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Natural Resource Stewardship and Science

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

ON THE COVER
Spotted Owl
Photograph by: Mandy Holmgren

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Contents

Contents (continued)

Figures

Page

Tables

Page

Executive Summary

Northern Spotted Owl populations have declined over the last century, and the subspecies has been listed by the federal government as "threatened" since 1990. The status of the northern Spotted Owl has not been well documented in the North Cascades of Washington and southwestern British Columbia. In 1993, National Park Service (NPS) resource management staff initiated the first comprehensive inventory of Spotted Owls in suitable habitat within North Cascades National Park Complex (NOCA), a four-year survey that identified 11 active Spotted Owl territories in NOCA.

During the ten years following completion of NOCA's 4-year baseline owl inventory in 1996, only sporadic compliance-related owl surveys occurred. More comprehensive, up-to-date information on the status of the park's Spotted Owl population was needed to aid NPS managers updating NOCA's Fire Management Plan, General Management Plans for both Lake Chelan National Recreation Area (LACH) and Ross Lake National Recreation Area (ROLA), and developing the Stehekin River Corridor Implementation Plan. In response to these needs, NPS partnered with The Institute for Bird Populations to initiate a multi-year study of the status of NOCA's Spotted Owl population. The project has three main objectives:

1. Revise NOCA's model of suitable habitat for Spotted Owl and develop a revised GIS map layer showing suitable Spotted Owl habitat throughout the park.

2. Resurvey transects that were established and surveyed from 1993 through 1996; locate active Spotted Owl territories, estimate relative abundance, and determine productivity at all activity sites found.

3. Develop individual Spotted Owl activity site management plans with recommendations for protection measures for both currently active and historic sites.

During the first year of the project, we revised NOCA's model of suitable Spotted Owl habitat, in completion of Objective 1 (Wilkerson and Siegel 2007).

During 2007 and 2008 we conducted fieldwork throughout the Stehekin River watershed and along Lake Chelan within LACH (Siegel et al. 2008), in completion of Objective 2 for the portion of NOCA that lies east of the Cascades crest. We also began drafting Spotted Owl activity site management plans for currently active and historic Spotted Owl activity sites throughout the portion of NOCA that we surveyed in 2007-2008.

In 2009 we began a two-year effort to complete Objective 2 for the northeastern portion of NOCA, including the Newhalem Creek, Panther Creek, Ross Lake, Big Beaver Creek, Little Beaver Creek, Ruby Creek, and Thunder Creek drainages – referred to collectively here as the Upper Skagit Watershed. This report details the final results from our 2009 and 2010 field seasons.

We surveyed transects throughout the five selected drainages using survey procedures that were virtually identical to those used during the 1990s survey, as well as during our 2007-2008 surveys in the greater Stehekin and Lake Chelan areas. During 2009-2010 we completed 141

surveys (75 surveys in 2009 and 66 surveys in 2010) of 74 transects (38 transects in 2009 and 36 transects in 2010), comprising 2,363 2-min or 10-min station surveys plus 41 follow-up visits to historic Spotted Owls activity sites (13 follow-up visits in 2009 and 28 follow-up visits in 2010). None of our transect surveys during the 2009 or 2010 field season yielded Spotted Owl detections, but our follow-up visits to sites with historical detections confirmed at least one resident Spotted Owl occupying the historical territory at Newhalem Creek. Additionally, an incidental detection of a single Spotted Owl was recorded near Pyramid Lake by an NPS Ranger during the 2010 field season. Our survey efforts suggest that historically occupied territories at Deer Lick, Little Devil/Stout Creek, and Big Beaver Boundary are no longer occupied.

Although our survey was designed specifically to detect Spotted Owls, we also documented all detections of other owl species. Throughout the two field seasons, we observed and documented individuals of five additional owl species: Great Horned Owl (2 detections, likely representing a single activity site), Barred Owl (183 detections, representing an estimated 34 activity sites), Western Screech-Owl (2 detections, at distinct sites), Northern Pygmy-Owl (13 detections, likely representing 9 distinct sites), and Northern Saw-whet Owl (14 detections, likely representing 10 distinct sites). The large number of Barred Owls we detected is particularly notable, both because it indicates a substantial population increase since the early 1990s when the species was already considered well-established in the park, and because local population growth in this species may be displacing Spotted Owls and affecting other competitors and prey species.

Acknowledgments

We are grateful to our field technicians for their hard work and dedication to the project. Our 2010 field crew was comprised of Amy Blake, Peggy Kuhn Darr, Daniel Mendez-Aranda, Michelle Toshack (crew leader), and Katy Wetzel. The 2009 field crew included Jordan Bell, Joanna Gehrig, Eric Huston, Kara Kuhlman (crew leader), Juan Pablo Medina, Kyle Piete, and Michelle Toshack. We thank Roger Christophersen for sharing his knowledge of the park's owls; Scott Gremel for survey advice; Rodney Bain, Greg Drum and Jesse MacMahan of the Park Maintenance staff, and also Hugh Anthony and Carmen Welsh from the park's aquatic resources crew for arranging boat rides on Ross Lake and supporting the field crew in numerous ways. We thank Kelly Bush, Rosemary Seifried, Lin Skavdahl, and the other rangers at the Wilderness Information Center in Marblemount for providing logistical advice and updates on trail and campground conditions. Finally, we thank Carol Beidleman and the Park Flight Migratory Bird Program for coordinating Juan Pablo Medina's visit from Mexico in 2009 and Daniel Mendez-Aranda's visit from Mexico in 2010. This is Contribution No. 405 of The Institute for Bird Populations.

Introduction

The Northern Spotted Owl (*Strix occidentalis caurina*) is a medium-sized, dark brown, owl with dark eyes, barred tail, and white spotting on its head, back, and breast. It occupies mature/old-growth conifer forest that has a multi-layered, multi-species canopy with moderate to high canopy closure (USDI 2007). One of three subspecies, the Northern Spotted Owl occurs from southwestern British Columbia through the Cascade Range and coastal mountains of Washington and Oregon to northern California, including the coastal ranges to just north of San Francisco (Gutiérrez et al. 1995). The Spotted Owl is relatively long-lived, has a long reproductive life span, and exhibits high adult survivorship compared to other owl species (Gutiérrez et al. 1995).

Northern Spotted Owl populations are thought to have declined over the last century (Gutiérrez et al. 1995). In June 1990, the U.S. Fish and Wildlife Service (USDI) listed this subspecies as "threatened" (USDI 1990). Major reasons for population declines cited habitat loss or alteration of mature and old-growth forests due to logging, urbanization, and changes in fire regimes (Thomas et al. 1990). The invasion of Barred Owls (*Strix varia*) into Spotted Owl habitat over the past 40 years also has contributed to declines in Spotted Owl abundance through competition for nesting habitat and prey (Hamer 1988, Dunbar et al. 1991, Gutiérrez et al. 1995, USDI 2007). Recent demographic data suggest that populations over the 14 long-term demographic study areas in Washington, Oregon, and California decreased by about 3.7 percent annually from 1985 to 2003 (Anthony et al. 2004).

The status of the northern Spotted Owl has not been well documented in the North Cascades of Washington and southwestern British Columbia. Past efforts to assess the status of Spotted Owls within North Cascades National Park Service Complex (NOCA) began in the early 1980s when random calling surveys were initiated by the Washington Department of Fish and Wildlife (WDFW). Only a few of the random survey transects actually entered NOCA boundaries and no Spotted Owls were detected in NOCA from these surveys (A. Potter, pers. comm. 1996). Other surveys conducted by NOCA biologists were conducted in conjunction with environmental assessments of NPS operations (NOCA files). No Spotted Owls were detected during these surveys either. In 1993, National Park Service (NPS) resource management staff initiated a comprehensive inventory of Spotted Owls in suitable habitat within NOCA. This 4-year survey, the first systematic survey of Spotted Owl habitat completed in the park (Kuntz and Christophersen 1996), identified 11 Spotted Owl activity sites within NOCA, and confirmed pair occupancy at 6 of the sites.

During the 10 years following completion of NOCA's 4-year baseline owl inventory in 1996, only sporadic compliance-related owl surveys occurred. In addition to the compliance related surveys, biologists from the National Council of the Paper Industry for Air and Stream Improvement, Incorporated (NCASI) completed reconnaissance-level surveys of known sites in the Stehekin Valley as part of their Spotted Owl investigations on U.S. Forest Service (USFS) lands adjacent to NOCA (Fleming 2005, unpubl. data). The NCASI surveys stopped in the late 1990s due to lack of funding. Acquisition of updated information on the status of the park's Spotted Owl population was needed to aid NPS managers updating NOCA's Fire Management Plan, General Management Plans for both Lake Chelan National Recreation Area (LACH) and Ross Lake National Recreation Area (ROLA), and developing the Stehekin River Corridor Implementation Plan. In response to these needs, NPS partnered with The Institute for Bird

Populations to initiate a multi-year study of the status of NOCA's Spotted Owl population. The project has three main objectives:

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In 2009 (Siegel et al. 2009) we began a two-year effort to complete Objective 2 for the northeastern portion of NOCA, including the Newhalem Creek, Panther Creek, Ross Lake, Big Beaver Creek, Little Beaver Creek, Ruby Creek, and Thunder Creek drainages – referred to collectively here as the Upper Skagit Watershed. This report details the final results from our 2009 and 2010 field seasons of this work.

Study Area

The North Cascades National Park Complex (NOCA) includes North Cascades National Park, Lake Chelan National Recreation Area, and Ross Lake National Recreation Area. NOCA is located in the North Cascades physiographic province in northwestern Washington. Fieldwork during the 2009 and 2010 field seasons was confined to the northeastern portion of NOCA (Fig. 1). In 2009 the field crews visited transects located in Newhalem Creek, Panther Creek, Ross Lake, Ruby Creek, and Thunder Creek drainages. In 2010 transects located in Fisher Creek, Big Beaver Creek, Little Beaver Creek, Ross Lake, and Thunder Creek drainages were visited for surveys.

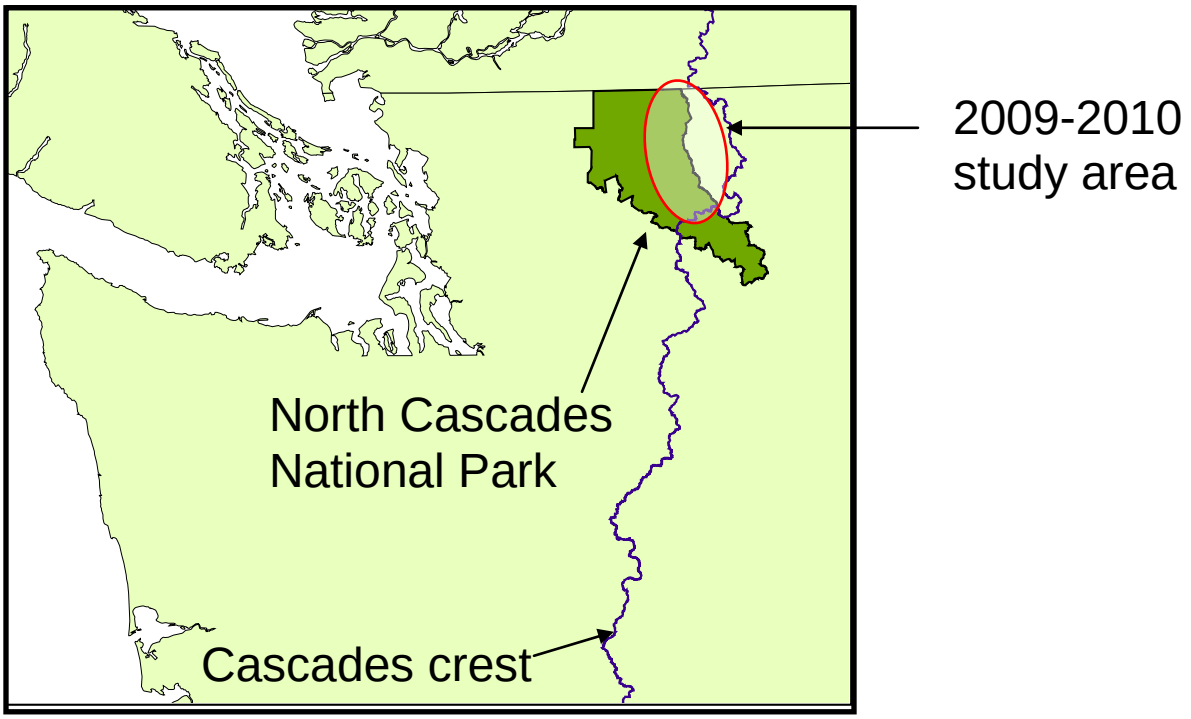

Figure 1. Portion of North Cascades National Park Complex (NOCA) targeted for Spotted Owl surveys during the 2009 and 2010 breeding seasons.

Methods

Survey Design

For our 2009 and 2010 field seasons, we sought to survey most of the transects in the upper Skagit Watershed that were established and surveyed by Kuntz and Christophersen (1996) in the early 1990s. We eliminated several transects that presented particular logistic difficulties (e.g., transects along remote portions of Ross Lake that could only be surveyed by boat) but did not yield any Spotted Owl detections during the early 1990s. This yielded a set of 74 transects (Figures 8, 9, 10, 11, and 12) that cover most of the appropriate Spotted Owl habitat in the selected drainages of NOCA.

Transects generally consisted of 8 to 12 survey stations placed at 400-m intervals in areas of suitable habitat, at all elevations. Survey stations were placed along trails and at off-trail locations. Whenever possible, stations were placed along ridges and away from streams to maximize coverage by enhancing sound transmission.

