

**RADAR AND AUDIO-VISUAL SURVEYS  
FOR MARBLED MURRELETS IN THE CEDAR RIVER  
MUNICIPAL WATERSHED, WASHINGTON, 2006**

BRIAN A. COOPER  
JEFF B. BARNA  
RICHARD J. BLAHA  
COREY M. GRINNELL

PREPARED FOR  
**CITY OF SEATTLE**  
**WATERSHED MANAGEMENT DIVISION**  
NORTH BEND, WASHINGTON

PREPARED BY  
**ABR, INC.—ENVIRONMENTAL RESEARCH & SERVICES**  
FOREST GROVE, OREGON



**RADAR AND AUDIO-VISUAL SURVEYS FOR MARBLED MURRELETS  
IN THE CEDAR RIVER MUNICIPAL WATERSHED, WASHINGTON, 2006**

FINAL REPORT

Prepared for  
**City of Seattle**  
**Watershed Management Division**  
19901 Cedar Falls Road S.E., North Bend, WA 98045

Prepared by  
Brian A. Cooper, Jeff B. Barna, Richard J. Blaha, and Corey M. Grinnell

**ABR, Inc.—Environmental Research & Services**  
P. O. Box 249, Forest Grove, OR 97116

March 2007



*Printed on recycled paper.*



## EXECUTIVE SUMMARY

- This report summarizes the results from the second year of a three-year effort to use a combination of ornithological radar and standard audio-visual (AV) methods to collect baseline information on distribution and abundance of Marbled Murrelets (*Brachyramphus marmoratus*) in the Cedar River Municipal Watershed (CRMW), Washington.
- The purpose of this study was to use radar and audio-visual techniques to monitor trends in the distribution and abundance of murrelets in the CRMW. Specifically, the objectives of the 2006 study were to: (1) collect baseline radar information on numbers of Marbled Murrelets using the watershed in 2006 as the second year of a long-term monitoring effort; (2) collect radar information on the presence of murrelets at the scale of sub-basins to help determine the distribution of murrelets in the CRMW and to focus future (2007) audio-visual survey efforts; and (3) to conduct audio-visual surveys for murrelets in the sub-basins identified by radar in 2005 as having murrelet presence, or in sites identified from timber inventory data and aerial photography as having the best potential murrelet nesting habitat in the CRMW.
- We conducted a total of 42 mornings of radar observations during summer 2006. We used radar to sample six long-term sites used for monitoring purposes and 10 short-term sites to determine presence of murrelets in a particular sub-basin or timber stand. Radar sampling was conducted for three mornings at all long-term sites and for two mornings at all short-term sites, from late June to July. Radar sampling occurred during the morning activity period for Marbled Murrelets, from 105 min before sunrise to 75 min after sunrise.
- We recorded a total of 89 pre-sunrise murrelet targets on 38 mornings of radar observation in the CRMW during summer 2006. An additional four mornings of radar sampling were cancelled by inclement weather. Of the 89 radar targets we observed, 36 (40%) were flying in a landward direction, 35 (39%) were flying in a seaward direction, and 18 (20%) were flying in “other” directions. We had no audio-visual observations of Marbled Murrelets during radar sampling, but we did observe one murrelet during standard audio-visual surveys at the South Fork South Site.
- Similar to 2005, mean daily counts of landward radar targets generally were quite low in 2006. Mean landward counts ranged between 0 and 4 targets per morning. The highest landward counts occurred at the Chester Morse site.
- Mean landward radar counts did not differ significantly between 2005 and 2006.
- Coefficients of Variation (CV’s) in landward radar counts at the long-term sites ranged from 0% at the three sites where no landward targets were observed, to ~90% at Chester Morse and Powerline North, to 173% at Powerline Central.
- Landward flight directions generally were centered along the main axis of the valley near each radar site. Other movements of targets toward old-growth stands at the West Point, Rack Creek, Taylor Ridge, Chester North, 155.1A, Findley, Rex Stand, Upper Rex, and Lindsay Creek sites suggested the possible presence of Marbled Murrelets at those stands.
- During summer 2006, we conducted 33 mornings of standard audio-visual surveys (plus two tandem visits) at sites with the best murrelet habitat in CRMW, and/or in areas of suitable habitat where radar observations in 2005 suggested presence of marbled murrelets. The only site we detected murrelets at in 2006 was the South Fork South site. At that site, we observed occupied behavior on our second survey visit: at 0444 h on 8 July 2006, we observed a murrelet flying in a southeasterly direction at 0.9 canopy heights from Station #1. We did not observe Marbled Murrelets during any of our five survey visits at the Chester North, Lindsay North, Lower Rex East (Findley), Rack Creek, and Taylor Ridge North sites. We also did not detect any murrelets during single visits to the South Fork North and Lost Creek sites (observations at both of those sites were discontinued after a single survey so that we could focus our survey efforts on higher priority sites).



## TABLE OF CONTENTS

EXECUTIVE SUMMARY .....	i
LIST OF FIGURES .....	iii
LIST OF TABLES.....	iv
LIST OF APPENDICES.....	iv
ACKNOWLEDGMENTS .....	v
INTRODUCTION.....	1
OBJECTIVES.....	2
STUDY AREA .....	2
METHODS.....	2
DATA COLLECTION .....	2
RADAR EQUIPMENT AND OPERATION .....	6
DATA ANALYSIS.....	9
RESULTS.....	10
DISTRIBUTION AND ABUNDANCE.....	10
FLIGHT PATHS.....	10
AUDIO-VISUAL SURVEYS.....	14
DISCUSSION.....	27
SUITABILITY OF CMRW FOR RADAR OBSERVATIONS.....	27
SPECIES IDENTIFICATION .....	27
DISTRIBUTION AND ABUNDANCE.....	28
USE OF RADAR TO MONITOR TRENDS OF MURRELETS.....	29
MONITORING TRENDS IN DIFFERENT AREAS OF THE WATERSHED .....	29
RECOMMENDATIONS FOR 2007 .....	30
LITERATURE CITED.....	31

## LIST OF FIGURES

Figure 1. Map showing the locations of radar sampling sites in the Cedar River Municipal Watershed, Washington, during summer 2005 and 2006.....	3
Figure 2. Map showing the locations of audio-visual sampling sites in the Cedar River Municipal Watershed, Washington, during summer 2005 and 2006 .....	5
Figure 3. Approximate sampling airspace for the Furuno FR-1510 marine radar at the 1.5-km range setting, as determined by field trials with Rock Pigeons, which are similar in size to Marbled Murrelets.....	9
Figure 4. Map showing the mean number of landward targets/day observed on radar at each site in the Cedar River Municipal Watershed, Washington, during summer 2006 .....	11
Figure 5. Map showing the mean flight direction of landward targets observed on radar at each site in the Cedar River Municipal Watershed, Washington, during summer 2006.....	13
Figure 6. Map showing the flight paths of radar targets observed before sunrise at the Powerline North, Powerline Central, and Powerline South sites in the Cedar River Municipal Watershed, Washington, during summer 2006 .....	15
Figure 7. Map showing the flight paths of radar targets recorded before sunrise at the Chester Morse site in the Cedar River Municipal Watershed, Washington, during summer 2006.....	16

Figure 8.	Map showing the flight paths of radar targets observed before sunrise at Site 155.1A in the Cedar River Municipal Watershed, Washington, during summer 2006 .....	17
Figure 9.	Map showing the flight paths of radar targets observed before sunrise at the Education Center and West Point sites in the Cedar River Municipal Watershed, Washington, during summer 2006.....	18
Figure 10.	Map showing the flight paths of radar targets observed before sunrise at the Rack Creek site in the Cedar River Municipal Watershed, Washington, during summer 2006 .....	19
Figure 11.	Map showing the flight paths of radar targets observed before sunrise at the Taylor Ridge site in the Cedar River Municipal Watershed, Washington, during summer 2006 .....	20
Figure 12.	Map showing the flight paths of radar targets observed before sunrise at the Chester North site in the Cedar River Municipal Watershed, Washington, during summer 2006 .....	21
Figure 13.	Map showing the flight paths of radar targets observed before sunrise at the Lindsay Creek site in the Cedar River Municipal Watershed, Washington, during summer 2006 .....	22
Figure 14.	Map showing the flight paths of radar targets observed before sunrise at the Lower Rex site in the Cedar River Municipal Watershed, Washington, during summer 2006 .....	23
Figure 15.	Map showing the flight paths of radar targets observed before sunrise at the Upper Rex and Rex Stand sites in the Cedar River Municipal Watershed, Washington, during summer 2006.....	24
Figure 16.	Map showing the flight paths of radar targets observed before sunrise at the Findley site in the Cedar River Municipal Watershed, Washington, during summer 2006 .....	25
Figure 17.	Map showing the flight paths of radar targets observed before sunrise at the South Fork site in the Cedar River Municipal Watershed, Washington, during summer 2006 .....	26

**LIST OF TABLES**

Table 1.	Location of summer 2005 and 2006 radar sampling sites in the Cedar River Municipal Watershed, Washington.....	4
Table 2.	Location of summer 2005 and 2006 audio-visual sampling sites in the Cedar River Municipal Watershed, Washington .....	6
Table 3.	Daily counts of radar targets observed at sites in the Cedar River Municipal Watershed, Washington, during summer 2006, by flight direction.....	7
Table 4.	Daily counts of Marbled Murrelets recorded during audio-visual surveys of the Rex Stand, Cedar River Municipal Watershed, Washington, during summer 2006 .....	8
Table 5.	Mean counts of radar targets by flight direction at sites in the Cedar River Municipal Watershed, Washington, during summer 2005 and 2006.....	12

## LIST OF APPENDICES

Appendix 1a.	Views toward the east and north at the Powerline North site, Cedar River Municipal Watershed, summer 2006 .....	34
Appendix 1b.	View toward the southeast at the Powerline Central site, Cedar River Municipal Watershed, summer 2006 .....	35
Appendix 1c.	View toward the south at the Powerline South site, Cedar River Municipal Watershed, summer 2006 .....	35
Appendix 1d.	Views toward the east at the Chester Morse site, Cedar River Municipal Watershed, summer 2006 .....	36
Appendix 1e.	View toward the northwest at the 155.1A site, Cedar River Municipal Watershed, summer 2006 .....	37
Appendix 1f.	View toward the north at the South Fork site, Cedar River Municipal Watershed, summer 2006 .....	37
Appendix 1g.	View toward the southwest at the Education Center site, Cedar River Municipal Watershed, summer 2006 .....	38
Appendix 1h.	Views toward the northwest at the West Point site, Cedar River Municipal Watershed, summer 2006 .....	39
Appendix 1i.	View toward the west at the Taylor Ridge site, Cedar River Municipal Watershed, summer 2006 .....	40
Appendix 1j.	Views toward the north at the Rack Creek site, Cedar River Municipal Watershed, summer 2006 .....	41
Appendix 1k.	View toward the north at the Lindsay site, Cedar River Municipal Watershed, summer 2006 .....	42
Appendix 1l.	Views toward the northwest and southeast at the Chester North site, Cedar River Municipal Watershed, summer 2006 .....	43
Appendix 1m.	View toward the west at the Upper Rex site, Cedar River Municipal Watershed, summer 2006 .....	44
Appendix 1n.	Views toward the west and east at the Rex Stand site, Cedar River Municipal Watershed, summer 2006 .....	45
Appendix 1o.	View toward the southwest at the Lower Rex site, Cedar River Municipal Watershed, summer 2006 .....	46
Appendix 1p.	Views toward the southwest and northeast at the Findlay site, Cedar River Municipal Watershed, summer 2006 .....	47
Appendix 2.	Coding information for radar surveys of Marbled Murrelets in the Cedar River Municipal Watershed, Washington, summer 2006 .....	48
Appendix 3.	Data file for Marbled Murrelet targets recorded on radar in the Cedar River Municipal Watershed, Washington, during summer 2006 .....	52
Appendix 4.	Data sheets for all audio-visual surveys for Marbled Murrelets in the Cedar River Municipal Watershed, summer 2006 .....	55

## ACKNOWLEDGMENTS

Seattle Public Utilities provided funds for this survey under the auspices of the Cedar River Managed Watershed Habitat Conservation Plan. We thank their biologist, Bill Richards, for his help with access, logistics, and study design. We also thank Peter Sanzenbacher, Alden Miller, Jon Plissner, Tia Adams, and Robert Day of ABR for their help with the study.

## INTRODUCTION

The Marbled Murrelet (*Brachyramphus marmoratus*) is a seabird that nests in large trees in old-growth coastal forests throughout most of its range in North America (Nelson 1997). Marbled Murrelets fly at high speeds, visit their nests primarily during periods of low ambient light, and nest up to ~80 km inland. Because of their secretive behaviors, their semicolonial nesting behavior, and the difficulty of locating their nests in large trees, only limited information is available on their nesting behavior, habitat associations, population size in specific areas, and demography. The Washington, Oregon, and California population of the Marbled Murrelet was federally listed as a Threatened Species in 1992 because of excessive loss and fragmentation of nesting habitat and because of mortality associated with oil spills and gill-net fishing (USFWS 1992, 1997). The species also is classified as endangered at the state level in California and as threatened at the state level in Washington and Oregon and is listed as threatened in Canada. Comparison of historical and current data suggest that Marbled Murrelets have disappeared or become rare over much of their range south of Alaska, but current population trends of the species in the Pacific Northwest are unknown (Nelson 1997).

The current ground-based Inland Forest Survey Protocol (IFSP) for Marbled Murrelets depends on the use of audio-visual cues to detect birds in flight (Evans Mack et al. 2003). Collecting information on murrelets this way is difficult because of the low light conditions during their dawn and dusk peaks in inland activity and their small size, cryptic coloration, rapid flight speed, and habitat preference for old-growth, closed canopy forests. Further, because 85% of the murrelet detections are auditory (Paton et al. 1990), it is difficult to determine with accuracy the number of birds that actually are flying over a particular survey area. In fact, audio-visual surveys (Evans Mack et al. 2003) were not designed to provide an index of abundance and, even if they were used, the high variation in audio-visual counts would require a massive survey effort to detect trends (Jodice et al. 2001, Bigger et al. 2006).

Several studies have shown that radar is an excellent tool for observing Marbled Murrelets (Hamer et al. 1995; Cooper et al. 2001, 2006a; Cooper and Blaha 2002; Cooper and Hamer 2003; Burger 1997, 2001; Raphael et al. 2002; Burger et al. 2004). The main advantages of using radar for inventorying murrelets are that it works under all light conditions, does not have the auditory bias of audio-visual surveys, and can sample a large area. Although radar cannot be used at all stands because certain terrain types preclude its use, it can be used in appropriate locations to determine quickly and accurately whether murrelets are present in a forest stand. Radar is particularly useful for detecting birds at low-use sites, where murrelets often are missed completely by audio-visual observers (Cooper and Blaha 2002). Radar data also can be used to focus ground observers' efforts toward "hot-spots" of murrelet activity. Further, radar can improve survey efficiency because it samples a much larger area (up to a 1,500-m radius) than audio-visual observers do (up to a 200-m radius).

In addition to determining presence of murrelets in an area, radar can provide a good index of abundance for Marbled Murrelets on several scales, including a river-drainage-sized scale that can be used for monitoring (Hamer et al. 1995; Burger 1997, 2001; Cooper et al. 2001, 2005, 2006a; Raphael et al. 2002; Cooper and Blaha 2002; Evans Mack et al. 2003). Power analyses have revealed that radar-based monitoring of murrelets can produce statistically-sensitive results in a timely, cost-effective fashion because of the low among-day variation in counts (Cooper et al. 2001, 2006a; Burger et al. 2004; Bigger et al., 2006).

The Cedar River Watershed Habitat Conservation Plan commits Seattle Public Utilities to managing the Cedar River Municipal Watershed (CRMW) as an ecological reserve with active forest restoration. Monitoring Marbled Murrelet activity in the CRMW is designated by the Habitat Conservation Plan: over the 50-year course of the HCP, local population indices of murrelets are expected to provide a barometer to gauge how well the old-growth forests are being restored. In this program, the activity of murrelets will be assessed within both old-growth and second-growth forests of the CRMW during three time periods:

2005–2007, 2025–2028, and 2045–2048. This report summarizes the results from the second year of the 2005–2007 effort to use radar and audio-visual methods to collect initial baseline information on murrelet distribution and abundance in the CRMW. Results of the first year of the study are summarized in Cooper et al. (2006b).

## **OBJECTIVES**

The purpose of this study was to use radar and audio-visual techniques to monitor trends in the distribution and abundance of murrelets in the CRMW. Specifically, the objectives of the 2006 study were to: (1) collect baseline radar information on numbers of Marbled Murrelets using the watershed in 2006 as the second year of a long-term monitoring effort; (2) collect radar information on the presence of murrelets at the scale of sub-basins to help determine the distribution of murrelets in the CRMW and to focus future (2007) audio-visual survey efforts; and (3) to conduct audio-visual surveys for murrelets in the sub-basins identified by radar in 2005 as having murrelet presence, or in sites identified as having the best potential murrelet nesting habitat in the CRMW.

