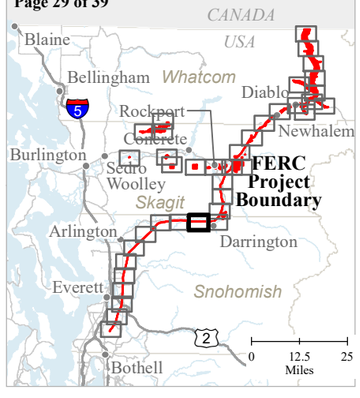

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TR-10 MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK

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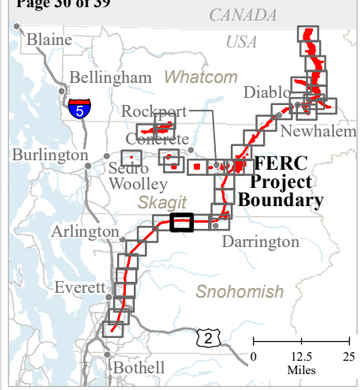

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TR-10 MODELED NORTHERN SPOTTED OWL NESTING, ROOSTING, AND FORAGING HABITAT MAPBOOK

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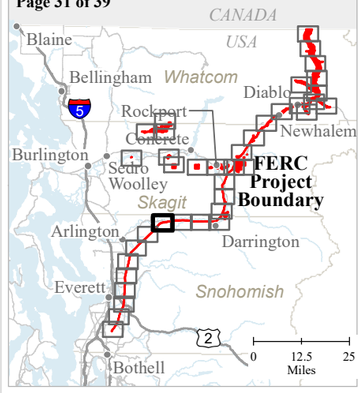

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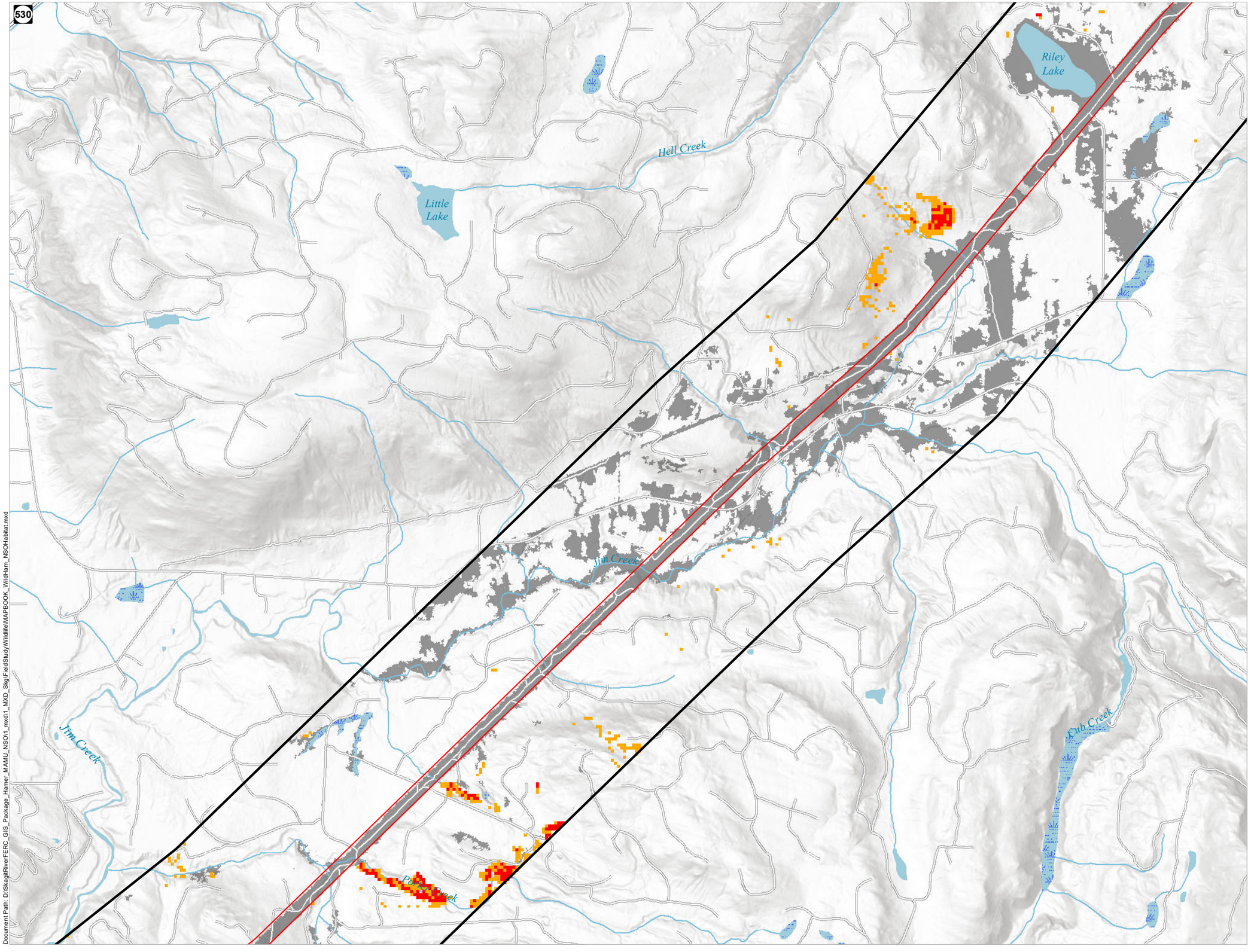