Approximately half of the selected transects were surveyed in 2009, with the remainder surveyed in 2010. In 2009 we surveyed transects in the Newhalem Creek, Panther Creek, Ross Lake (east side of lake only), Ruby Creek, and Thunder Creek drainages. In 2010 we surveyed transects in the Fischer Creek, Big Beaver Creek, Little Beaver Creek, Ross Lake (west side of lake only), and Thunder Creek drainages.

Crew Training and Certification

At the start of each field season (beginning on April 1 in 2009 and April 7 in 2010), we provided the crew with an intensive week-long training session, that focused on owl calling, owl identification, orienteering, first aid and backcountry safety, and data collection procedures. By the end of each training session all crew members could confidently perform all the tasks necessary to conduct surveys.

Data Collection

Most agencies conducting Spotted Owl surveys in the Pacific Northwest use six survey visits to determine annual pair occupancy and reproductive status within a defined geographical location (USDI 1992). This standard was developed mainly for use in determining Spotted Owl presence/absence in areas where management actions that could affect Spotted Owls (such as logging or road construction) are planned. Since our objective was to find as many activity sites as possible, mostly in areas without imminent management activities that would jeopardize owls, we chose to deviate from the standard protocol for most transects in order to maximize coverage of potential habitat in the park, although we did largely adhere to the 6-visit guideline for follow-up visits to historically occupied sites. We realize that surveying most transects only two times may have caused us to miss detections of some occupied but unknown activity sites. However, the probability of detecting Spotted Owls is generally fairly high. Results from surveys conducted at Olympic National Park showed there was a high probability of detecting at least one member of a resident pair during the first three visits to an occupied territory and most owl pairs were detected on the first visit (Seaman et al. 1992). More recently, Bailey et al. (2009) estimated average detection probability during a single follow-up visit to an occupied territory to be somewhere around 0.6 (which would yield a cumulative annual detection probability of 99.6% over 6 follow-up visits in a single breeding season).

Spotted Owl surveys are usually conducted at night, when owls are more active and are thought to be more responsive to standard survey techniques (USDI 1992). Because much of our study area is in remote, rugged backcountry, the location of transects influenced the time of day we conducted them. We surveyed off-trail transects during daylight hours to provide a safer working environment for field crews. We surveyed trail and road transects at night, beginning no earlier than 30 minutes after official sunset.

We conducted our first field survey on April 2 in 2009 and April 12 in 2010 and our last field survey was completed on June 27 in 2009 and July 10 in 2010. Data collection procedures were virtually identical to those used by Kuntz and Christophersen (1996) and Siegel et al. (2008). Technicians conducted a series of ten-minute surveys placed every 400 m along each transect. Two-minute surveys were conducted at the mid-point (200 m) between ten-minute survey stations. We used standard methods for locating Spotted Owls (Forsman 1983). Using a series of vocal imitations of Spotted Owl calls—a mix of three-note or four-note location calls and series calls—technicians hooted at the surveys stations. For both the 10- and 2-minute surveys, technicians hooted once every thirty seconds, except that the frequency was reduced to once every minute during the last three minutes of the 10-minute surveys.

When a Spotted Owl was detected, observers attempted to locate the owl to determine its sex, age, and if the owl was banded, band colors and band positions. Using standard mousing techniques (Forsman 1983), Spotted Owls would then be monitored throughout the season to determine pair status and locate nests and juveniles, as we did in the greater Stehekin River and Lake Chelan watersheds on the east side of NOCA (Siegel et al. 2008). We also documented detections of any other owl species detected during transect surveys or at any other time during the field season.

We originally hoped to survey each of the transects in our selected drainages three times, consistent with the methods we used in the greater Stehekin River and Lake Chelan watersheds on the east side of NOCA (Siegel et al. 2008). However, this level of sampling effort proved to be unworkable with our small field crew because:

- at the beginning of the 2009 field season, park law enforcement officials advised us not to assign crew members to survey transects on the east side of Lake Chelan alone at night—not even transects that lay entirely on-trail—due to safety concerns stemming from recently discovered marijuana growing activities in the area; and

- also during the 2009 field season three of our five crew members sustained injuries that left them unable to work to their full capacity for at least part of the field season.

We therefore curtailed our protocol such that most transects we surveyed in 2009 and 2010 were only visited twice, rather than three times, with a few exceptions as noted below.

We also conducted multiple historical follow-up visits to each of the five sites in our selected drainages where Spotted Owls have been detected at any time since 1994:

- Deer Lick
- Big Beaver Boundary

- Newhalem Creek
- Little Devil/Stout Creek
- Pyramid Lake

Historical follow-up visits involved two or more technicians visiting areas with historical detections during daylight (but near dawn or dusk, if possible) and spending a minimum of 4 person-hours walking throughout the area, calling, listening, and watching for owl sign (whitewash, pellets, etc.).

Results

During our two-year Spotted Owl survey we completed 141 surveys (75 in 2009 and 66 in 2010) of 74 transects (38 transects in 2009 and 36 transects in 2010), comprising 2,363 2-min or 10-min station surveys plus 41 follow-up visits to historic Spotted Owls activity sites (13 follow-up visits in 2009 and 28 follow-up visits in 2010).

Spotted Owl Detections and Activity Sites

None of our transect surveys during the 2009 and 2010 field seasons yielded Spotted Owl detections. During 2009 we detected one Spotted Owl on the last day of the field season during a follow-up visit to a historically occupied site along Newhalem Creek (Table 1, Fig. 2). An additional, incidental detection of a single Spotted Owl was made during the 2010 field season by Park Service Wilderness Ranger Cory Conner near Pyramid Lake. This site was visited for follow-up surveys by our field crew four times beginning two days after the initial detection on June 27, 2010, but our crew was not able to relocate the owl.

Table 1. Results of follow-up surveys at historical Spotted Owl activity sites surveyed during the 2009 and 2010 field seasons in North Cascades National Park.

	2009		2010	
Activity Site Name	**No. of visits**	**Status**	**No. of visits**	**Status**
Deer Lick	6	Not detected	6	Not detected
Little Devil/Stout Creek	4	Not detected	6	Not detected
Newhalem Creek Trail	3	Unknown; one indiv. detected	6	Not detected
Big Beaver Boundary		Not visited	6	Not detected
Pyramid Lake		Not visited	4	Unknown; one indiv. detected

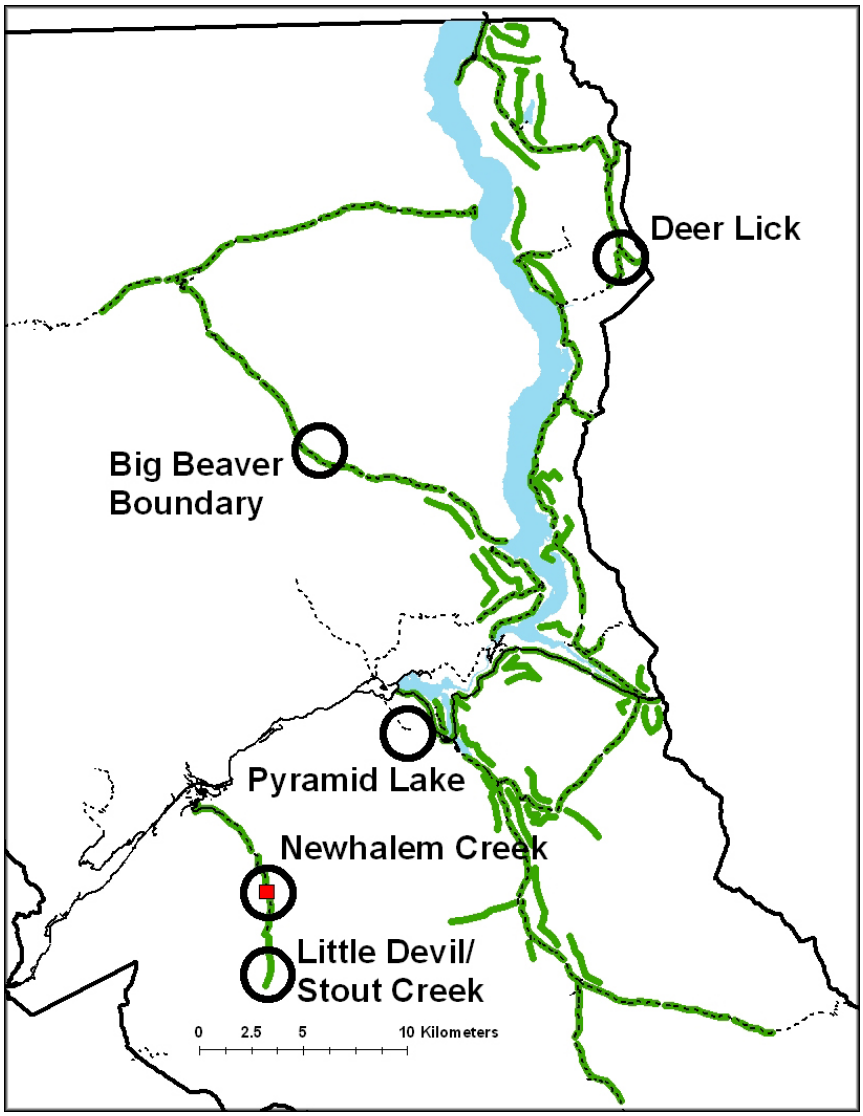

Figure 2. Historic Spotted Owl activity sites (indicated with black circles) surveyed with 'follow-up visits' during the 2009 and 2010 Spotted Owl survey at North Cascades National Park. Red square indicates the only Spotted Owl detection recorded during the two field seasons (detection made in 2009). Green lines indicate Spotted Owl survey transects surveyed in 2009 or 2010; dashed black lines indicate trails; thin black lines indicate roads; thick black lines indicate park boundaries.

Below we detail survey effort and results from our follow-up visits and transect surveys.

Big Beaver Boundary Historic Detection Site

A Spotted Owl was detected at this site during NOCA's landbird inventory survey in 2001. The actual detection site (presumably the location of the observer, rather than the owl) was difficult to access, with a cliff and large talus slope spanning the area. However, there was a mature stand of Western Redcedar/Western Hemlock forest just downslope. Lightly vegetated talus slopes are great for projecting sound, and we searched the area extensively, including the downslope forest stand, and south of the trail towards Big Beaver Creek. No Spotted Owls were detected during six visits to the area. A very vocal Barred Owl was detected during many of the visits, and was eventually confirmed to have a mate. Barred Owl detections were frequent in this area

throughout the field season; one night a Barred Owl followed us for approximately an hour, repeatedly giving both the agitated contact call and the location call.

Deer Lick Historic Activity Center

Despite intensive search efforts, including six follow-up visits in each survey year, we did not find Spotted Owls in this historic territory. We did, however, discover a Barred Owl in 2009 near the Deer Lick Cabin in the same area as the southernmost grouping of recorded Spotted Owl detections (we did not detect the Barred Owls at this location in 2010).

Pyramid Lake Detection Site

On June 27, 2010 in the early afternoon, Cory Conner, a NOCA wilderness ranger with previous experience surveying Spotted Owls, was patrolling Pyramid Lake on the climber's trail that extends south past the lake and upslope. Cory Conner was a Spotted Owl surveyor during NOCA's previous extensive Spotted Owl survey in the 1990s (Kuntz and Christophersen 1996). While hiking, she observed that the forest could be prime spotted owl habitat, and decided to vocally call for Spotted Owls. A Spotted Owl responded from far in the distance. Cory hooted again, and a little while later detected a Spotted Owl visually, approximately 6 m away. The owl repeatedly the Spotted Owl's typical four note location call. When word of this detection reached the Spotted Owl crew, we followed up two days later with the first of 4 follow-up visits conducted over the following two weeks. We were unable to relocate the owl. The area where the owl was detected is dominated by large Western Hemlocks and Pacific Silver Firs, with an abundance of large snags and downed logs, at approximately 1,000 m above sea level.

Newhalem Creek Historic Activity Center

We detected a Spotted Owl near Station 16.5 during our third historic follow-up visit on the morning of June, 27 – the last day of the 2009 field season. The owl responded to hooting, giving location calls at one to two minute intervals, which allowed the surveyor to visually locate the perched owl. The owl was observed roosting (preening occasionally and appearing to sleep) in a large Western Hemlock for over three hours. A mouse was offered, but the owl showed no interest. The roost site could possibly be a nest tree, though a nest was not located and no obvious signs of nesting were observed. The observer was unable to determine the sex of the owl, and the owl's legs were not visible, so no bands could be seen.

In 2010 we conducted six full follow-up visits to Newhalem Creek site, but we detected no Spotted Owls. The area was occupied by at least one Barred Owl, which responded to our hooting during multiple follow-up visits.

Stout Creek/Little Devil Historic Activity Center

We detected no Spotted Owls at this historic activity site in either 2009 or 2010. In both years high water in Newhalem Creek made crossings dangerous, so we were unable to reach the western (Little Devil) portion of the historic activity site. Rather, all follow-up visits were focused around the eastern (Stout Creek) portion of the site. We conducted three full follow-up visits, and a fourth that was cut short due to a crew injury in 2009. In 2010 we conducted a follow-up close to the creek in an effort to project our hooting towards the Little Devil site - we surveyed this area once and made five visits to the Stout Creek site. We detected a Barred Owl and found what was believed to be a *Strix* pellet within 200 m of the Stout Creek site in 2009. In 2010 a Barred Owl was detected close to Station 4 of the Newhalem Creek East transect, very

close to the past Spotted Owl detection. The crew noted that the area contained excellent stands of old-growth Western Redcedar and Western Hemlock.

Detections of Other Owl Species

While surveying transects, hiking to transects, and backcountry camping, our field crew documented their observations each time they detected owls of any species. During the 2009 field season we detected and documented five owl species in addition to Spotted Owl: Great Horned Owl, Barred Owl, Western Screech-Owl, Northern Pygmy-Owl, and Northern Saw-whet Owl.