## **STUDY AREA**

The entire 90,546-acre Cedar River Municipal Watershed (CRMW) lies within 45 miles of Puget Sound and encompasses roughly 14,000 acres of old-growth forest and 71,500 acres of second-growth forest (Fig. 1). The elevation of the area ranges from ~400 to ~1,500 m above sea level. Currently managed under the 50-year Cedar River Watershed Habitat Conservation Plan, old-growth forest in the watershed is protected as a reserve and the second-growth forests are subject to limited habitat restoration with the objective of shortening the time to old-growth forest conditions. Marbled Murrelets were detected at one location in the CRMW in the mid-1990s (W. P. Ritchie, WDFW, pers. comm.); however, there has been no other systematic assessment of use of this area by murrelets until the current study. During summer 2006, we conducted radar-based sampling for Marbled Murrelets at 16 sites in the study area

that provided good radar coverage over areas of interest (Fig. 1, Table 1). All radar sites were photo documented to help future observers compare suitability of the sites in the future with current suitability, in terms of the amount of screening of the radar view by nearby vegetation (Appendix 1). We also conducted audio-visual observations for murrelets at eight sites within the CRMW (Fig. 2, Table 2).

## **METHODS**

### **DATA COLLECTION**

We conducted a total of 42 mornings of radar observation and 33 mornings of audio-visual observations (plus two tandem visits) during summer 2006 (Tables 3 and 4). We used radar to sample (1) six long-term sites used for monitoring purposes (i.e., the Powerline North, Powerline Central, Powerline South, Chester Morse, 155.1A, and South Fork sites) and (2) 10 short-term sites to determine presence of murrelets in a particular sub-basin or timber stand (Table 1). Radar sampling was conducted for three mornings at long-term sites and for two mornings at all short-term sites, from late June to July 2006 (Table 3). Radar sampling occurred during the morning activity period for Marbled Murrelets, from 105 min before sunrise to 75 min after sunrise. This period encompasses the known peak of daily murrelet activity (Burger 1997, Cooper et al. 2001, Cooper and Blaha 2002, Cooper and Hamer 2003).

During sampling, a single observer set up the radar and video recorder, then attempted to obtain an audio-visual confirmation of each radar target to confirm the species identity of Marbled Murrelets and other species likely to be confused with murrelets on radar. Audio-visual observations were transmitted by voice directly to the videotape of the radar screen. For each radar target, we recorded date, time, flight direction (to the nearest 1°), transect quadrant, minimal distance to target, groundspeed (mi/h), flight behavior (straight-line, erratic, circling), overlap category (recorded only on radar, recorded only by audio-visual observer, recorded by both radar and audio-visual observer), species (if known), number of birds represented by that radar echo (if known), flight altitude (if known), and audio-visual detection category (not

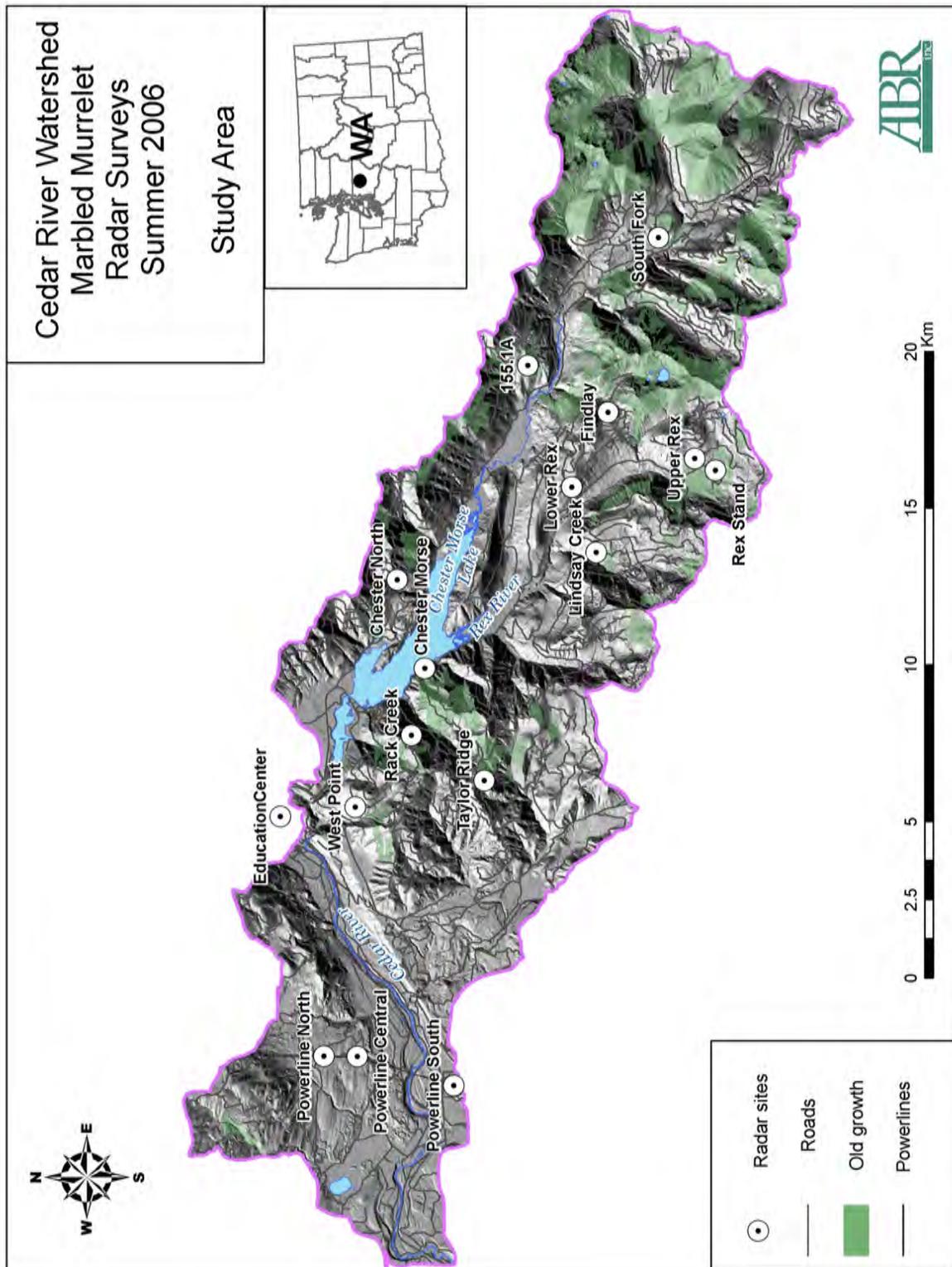


Figure 1. Map showing the locations of radar sampling sites in the Cedar River Municipal Watershed, Washington, during summer 2005 and 2006.

Table 1. Location of summer 2005 and 2006 radar sampling sites in the Cedar River Municipal Watershed, Washington.

Site type/site name	UTM coordinates <sup>1</sup>		Elevation	Comments
<b>LONG-TERM SITES</b>				
Powerline North	584934 E	5251791 N	408 m	1.07 km north of Powerline Central.
Powerline Central	584945 E	5250723 N	333 m	At end of road, 3.15 km from Powerline South.
Powerline South	584115 E	5247628 N	280 m	On north side of Line 1, Mile 22, Tower 1; northern side of third set of poles south of road.
Chester Morse	597393 E	5248917 N	502 m	In largest pullout on lake side of road.
155.1A	607146 E	5245901 N	872 m	Park in Spur Road 155.1a.
South Fork	611339 E	5241839 N	767 m	At landing at end of Road 521.
<b>SHORT-TERM SITES</b>				
Education Center	592538 E	5253385 N	275 m	In middle of northern lot at Education Center.
West Point	592897 E	5251013 N	799 m	On large landing at end of Road 820.
Taylor Ridge	593869 E	5246922 N	1065 m	At end of Spur Road #815.5.
Rack Creek	595244 E	5249277 N	961 m	Along Road 811, ~100 m before fork.
Lindsay	601245 E	5243557 N	817 m	100 m from end of Spur Road 205, adjacent to large log pile.
Chester North <sup>2</sup>	600135 E	5249969 N	813 m	Along roadside, 400 m from end of road 110.8.
Upper Rex	604331 E	5240500 N	1,033 m	At end of Spur Road 730.1.
Rex Stand	603962 E	5239832 N	954 m	In opening next to log pile.
Lower Rex	603301 E	5244402 N	888 m	At end of Road 310.
Findley	605714 E	5243307 N	1,076 m	At end of Road 354.
150 <sup>3</sup>	607248 E	5245332 N	761 m	Park along road with downhill slant toward the east.
Cedar <sup>3</sup>	611373 E	5242572 N	748 m	Western end of opening with few trees alongside road.

<sup>1</sup>UTM Zone 10; <sup>2</sup>New site that was not sampled in 2005; <sup>3</sup>Site only sampled in 2005.

detected by audio-visual observer, heard only, seen only, both seen and heard). We also plotted the flight path of each murrelet target on a transparency overlay of the radar screen. We recorded the following weather information at the beginning of each session or when conditions changed during a session: wind direction, average wind speed at ground level, estimated cloud cover (%), average ceiling height (in meters) above ground level at the radar sampling site, visibility, precipitation, and air temperature (°C). See

Appendix 2 for categories for each target and weather variable.

During summer 2006, we also conducted 33 mornings of standard audio-visual surveys (plus two tandem visits) at sites with the best murrelet habitat in CRMW, and/or in areas of suitable habitat where radar observations in 2005 suggested presence of marbled murrelets. All surveys occurred from late June to July (Table 4). Except for the seasonal timing of surveys, the audio-visual survey methods followed standard protocols

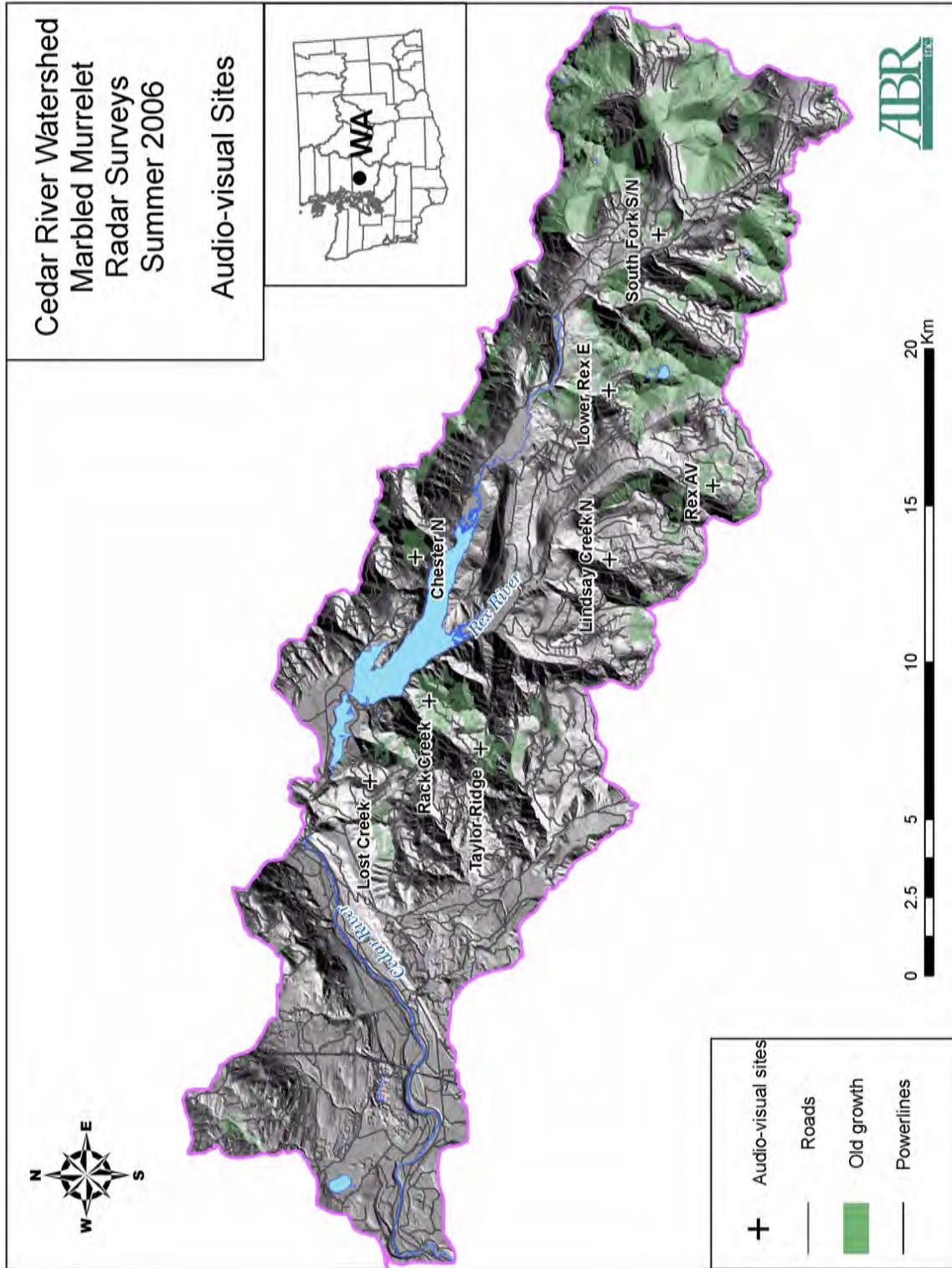


Figure 2. Map showing the locations of audio-visual sampling sites in the Cedar River Municipal Watershed, Washington, during summer 2005 and 2006.

Table 2. Location of summer 2005 and 2006 audio-visual sampling sites in the Cedar River Municipal Watershed, Washington.

Site	Station	UTM coordinates <sup>1</sup>		Elevation (m)
Lost Creek <sup>2</sup>	1	594882 E	5250301 N	739
Taylor Ridge North <sup>2</sup>	1	594828 E	5247069 N	1053
	3	594696 E	5247009 N	1063
Rack Creek <sup>2</sup>	1	596219 E	5248719 N	934
	2	596282 E	5248774 N	914
	3	596403 E	5248698 N	887
Chester North <sup>2</sup>	3	600811 E	5249252 N	723
Lindsay Creek <sup>2</sup>	1	601172 E	5243187 N	871
	2	601032 E	5243132 N	826
	3	601178 E	5243286 N	849
Lower Rex E (Findley) <sup>2</sup>	1	606326 E	5243160 N	958
	2	606438 E	5243247 N	832
Rex AV <sup>3</sup>	1	603432 E	5240777 N	871
	2	603645 E	5239650 N	965
	3	603390 E	5239890 N	912
South Fork South <sup>2</sup>	1	611158 E	5241522 N	684
South Fork North <sup>2</sup>	1	611067 E	5242333 N	659

<sup>1</sup>UTM Zone 10; <sup>2</sup>New site that was not sampled in 2005; <sup>3</sup>Site only sampled in 2005.

(Evans Mack et al. 2003). Survey conditions (e.g., ceiling height, wind conditions) met protocol requirements on all but five surveys, which were later resurveyed (Table 4) so that all sites had a minimum of five survey visits, unless occupancy was determined before then. The exception to this occurred at the Lost Creek and South Fork North sites, which were dropped after one survey because higher priority areas were identified to be surveyed in 2006.

#### RADAR EQUIPMENT AND OPERATION

Our mobile radar laboratories consisted of a marine surveillance radars mounted on vans. The radars scanned the entire area around the labs and were used to obtain information on flight paths, movement rates, and ground speeds of murrelets. A similar radar laboratory is described in Gauthreaux

(1985a, 1985b) and Cooper et al. (1991). The lab was powered by four 6-V batteries that were linked in series. The surveillance radar (Furuno Model FCR-1510; Furuno Electric Company, Nishinomiya, Japan) is a standard marine radar transmitting at 9,410 MHz (i.e., X-band) through a slotted wave guide (i.e., antenna) 2 m long with a peak power output of 12 kW. The radar was operated at the 1.5-km range with the pulselength set at 0.07  $\mu$ sec and the forward edge of the antenna elevated by  $\sim 15^\circ$ . Figure 3 shows the approximate murrelet-sampling airspace for the Furuno FR-1510 marine radar at the 1.5-km range setting, as determined by field trials with Rock Pigeons, which are similar in size to Marbled Murrelets.

Whenever energy is reflected from the ground, surrounding vegetation, or other objects

Table 3. Daily counts of radar targets observed at sites in the Cedar River Municipal Watershed, Washington, during summer 2006, by flight direction. Table counts include only targets recorded before sunrise.