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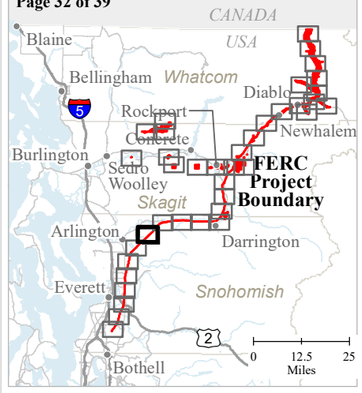
Miles



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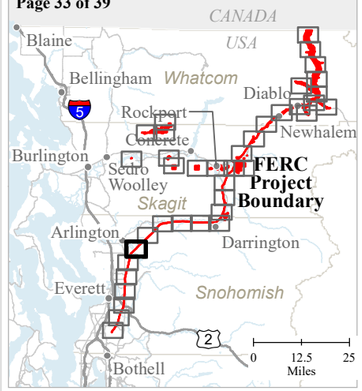

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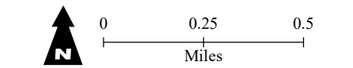

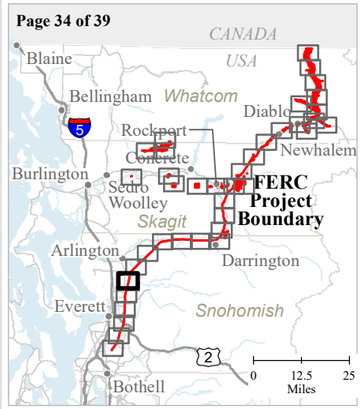

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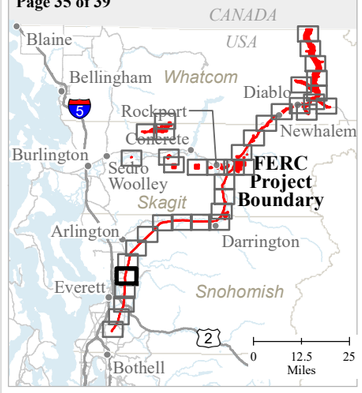

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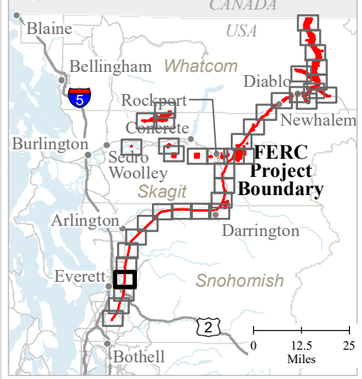