Great Horned Owl

During the 2009 field season a single Great Horned Owl was detected twice, once while surveying the Roland Point transect and once as an incidental detection at nearly the same location. This detection represents one activity site near Roland Point (Table 2, Fig. 3). No other Great Horned Owls were detected in 2009 and no Great Horned Owls were detected in 2010.

Table 2. Great Horned Owl activity sites identified during the 2009 Spotted Owl survey in North Cascades National Park.

Activity Site Code[a]	Location Description	Years Detected	Breeding Status	Breeding Status Notes
A	Roland Point	2009	Unknown	Unknown

[a] Letters correspond to those in Figure 3.

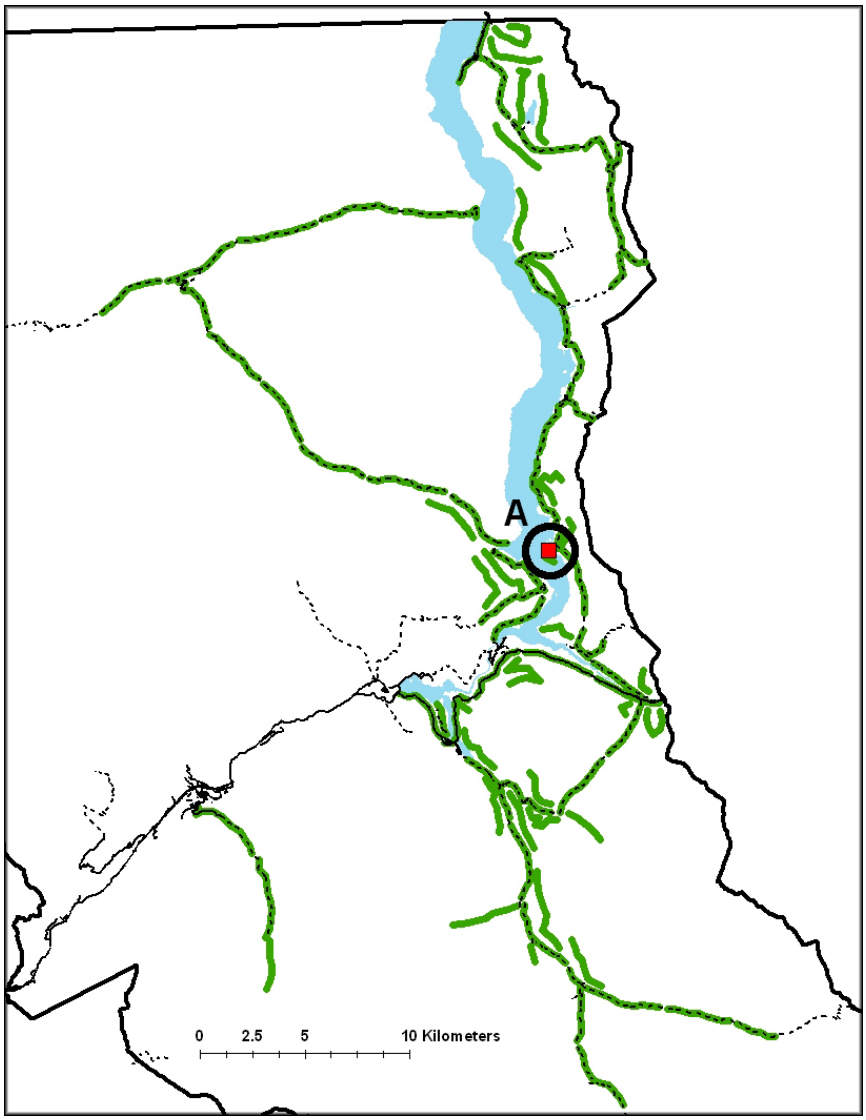

Figure 3. Location of Great Horned Owl detections recorded during the 2009 Spotted Owl survey in North Cascades National Park; no Great Horned Owls were detected during our Spotted Owl surveys in 2010. Red squares indicate individual Great Horned Owl detections (there are two in the figure, but they almost entirely overlap). Lettered black circle groups the detections according to our best guess of the number of distinct territories represented by the detections, but is not intended to indicate territory size; see Table 2 for more information. Green lines indicate Spotted Owl survey transects; dashed black lines indicate trails; thin black lines indicate roads; thick black lines indicate park boundaries.

Barred Owl

We documented 183 detections of adult Barred Owl (69 in 2009 and 114 in 2010) representing an estimated 34 activity sites, including 16 confirmed pairs (Table 3, Fig. 4). In 2009 activity sites with confirmed pairs, where a male and female were heard calling in chorus, included: Highway 20 I (near Thunder Lake), Panther Creek Trail II (near 4th of July Pass), Happy Creek, East Bank Trail IV (near Hidden Hand Pass), Roland Point, East Bank Trail III (near Rainbow Point), East Bank Trail II (near Devil's Creek), Lightning Creek Trail II (near Hozomeen Lake), and Hozomeen Road (near the Hozomeen bunkhouse). The pair at Happy Creek was not heard calling in chorus, but both the male and female were detected on separate visits. There were also

detections of Barred Owl pairs on the Canadian Border East and Devils Creek Trail transects, which we believe to be the same pairs that we detected on Hozomeen Road and East Bank Trail II, respectively. At least one juvenile was confirmed to have fledged from the East Bank Trail III site.

In 2010 activity sites with confirmed pairs included: Lower Ross Dam (along Ross Lake to junction of Pierce Mountain Trail), Big Beaver Creek Trail I (approximately 350 m up creek from Ross Lake), Big Beaver Creek Trail II (approximately 5.5 miles up the trail from Ross Lake), Big Beaver Creek Trail III (approximately 9 miles up trail from Ross Lake), Big Beaver Creek Trail VI (near Beaver Pass Campground), Thunder Creek Trail III (650 m south of North Cascades National Park boundary with Ross Lake National Recreation Area). The same pair of owls identified at Panther Creek Trail II in 2009 was believed to have been detected on an adjacent trail in 2010 (Panther Creek Trail I). One or more juveniles fledged from the following sites in 2010: Fisher Creek Trail, Middle Big Beaver Creek Trail I, and Big Beaver Creek Trail II. Although an adult male was detected at the Fisher Creek Trail Middle site, a female was never detected, so pair occupancy at this site remains unconfirmed.

Table 3. Barred Owl activity sites detected during the 2009 - 2010 Spotted Owl survey in North Cascades National Park.

Activity Site Code[a]	Location Description	Years Detected	Breeding Status	Breeding Status Notes
A	Hozomeen Road	2009	Pair	Male and female detected
B	Lightning Creek Trail I	2009	Pair	Male and female detected
C	Lightning Creek Trail II	2009	Pair	Male and female detected
D	Desolation Bench	2009	Unknown	None
E	East Bank Bench	2009	Unknown	None
F	Lightning Creek Trail V	2009	Unknown	None
G	East Bank Tail I	2009	Unknown	None
H	East Bank Trail II	2009	Pair	Male and female detected
I	East Bank Trail III	2009	Nest	Male, female, and one juvenile detected
J	Roland Point	2009	Pair	Male and female detected
K	East Bank Trail IV	2009	Pair	Male and female detected
L	Ruby Creek Trail Lower	2009	Unknown	None
M	Happy Creek	2009	Pair	Male and female detected
N	Panther Creek Trail II	2009	Pair	Male and female detected
O	Thunder Lake	2009	Pair	Male and female detected
P	Highway 20 I	2009	Unknown	None
Q	Stetattle Creek	2009	Unknown	None
R	Newhalem Creek Upper	2009	Unknown	Probable pair but not confirmed
S	Nightmare Campground	2010	Unknown	None
T	Little Beaver Creek Trail II	2010	Unknown	None
U	Little Beaver Creek Trail III	2010	Unknown	None
V	Big Beaver Creek Trail VI	2010	Pair	Male and female detected
W	Big Beaver Creek Trail III	2010	Pair	Male and female detected
X	Big Beaver Creek Trail II	2010	Pair	Male and female detected, two juveniles detected
Y	Big Beaver Creek Trail I	2010	Pair	Male and female detected, two juveniles detected
Z	Newhalem Creek	2010	Unknown	None
A1	Fisher Creek Trail Middle	2010	Unknown	Probable pair, one juvenile detected

Table 3. Barred Owl activity sites detected during the 2009 - 2010 Spotted Owl survey in North Cascades National Park. (continued)

Activity Site Code[a]	Location Description	Years Detected	Breeding Status	Breeding Status Notes
B1	Thunder Creek Trail V	2010	Unknown	None
C1	Thunder Creek Trail IV	2010	Unknown	None
D1	Thunder Creek Trail III	2010	Pair	Male and female detected
E1	Thunder Creek East	2010	Unknown	None
F1	Panther Creek Trail I	2010	Unknown	None
G1	Thunder Creek Trail I	2010	Unknown	None
H1	Lower Ross Dam	2010	Pair	Male and female detected

[a] Letters correspond to those in Figure 4.

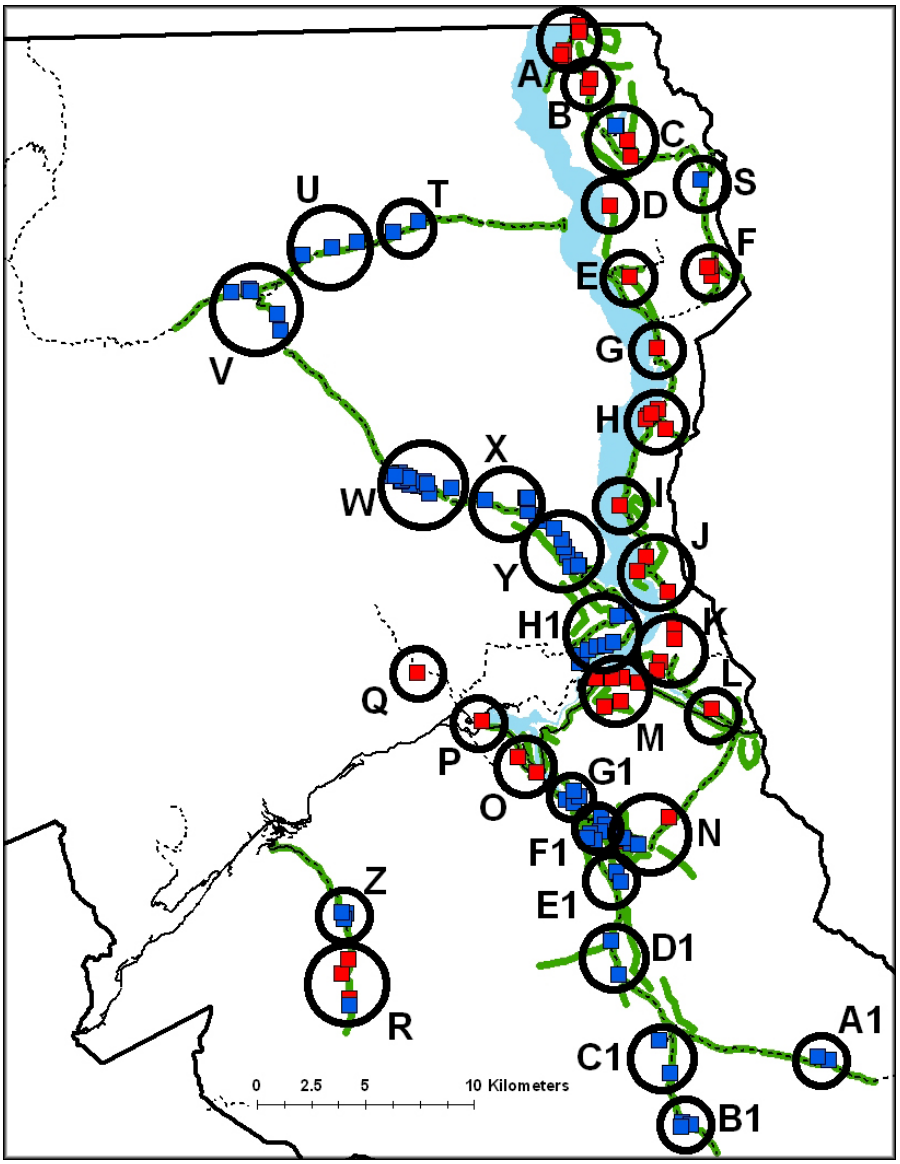

Figure 4. Location of Barred Owl detections recorded during the 2009 (red squares) and 2010 (blue squares) Spotted Owl survey in North Cascades National Park. Lettered black circles group the detections according to our best guess of the number of distinct territories represented by the detections, but are not intended to indicate territory size; see Table 3 for more information. Green lines indicate Spotted Owl survey transects; dashed black lines indicate trails; thin black lines indicate roads; thick black lines indicate park boundaries.

Western Screech-Owl

We detected two Western Screech-Owls, representing two activity sites, in 2009 and none in 2010 (Table 4, Fig. 5). One detection was made from the Hidden Hand campground near the Ruby Creek Trail Upper transect. A second individual was detected on two occasions along the Lightning Creek Trail I transect near station 6.5.

Table 4. Western Screech-Owl activity sites detected during the 2009 Spotted Owl survey in North Cascades National Park.

Activity Site Code[a]	Location Description	Years Detected	Breeding Status	Breeding Status Notes
A	Hidden Hand Campground	2009	Unknown	None
B	Lightning Creek Trail I	2009	Unknown	None

[a] Letters correspond to those in Figure 5.