Date	Site	Sampling hours	Number of targets recorded on radar		
			Landward	Seaward	Other
22 June	Powerline South	0327–0627	0	9	0
	Chester Morse	0327–0627	8	3	0
23 June	Powerline Central	0327–0627	0	1	1
	Powerline North	0327–0627	1	0	2
24 June	South Fork	0328–0628	0	0	0
	Site 155.1A	0328–0628	0	2	1
25 June	Rack Creek	0328–0628	0	1	0
	Chester North	0328–0628	0	0	0
26 June	Education Center	0328–0628	0	0	0
	Lower Rex	0328–0628	0	0	0
27 June	Findley	0329–0629	3	1	0
	Lindsay	0329–0629	0	2	0
28 June	Taylor Ridge	0329–0629	0	0	2
	West Point	0329–0629	0	0	1
29 June	Rex Stand	0330–0630	1	2	0
	Chester Morse	0330–0630	1	1	0
30 June	Upper Rex	0330–0630	1	0	1
	Powerline South	0330–0630	0	1	1
1 July	Powerline North	0331–0631	1	1	0
	Powerline Central	0331–0631	0	0	0
8 July	South Fork	0336–0636	0	0	0
	Site 155.1A	0336–0636	0	3	0
9 July	Lindsay	0337–0637	2	0	0
	Chester North	0337–0637	1	0	0
10 July	Rack Creek*	0337–0637*	--	--	--
	Taylor Ridge*	0337–0637*	--	--	--
11 July	Rack Creek	0338–0638	2	0	0
	Taylor Ridge	0338–0638	0	0	0
12 July	Findley*	0339–0639*	--	--	--
	Rex Stand	0339–0639	1	0	0
13 July	Education Center*	0340–0640*	--	--	--
14 July	Education Center	0341–0641	0	0	1
18 July	West Point	0345–0645	4	1	2
	Upper Rex	0345–0645	2	0	0
19 July	Findley	0346–0646	2	0	1
	Site 155.1A	0346–0646	0	1	0
20 July	Lower Rex	0347–0647	1	2	0
	South Fork	0347–0647	0	0	0
21 July	Powerline North	0349–0649	0	2	1
	Powerline Central	0349–0649	2	0	3
22 July	Powerline South	0350–0650	0	1	1
	Chester Morse	0350–0650	3	1	0

\* Sampling session cancelled by rain.

Table 4. Daily counts of Marbled Murrelets recorded during audio-visual surveys of the Rex Stand, Cedar River Municipal Watershed, Washington, during summer 2006.

Site	Station	Date	Survey to protocol?	Number of detections	
				Presence <sup>1</sup>	Occupied <sup>1</sup>
Chester North	3	29 June	Yes	0	0
	3	9 July	Yes	0	0
	3	12 July	Yes	0	0
	3	20 July	Yes	0	0
	3	22 July	Yes	0	0
Lindsay Creek North	1	24 June	Yes	0	0
	2	30 June	Yes	0	0
	1	09 July	Yes	0	0
	2	13 July	No	0	0
	2	18 July	Yes	0	0
	3	23 July	Yes	0	0
Lost Creek	1	22 June	Yes	0	0
Lower Rex East (Findley)	1	27 June	Yes	0	0
	1	12 July	Yes	0	0
	2	19 July	Yes	0	0
	2 (tandem)	19 July	Yes	0	0
	1	21 July	Yes	0	0
Rack Creek	1	23 July	Yes	0	0
	1	23 June	Yes	0	0
	1	10 July	No	0	0
	1	11 July	Yes	0	0
	2	13 July	No	0	0
	2	18 July	Yes	0	0
	3	21 July	Yes	0	0
South Fork South	2	24 July	Yes	0	0
	1	29 June	No	0	0
	1	08 July	Yes	0	1
South Fork North	1 (tandem)	08 July	Yes	0	0
	1	28 June	Yes	0	0
Taylor Ridge North	1	25 June	Yes	0	0
	1	10 July	No	0	0
	3	11 July	Yes	0	0
	3	20 July	Yes	0	0
	3	22 July	Yes	0	0
	3	24 July	Yes	0	0

<sup>1</sup> Murrelet detections, as defined by the PSG survey protocol (Evans Mack et al. 2003).

that surround the radar unit, a ground-clutter echo appears on the display screen. Because ground clutter can obscure bird targets on the radar display screen, we attempted to minimize it by parking the radar laboratory in a location that was surrounded closely by low vegetation or small hillsides. These objects acted as a radar fence that shielded the radar from low-lying objects farther away from the lab and that produced only a small amount of ground clutter in the center of the display screen. For further discussion of radar fences, see Eastwood (1967), Williams et al. (1972), and Skolnik (1980).

Maximal distances of detection of birds by the surveillance radar depends on body size of the birds, flock size, flight profile of the birds, distance between flying birds, atmospheric conditions, and,

to some extent, the amount and location of ground clutter. Marbled Murrelets usually are detectable to at least 1.5 km, whereas single, small passerines are detectable to ~1 km (Fig. 3; Cooper et al. 1991, 2001; Cooper, unpubl. data).

#### DATA ANALYSIS

For all analyses, we classified targets as “landward” or “seaward” if they were flying within 60° of the main axis of the valley in an landward (i.e., inbound flights from the ocean) or seaward (i.e., outbound) direction, respectively, and classified targets as “other” if they were not flying in a landward or seaward direction. The exceptions to this rule occurred at the Rack, Rex Stand, Upper Rex, Lindsay, Cedar, and South Fork sites. Those drainages had more of a North–South orientation,

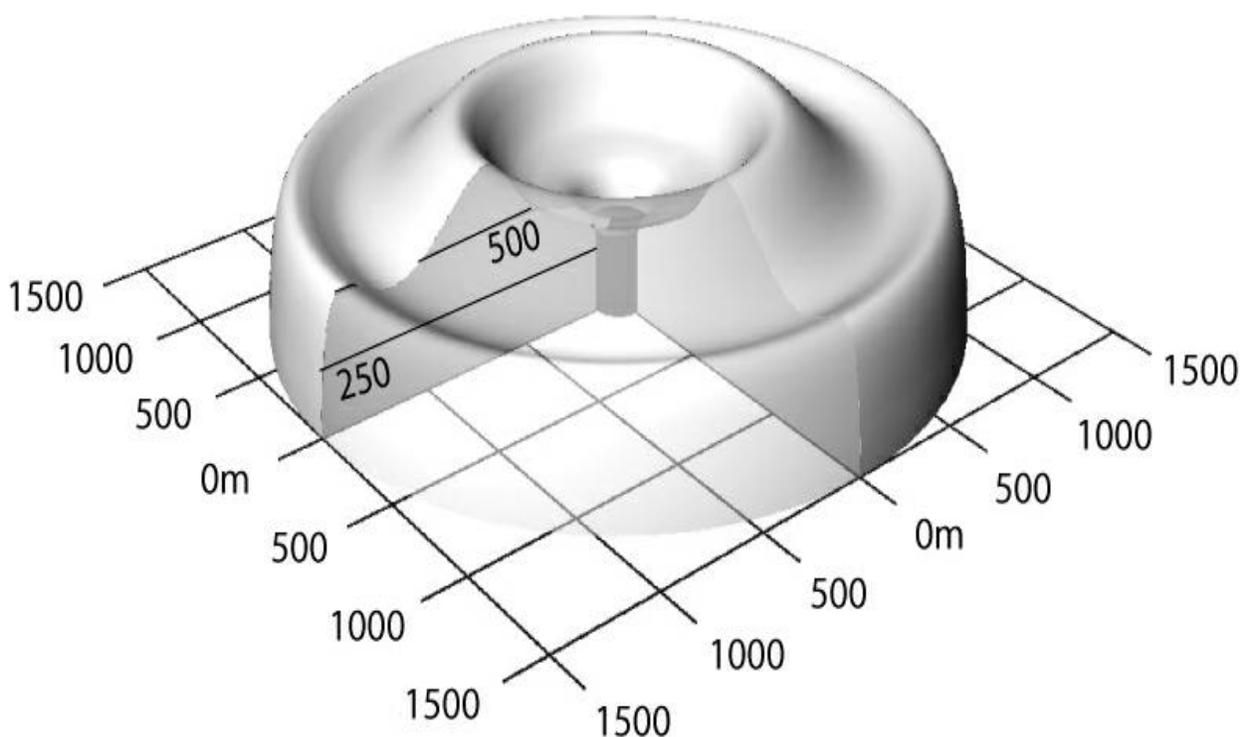


Figure 3. Approximate sampling airspace for the Furuno FR-1510 marine radar at the 1.5-km range setting, as determined by field trials with Rock Pigeons, which are similar in size to Marbled Murrelets. Note that the configuration of the radar beam within 250 m of the origin (i.e., the darkened area) was not determined.

plus there was habitat to the east of the sampling sites, so we broadened our landward and/or seaward categories at those sites to include flight paths beyond 60° of the main axis of the valley. Specifically, the landward category was 30°–195° for South Fork and Cedar, 30°–180° for Upper Rex and Rex, and 30°–210° for Rack and Lindsay. The seaward category was 255°–15° for South Fork and Cedar, 210°–360° for Upper Rex and Rex, and 211°–29° for Rack and Lindsay. Following Cooper et al. (2001, 2006a), we used radar counts of landward-flying targets as our daily index of murrelet abundance at a site.

Marbled Murrelet targets detected on radar were distinguished from other species by their flight speed, timing, and (sometimes) target signature. We have determined that a >40-mi/h (64-km/h) speed cutoff minimizes the number of non-murrelet species while eliminating a small percentage (~3%) of Marbled Murrelets (Cooper and Blaha 2002, Cooper et al. 2001). Thus, all targets with a flight speed greater than 40 mi/h (64 km/h) were considered to be Marbled Murrelets, unless the target signature was typical of a flock of Band-tailed Pigeons (*Columba fasciata*) or the target was observed after sunrise. Band-tailed Pigeon flocks sometimes exhibit a characteristic signature that is large and composed of multiple targets that repeatedly break apart, then coalesce. These targets are easily distinguished from a typical Marbled Murrelet target. In addition, we eliminated targets that were observed after sunrise to help eliminate single Band-tailed Pigeons from the data set. We have found that Band-tailed Pigeon activity generally does not start until a few minutes after sunrise (i.e., 105 min after our radar surveys begin), so we have a higher degree of confidence in the radar identification of murrelets before sunrise than after sunrise in areas like the CRMW where Band-tailed Pigeons are common. Nearly all murrelets fly into nesting stands well before sunrise (Cooper et al. 2001, Burger 1997), so it is likely that few landward targets would be missed using this sunrise cutoff time. Further, a precedent for this method has been set by Burger (2001) and Burger et al. (2005), who used sunrise for their cutoff period to count murrelets.

## RESULTS

We recorded a total of 89 pre-sunrise murrelet targets on 38 mornings of radar observation in the CRMW during summer 2006 (Table 3, Appendix 3). An additional four mornings of radar sampling were cancelled by inclement weather. Of the 89 radar targets, 36 (40%) were flying in a landward direction, 35 (39%) were flying in a seaward direction, and 18 (20%) were flying in “other” directions. We had no audio-visual observations of Marbled Murrelets during radar sampling (Table 3), but we did observe one murrelet during standard audio-visual surveys in the South Fork South Site (Table 4).

## DISTRIBUTION AND ABUNDANCE

Similar to 2005, mean daily counts of landward radar targets generally were quite low in 2006. Mean landward counts ranged between 0 and 4 targets per morning (Fig. 4, Tables 3 and 5). The highest landward counts (4.0 targets/morning) occurred at the Chester Morse site, which is situated at the bottleneck formed by the valley along Chester Morse Lake. No landward targets were observed at 5 of the 16 radar sites (i.e., no targets at Powerline South, Education Center, Taylor Ridge, 155.1A, and South Fork). Mean landward counts did not differ significantly between 2005 and 2006 ( $t = 0.673$ ,  $df = 14$ ,  $P = 0.512$ ; Table 5).

Even though the range of daily landward counts varied by only a few birds, we still observed relatively high among-day variation in landward counts because of the low counts (Table 5). Coefficients of Variation (CV's) ranged from 0% at the three sites where no landward targets were observed, to ~90% at Chester Morse and Powerline North, to 173% at Powerline Central.

## FLIGHT PATHS

As expected, landward flight directions generally were centered along the main axis of the valley near each radar site (Fig. 5). An exception to this pattern occurred at Rack Creek, where the mean flight direction was perpendicular to, rather than parallel with, the main axis of the creek valley.

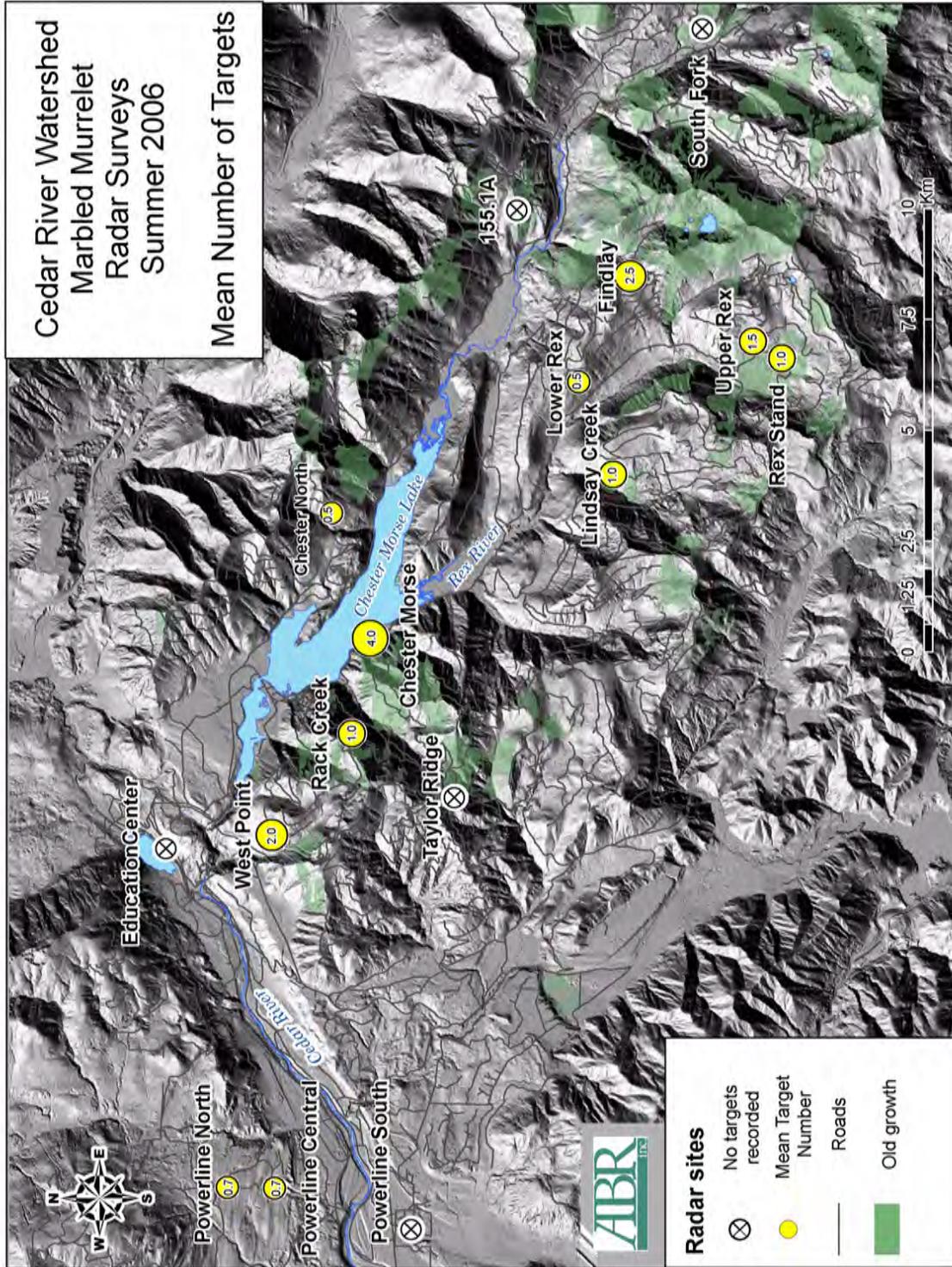


Figure 4. Map showing the mean number of landward targets/day observed on radar at each site in the Cedar River Municipal Watershed, Washington, during summer 2006. Size of circles are proportional to the mean rate; numbers within the circles are the actual means.

Table 5. Mean counts (targets or flocks/day  $\pm$  1 SE) of radar targets by flight direction at sites in the Cedar River Municipal Watershed, Washington, during summer 2005 and 2006. Table excludes data for days with high winds or persistent precipitation; counts only include targets recorded before sunrise.  $n$ =number of sampling days.