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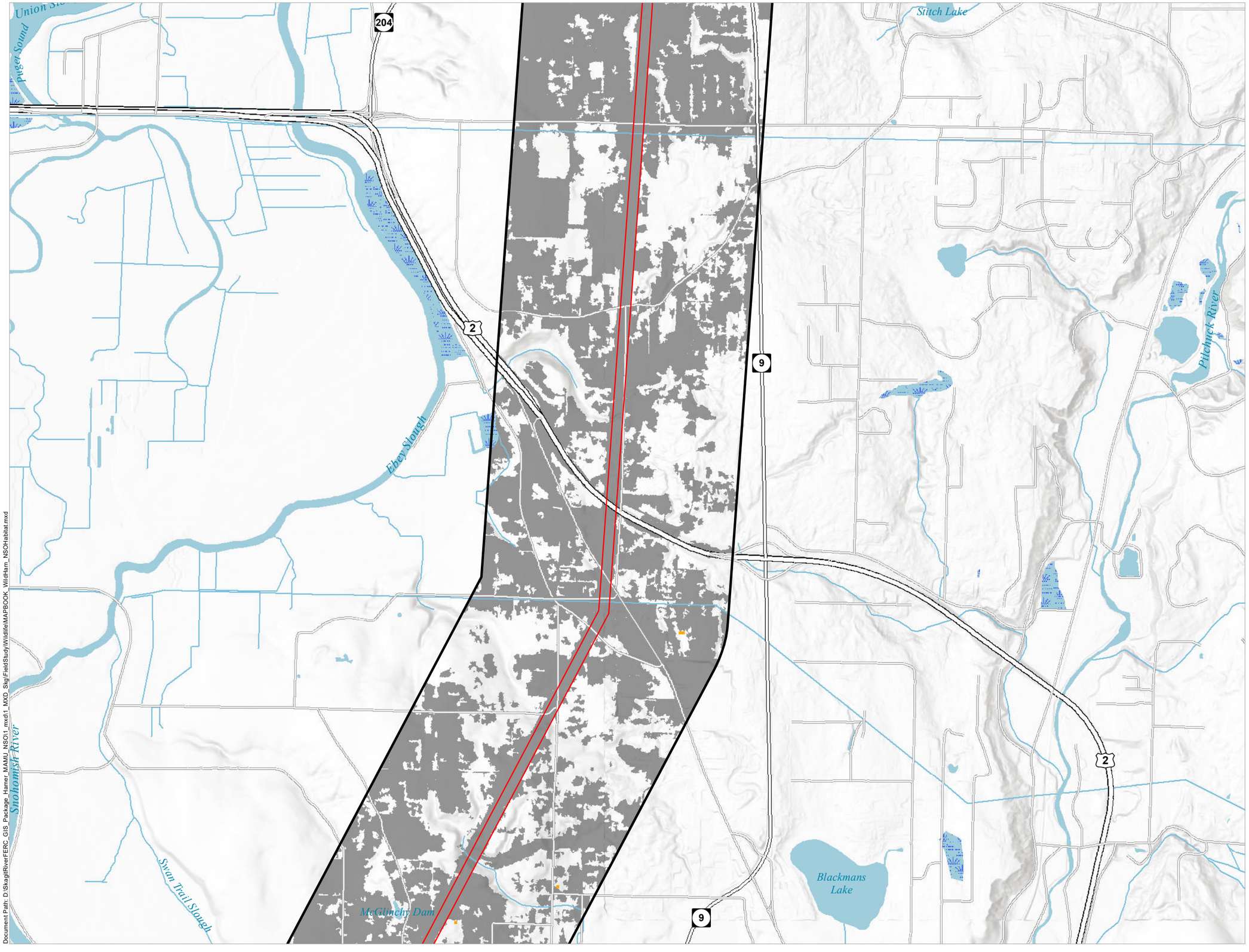

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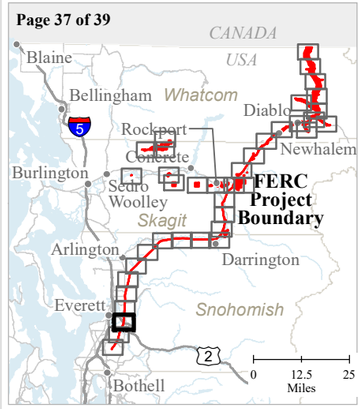