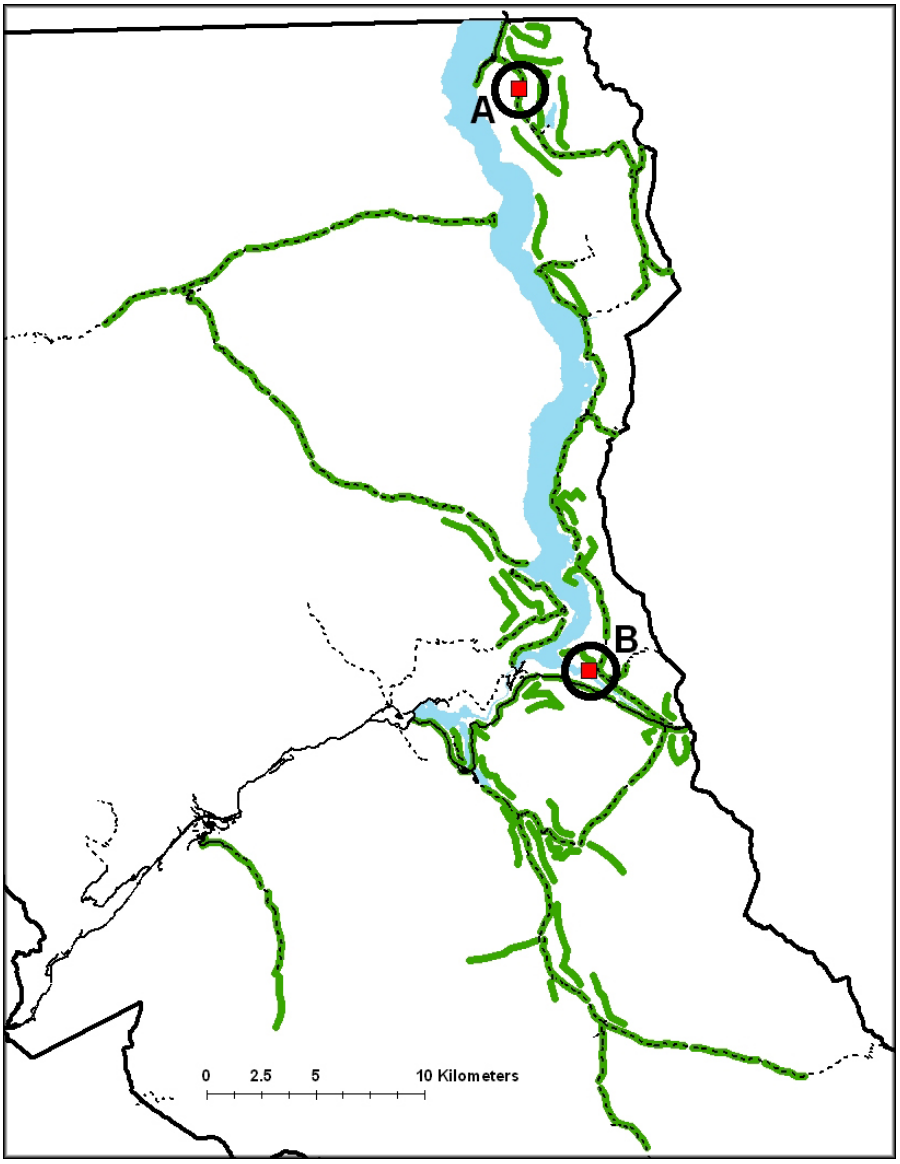

Figure 5. Location of Western Screech-Owl detections recorded during the 2009 Spotted Owl survey in North Cascades National Park; no Western Screech-Owls were detected during our Spotted Owl surveys in 2010. Red squares indicate individual detections. Lettered black circles group the detections according to our best guess of the number of distinct territories represented by the detections; see Table 4 for more information. Green lines indicate Spotted Owl survey transects; dashed black lines indicate trails; thin black lines indicate roads; thick black lines indicate park boundaries.

Northern Pygmy-Owl

We documented seven Northern Pygmy-Owl detections, representing six activity sites in 2009 and six detections representing three additional activity sites in 2010 (Table 5, Fig. 6). In 2009 single detections were recorded during surveys of the Ruby Arm, Roland Point, and Howlett Creek transects, and incidental detections of single birds were recorded along the Ruby Creek Trail Lower and Newhalem Creek East transects. We heard two individuals calling simultaneously on the East Bank Bench transect. In 2010 one activity site was believed to be represented by detections on three distinct but tightly clustered transects: Panther Potholes, Thunder Creek East (two detections were made on this same transect), and an incidental detection on Thunder Creek Trail II. These four detections were all within 1 mile of each other. Another activity site is represented by an incidental detection from Stillwell campground. The final activity site is from a single detection from the McAllister Creek Lower transect.

Table 5. Northern Pygmy-Owl activity sites detected during the 2009 and 2010 Spotted Owl survey in North Cascades National Park.

Activity Site Code[a]	Location Description	Years Detected	Breeding Status	Breeding Status Notes
A	Howlett Creek	2009	Unknown	None
B	East Bank Bench	2009	Possible pair	2 owls calling simultaneously
C	Roland Point	2009	Unknown	None
D	Ruby Arm	2009	Unknown	None
E	Ruby Creek Trail Lower	2009	Unknown	None
F	Newhalem Creek East	2009	Unknown	None
G	Thunder Creek	2010	Unknown	None
H	Stillwell Campground	2010	Unknown	None
I	McAllister Creek Lower	2010	Unknown	None

[a] Letters correspond to those in Figure 6.

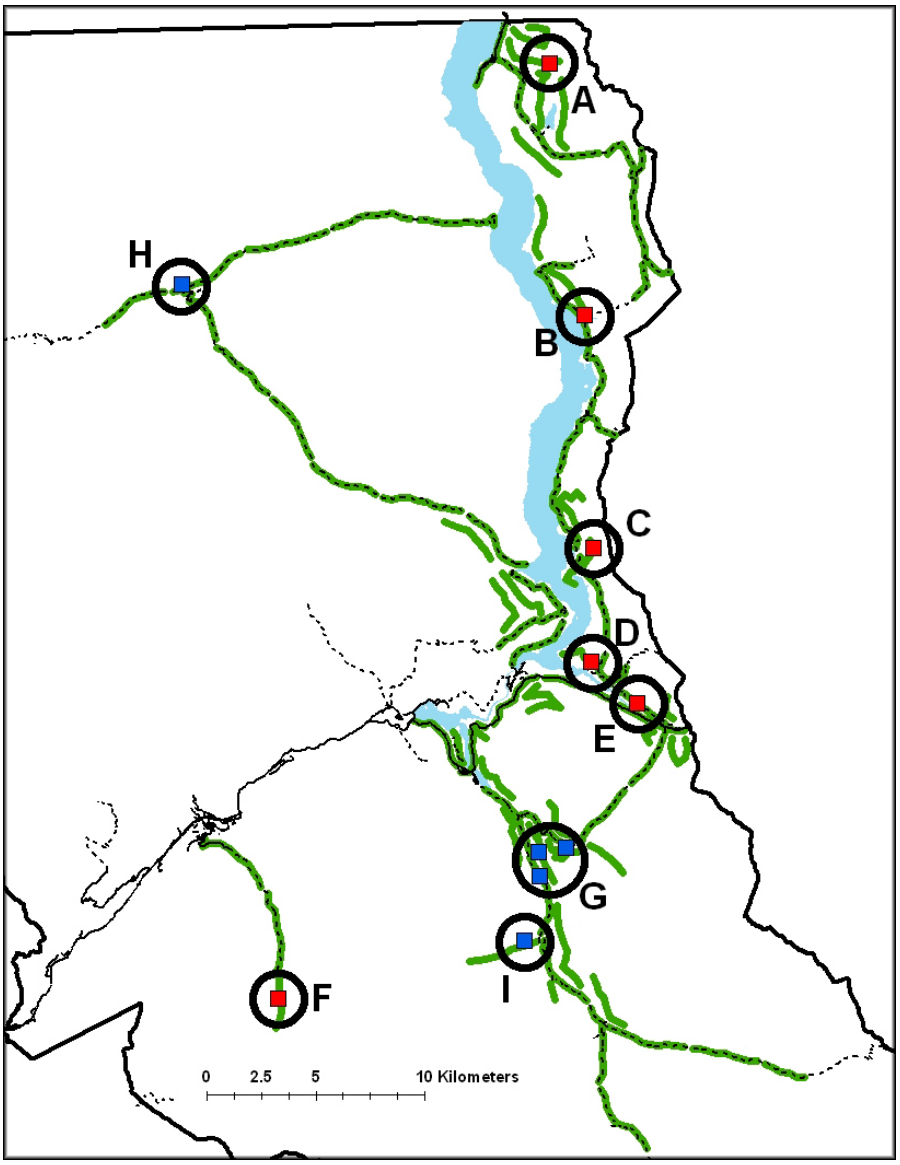

Figure 6. Location of Northern Pygmy-Owl detections recorded during the 2009 (red squares) and 2010 (blue squares) Spotted Owl survey in North Cascades National Park. Lettered black circles group the detections according to our best guess of the number of distinct territories represented by the detections, but are not intended to indicate territory size; see Table 5 for more information. Green lines indicate Spotted Owl survey transects; dashed black lines indicate trails; thin black lines indicate roads; thick black lines indicate park boundaries.

Northern Saw-whet Owl

In 2009 we documented eight Northern Saw-whet Owl detections, representing up to five activity sites (Table 6, Fig. 7). One individual (perhaps the same bird) was detected during each of three surveys of the Highway 20 IV transect. The remaining detections were all of single owls along transects Highway 20 V, Ruby Creek Trail Lower, Devil's Creek Trail, East Bank Trail I, and Canadian Border East. Given the close proximity of the detections on Ruby Creek Trail Lower and Highway 20 V, we believe they represent a single activity site separate from the Highway 20 IV activity site. In 2010 we documented six Northern Saw-whet Owl detections, representing five additional activity sites. Two detections of single owls were made within two

days of each other near the Thunder Creek trailhead. The other detections were single detections along Thunder V, Panther Creek Trail I, Big Beaver III, and Big Beaver I; these individuals are far enough apart to suggests distinct territories.

Table 6. Northern Saw-whet Owl activity sites detected during the 2009 and 2010 Spotted Owl survey in North Cascades National Park.

Activity Site Code[a]	Location Description	Years Detected	Breeding Status	Breeding Status Notes
A	Canadian Border East	2009	Unknown	None
B	East Bank Trail I	2009	Unknown	None
C	Devil's Creek Trail	2009	Unknown	None
D	Highway 20 IV	2009	Unknown	None
E	Highway 20 V	2009	Unknown	None
F	Thunder Creek Trailhead	2010	Unknown	None
G	Thunder V	2010	Unknown	None
H	Panther Creek trail I	2010	Unknown	None
I	Big Beaver III	2010	Unknown	None
J	Big Beaver I	2010	Unknown	None

[a] Letters correspond to those in Figure 7.

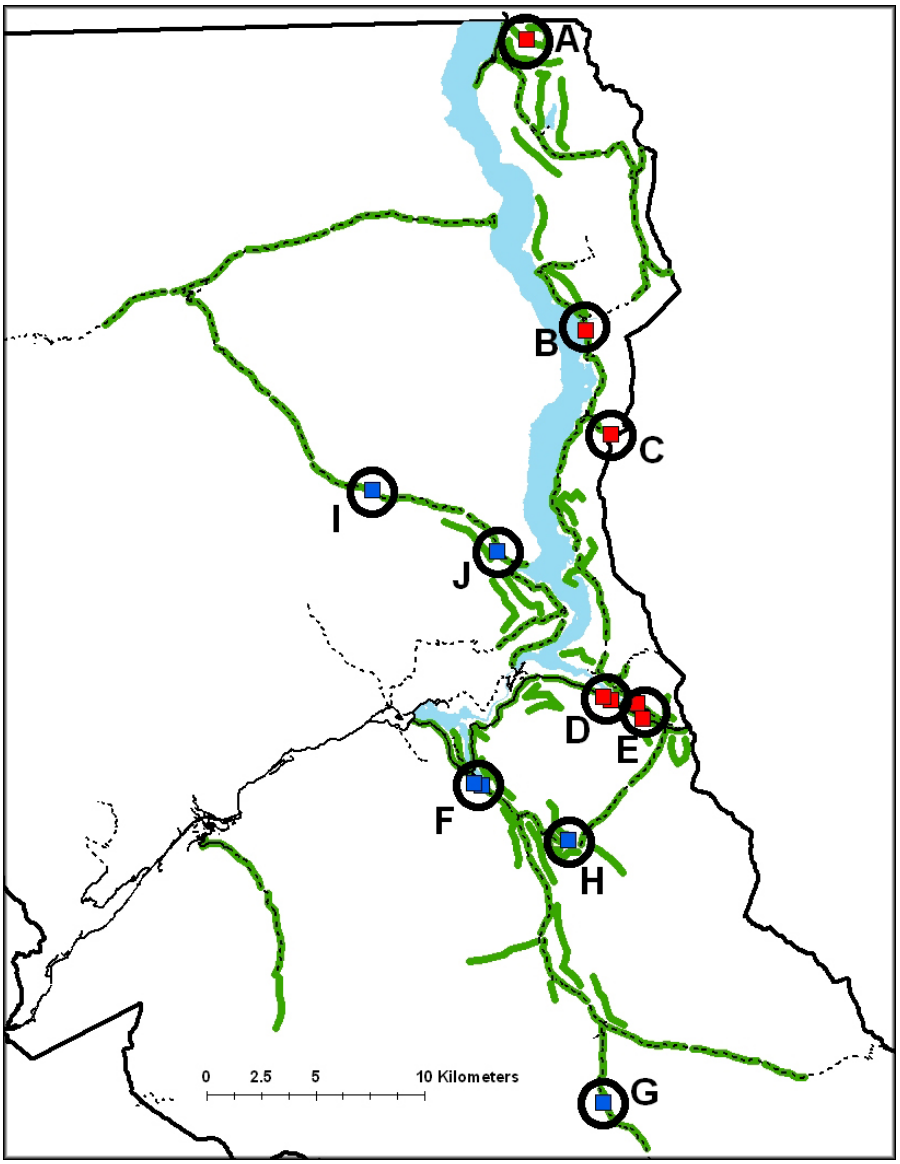

Figure 7. Location of Northern Saw-whet Owl detections recorded during the 2009 (red squares) and 2010 (blue squares) Spotted Owl survey in North Cascades National Park. Lettered black circles group the detections according to our best guess of the number of distinct territories represented by the detections, but are not intended to indicate territory size; see Table 6 for more information. Green lines indicate Spotted Owl survey transects; dashed black lines indicate trails; thin black lines indicate roads; thick black lines indicate park boundaries.