Site	Year	Mean number of targets recorded on radar			n
		Landward-flying	Seaward-flying	Other directions	
<b>LONG-TERM SITES</b>					
Powerline North	2005	0.7 $\pm$ 0.7	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	3
	2006	0.7 $\pm$ 0.3	1.0 $\pm$ 0.6	1.0 $\pm$ 0.6	3
Powerline Central	2005	1.0 $\pm$ 0.4	1.8 $\pm$ 0.9	0.0 $\pm$ 0.0	4
	2006	0.7 $\pm$ 0.7	0.3 $\pm$ 0.3	1.3 $\pm$ 0.9	3
Powerline South	2005	1.0 $\pm$ 0.6	0.3 $\pm$ 0.3	0.3 $\pm$ 0.3	3
	2006	0.0 $\pm$ 0.0	3.7 $\pm$ 2.7	0.7 $\pm$ 0.3	3
Chester Morse	2005	7.3 $\pm$ 3.5	2.7 $\pm$ 1.5	0.0 $\pm$ 0.0	3
	2006	4.0 $\pm$ 2.1	1.7 $\pm$ 0.7	0.0 $\pm$ 0.0	3
155.1A	2005	2	0	0	1
	2006	0.0 $\pm$ 0.0	2.0 $\pm$ 0.6	0.3 $\pm$ 0.3	3
South Fork	2005	0	1	1	1
	2006	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	3
<b>SHORT-TERM SITES</b>					
Education Center	2005	1	2	0	1
	2006	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.5 $\pm$ 0.5	2
West Point	2005	1	2	0	1
	2006	2.0 $\pm$ 2.0	0.5 $\pm$ 0.5	1.5 $\pm$ 0.5	2
Taylor Ridge	2005	0	0	0	1
	2006	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	1.0 $\pm$ 1.0	2
Rack Creek	2005	4	0	0	1
	2006	1.0 $\pm$ 1.0	0.5 $\pm$ 0.5	0.0 $\pm$ 0.0	2
Lindsay	2005	0	0	0	1
	2006	1.0 $\pm$ 1.0	1.0 $\pm$ 1.0	0.0 $\pm$ 0.0	2
Chester North <sup>2</sup>	2006	0.5 $\pm$ 0.5	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	2
Upper Rex	2005	1	0	0	1
	2006	1.5 $\pm$ 0.5	0.0 $\pm$ 0.0	0.5 $\pm$ 0.5	2
Rex Stand	2005	0	1	0	1
	2006	1.0 $\pm$ 0.0	1.0 $\pm$ 1.0	0.0 $\pm$ 0.0	2
Lower Rex	2005	0	0	1	1
	2006	0.5 $\pm$ 0.5	1.0 $\pm$ 1.0	0.0 $\pm$ 0.0	2
Findley	2005	0	0	0	1
	2006	2.5 $\pm$ 0.5	0.5 $\pm$ 0.5	0.5 $\pm$ 0.5	2

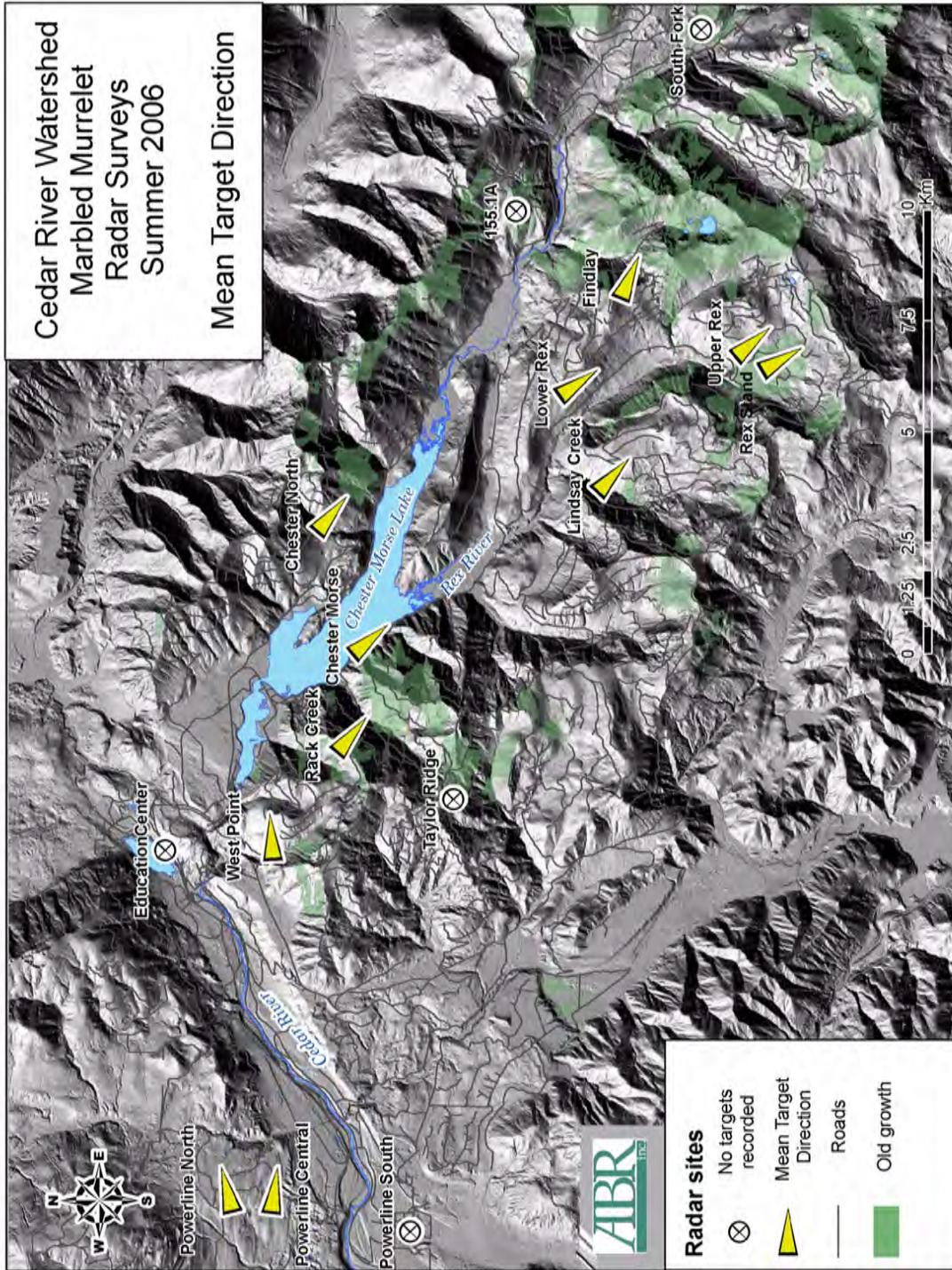


Figure 5. Map showing the mean flight direction of landward targets observed on radar at each site in the Cedar River Municipal Watershed, Washington, during summer 2006. Arrows indicate the mean direction of flight; sites without an arrow are locations where no landward targets were detected.

We also examined specific flight paths of all murrelet targets to obtain information on smaller-scale patterns of movement and information on movements toward/near old-growth habitat that might be suggestive of use by Marbled Murrelets. At Powerline North, Powerline Central, and Powerline South, most of the movements were either inbound or outbound birds flying along the approximate axis of the Cedar River valley though several targets traveling in “other” directions also were seen (Fig. 6). There is no old-growth habitat in the vicinity of those three sites, however.

Similar to 2005, nearly all of the 2006 targets at Chester Morse were flying over the lake, along the approximate axis of the valley (Fig. 7). A few of those targets were oriented slightly south of the axis, however, suggesting that they were using the Rex River drainage, rather than the main Cedar River valley.

All of the targets observed at site 155.1A were headed in a seaward or “other” direction (Figure 8). Two of the targets were flying toward the southwest away from old growth areas just north of the radar site, suggesting possible presence of murrelets in those areas.

One “other” target was observed at the Education Center site, but there was no nesting habitat in the vicinity of that target (Figure 9). A total of eight targets observed at West Point (Figure 9). Half of those targets at West Point were on trajectories that would take them into/out of the portion of the main Cedar River valley to the west of the station and the other half of those targets had a southerly heading (Figure 9). None of the tracks with a southerly heading were clearly associated with patches of old-growth habitat even though it is a possibility.

Similar to 2005, all 2006 targets at Rack Creek were headed across Rack Creek, suggesting that they were either using the nesting habitat on the east side of the creek, or were flying at high altitudes to/from destinations located further east in the main Cedar River valley (Fig. 10).

Two targets were observed at the Taylor Ridge site in 2006. One of the two of the targets was heading toward some old-growth habitat to the southeast of the station, suggesting possible use of that stand (Figure 11).

At the Chester North site, we only observed a single target which was flying over the reservoir (Figure 12). There were no targets associated with the large patch of old-growth habitat located just east of the site where we made audio-visual observations. In contrast, all four targets observed at Lindsay Creek were located in the vicinity of old-growth habitat (Figure 13).

All three targets observed at Lower Rex were headed up or down the Rex River valley (Figure 14). Further upstream, at the Upper Rex and Rex Stand sites, we observed several targets flying into and over the large patch of established murrelet habitat (Figure 15). We also observed two targets that flew towards the east or southeast, beyond that large block of old-growth habitat.

Five of the seven targets observed at Findley had landward flight paths that placed the targets either over, or heading toward, old-growth habitat in the Findley Creek drainage (Figure 16). No radar targets were recorded near the remaining study site (i.e., South Fork), but one AV target was detected in a stand of old growth ~500 m to the southwest during AV surveys on 8 July 2006 (Figure 17).

## AUDIO-VISUAL SURVEYS

During summer 2006, we conducted 33 mornings of standard audio-visual surveys (plus two tandem visits) at sites with the best murrelet habitat in CRMW, and/or in areas of suitable habitat where radar observations in 2005 suggested presence of marbled murrelets (Fig. 2, Table 4). The only site we detected murrelets at in 2006 was the South Fork South site (Table 4). At that site, we observed occupied behavior on our second survey visit: at 0444 h on 8 July 2006, we visually observed a murrelet flying in a southeasterly direction at 0.9 canopy heights from Station #1 (Figure 17). We did not observe Marbled Murrelets during any of our five survey visits at the Chester North, Lindsay North, Lower Rex East (Findley), Rack Creek, and Taylor Ridge North sites (Table 4). We also did not detect any murrelets during single visits to the South Fork North and Lost Creek sites. Observations at both of those sites were discontinued after a single survey so that we could focus our survey efforts on higher priority sites.

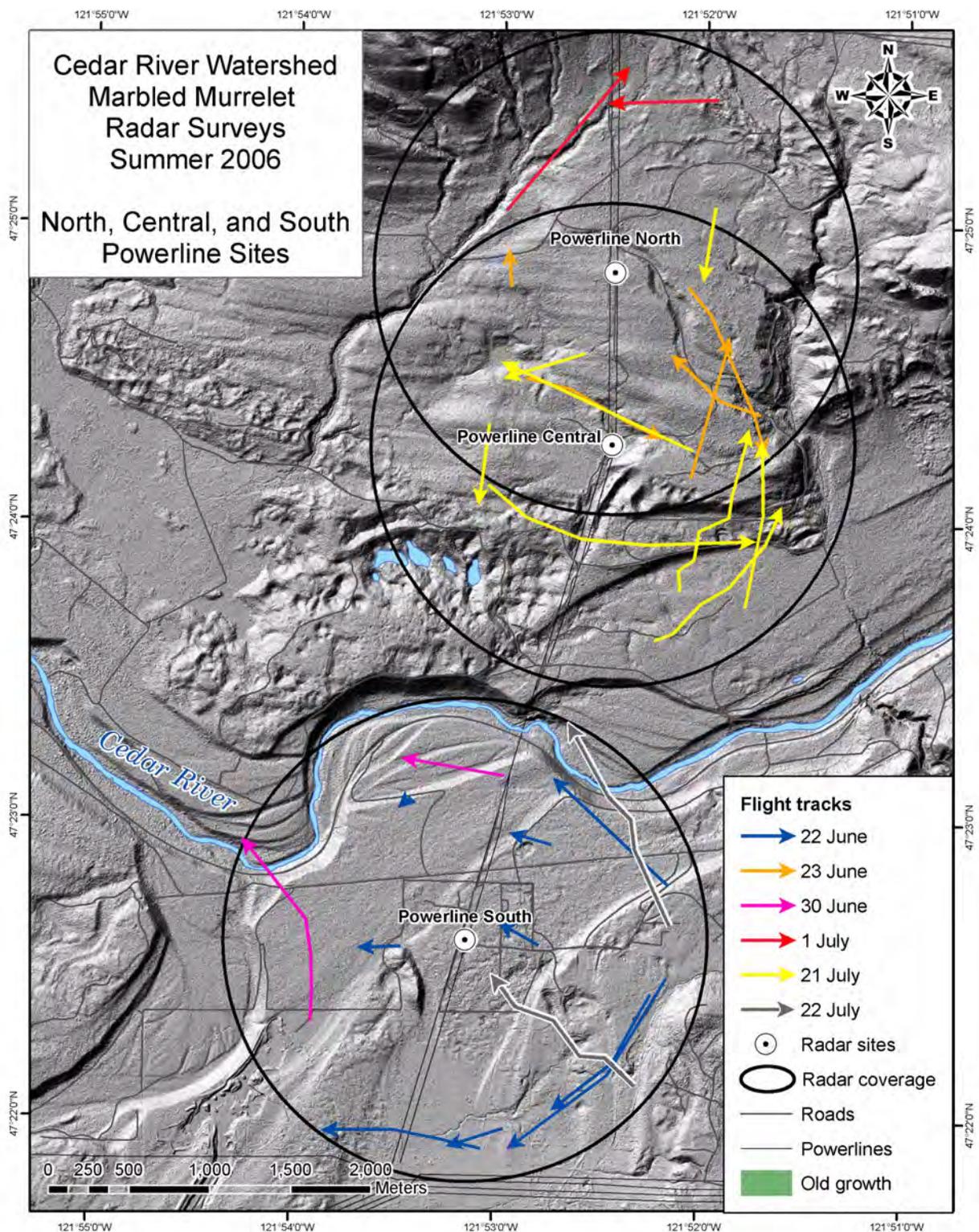


Figure 6. Map showing the flight paths of radar targets observed before sunrise at the Powerline North, Powerline Central, and Powerline South sites in the Cedar River Municipal Watershed, Washington, during summer 2006. Note that the 1.5-km ring denotes the maximal range of the radar, but there were gaps in radar coverage within that range because of radar shadows and ground clutter.

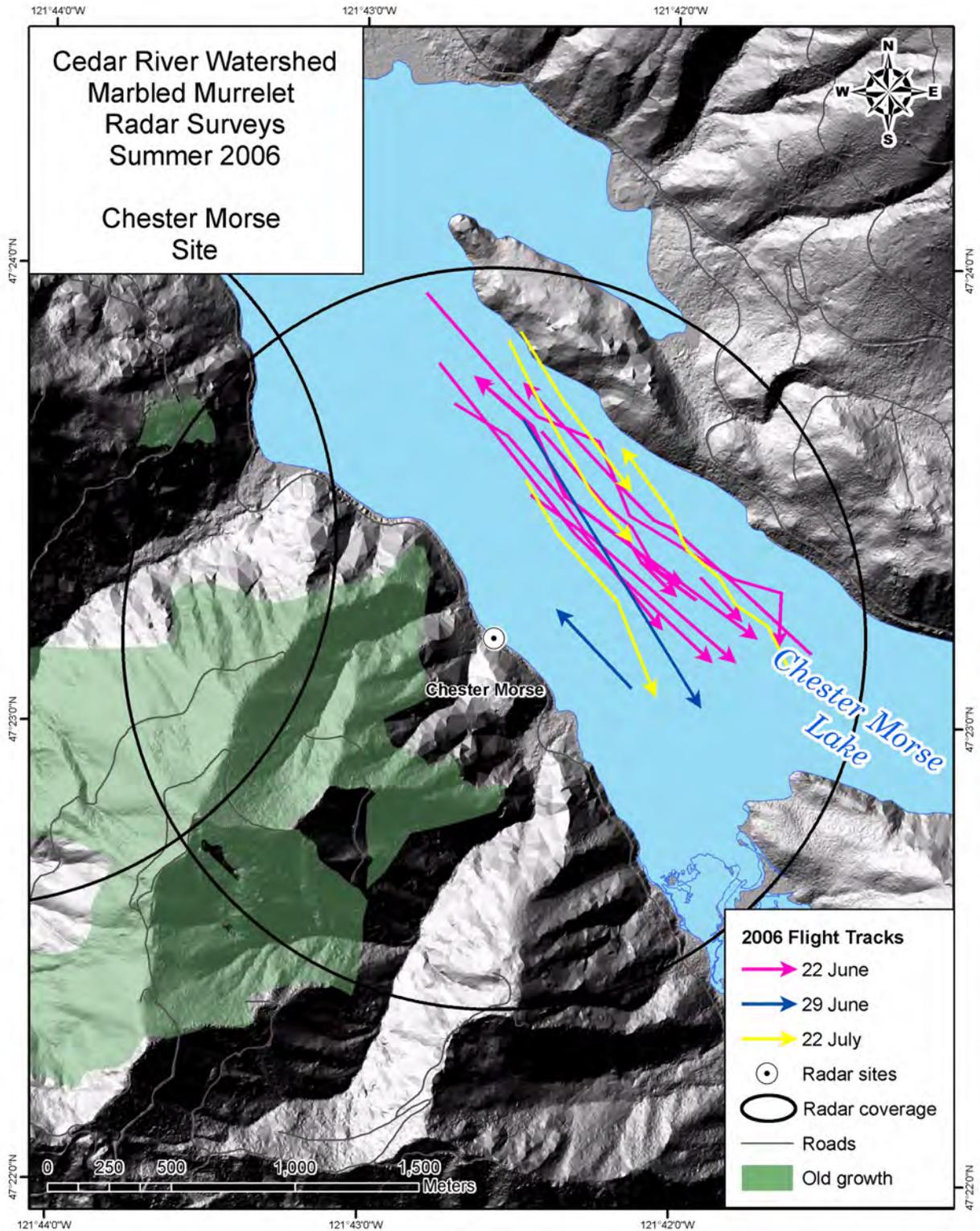


Figure 7. Map showing the flight paths of radar targets recorded before sunrise at the Chester Morse site in the Cedar River Municipal Watershed, Washington, during summer 2006. Note that the 1.5-km ring denotes maximal range of the radar, but there were gaps in radar coverage within that range because of radar shadows and ground clutter.