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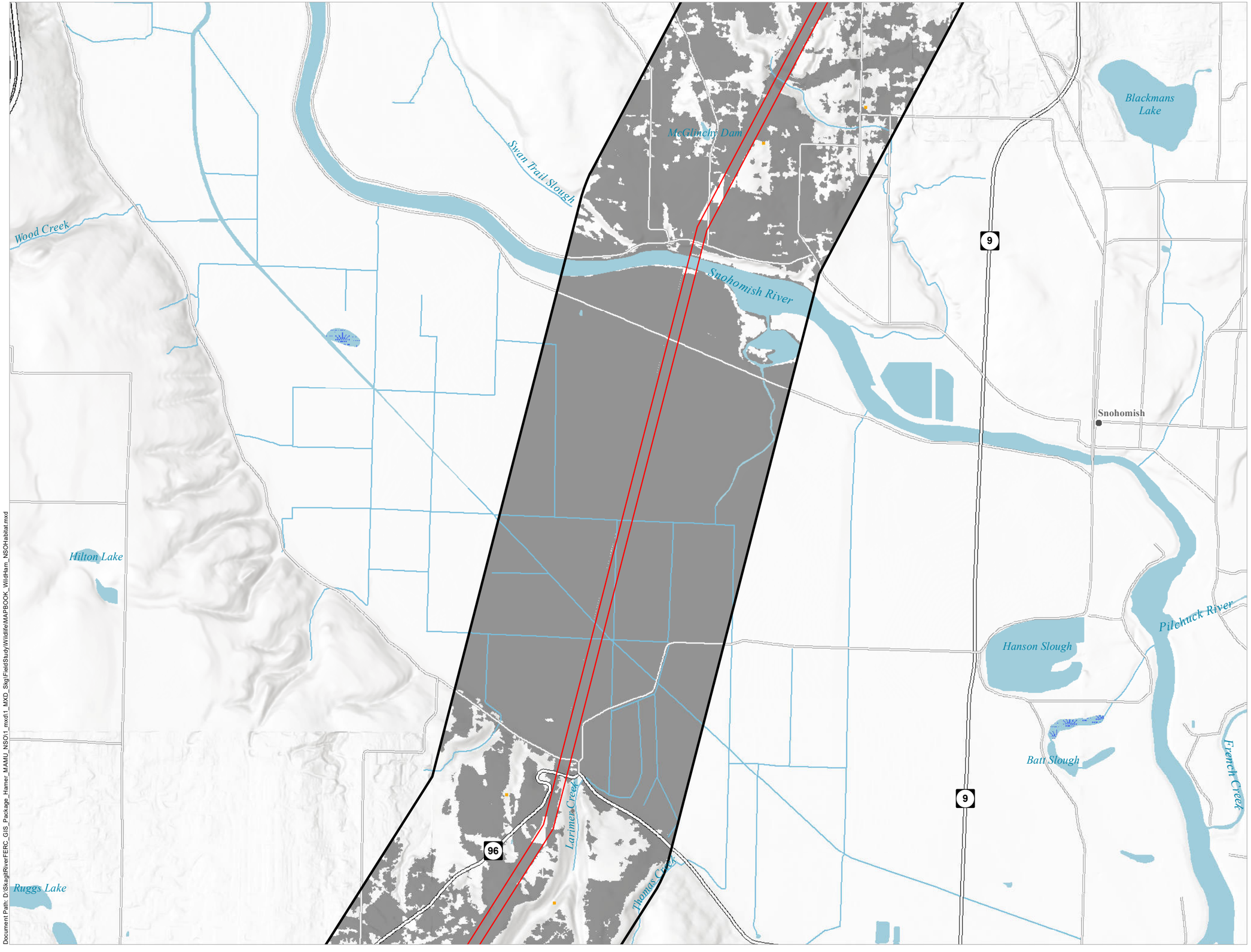

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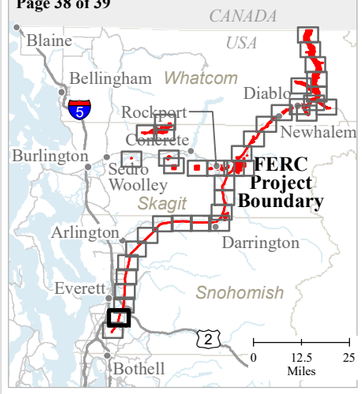

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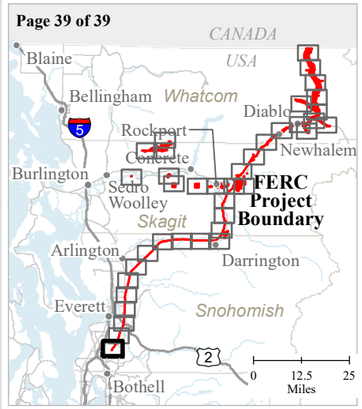

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