Transects Surveyed

Below we provide an annotated list of all transects surveyed in 2009 and 2010. The average elevation of the survey stations along each transect is provided in parentheses, along with the dates the transect was surveyed. Transect locations are indicated in Figure 8 (northern half of the Ross Lake drainage), Figure 9 (southern half of the Ross Lake drainage, plus the Panther Creek, Ruby Creek, and Thunder Creek drainages), Figure 10 (Newhalem Creek drainage), Figure 11 (western portion of the Ross Lake drainage) and Figure 12 (Thunder Creek and Fisher Creek drainages).

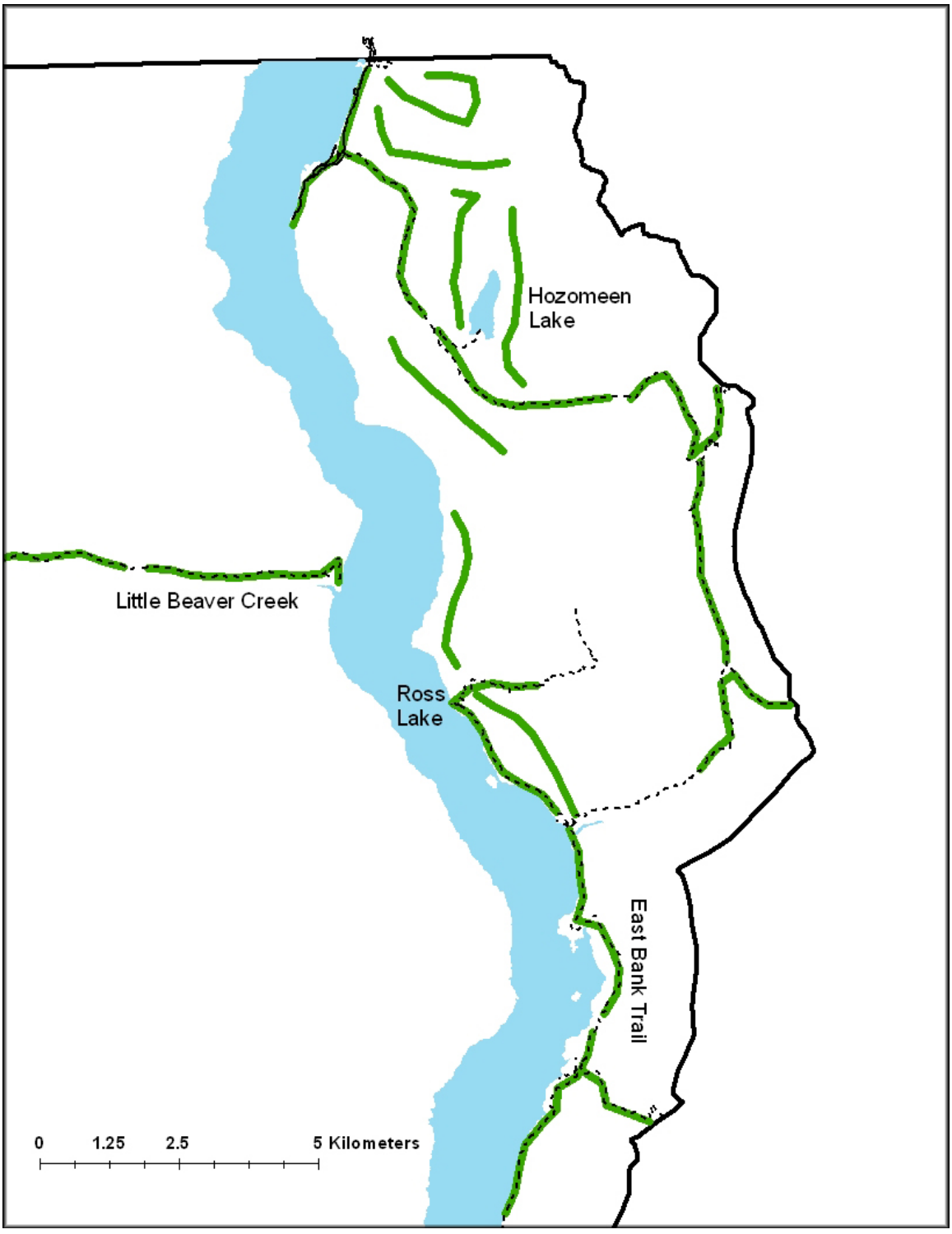

Figure 8. Northernmost transects (green lines) in the Ross Lake drainage surveyed for Spotted Owls during the 2009 or 2010 field seasons in North Cascades National Park. Dashed black lines indicate trails; thin black lines indicate roads; thick black lines indicate park boundaries.

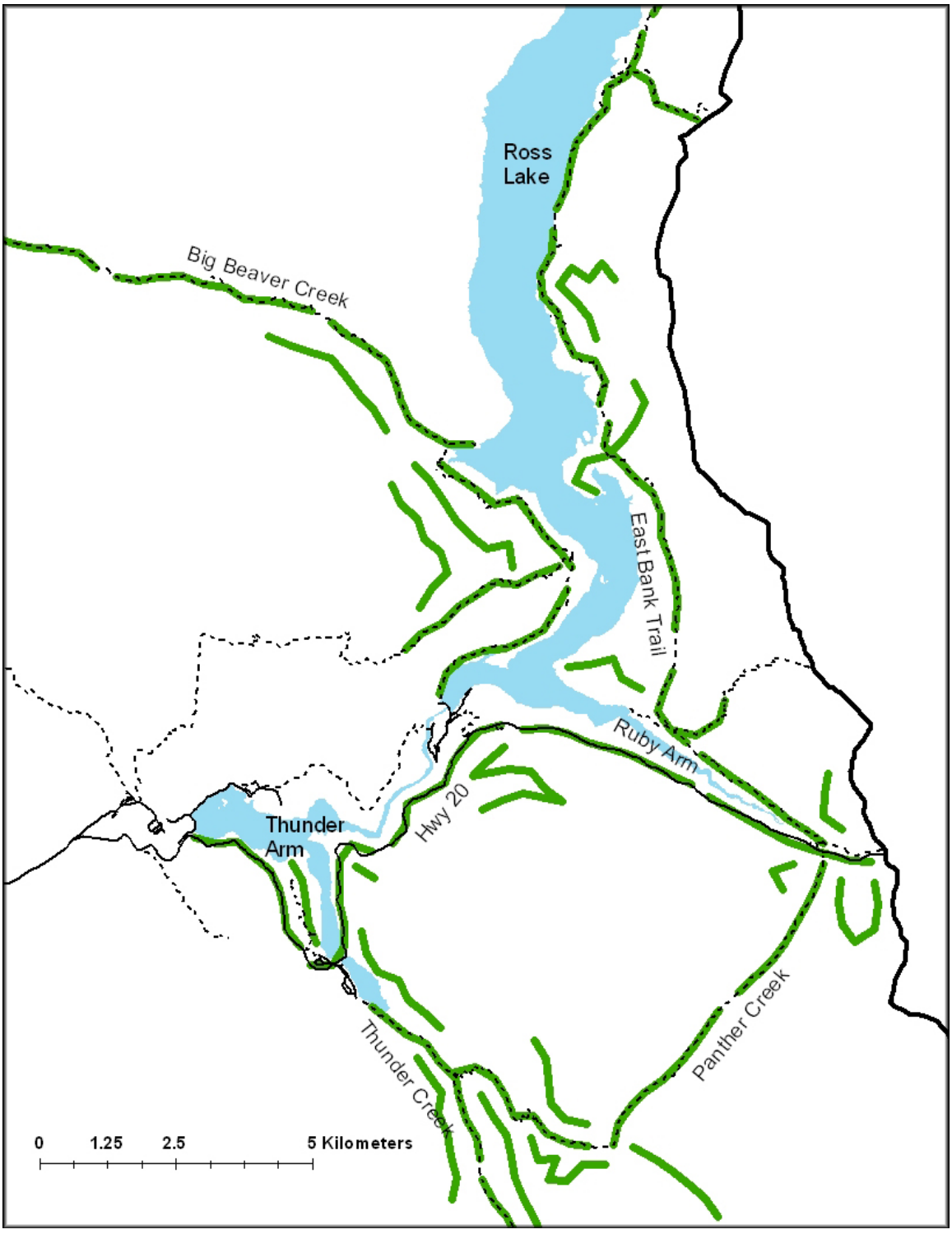

Figure 9. Transects (green lines) in the Panther Creek, Ross Lake (southern portion only), Ruby Creek, and Thunder Creek drainages surveyed for Spotted Owls during the 2009 or 2010 field seasons in North Cascades National Park. Dashed black lines indicate trails; thin black lines indicate roads; thick black lines indicate park boundaries.

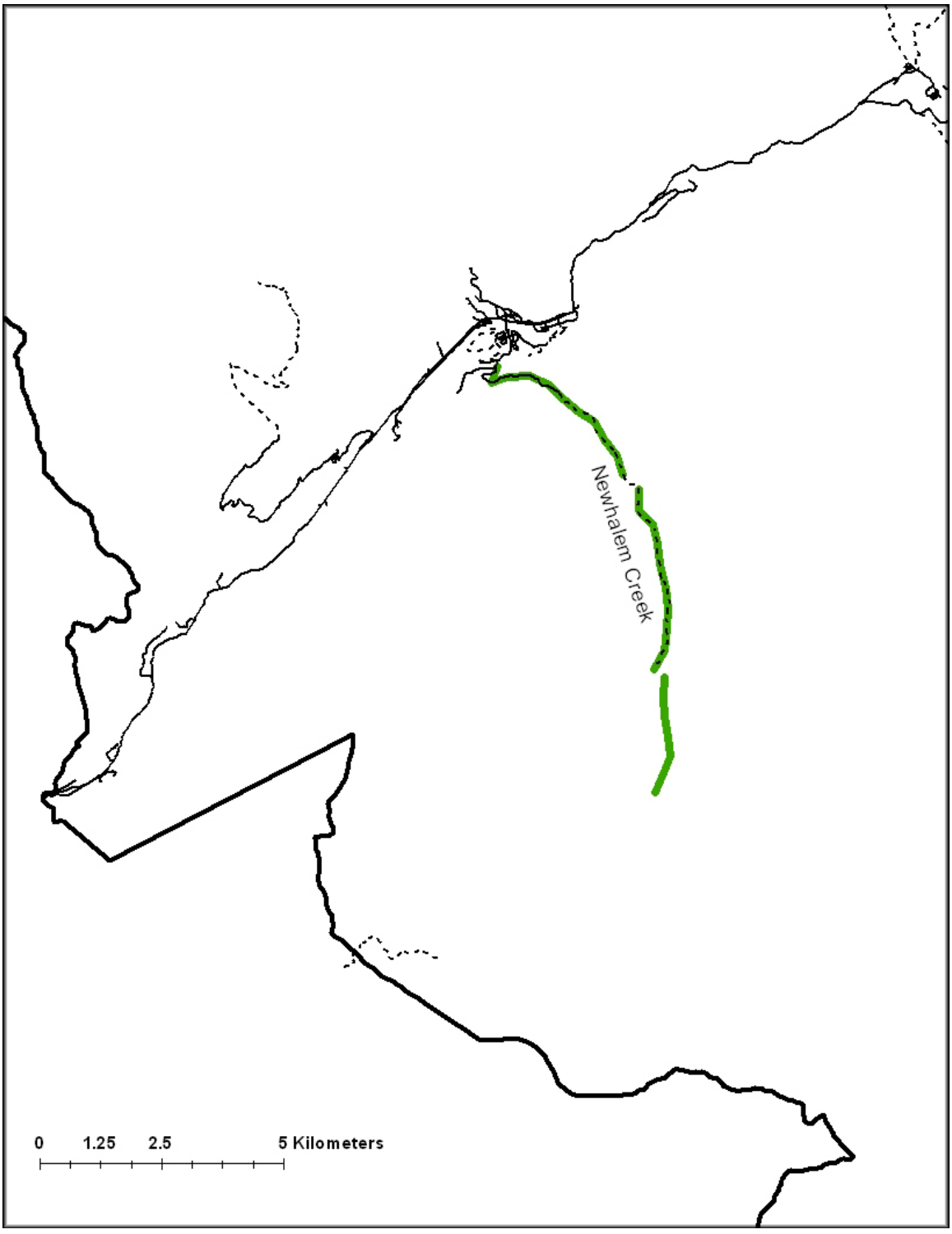

Figure 10. Transects (green lines) in the Newhalem Creek drainage surveyed for Spotted Owls during the 2009 or 2010 field seasons in North Cascades National Park. Dashed black lines indicate trails; thin black lines indicate roads; thick black lines indicate park boundaries.