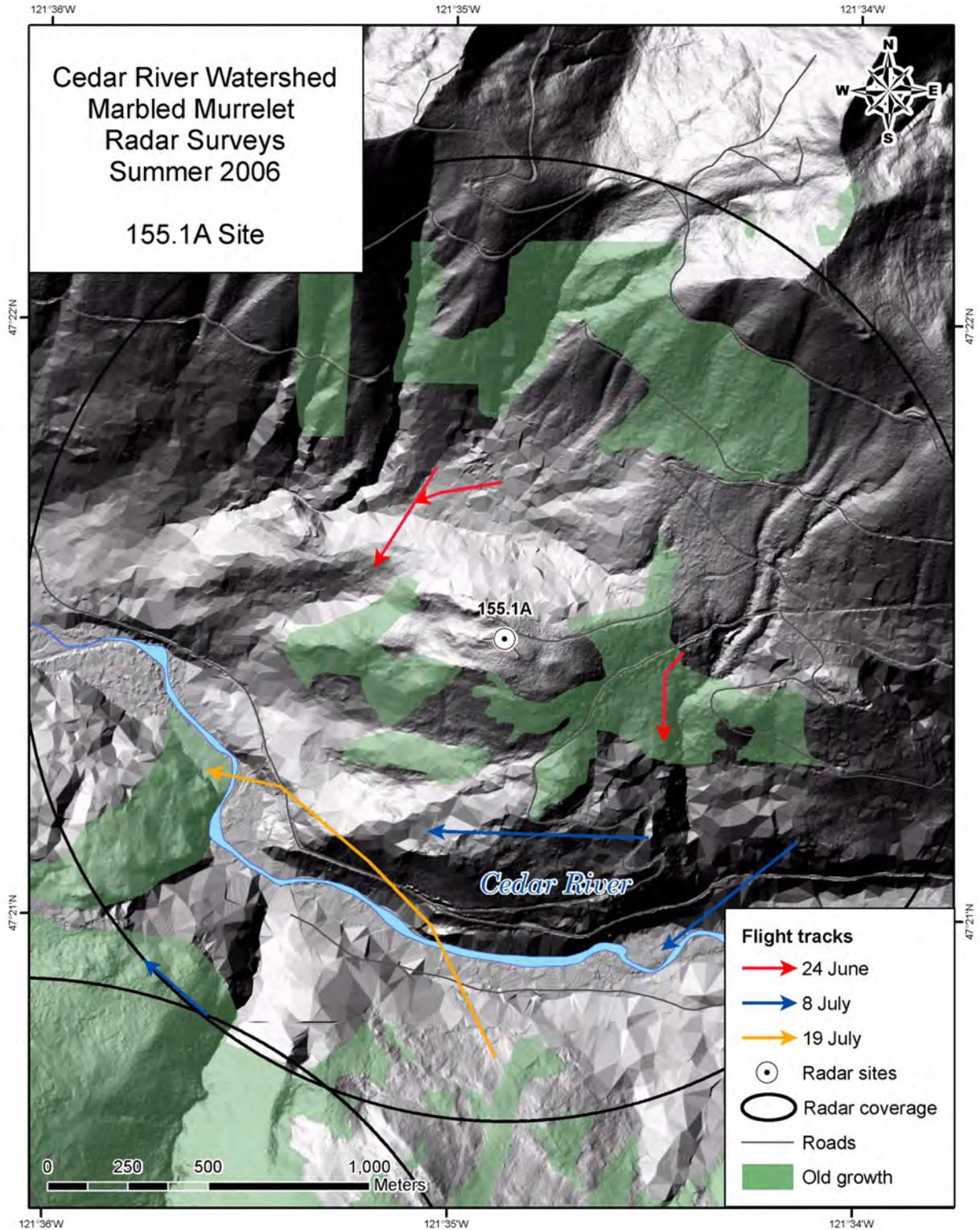


Figure 8. Map showing the flight paths of radar targets observed before sunrise at Site 155.1A in the Cedar River Municipal Watershed, Washington, during summer 2006. Note that the 1.5-km ring denotes maximal range of the radar, but there were gaps in radar coverage within that range because of radar shadows and ground clutter.

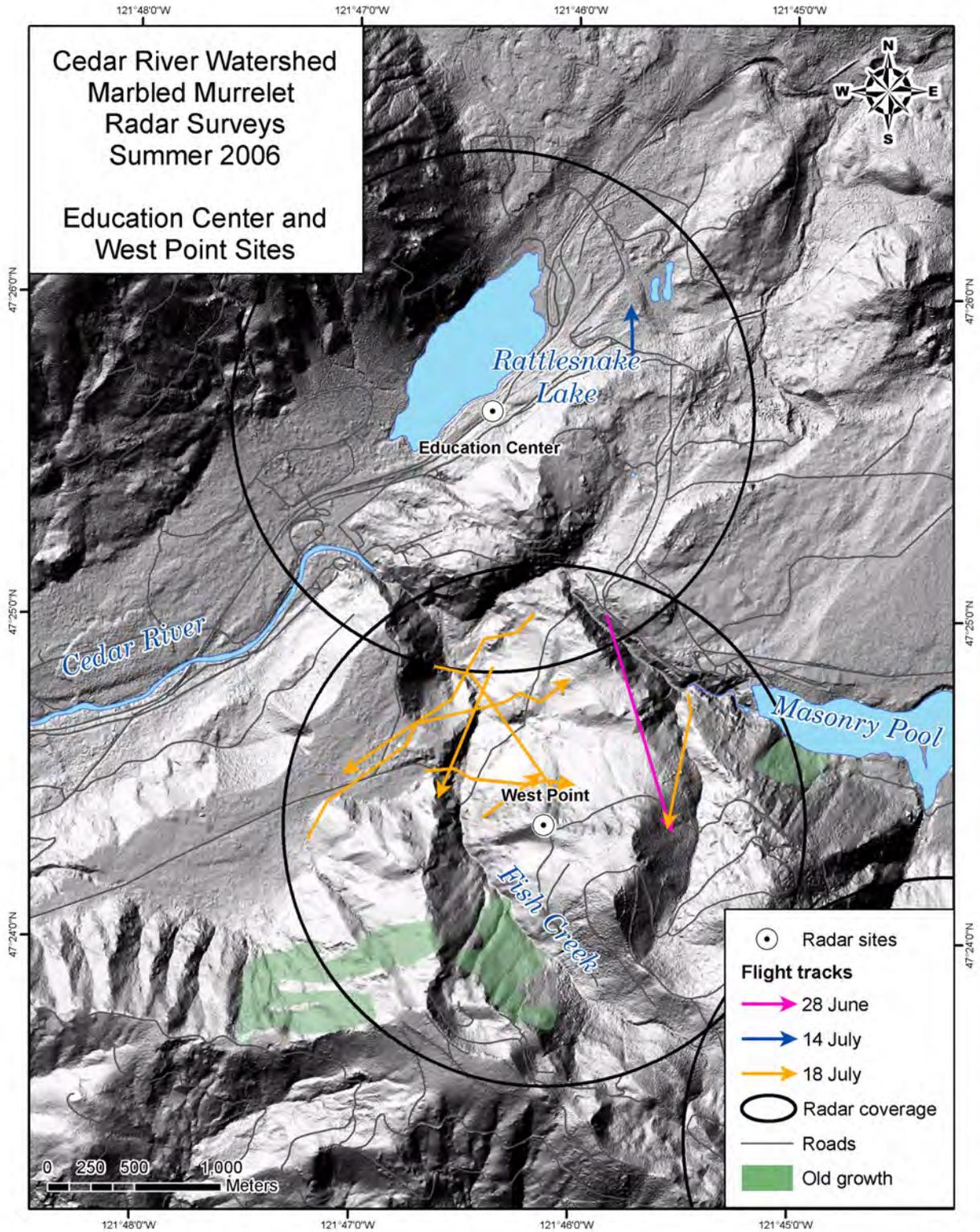


Figure 9. Map showing the flight paths of radar targets observed before sunrise at the Education Center and West Point sites in the Cedar River Municipal Watershed, Washington, during summer 2006. Note that the 1.5-km ring denotes maximal range of the radar, but there were gaps in radar coverage within that range because of radar shadows and ground clutter.

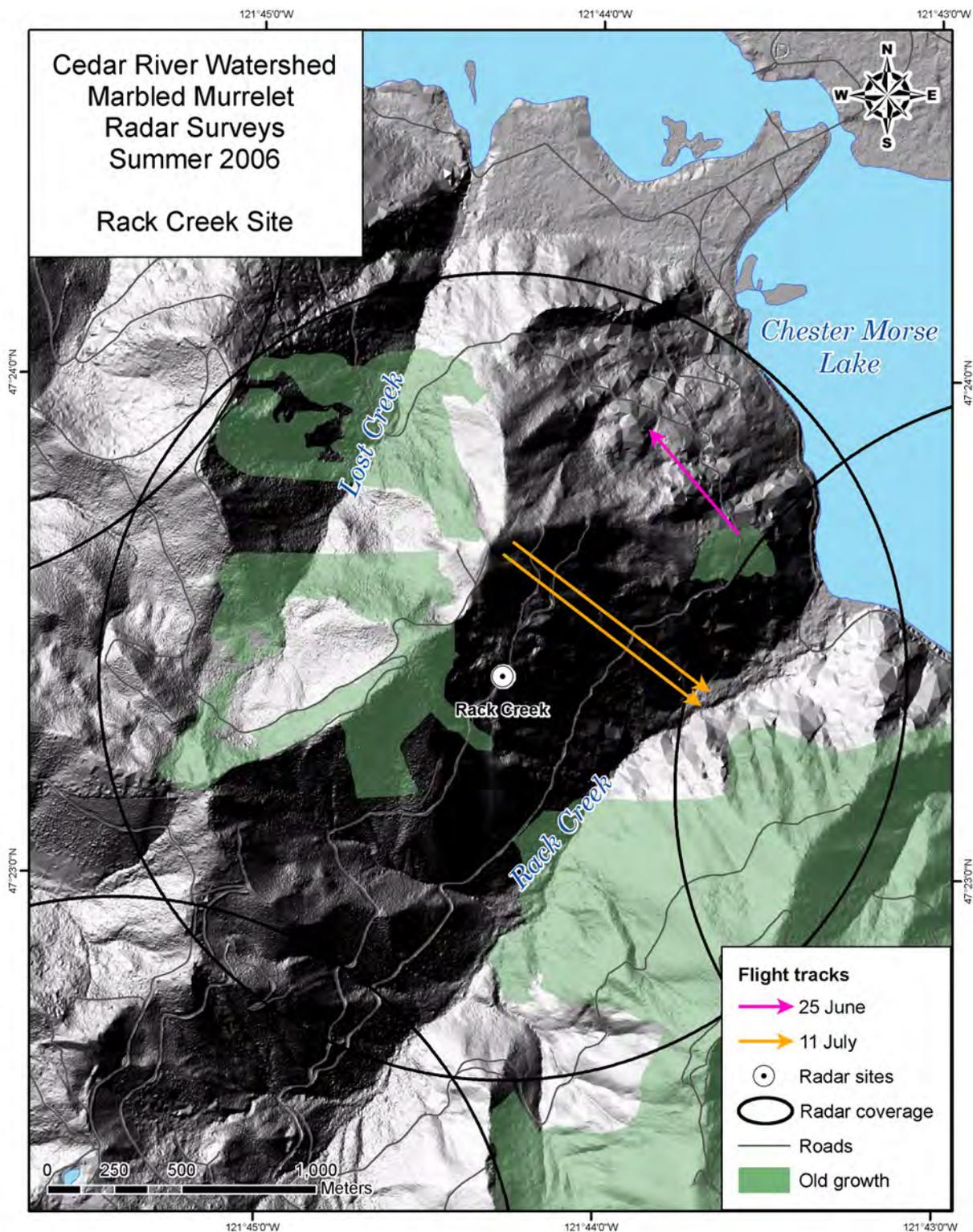


Figure 10. Map showing the flight paths of radar targets observed before sunrise at the Rack Creek site in the Cedar River Municipal Watershed, Washington, during summer 2006. Note that the 1.5-km ring denotes maximal range of the radar, but there were gaps in radar coverage within that range because of radar shadows and ground clutter.

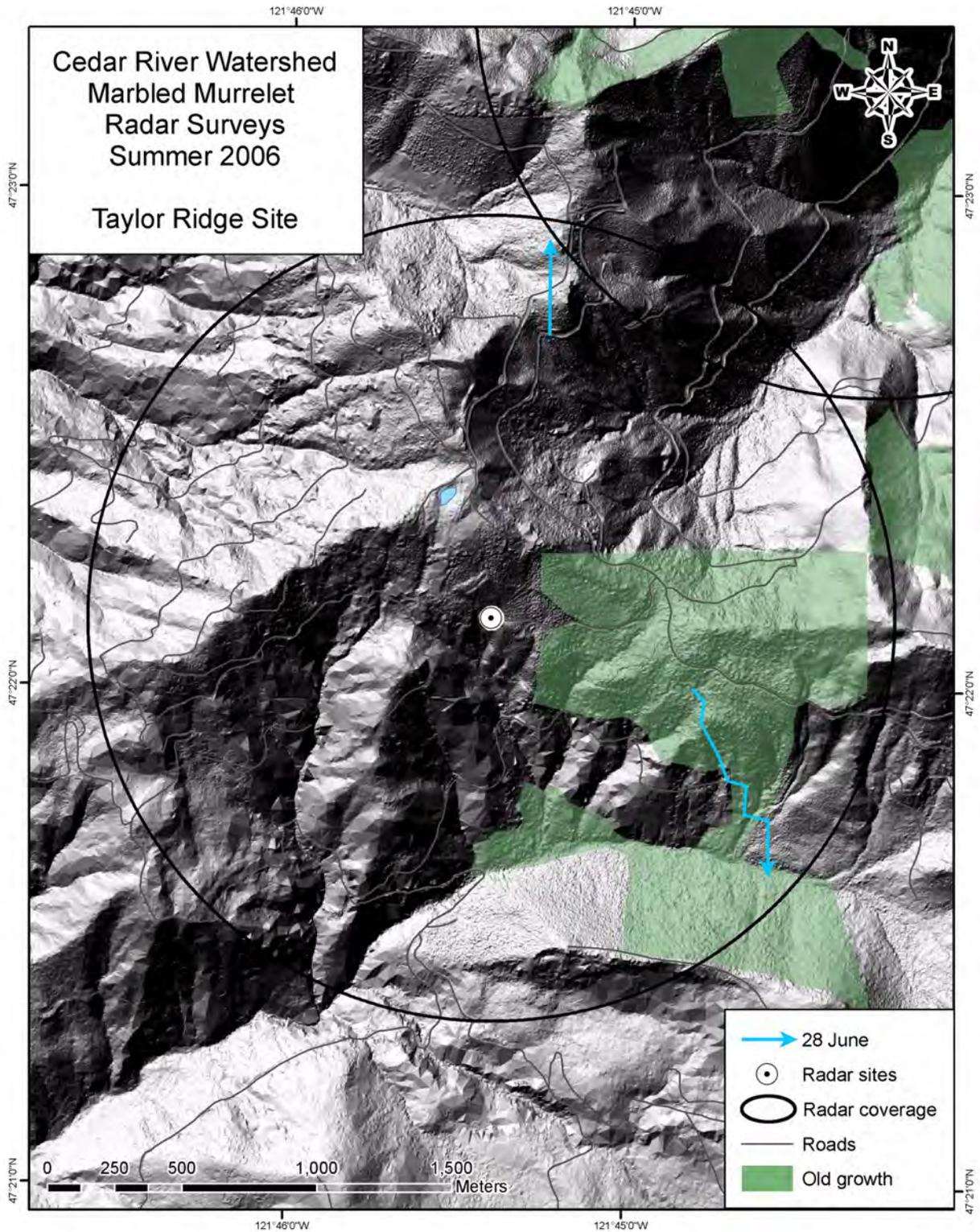


Figure 11. Map showing the flight paths of radar targets observed before sunrise at the Taylor Ridge site in the Cedar River Municipal Watershed, Washington, during summer 2006. Note that the 1.5-km ring denotes maximal range of the radar, but there were gaps in radar coverage within that range because of radar shadows and ground clutter.