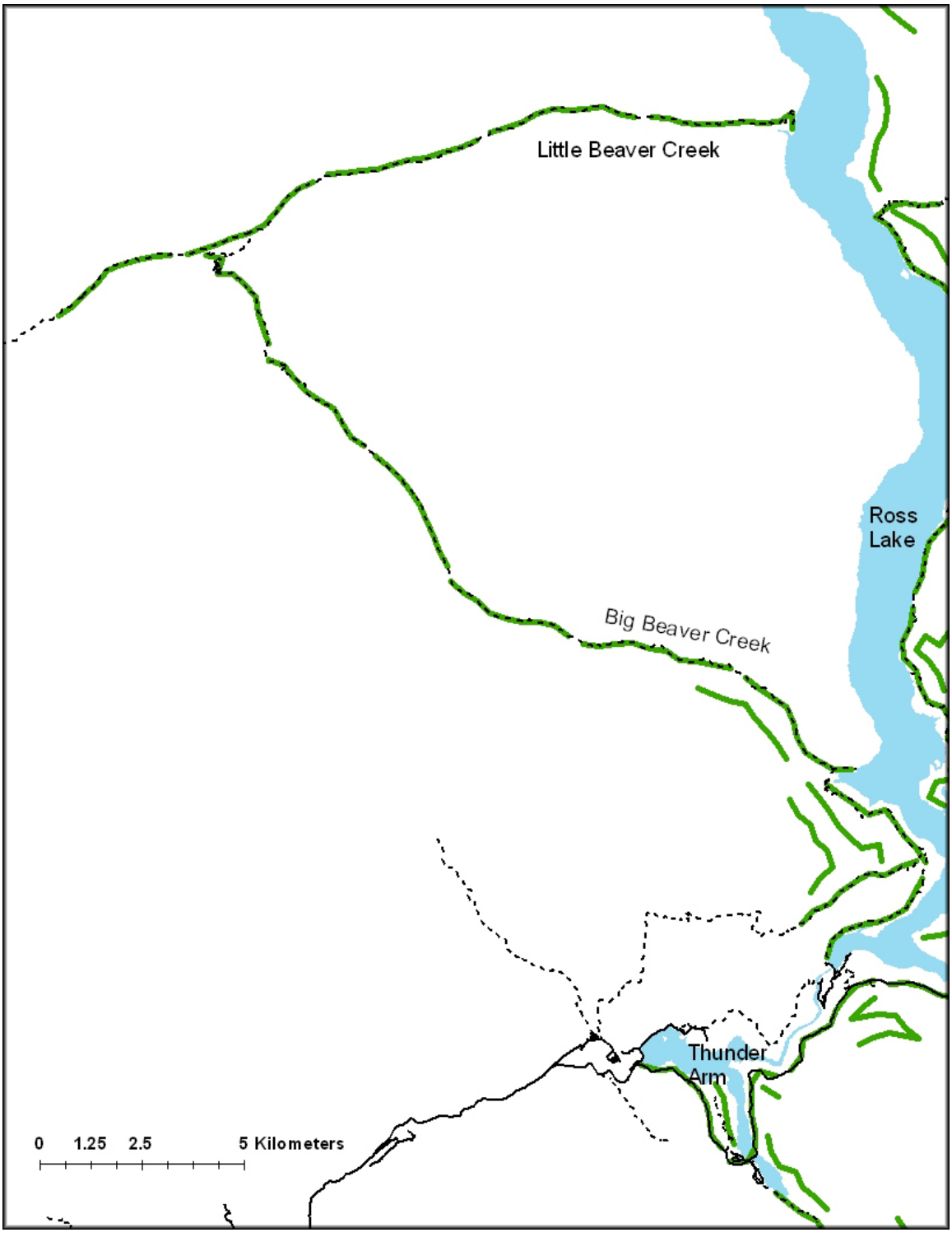

Figure 11. Transects (green lines) in the Ross lake drainage (western portion) surveyed for Spotted Owls during the 2009 or 2010 field seasons in North Cascades National Park. Dashed black lines indicate trails; thin black lines indicate roads; thick black lines indicate park boundaries.

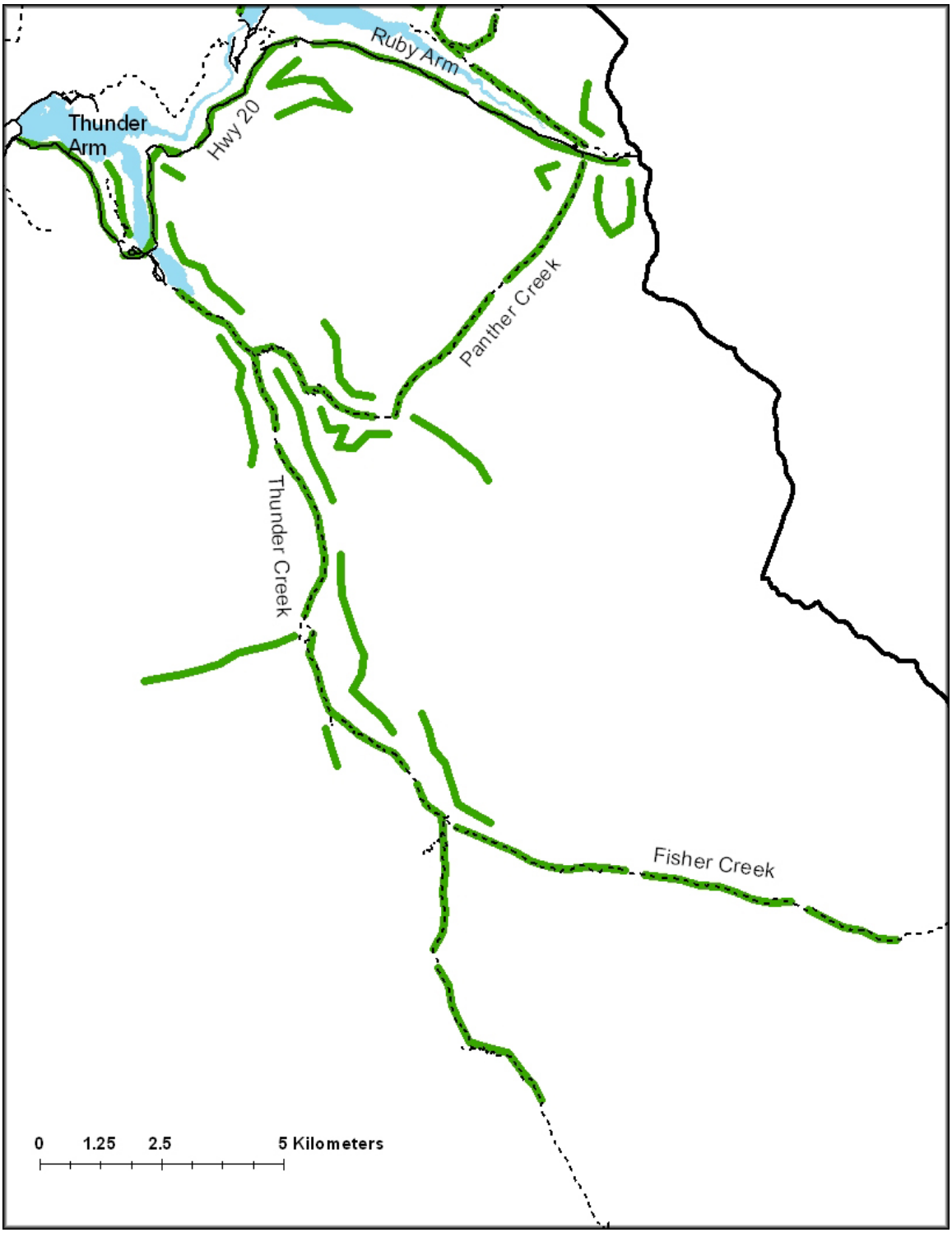

Figure 12. Transects (green lines) in the Thunder Creek and Fisher Creek drainages surveyed for Spotted Owls during the 2009 or 2010 field seasons in North Cascades National Park. Dashed black lines indicate trails; thin black lines indicate roads; thick black lines indicate park boundaries.

Fisher Creek Drainage Transects

Fisher Creek Trail Lower (1,063 m; surveyed April 23 and May 18, 2010): Stations 7.0-10.0 were excluded from the survey on the first attempt due to ice and snow on the trail. On the second attempt, we realized that a bridge had been destroyed, and there was a network of streams to cross using fallen logs. Due to the added hazard, we decided to deploy a pair of surveyors to survey this transect together. During the second visit, we detected an unidentified *Strix* at Station 1.0. It was a subtle one-note contact call, and we stayed at the station for 20 minutes hoping that it would hoot again. We conducted two follow-up visits in this area to identify this owl, but no owls were detected during the follow-up visits. A Barred Owl was detected incidentally from Meadow Cabins, which is about 800 meters from where we detected the unidentified *Strix*. This may represent the same Barred Owl activity site.

Fisher Creek Trail Middle (1,123 m; surveyed May 17 and July 7, 2010): Patchy snow was present on the first visit. We detected no owls on the survey itself; however, we recorded multiple incidental detections in this area. We detected a Barred Owl east of Station 19.0, an unidentified *Strix* from Cosho Camp (close to Station 18.0) and an unidentified juvenile from Cosho Camp. These unidentified owls are most likely Barred Owls due to their proximity to the known Barred Owl detection. The location of the bridge over Fisher Creek is different from how it appears on the topographic map - it is now located west of Station 17.0 (it appears on the map right past Station 18.0). Fisher Creek Trail is generally in poor condition, requiring numerous stream crossings.

Fisher Creek Trail Upper (1,231 m; surveyed May 16 and July 8, 2010): Heavy snow interfered with our first visit to this transect, forcing us to exclude Station 25.0. By the end of the season, the snow had melted and we were able to complete the full transect on the second visit. We detected no owls.

Fisher Creek Lower (1,015 m; surveyed May 15, 2010): Historically, a bridge was present that crossed Fisher Creek, with a campground on the other side. No such bridge exists today, and in order to access Fisher Creek Lower, a rushing Fisher Creek must be crossed. During our first visit, we found a stable log to cross the creek. During the second (attempted) visit the crew did not feel comfortable crossing on the log, due to high velocity flow. Because of this, we were only able to survey this transect once. We only partially surveyed this transect, excluding Stations 6.5 through 8.0 due to difficult terrain and time constraints. We detected no owls.

Newhalem Creek Drainage Transects

Newhalem Creek East (742 m; surveyed May 24 and June 12, 2009): During the second visit, we found an owl pellet, approximately 5 cm long and containing bones of a squirrel or other large rodent, at station 3.5. Later, we detected a Barred Owl and a Northern Pygmy-Owl near station 3.5 during a historical follow-up visit after transect surveys were completed. We grouped the Barred Owl detected on this transect as belonging to the Newhalem Creek Upper activity site.

Newhalem Creek Trail Lower (297 m; surveyed April 13 and May 2, 2009): We detected no owls of any species along this transect.

Newhalem Creek Trail Upper (520 m; surveyed May 23 and June 11, 2009): We detected a Spotted Owl near station 16.5 during a historical follow-up visit on June 27, 2009 (see above).

During transect surveys, we recorded two Barred Owl detections on this transect, one near station 19.5 during our first visit, and the other at station 21.0 during the second visit. The observer of the first Barred Owl detection may have also heard a second Barred Owl near the same station, but noise interference from Newhalem Creek prevented positive pair confirmation. The Newhalem Creek Trail is no longer maintained by park trail crews. In the early season high snow made it easily passable, but by mid June the snow had largely melted and dense brush made for very difficult traveling. For logistics and planning purposes, the transect should be treated as on off-trail transect in the future.

Panther Creek Drainage Transects

Panther Creek Trail II (888 m; surveyed May 25, 2009): We detected a single Barred Owl while surveying this transect; positive pair status was later confirmed from the 4th of July Pass campground near station 10.0.

Panther Creek Trail III (640 m; surveyed May 3, May 21, and June 14, 2009): We detected no owls of any species on this transect.

Panther Creek Spur Trail (911 m; surveyed May 26, 2009): We detected no owls of any species on this transect. The field crew noted that much of the habitat seemed particularly suitable for Spotted Owls, with many old growth stands of Western Redcedar and Western Hemlock.

Stillwell Creek (1,057 m; surveyed May 27, 2009): We detected no owls of any species along this transect. Due to difficult, steep terrain, the crew did not survey stations 4.5 through 8.0, and relocated stations 3.0 and 3.5 to safer terrain closer to Stillwell Creek. With the historical bridge missing on Panther Creek, the hiker camp was inaccessible and this transect was conducted as a day trip from Diablo, adding another five miles of hiking needed to complete the transect survey. The crew recommended omitting this transect from future survey efforts.

Ross Lake Drainage Transects

Beaver Creek Wetlands (531 m; surveyed May 8 and June 18, 2010): Both attempts to survey this transect were cut short due to the ruggedness of the terrain. The start of this transect is only accessed by traveling off-trail, and considerable time is required to reach the beginning of the survey. There are large talus slopes and extensive patches of vine maple on the transect itself. Points 3.5-8.0 were not surveyed during either visit. No owls were detected on the transect itself, although a Barred Owl was detected as we hiked towards Beaver Creek Wetlands. We assumed this owl to be part of the Big Beaver I activity site.

Big Beaver Creek Trail I (505 m; surveyed April 16 and May 28, 2010): On the first visit to this transect a pair of Barred Owls was observed calling in chorus near Station 4.0. During the second visit a single Barred Owl was detected near Station 5.0 and Station 9.0. An individual owl was detected at Station 10.0, and gave an unusual one-note hoot. An individual was also detected twice incidentally south of Station 3.0, on the south side of Big Beaver Creek. Two juveniles were also detected in this area. Incidentals detections included Barred Owl detections all along this transect, including stations 5, 6, 7, 9, and 10. A Northern Saw-whet owl was also detected during the second visit, near Station 4.5.