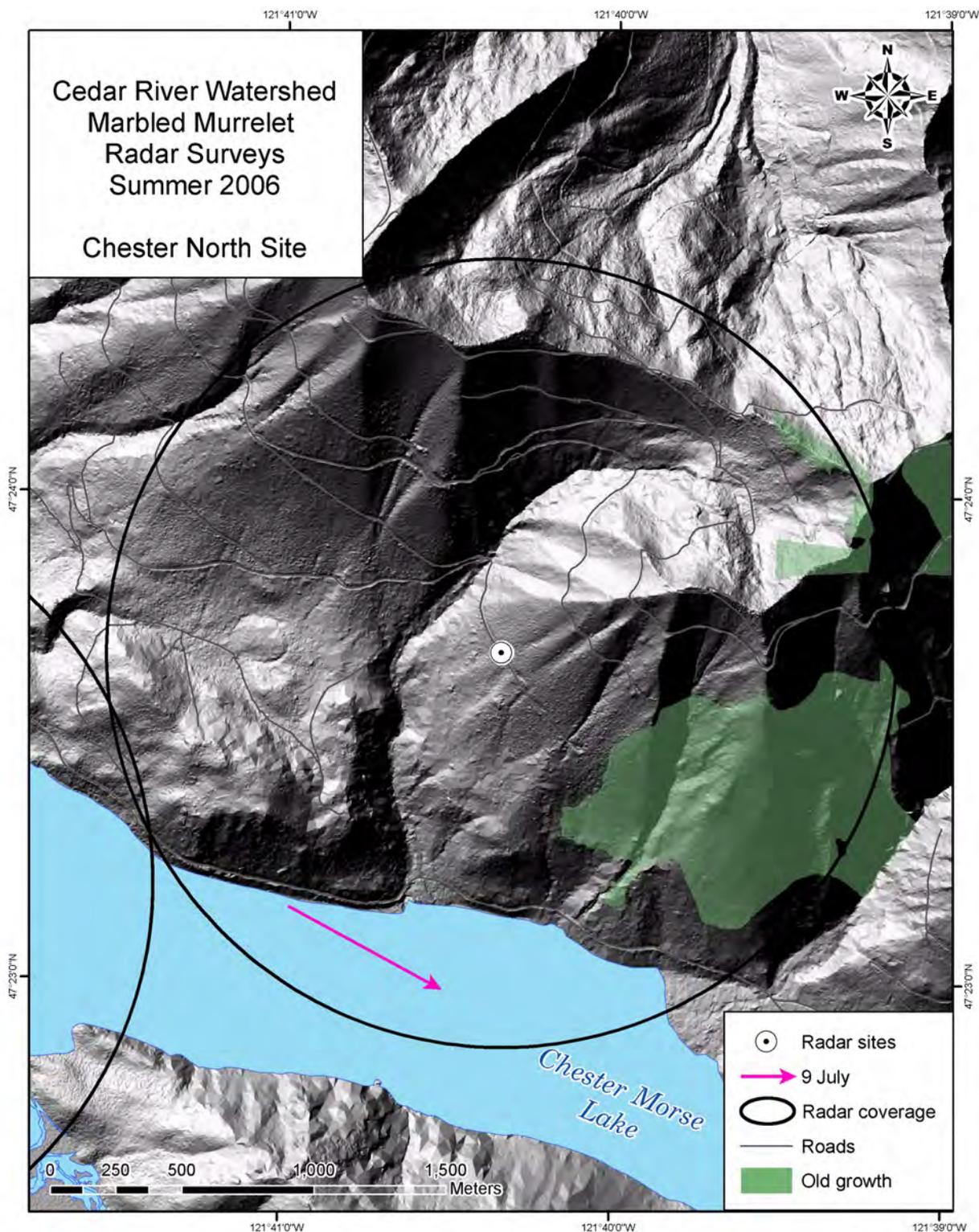


Figure 12. Map showing the flight paths of radar targets observed before sunrise at the Chester North site in the Cedar River Municipal Watershed, Washington, during summer 2006. Note that the 1.5-km ring denotes maximal range of the radar, but there were gaps in radar coverage within that range because of radar shadows and ground clutter.

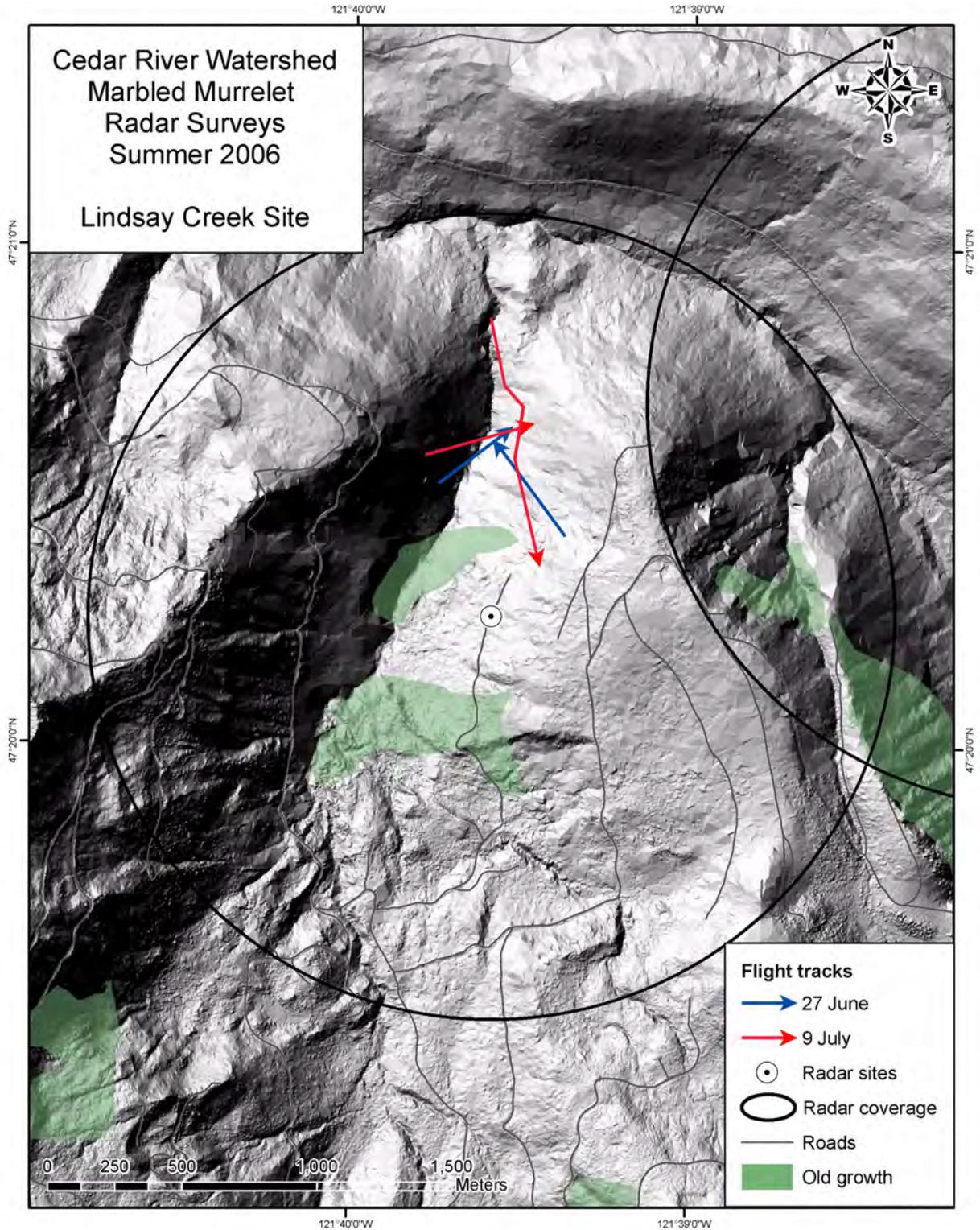


Figure 13. Map showing the flight paths of radar targets observed before sunrise at the Lindsay Creek site in the Cedar River Municipal Watershed, Washington, during summer 2006. Note that the 1.5-km ring denotes maximal range of the radar, but there were gaps in radar coverage within that range because of radar shadows and ground clutter.

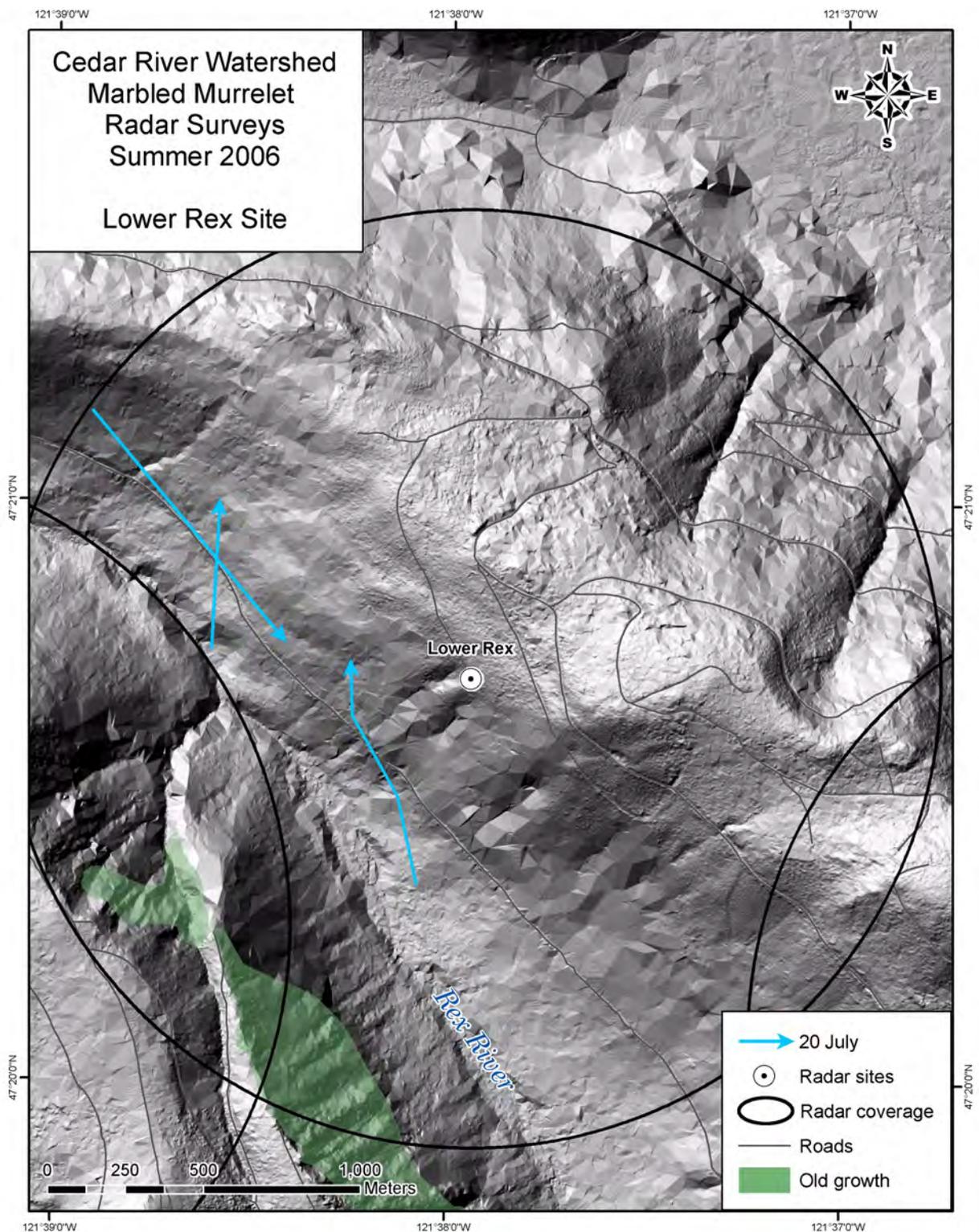


Figure 14. Map showing the flight paths of radar targets observed before sunrise at the Lower Rex site in the Cedar River Municipal Watershed, Washington, during summer 2006. Note that the 1.5-km ring denotes maximal range of the radar, but there were gaps in radar coverage within that range because of radar shadows and ground clutter.

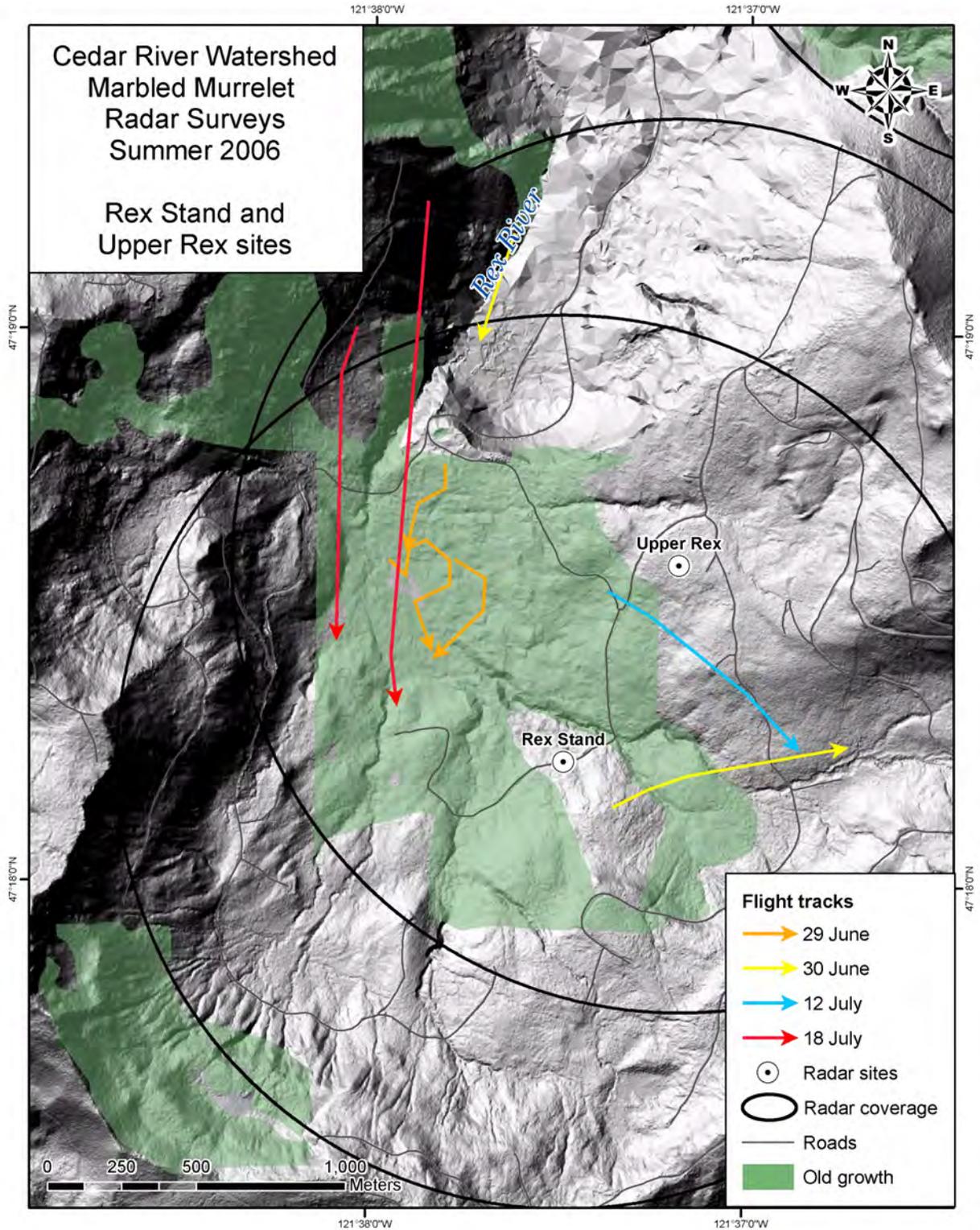


Figure 15. Map showing the flight paths of radar targets observed before sunrise at the Upper Rex and Rex Stand sites in the Cedar River Municipal Watershed, Washington, during summer 2006. Note that the 1.5-km ring denotes maximal range of the radar, but there were gaps in radar coverage within that range because of radar shadows and ground clutter.