Big Beaver Creek Trail II (515 m; surveyed April 17 and May 5, 2010): This transect was first visited during training, and a single Barred Owl was detected near Station 11.0. The second visit

resulted in a Barred Owl pair detection, close to Station 16.0. Incidental detections included a pair of Barred Owls close to Station 11.0, with two fledged juveniles. During the second visit to this transect, a crew member had a close encounter with two cougars.

Big Beaver Creek Trail III (577 m; surveyed May 5 and May 25, 2010): The Big Beaver Boundary historical detection site is close to this transect. This was one of the most congested areas for Barred Owl detections this season, with very vocal and persistent owls. A Barred Owl pair was detected while conducting a follow up visit, north of Station 25.0. A Northern Saw-whet Owl was also detected near Station 21.0.

Big Beaver Creek Trail IV (738 m; surveyed June 7 and July 8, 2010): No owls were detected along this transect. During the second visit Stations 33.5-38.0 were not surveyed due to a high-velocity stream that the crew did not feel safe crossing.

Big Beaver Creek Trail V (854 m; surveyed June 7, 2010): This transect was only visited once. A second visit was attempted but aborted due to the high-velocity stream in the middle of Big Beaver Creek Trail IV transect (see above). No owls were detected along this transect.

Big Beaver Creek Trail VI (998 m; surveyed June 6 and June 29, 2010): During the first visit to this transect, stations 48.0-49.5 were not surveyed due to the difficulty of navigating in the snow after dark. We detected a pair of Barred Owls calling in chorus during the second visit at Station 49.0, and an individual was heard that same night from station 51.0. A Northern Pygmy Owl was detected incidentally from Stillwell Campground, north of Station 56.0 of this transect.

Canadian Border East (785 m; surveyed May 17 and June 14, 2009): We detected a Northern Saw-whet Owl at Station 3.0 during our first visit. We also detected a pair of Barred Owls during our first visit, first incidentally while hiking to the start point, and then again during the survey at station 1.5. We believe this pair is the same pair identified on the Hozomeen Road transect.

Desolation Bench (636 m; surveyed April 23 and June 2, 2009): During our second visit, we detected a Barred Owl at Station 7.5 (we also detected a Northern Goshawk at Station 3.5).

Desolation Lookout Trail (658 m; surveyed April 22 and May 31, 2009): We detected no owls of any species on this transect.

Devils Creek Trail (765 m; surveyed April 26 and June 3, 2009): We recorded an incidental detection of a Northern Saw-whet Owl during the first visit. During the second visit we detected a pair of Barred Owls at Station 3.0. The field crew noted that this could be the same pair detected on the East Bank Trail II transect.

East Bank Bench (727 m; surveyed April 22 and June 1, 2009): We detected a Barred Owl during our first visit, at station 6.0. The crew believed the owl was female, though they were not certain. Two Northern Pygmy-Owls were detected, calling in chorus, on the second visit at Stations 1.0 and 1.5.

East Bank Trail I (532 m; surveyed April 15 and May 31, 2009): We detected a Northern Saw-whet Owl during our first visit. During the second visit, we detected a Barred Owl at Station 4.0.

East Bank Trail II (531 m; surveyed April 15 and June 3, 2009): We detected a Barred Owl pair during the first visit at Station 12.0. There were also three incidental Barred Owl detections made from the Devils Creek Campground, near Station 13.0, on various dates throughout the survey season.

East Bank Trail III (526 m; surveyed April 14 and June 4, 2009): We detected a Barred Owl pair during both the first and second visits at Station 24.0. Additionally, during the second visit we heard a fledgling Barred Owl giving the juvenile hissing call.

East Bank Trail IV (632 m; surveyed April 4 and April 14, 2009): We detected two Barred Owls during the first visit, one at Station 36.5 and the other at Station 40.0. Three Barred Owls were detected during the second visit—a pair at station 40.0 and a single detection at station 31.0. The owl at station 31.0 was likely one of the same birds detected on the Roland Point transect.

Howlett Creek (770 m; surveyed May 16 and June 10, 2009): We detected a Northern Pygmy-Owl during the first visit at Station 7.0.

Hozomeen Creek (808 m; surveyed May 15 and June 11, 2009): We detected no owls of any species while surveying this transect, but recorded several incidental owl detections in the general area. While hiking towards the start point of this transect for our second visit, we saw an unidentified *Strix* owl fly overhead near Station 1.0. The owl was unresponsive to our hooting. We recorded three incidental Barred Owl detections later that night, including a confirmed pair approximately 400 m southeast of station 1.0 at the Hozomeen Lake campground. Because of the proximity to the location of the Lightning Creek II Barred Owl pair, we believe the Hozomeen Creek detections to be the same pair.

Hozomeen Road (504 m; surveyed May 12 and May 16, 2009): We detected a Barred Owl at Station 4.0 during our first visit. The presence of a Barred Owl pair was confirmed with seven incidental detections recorded from the Hozomeen bunkhouse near station 5.0 on various dates.

Jackass Ridge (1,110 m; surveyed June 13, 2009): We visited this transect only once, and detected no owls of any species.

Lightning Creek Trail I (720 m; surveyed May 11 and May 14, 2009): We recorded three Barred Owl detections during our first visit. An individual Barred Owl was recorded at Station 6.5 and the Hozomeen Road pair was detected from Station 1.0. During the second visit, we detected a Barred Owl at station 5.5. We recorded an incidental Western Screech-Owl detection near Station 6.5 prior to each survey visit.

Lightning Creek Trail II (857 m; surveyed May 12 and June 24, 2009): During the first visit, we detected a Barred Owl at Station 16.0, and an unidentified owl was recorded incidentally from the Willow Lake campground near Station 19.0. During our second visit, heavy rain prevented survey of Stations 14.0 and 15.0-20.0.

Lightning Creek Trail III (813 m; surveyed May 13 and June 23, 2009): We detected no owls of any species along this transect. During the first visit, heavy rain prevented the survey of Stations 21.0-25.5. During the second visit, loose debris and the risk of a rockslide prevented the survey of Stations 28.0-30.0.

Lightning Creek Trail IV (645 m; surveyed April 25 and June 22, 2009): We detected no owls of any species along this transect, despite the historical Spotted Owl detections and the presence of particularly high quality Spotted Owl habitat. We also conducted six 'follow-up surveys' in the vicinity (the Deer Lick site), because the area was known to have been occupied in the past (see Deer Lick Historic Activity Center on page 9).

Lightning Creek Trail V (689 m; surveyed April 24 and June 21, 2009): During our second visit, we detected a Barred Owl at Station 46.5. Two other Barred Owl detections were recorded near Stations 44.0 and 45.0 earlier that day while surveyors were conducting a historical follow-up visit at the Deer Lick site. All detections may have been of the same individual Barred Owl.

Little Beaver Creek Trail I (600 m; surveyed June 4 and June 26, 2010): No owls were detected along this transect.

Little Beaver Creek Trail II (628 m; surveyed June 3 and June 25, 2010): An extremely vocal Barred Owl was detected during the first visit, near Station 18.0. A second individual could have been present, although the crew member was not confident enough to list a pair. No owls were detected during the second visit.

Little Beaver Creek Trail III (655 m; surveyed June 3 and June 26, 2010): A Barred Owl was detected on this transect during the second visit, near Station 28.0 and again near Station 25.0. A Barred Owl – perhaps the same individual – was detected incidentally south of Station 21.0

Little Beaver Creek Trail IV (723 m; surveyed June 5 and June 28, 2010): An individual Barred Owl was detected during the first visit to this transect, near Station 39.5. On the second visit, no owls were detected. A Barred Owl was detected incidentally near Station 31.5

Little Beaver Creek Trail V (809 m; surveyed June 5 and June 28, 2010): A Barred Owl was detected near Station 41.5 during the first visit. This is likely the same individual that was detected on Little Beaver Creek Trail IV the same night. Stations 49.0-45.0 were not surveyed during the second visit due to a large stream that the crew did not feel comfortable crossing. No owls were detected the second visit.

Lower Ross Dam (591 m; surveyed April 15 and April 26, 2010): A pair of Barred Owls was detected during both visits to this transect. During both visits the pair was heard near Station 3.0. Barred Owls were heard at subsequent survey stations during both visits, ranging from Station 1.5 to 5.0. On the first visit, a single Barred Owl was heard across the lake, which may represent an additional activity site.

May Creek (806 m; surveyed May 2 and June 4, 2009): We detected no owls of any species on this transect. The transect covers steep, rugged terrain requiring bouldering over small cliffs and traversing steep slopes with loose rock—the survey crew recommended omitting it from future surveys out of safety concerns.

Pierce Creek Lower (706 m; surveyed April 27 and May 7, 2010): During the first attempt to survey this transect we had difficulty finding a crossing over Pierce Creek, and only surveyed Stations 1.0-2.0. During the second attempt we were able to fully survey this transect due a log spanning the banks of the creek. No owls were detected during either visit.

Pierce Creek Upper (901 m; surveyed June 17): This transect required many miles of trail travel to access the departure point from the trail. We were only able to make one visit to this transect, during which we did not survey Stations 6.5 - 8.0 due to time constraints stemming from the long trail hike and difficult off-trail travel. No owls were detected.

Pierce Mountain Trail (916 m; surveyed May 9 and June 19, 2010): Early in the season, this transect retained substantial snow at the higher elevation stations. Due to this, Stations 8.5 and 9.0 were not surveyed during the first visit. As the season progressed and the snow melted, this transect became more accessible. During the second visit the crew made an error and accidentally failed to survey Stations 8.5 and 9.0. An individual Barred Owl was detected on the first visit, near Station 1.0. Based on the pitch of the call, this individual was believed to be a female. On the second visit, a pair was detected calling in chorus at Station 2.0, and subsequently at additional stations.

Ridley Creek (976 m; surveyed June 12, 2009): We detected a Barred Owl at Station 2.0, likely a member of the same pair detected on Lightning Creek Trail II.

Roland Point (596 m; surveyed April 17 and June 5, 2009): During our first visit, we detected a Northern Pygmy-Owl at Station 7.5 and a Great Horned Owl at Station 3.0. During the second visit, we detected a Barred Owl pair at Station 3.0.

Ross Dam Trail Upper (589 m; surveyed April 16 and May 28, 2010): No owls were detected along this transect.

Ruby Creek Drainage Transects

Happy Creek (936 m; surveyed May 4 and June 10, 2009): We detected a Barred Owl at Station 6.0 during the first and second visits. During the second visit, another Barred Owl, believed to be a female, was also detected at station 9.0. The field crew noted that this transect crosses through particularly good Spotted Owl habitat, with mature stands of Western Redcedar and Douglas-fir.

Highway 20 III (620 m; surveyed April 3, April 11, and April 23, 2009): We detected a male Barred Owl at Station 26.0 during our first visit. The owl was likely a member of the pair detected on the Happy Creek transect.

Highway 20 IV (661 m; surveyed April 4, April 11, and April 22, 2009): We detected a Northern Saw-whet Owl during each visit, ranging between Stations 36.0 and 35.0. We also recorded three Barred Owl detections along this transect. During our first visit we detected Barred Owls at Stations 29.0 and 31.0, though it was unclear if these detections represented a single owl that had moved or two distinct owls. During our second visit, the detection was recorded at Station 28.0. The crew believed all three detections to be the same birds detected on the Happy Creek transect.

Highway 20 V (607 m; surveyed April 4, April 21, and May 5, 2009): We detected a Northern Saw-whet Owl at Station 40.0 during our first visit. The crew believed this detection to be unrelated to the detection on the Highway 20 IV transect because the two detections were recorded 1,600 m apart on the same night.

Ruby Arm (749 m; surveyed April 6, 2009): We surveyed this transect only once, and even then omitted Stations 6.0-9.0 due to safety concerns stemming from a recent discovery of a nearby

marijuana growing operation. We detected a Barred Owl and a Northern Pygmy-Owl at Station 1.0. This Barred Owl detection was grouped with the East Bank Trail IV activity site.

Ruby Boundary (919 m; surveyed May 6 and May 22, 2009): We detected no owls of any species on this transect.

Ruby Creek Trail Lower (574 m; surveyed April 4 and May 3, 2009): We detected a Northern Saw-whet Owl at Station 5.5 during the first visit; it called continuously throughout the night and was heard at subsequent survey stations. During the second visit we detected a single Barred Owl at Station 4.0, and also recorded an incidental Northern Pygmy-Owl detection near Station 5.5.

Ruby Creek Trail Upper (739 m; surveyed May 1, 2009): We detected no owls of any species during our survey of this transect. However, we recorded three incidental owl detections along the survey route on the night of April 6, 2009: a Barred Owl near Station 13.0, and then another Barred Owl (possibly the same individual) and a Western Screech-Owl from the Hidden Hand campground near Station 11.0. These Barred Owl detections were grouped as part of the East Bank Trail IV pair activity site.

Thunder Creek Drainage Transects

Fisher Creek Boundary (814 m; surveyed May 16 and June 26, 2010): During both visits this transect were only partially surveyed, due to steep terrain and dense vegetation. Stations 1.0 through 5.5 were not surveyed during the first visit, and Stations 1.0 through 4.5 were not surveyed during the second visit. No owls were detected.

Highway 20 I (429 m; surveyed April 2, April 11, and April 25, 2009): We detected a pair of Barred Owls during the first visit at Station 8.5, near the south end of Thunder Lake; this pair is associated with the Thunder Lake activity site. During the second visit, we heard a single Barred Owl calling from across Diablo Lake on the north side of Diablo Dam. This likely represents an additional activity site (Highway 20 I activity site), distinct from the pair detected during the first visit.