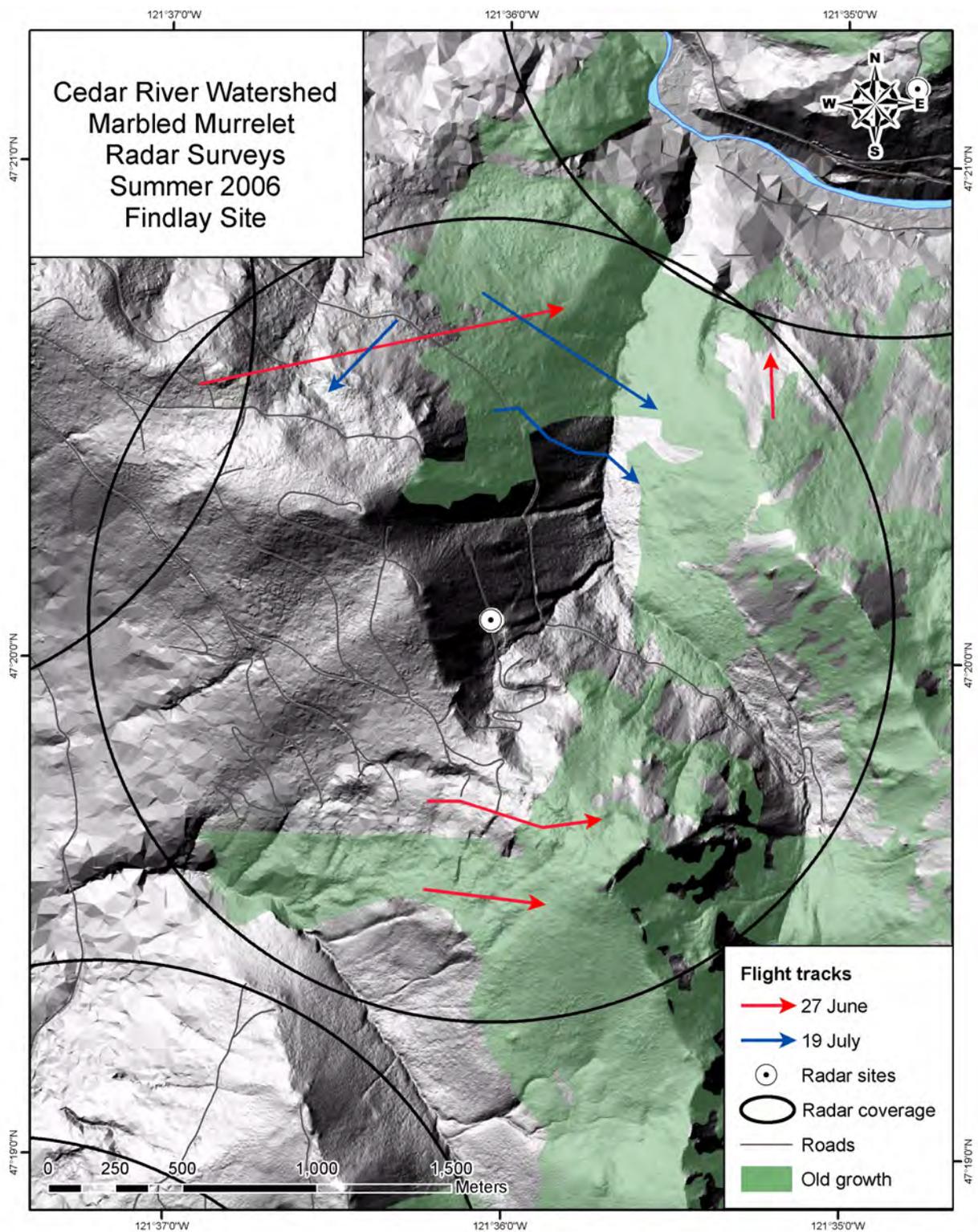


Figure 16. Map showing the flight paths of radar targets observed before sunrise at the Findlay site in the Cedar River Municipal Watershed, Washington, during summer 2006. Note that the 1.5-km ring denotes maximal range of the radar, but there were gaps in radar coverage within that range because of radar shadows and ground clutter.

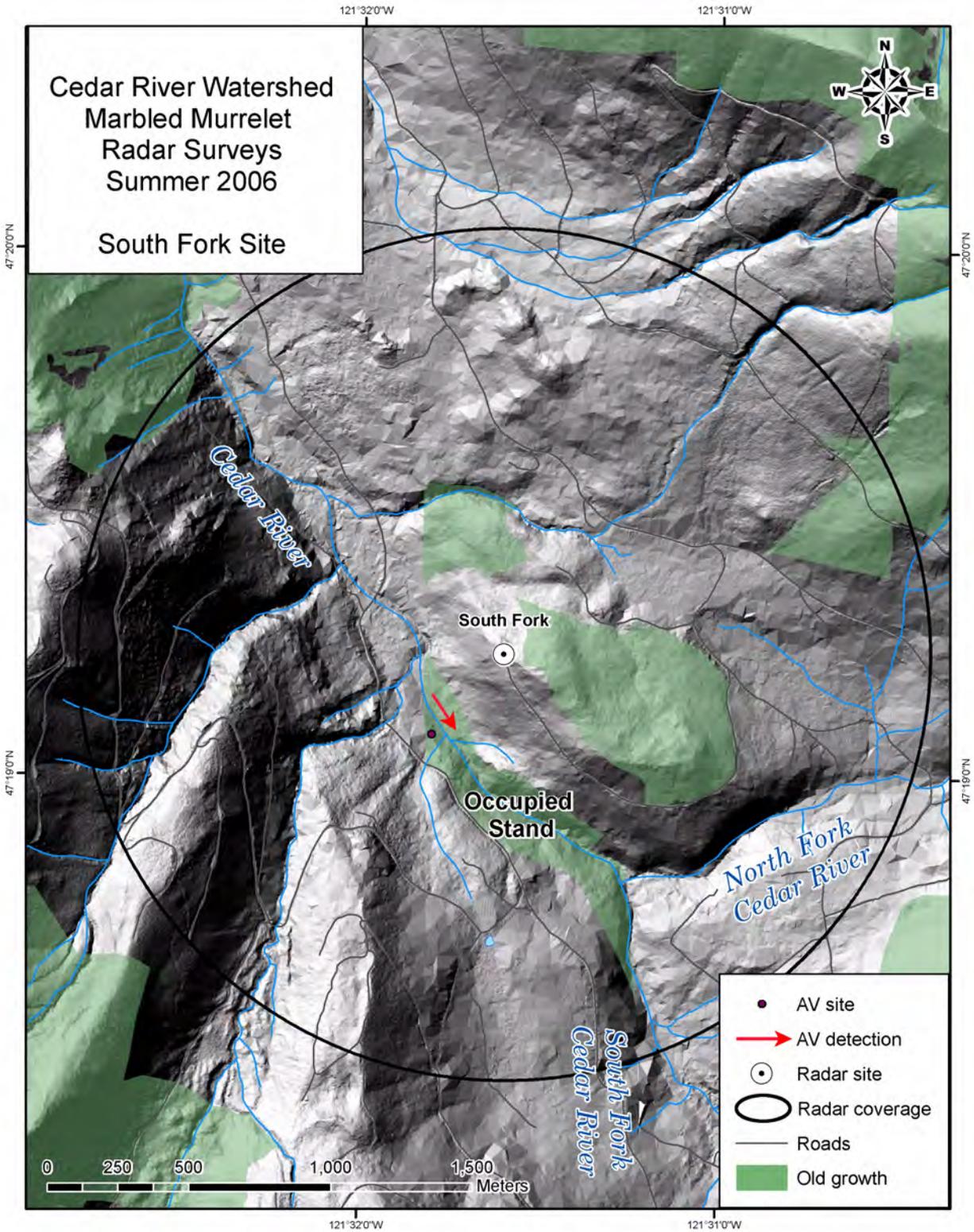


Figure 17. Map showing the flight paths of radar targets observed before sunrise at the South Fork site in the Cedar River Municipal Watershed, Washington, during summer 2006. Note that the 1.5-km ring denotes maximal range of the radar, but there were gaps in radar coverage within that range because of radar shadows and ground clutter.

## DISCUSSION

### SUITABILITY OF CMRW FOR RADAR OBSERVATIONS

The CRMW is heavily forested and has very few natural or human-made openings, so there are few good radar sampling sites in the area. Fortunately, we were able to find excellent sites at key locations for long-term sampling as well as at several locations for short-term radar sampling. The three long-term sites located along the wide powerline corridor near the western border of the CRMW (i.e., Powerline North, Powerline Central, and Powerline South) are good sampling sites but will have good radar-sampling views in the future only if there is long-term maintenance of a wide powerline corridor. The Chester Morse site offers an excellent view over Chester Morse Lake, across the entire width of the Cedar River Valley, and should remain a good sampling site well into the future. Along with the good radar view over the lake, an additional benefit of the Chester Morse site is that it is located at a topographical bottleneck that helps funnel most Marbled Murrelets in the area through the radar-sampling zone.

The three Powerline sites were placed to provide the best possible radar coverage of the western edge of the CRMW. The Powerline North and Powerline Central sites are within 1.5 km of each other, so there is some overlap in radar coverage, but there was no spatial overlap in targets detected at the two sites in 2006 or in 2005. For example, none of the targets observed during the four days of concurrent radar sampling at Powerline North and Powerline Central in 2005 and 2006 were detected at both sites. This apparent lack of overlapping targets probably occurred because of differences in altitudinal bands that were sampled and because ground-clutter patterns differed between the two sites. Nevertheless, we suggest concurrent sampling at the Powerline North and Powerline Central sites so that we will know if any targets are getting double-counted at the two sites.

Judging by the higher counts at Chester Morse (~7 and ~4 targets/day in 2005 and 2006, respectively) than at all three powerline sites combined (~3 and ~2 targets/day in 2005 and 2006,

respectively), it is clear that some murrelets are entering and exiting the western end of the CRMW in areas not covered by the Powerline sites (e.g., areas to the north or south of those sites). Unfortunately, no additional radar sites were available to cover those areas to the north or south of the existing Powerline sites. The Powerline sites still provide a good index for monitoring, however, and there are methods for correcting the number of murrelets that pass undetected to the north or south of the combined Powerline sites (see below).

The South Fork and/or 155.1A sites were each upgraded from a short-term sampling site to a long-term sampling site in 2006. The hope was that these sites might provide information to help monitor trends in the far eastern end of the upper CRMW. Site 155.1A is a good site for monitoring murrelets that fly past the station at similar altitudes as the site, but it is likely that low-flying birds over the Cedar River would be missed. Thus, 155.1A is not an ideal site because counts there may be affected by factors like weather that might influence flight altitudes (and thus, increase variation in counts). There also are potential problems with the longevity of both the 155.1A and South Fork sites. Unless a large portion of the surrounding forest is actively managed to maintain a good radar-sampling view, the radar views at both sites will be blocked by vegetation in a few years.

Similarly, all short-term sites are in locations where trees will grow large enough to obscure the radar view within a few years. Unfortunately, there are only a few additional sites where radar observations are currently possible in the CRMW besides those sampled in 2005 and 2006, with each of them being likely to be obscured by tree cover in the future. Those additional sites also tended to be located in the uppermost reaches of the watershed, so they probably are of minimal value for sampling in 2007.

### SPECIES IDENTIFICATION

Band-tailed Pigeons were common in the CRWM, and Common Loons (*Gavia immer*) were seen flying over Chester Morse Lake. Both of these species can be confused with Marbled Murrelet targets on radar, suggesting the need to continue the dawn cutoff time for observations and the

continued need for target confirmation by audio-visual observers during radar surveys. We have found that Band-tailed Pigeon activity generally does not start until a few minutes after sunrise (i.e., 105 min after our radar surveys begin), so a sunrise cutoff time is very effective in minimizing contamination of the radar data. Further, nearly all murrelets fly into nesting stands well before sunrise (Burger 1997, Cooper et al. 2001), so there is little risk of missing the majority of landward flights, even with a sampling-cutoff time of sunrise. Others also have used sunrise for their cutoff time for radar monitoring of Marbled Murrelets (Burger 2001, Burger et al. 2005).

### **DISTRIBUTION AND ABUNDANCE**

Our radar counts in the CRMW were lower than those at most locations on the Olympic Peninsula (Cooper et al. 2001; 2006a), the Oregon coast (Cooper et al. 2000), and California (Cooper et al. 2005), which is no surprise given the much smaller amount of nesting habitat in the CRMW and the large distance from many parts of the CRMW to ocean foraging areas. In contrast, our CRMW radar counts generally were similar to those at other sites far inland in the Washington Cascades (Cooper et al. 1999; Cooper and Blaha 2001a, 2001b; ABR, Inc. 2005). In Washington, the most-inland known Marbled Murrelet nest location is 35 km, and the most-inland occupied site is 84 km (Evans Mack et al. 2003). The upper reaches of the CRMW is ~70 km inland (i.e., approaching the limit of murrelet distribution in Washington).

The lack of nesting platform structure (especially in old-growth habitat in the higher altitudes) is another possible explanation for the low number of targets in the CRMW. For example, the Findley site (where no radar targets were detected in 2005 and 2.5 landward targets/day were detected in 2006 and where no murrelets were observed during audio-visual surveys in 2006) is adjacent to a huge patch of old-growth forest, but nearly all of that habitat is located >1,000 m asl in elevation and a cursory examination of the habitat suggested that with a few exceptions, it generally contained few nesting platforms. Similarly, much of the old-growth habitat in CRMW is above 1,000 m in elevation and lacks abundant nest platforms.

Nests normally occur below 1,000 m because the trees at higher elevations often lack the structural features that form platforms (Nelson 1997, Burger 2002). Nests have been found up to 1,530 m asl, however, so elevation per se should not be used to assess habitat suitability. Instead, habitat suitability should be based on the availability of nesting platforms and other features common to known nest sites. For example, sites with the highest likelihood of nesting murrelets generally have more potential nesting platforms, larger trees, and greater moss cover on tree limbs than do other sites (Grenier and Nelson 1995, Hamer 1995, Kuletz et al. 1995, Nelson 1997, Burger 2002). Specifically, murrelet nesting and activity usually is positively associated with: older stands of trees, tree diameter (dbh), density of large (dbh >80 cm) trees/ha, areas with larger basal area of trees, areas with greater vertical complexity in canopy structure, areas with greater epiphyte cover on branches, areas with a higher density of potential nesting platforms, areas in lower elevations and areas >500 m from the coastline.

In 2006, we cruised ten areas identified from timber inventory and aerial photography as having the best available murrelet nesting habitat in the CRMW and found that most locations contained a few potential nesting platforms, but the overall quality of the habitat was only marginal in all but two of the areas (South Fork and Lower Rex East [Findley area]). It would be beneficial to conduct further murrelet habitat assessments in the CRMW to help continue to determine which of the high altitude stands of old-growth forest are not suitable for nesting murrelets. That habitat information then could be used in 2007 (as it was in 2006) to help predict murrelet distribution in the CRMW (along with radar information) and to help focus future audio-visual survey efforts.

The flight directions that we observed on radar mostly followed the main axis of valleys, except in some cases where local movements into patches of old growth suggested possible use of those patches by nesting or prospecting murrelets. For example, our 2005 radar data suggested that Marbled Murrelets might be using old-growth patches in West Point, Rack Creek, Rex Stand, Upper Rex, and South Fork (and perhaps the old-growth patch southwest of the Lower Rex site). The 2006 radar data suggested possible murrelet

use of habitat near West Point, Rack Creek, Taylor Ridge, Chester North, 155.1A, Findley, Rex Stand, Upper Rex, and Lindsay Creek. Audio-visual surveys would be needed to verify presence of murrelets in those stands, however.

There are now a total of two sites in the CRMW where Marbled Murrelets have been detected on audio-visual (AV) surveys. One stand in the far eastern portion of the CRMW (i.e., South Fork South) was determined to be “occupied” by murrelets during our 2006 surveys. Audio-visual observers also found Marbled Murrelets in the Rex Stand during 2005 (Cooper et al. 2006b), verifying current occupancy of that stand. Murrelets were detected during a single visit to the Rex Stand in the mid-1990s (W. P. Ritchie, WDFW, pers. comm.). Radar counts at South Fork and at the Rex Stand and Upper Rex suggest that a low number of murrelets used those areas in both 2005 and 2006.