Highway 20 II (451 m, surveyed April 3, April 11, and April 24, 2009): We detected one Barred Owl, likely a member of the pair detected on the Highway 20 I transect, during our first visit.

McAllister Creek Lower (627 m; surveyed May 15 and June 27, 2010): A Northern Pygmy Owl was detected on the first visit close to Station 2.0. The survey ended early because the crew had GPS failure and slow travel through a brushy transect, excluding Stations 5.5-9.0. These same stations were excluded the second visit as well. On the second visit, two unidentified *Strix* juveniles were detected at Stations 4.5 and 5.0. The crew stayed in the area, hoping to locate an adult, but no adult appeared. The juveniles had slightly yellow beaks, which suggested they were Barred Owls, but perhaps not conclusively. Two follow-up visits were conducted in this area in hopes of detecting an adult to positively identify these owls. During the first follow-up visit the juveniles were detected but no adults were seen or heard, and during the second visit no owls were detected at all.

Panther Creek Trail I (811 m; surveyed April 27 and June 8, 2010): A Northern Saw-whet Owl was detected during the first visit to this transect at Station 9.0. A pair of Barred Owls was

detected at Station 4.0. During the second visit a pair of Barred Owls was detected at Station 8.0, and at subsequent survey stations. A Barred Owl was detected incidentally near Station 7.0.

Panther Creek (1,209 m; surveyed June 19, 2010): This transect is steep between Stations 3.0 and 4.0, and due to this the survey was cut short, eliminating Stations 4.0-6.0. No owls were detected.

Panther Potholes (1,084 m; surveyed June 18, 2010): We detected a Northern Pygmy Owl near Station 2.0.

Thunder Arm (491 m; surveyed April 14 and June 10, 2010): We surveyed this off-trail transect during training, and realized how slow-going it was, due to steep terrain and dense vegetation. Due to slow travel time and fading daylight, we decided not to survey Stations 6.5 and 7.0. We dropped these stations for the next visit for similar reasons. An individual Barred Owl was detected during the second visit near Station 1.0.

Thunder Creek East (671 m; surveyed May 29 and June 21, 2010): This transect required a long hike up 4th of July Pass Trail in order to access the trail departure point. We visited this transect twice. During the second visit, a nearby raven was heard at Station 5.0 and so the survey continued at Station 7.0. A pair of Barred Owls was detected during the first visit at Station 2.0. A pair was also detected at Station 8.0. A Northern Pygmy Owl was detected during the second visit at Station 5.0, and again at Station 7.0.

Thunder Creek Trail I (405 m; surveyed April 13 and July 10, 2010): This transect was full of Barred Owl hoots during our first visit during training week. At Station 9.0 there was a probable pair, and we had subsequent detections at Stations 5.0, 4.0 and 2.0. Two days after the first visit was made to this transect, a Barred Owl was incidentally detected near Station 10.0. A Northern Saw-whet owl was detected near Station 2.0 during the first visit. A few days later a Northern Saw-whet was also detected incidentally in the parking lot for the Thunder Creek Trail, which we assume was the same individual. A second visit was made late in the season and surprisingly we heard no owls.

Thunder Creek Trail II (518 m; surveyed April 15 and May 17, 2010): A Northern Pygmy Owl was incidentally detected close to Station 15.0 of this transect.

Thunder Creek Trail III (619 m; surveyed April 23 and May 17, 2010): During the first visit, 7 minutes into our survey at Station 30, heavy rain set in and precluded finishing the survey. Station 31.0 was the only full station not surveyed. We heard a pair of Barred Owls on the second visit, close to Station 26.0, and a distant Barred Owl call was heard near Station 22.0.

Thunder Creek Trail IV (810 m; surveyed April 24 and June 5, 2010): A single Barred Owl was detected at Station 40.0. No owls were detected on the second visit. An incidental Barred Owl was detected close to Meadow Cabins, which is approximately 400 meters west of this transect.

Thunder Creek Trail V (999 m; surveyed April 25 and June 5, 2010): An individual Barred Owl was detected during both visits to this transect. Both detections were close to Station 47.0. A pair of Barred Owls was detected from Skagit Queen campground, southwest of Station 46. A Northern Saw-whet Owl was also detected on the second visit, close to Station 44.5. Heavy snow

pack and ice on the trail made portions of this transect unsuitable for surveying, even late into the season. During the first visit stations 47.5-51.0 were excluded for this reason. During the second visit stations 49.5-51.0 were not surveyed.

Thunder Creek West (489 m; surveyed May 25 and June 21, 2010): Stations 5.0 through 8.0 were not surveyed during the first visit due to slow travel through talus slopes and vine maple. An animal trail is present at the base of the talus slope, as discovered later, and makes travel much faster. The second visit we were able to survey a little bit further, but were still unable to survey Stations 6.5-8.0. Again, this was due to slow off-trail travel because of rugged terrain. No owls were detected on this transect.

Thunder Lake (552 m; surveyed April 28 and May 30, 2010): Thunder Knob Trail was created close to this transect after the survey was originally designed. Due to this, we decided to survey part of this transect on the Thunder Knob Trail, which is generally less than 50 meters from the designated stations. Off-trail travel is required to access Station 5.0, so we decided to keep it as an "off-trail" transect and survey it during the day. Stations 6.0-7.0 were dropped due to their distance from the other stations and the difficulty of the terrain. We detected no owls along this transect.

Thunder Wetland Lower (613 m; surveyed may 17, 2010): During the first attempt to survey this transect we were repelled by a difficult stream crossing. During the second attempt we were able to find a way to cross the stream in order to access the transect, but were not able to survey Stations 2.5 and 3.0 due to another high-velocity stream that we decided was not safe to attempt crossing. No owls were detected on this transect.

Discussion

Spotted Owl detection probability

Although sample sizes from our survey are too low to estimate detection probability, results from similar surveys conducted at Olympic National Park showed there was a high probability of detecting at least one member of a resident pair during the first three follow-up visits to an occupied territory and most owl pairs were detected on the first visit (Seaman et al. 1992). More recently, Bailey et al. (2009) reported that the probability of detecting a Spotted Owl while conducting a follow-up visit to an occupied territory may be reduced if Barred Owls are present. However, even taking this factor into account, Bailey et al. (2009) estimated average Spotted Owl detection probability during a single follow-up visit to an occupied territory to be somewhere around 0.6, which would yield a cumulative annual detection probability of 0.996 over 6 follow-up visits in a single breeding season. All sites were visited 6 times in at least 1 of the 2 years except Pyramid Lake, which was visited only 4 times. This still yielded a detection probability of 0.962 at Pyramid Lake.

Status of historical Spotted Owl activity sites

Our results suggest that at least two historically occupied Spotted Owl territories have been lost from our 2009-2010 study area during the last 15 years: Deer Lick and Little Devil/Stout Creek. The historical Deer Lick territory in the northeast corner of NOCA was discovered on April 8, 1995 (pair heard and observed). Surveys conducted in 1996, 1997, and 1998 confirmed occupancy each year with successful reproduction in 1996 and 1998. Spotted owls were last confirmed present on June 8, 1998. During the this 4-year period NOCA biologists visited the Deer Lick activity site 13 times, confirming spotted owl presence 8 times. This activity site was not visited again until we started surveys in 2009.

Our crew conducted six follow-up visits to the area in 2009 and six more in 2010, and also completed two visits each in 2009 to the Lightning Creek Trail IV and Lightning Creek Trail V Spotted Owl survey transects that pass though the area. It seems unlikely that Spotted Owls occupying the area would remain undetected through so much survey effort. A Barred Owl responded to our surveys in the vicinity on multiple occasions in 2009.

We were also unable to relocate Spotted Owls at another historically occupied site, the Little Devil/Stout Creek activity site, which was first discovered on April 13, 1994. During 6 return surveys over 4 years from 1994 through 1997, no Spotted Owls were re-sighted. This site was not monitored from 1998 through 2008. We conducted 4 follow-up visits to the area in 2009 and six additional visits in 2010, although high water flow in Newhalem Creek prevented the crew from accessing the western (Little Devil) portion of the historical activity site in either year. As with the Deer Lick site, although the crew detected no Spotted Owls in the vicinity, a Barred Owl did respond to their survey efforts, in this case during both 2009 and 2010.

A third historical activity site within the study area, Big Beaver Boundary, also failed to produce any Spotted Owl detections, despite being surveyed in 2010 with six follow-up visits and two visits to the Big Beaver Creek Trail III transect which passes through the area. As with the two historical activity sites described above, Barred Owls were frequently detected during the Spotted Owl surveys at this site. However, unlike the other two sites discussed above, the designation of the Big Beaver Boundary activity site is not based on a recent multi-year history

of known occupancy, but rather on a June 1979 observation (Harrington-Tweit et al. 1979) and a single detection during NOCA's landbird inventory in 2001 (Siegel et al. 2004), so it is less clear in this case that a once consistently-occupied activity site has been lost.

Results from a fourth activity site, Newhalem Creek, are somewhat equivocal. The Newhalem Creek Spotted Owl activity site was discovered on March 29, 1994. One of three follow-up surveys conducted in 1994 confirmed presence of a pair. Spotted Owls were last confirmed at this site on May 1, 1997. This activity site was not monitored from 1998 through 2008.

In 2009 we completed three follow-up visits to the site, and also twice surveyed the Newhalem Creek Trail Upper transect that passes through it. Our efforts yielded a single Spotted Owl detection on the last day of the 2009 field season, which precluded additional visits to determine pair status or assess reproductive effort. In 2010 we returned and conducted six follow-up visits but were unable to relocate the owl. The rather inconsistent detection history at this site may suggest that the area where we have detected Spotted Owls is at the periphery of a territory, lending a large stochastic element to whether or not surveys elicit responses.

Finally, there may be a previously unknown territory between Pyramid Lake and Colonial Creek Campground, as a Spotted Owl was audio recorded by park staff on August 18 and 26, 2009 while conducting a soundscape baseline inventory and incidentally detected in August 2010 by a backcountry ranger. However our crew was unable to locate the owl during four subsequent follow-up visits in 2010.

Continued growth in NOCA's Barred Owl population

During recent decades Barred Owls have displaced Spotted Owls throughout much of the Pacific Northwest and British Columbia (Dunbar et al. 1991, Hamer et al. 1994, Kelly et al. 2003, Peterson and Robbins 2003). Colonization of an area by Barred Owls can have negative consequences for Spotted Owls (Gutiérrez et al. 2007), including accelerated population declines (Kelly et al. 2003), increased probabilities of local extinction (Olson et al. 2005), decreased probabilities of colonization (Olson et al. 2005), and reduced nesting productivity (Olson et al. 2004).

One of the major roles of national parks is to serve as 'reference sites' for assessing the effects of regional land use and land cover changes (Silsbee and Peterson 1991, Simons et al. 1999). In the North Cascades, North Cascades National Park Complex provides vast tracts of relatively pristine closed-canopy conifer forests. Information from such areas may be especially valuable to the scientific debate about factors driving Barred Owl population increases, because the park ecosystem has been managed primarily for ecosystem protection for many decades, without commercial timber extraction. It has been suggested that elsewhere in the Pacific Northwest, commercial timber extraction that has tended to reduce average stand age may have favored Barred Owls at the expense of Spotted Owls (Pearson and Livezey 2003). However our results from within the park suggest that Barred Owls have successfully colonized forest stands that have been managed primarily for wilderness values for many decades.

Although our study was intended to assess changes in the status and distribution of Spotted Owls in the park, our survey results for Barred Owls, which respond aggressively to broadcast playbacks and vocal hoots of Spotted Owl calls (Hamer 1988, Dunbar et al. 1991), may be

equally valuable. We estimate that we found 34 Barred Owl activity sites in our study area. Kuntz and Christophersen (1996) estimated that they found 27 Barred Owl activity sites on the same set of transects (they found a few additional Barred Owl sites in the same watersheds but on transects that we excluded from our re-survey efforts for logistic reasons) during the early 1990s. This represents a 26% increase in the estimated number of Barred Owl activity sites within the area surveyed in both the early 1990s and during 2009-2010. During similar Spotted Owl surveys of the Lake Chelan and greater Stehekin River watersheds in 2007-2008 (Siegel et al. 2008), we found an estimated ten Barred Owl activity sites in an area where Kuntz and Christophersen estimated they found six during the early 1990s (Kuntz and Christophersen 1996), an even more dramatic increase of 67%.

Near the northern border of the Spotted Owl's range, North Cascades National Park was one of the first areas in the U.S. Pacific Northwest to be colonized by Barred Owls (R. Kuntz pers. observation). By the early 1990s Barred Owls had already become well established in lower-elevation habitats throughout the park - Kuntz and Christophersen (1996) detected Barred Owls approximately as frequently as Spotted Owls east of the Cascades crest, and eight times as frequently on the west side of the crest. Yet our results indicate the Barred Owl population at North Cascades National Park has continued to grow since the 1993-1996 survey, when Barred Owls had already become much more common in the park than Spotted Owls.

Regardless of whether Barred Owls are directly implicated in displacing or suppressing Spotted Owl populations, the increasingly high population density of this top-level predator is likely having substantial ecological interactions with other species (Simberloff 1981, Mack et al. 2000, D'Antonio et al. 2001) - not just with Spotted Owls, but also with other owl species, and with prey species (e.g., Ekerholm et al. 2004). Relatively little information is available about the ecology and behavior of Barred Owls in western North America (Mazur and James 2000, Gutiérrez et al. 2004, Gutiérrez et al. 2007) and more study is warranted to better understand and possibly mitigate the consequences of Barred Owl invasion for native species within the park ecosystem (Buchanan et al. 2007).

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