#### **USE OF RADAR TO MONITOR TRENDS OF MURRELETS**

In this first two years of study, we found high Coefficients of Variation (CVs) in landward radar counts at our long-term sites (i.e., average CV = 109% in 2005 [Cooper et al. 2006b] and 117% in 2006 [2006 average excludes the three sites where no landward targets were observed]). These values suggest that there generally was high among-day variation in CRMW counts compared to counts at many other locations. For example, CVs of landward radar counts were 28% in the Olympic Peninsula (Cooper et al. 2001), 10–55% in Oregon (Cooper et al. 2000, Cooper and Augenfeld 2001), and 23–25% in California (Cooper et al. 2005, Bigger et al., 2006). Note that most of the sites in these cited studies had much higher daily counts than the extremely low counts that we observed in this study, which could have contributed to the higher percent variation. To help put some of those CV's into perspective, power analyses on the Olympic Peninsula radar data (Cooper et al. 2006a) indicated that they had high power (80%) to detect a 2%/yr decline in 15 years with ~3 surveys/year at their seven sites. Bigger et al. (2006) did a radar study in northern California and determined it would take 22 sites surveyed 4 times/yr to detect a 2.5%/yr decline in 10 years, with the same (80%)

power. Our CVs at CRMW suggest that we have much lower power than other radar studies to detect changes in radar counts. The long, 40-year interval between the first and last radar counts planned for CRMW should help reduce the impact of that higher variation on our ability to detect a change in the number of murrelets in the area, however, it still might be difficult to detect small annual changes in the population size even after 40 years. The radar data collected at our long-term sites in 2007 will help determine if the variation in counts observed in 2005 and 2006 was unusually high.

Data collected in 2007 also will provide more information on the amount of interannual variation in counts in the CRMW. No differences in radar counts in the CRMW were detected between 2005 and 2006, however. Similarly, Cooper et al. (2006) did not detect any among-year differences in radar counts on the Olympic Peninsula, Washington, during 1996–2004.

#### **MONITORING TRENDS IN DIFFERENT AREAS OF THE WATERSHED**

Because the western portion of the CRMW currently is largely devoid of Marbled Murrelet nesting habitat, there is interest in being able to separately determine local population trends of murrelets in both that western portion and the eastern portion of the watershed. In the future, it might be possible to separate trends in radar counts from the portion of CRMW west of the Chester Morse site (i.e., the western side), with trends east of the Chester Morse site (i.e., the eastern side), if one is willing to assume that flight corridor patterns of murrelets over the western end of the CRMW in the future are similar to present patterns. Put simply, this calculation would use the mean landward count at Chester Morse as an index of murrelet levels in the eastern side of the CRMW and the difference between the Chester Morse site and the sum of the three Powerline sites as an index of murrelet abundance in the western side. To separate eastern-side trends from western-side trends, however, it would first be necessary to correct the Powerline counts for a “detectability” factor to account for the proportion of birds flying into the western portion of CRMW that enter beyond the radar coverage of the three powerline

sites (i.e., either north of, south of, or between the three sites). A similar approach could be used to separate out trends east of the South Fork site with trends between Chester Morse and South Fork, but we are assuming that the South Fork site will not be used for sampling in future years because the site will be screened by surrounding vegetation.

Based on 2006 data, the correction factor for the Powerline site counts would be 5.7X (Correction factor = (((mean landward count at Chester Morse) + (the number of targets that were observed at sites between the Powerline sites and Chester Morse that could be assumed to have stopped before getting to Chester Morse, or would not have passed over the Chester Morse sampling area, even though they flew inland beyond the site))/(sum of the mean landward counts at the three Powerline sites)) =  $(4.0+4)/1.4 = 5.7$ ). Based on 2005 data, the correction factor would be 4.9X (=  $(7.3+6)/2.7$ ). By subtracting the mean number of targets observed at Chester Morse from the corrected sum of the mean radar count at the Powerline sites, one obtains the mean number of targets observed in the western side of the CRMW. Thus, in 2006, our abundance index for murrelets using the portion the CRMW west of the Chester Morse site was 4 murrelets (=  $(1.4*5.7) - 4.0$ ), and our index for the number using the portion of CRMW east of Chester Morse was 4 murrelets (i.e., our radar mean daily rate at the Chester Morse site). In 2005, our abundance index for murrelets using the portion the CRMW west of the Chester Morse site was 6 murrelets (=  $(2.7*4.9) - 7.3$ ), and our index for the number using the portion of CRMW east of Chester Morse was 7 murrelets (i.e., our radar mean daily rate at the Chester Morse site).

To illustrate how this index could be used in the future, let us provide an example assuming that, in 2045, the sum of mean landward counts at the three Powerline sites was 12 targets and the Chester Morse count was 14 targets. The murrelet index for that portion of the CRMW east of the Chester Morse site is then 14 in 2045 (a 200%, or 7-bird, increase over the 2005 index of 7 birds). The murrelet index for that portion of the CRMW lying between the Powerline sites and Chester Morse is more difficult to compute (i.e., 2005 index =  $(2.7 * 4.9) - 7.3 = 6$  murrelets and 2045

index =  $((12*4.9) - 14) = \sim 45$  murrelets), which would be a 39-bird increase for the western portion of the CRMW between 2005 and 2045. The murrelet indices could be used to make separate trend lines for the western and eastern portions of the CRMW. Further radar observations during 2007 at the long-term sites and at the short-term sites between the Powerline sites and Chester Morse (i.e., at Education Center, West Point, Rack Creek, and Taylor Ridge) could help refine the correction factor for the powerline sites and be used to produce a mean correction factor based on 2005–2007 data. This mean correction factor then could be used in future years, if one is willing to assume that the flight corridor patterns of murrelets into the CRMW at that time are similar to current patterns. If the distribution of nesting habitat in the CRMW changes dramatically in future years, however, it could affect the flight patterns of birds entering the western end of the CRMW. Thus, use of the correction factor will have to be considered carefully in future years based on a comparison of the general distribution of future murrelet nesting areas with the current distribution of active nesting habitat. Even if the correction factor is not used, the uncorrected radar counts could still be used to monitor trends of all murrelets inland from each site. Those uncorrected radar counts could not be used to separately track abundance patterns in the eastern and western portion of the CRMW, however.

#### RECOMMENDATIONS FOR 2007

In 2007, we suggest continued radar sampling at the existing long-term sites (with the possible exception of 155.1A and South Fork, for the reasons discussed above), with 4–5 visits per site to get better information on daily variation in counts. Continued sampling for 2–3 days each at the short-term sites between the three Powerline sites and Chester Morse would help provide data to fine tune the correction factor for targets that pass undetected by the Powerline sites. Radar surveys at Powerline North and Powerline Central should be conducted concurrently to minimize chances of double-counting targets observed in the zone of overlapping range between the two sites. We suggest continuing to use the sunrise sampling cut-off time to eliminate Band-tailed Pigeons from

the data. Further, we suggest continued efforts to get visual confirmation of all radar targets to help eliminate waterfowl (e.g., loons) over Chester Morse Lake and the occasional Band-tailed Pigeon that is active prior to sunrise.

A second year of AV surveys should be collected at the four AV sites where murrelets were not detected in 2007 (Chester North, Lindsay North, Rack, Lower Rex East [Findley], and Taylor Ridge North). Next in the priority list for AV surveys would be to scout for new low-elevation sites near Chester Morse reservoir and survey any areas found there (or elsewhere) that contain good quality habitat. Next in the priority list would be to resurvey Lost Creek and South Fork North and survey the patch of habitat southeast of West Point on the 860 Road. We also could conduct AV surveys at the old-growth stands near the 155.1A and Taylor Ridge sites where 2006 radar observations suggested the presence of Marbled Murrelets, if it is determined that nesting platforms are present in those areas.

#### LITERATURE CITED

- ABR, Inc. 2005. Radar observations of Marbled Murrelets in Mt. Rainier National Park, Washington, 2005. Unpublished report prepared for Mt. Rainier National Park, WA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 17 pp.
- Bigger, D., M. Z. Peery, J. Baldwin, S. Chinnici, and S. P. Courtney. 2006. Power to detect trends in Marbled Murrelet breeding populations using audiovisual and radar surveys. *Journal of Wildlife Management* 70: 493–504.
- Burger, A. E. 1997. Behavior and numbers of Marbled Murrelets measured with radar. *Journal of Field Ornithology* 68: 208–223.
- Burger, A. E. 2001. Using radar to estimate populations and assess habitat associations of Marbled Murrelets. *Journal of Wildlife Management* 65: 696–715.
- Burger, A. E. 2002. Conservation assessment of Marbled Murrelets in British Columbia: review of the biology, populations, habitat associations, and conservation of this threatened species. Technical Report Series No. 387, Canadian Wildlife Service, Delta, BC.
- Burger, A. E., T. A. Chatwin, S. A. Culler, N. P. Holmes, I. A. Manley, M. H. Mather, B. K. Schroeder, J. D. Steventon, J. E. Duncan, P. Arcese, and E. Selak. 2004. Application of radar surveys in the management of nesting habitat of Marbled Murrelets *Brachyramphus marmoratus*. *Marine Ornithology* 32: 1–11.
- Cooper, B. A., and K. H. Augenfeld. 2001. Radar surveys for Marbled Murrelets in the Elliott State Forest, Oregon, 2001. Unpublished report prepared for Oregon Department of Forestry, Salem, OR, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 24 pp.
- Cooper, B. A., Jeff B. Barna, R. J. Blaha, and Peter M. Sanzenbacher. 2006b. Radar and audio-visual surveys for Marbled Murrelets in the Cedar River Municipal Watershed, Washington, 2005. Unpublished report prepared for City of Seattle Watershed Division, North Bend, WA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 34 pp. + appendices.
- Cooper, B. A., and R. J. Blaha. 2001a. Audio-visual and radar surveys of Marbled Murrelets in the Titicaed Creek drainage, Washington, 2001. Unpublished report prepared for Cugini Land and Timber Company, Renton, WA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 13 pp.
- Cooper, B. A., and R. J. Blaha. 2001b. Audio-visual and radar surveys of Marbled Murrelets in the Hancock Creek drainage, Washington, 2001. Unpublished report prepared for Cugini Land and Timber Company, Renton, WA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 59 pp.

- Cooper, B. A., and R. J. Blaha. 2002. Comparison of radar and audio-visual counts of Marbled Murrelets during inland forest surveys. *Wildlife Society Bulletin* 30: 1182–1194.
- Cooper, B. A., R. J. Blaha, and J. H. Plissner. 2005. Determining local population trends of Marbled Murrelets in that portion of Conservation Zone Four North of the Palco HCP Area, 2004. Unpublished report prepared for Palco, Scotia, CA, U.S. Fish and Wildlife Service, Arcata, CA, and California Dept. of Fish and Game, Arcata, CA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 26 pp.
- Cooper, B. A., R. J. Blaha, H. Stabins, and D. R. Herter. 1999. Radar surveys of Marbled Murrelets in the upper Green River drainage, Washington, 1999. Unpublished report prepared for Plum Creek Timber Company, Seattle, WA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 23 pp.
- Cooper, B. A., R. H. Day, R. J. Ritchie, and C. L. Cranor. 1991. An improved marine radar system for studies of bird migration. *Journal of Field Ornithology* 62: 367–377.
- Cooper, B. A., and T. E. Hamer. 2003. Use of radar for Marbled Murrelet surveys, Appendix H. In Evans, D. R., W. P. Ritchie, S. K. Nelson, E. Kuo-Harrison, P. Harrison, and T. E. Hamer (eds.). *Methods for surveying Marbled Murrelets in forests: a revised protocol for land management and research*. Pacific Seabird Group unpublished document, available at website: <http://www.pacificseabirdgroup.org>.
- Cooper, B. A., M. G. Raphael, and D. R. Evans Mack. 2001. Radar-based monitoring of Marbled Murrelets. *Condor* 103: 219–229.
- Cooper, B. A., M. G. Raphael, and Z. M. Peery. 2006a. Trends in radar-based counts of Marbled Murrelets in the Olympic Peninsula, Washington, 1996–2004. *Condor* 108: 936–947.
- Cooper, B. A., C. Strong, and L. Folliard. 2000. Radar-based monitoring of Marbled Murrelets in Oregon, 1996–1999. Unpublished report prepared for U.S. Fish and Wildlife Service, Portland, OR, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 46 pp.
- Eastwood, E. 1967. *Radar ornithology*. Methuen and Co., Ltd., London, United Kingdom. 278 pp.
- Evans Mack, D. M., W. P. Ritchie, S. K. Nelson, E. Kuo-Harrison, P. Harrison, and T. E. Hamer (eds.). 2003. *Methods for surveying Marbled Murrelets in forests: a revised protocol for land management and research*. Pacific Seabird Group unpublished document; available at website: <http://www.pacificseabirdgroup.org>.
- Gauthreaux, S. A., Jr. 1985a. Radar, electro-optical, and visual methods of studying bird flight near transmission lines. Unpublished Final Report prepared for Electric Power Research Institute, Palo Alto, CA, by Clemson University, Clemson, SC. 76 pp.
- Gauthreaux, S. A., Jr. 1985b. An avian mobile research laboratory: hawk migration studies. Pages 339–346 in M. Harwood (ed.). *Proceedings of Hawk Migration Conference IV*. Hawk Migration Association of North America, Washington, CT.
- Grenier, J. J., and S. K. Nelson. 1995. Marbled Murrelet habitat associations in Oregon. Pages 191–201 in Ralph, C. J., G. L. Hunt, Jr., M. G. Raphael, and J. F. Piatt (tech. eds.). *Ecology and conservation of the Marbled Murrelet*. USDA Forest Service, Albany, CA. General Technical Report No. PSW-GTR-152.
- Hamer, T. E., B. A. Cooper, and C. J. Ralph. 1995. Use of radar to study the movements of Marbled Murrelets at inland sites. *Northwestern Naturalist* 76: 73–78.

- Hamer, T. E. 1995. Inland habitat associations of Marbled Murrelets in western Washington. Pages 163–175 in Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (tech. eds.). Ecology and conservation of the Marbled Murrelet. USDA Forest Service, Albany, CA. General Technical Report PSW-GTR-152.
- Jodice, P. G. R., S. L. Garman, and M. W. Collopy. 2001. Using resampling to assess reliability of audio-visual survey strategies for Marbled Murrelets at inland forest sites. *Waterbirds* 24: 331–344.
- Kuletz, K. J., D. K. Marks, N. L. Naslund, N. J. Goodson, and M. B. Cody. 1995. Inland habitat suitability for Marbled Murrelets in southeastern Alaska. Pages 141–149 in Ralph, C.J., G.L. Hunt Jr., M.G. Raphael, and J.F. Piatt (tech. eds.). Ecology and conservation of the Marbled Murrelet. USDA Forest Service, Albany, CA. General Technical Report PSW-GTR-152, Albany, CA.
- Nelson, S. K. 1997. Marbled Murrelet (*Brachyramphus marmoratus*). In A. Poole and F. Gill (eds.). *The Birds of North America*, No. 276. Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington, D.C. 32pp.
- Paton, P. W., C. J. Ralph, H. R. Carter, and S. K. Nelson. 1990. Surveying Marbled Murrelets at inland forest sites: a guide. USDA Forest Service, Pacific Southwest Research Laboratory, Arcata, CA. General Technical Report No. PSW-120. 9 pp.
- Skolnik, M. I. 1980. Introduction to radar systems. McGraw-Hill, New York, NY. 581 pp.
- Raphael, M. G., D. Evans Mack, and B. A. Cooper. 2002. Use of radar to investigate landscape-scale relationships between abundance of Marbled Murrelets and nesting habitat. *Condor* 104: 331–342.
- USFWS (U.S. Fish and Wildlife Service). 1992. Endangered and threatened wildlife and plants determination of threatened status for the Washington, Oregon, and California population of the Marbled Murrelet. Federal Register 61: 26,256–26,320.
- USFWS (U.S. Fish and Wildlife Service). 1997. Recovery Plan for the Marbled Murrelet (Washington, Oregon, and California population). U.S. Fish and Wildlife Service, Portland, OR. 203 pp.
- Williams, T. C., J. Settel, P. O'Mahoney, and J. M. Williams. 1972. An ornithological radar. *American Birds* 26: 555–557.



Appendix 1a. Views toward the east (top) and north (bottom) at the Powerline North site, Cedar River Municipal Watershed, summer 2006.



Appendix 1b. View toward the southeast at the Powerline Central site, Cedar River Municipal Watershed, summer 2006.



Appendix 1c. View toward the south at the Powerline South site, Cedar River Municipal Watershed, summer 2006.



Appendix 1d. Views toward the east at the Chester Morse site, Cedar River Municipal Watershed, summer 2006.



Appendix 1e. View toward the northwest at the 155.1A site, Cedar River Municipal Watershed, summer 2006.



Appendix 1f. View toward the north at the South Fork site, Cedar River Municipal Watershed, summer 2006.



Appendix 1g. View toward the southwest at the Education Center site, Cedar River Municipal Watershed, summer 2006.



Appendix 1h. Views toward the northwest at the West Point site, Cedar River Municipal Watershed, summer 2006.



Appendix 1i. View toward the west at the Taylor Ridge site, Cedar River Municipal Watershed, summer 2006.



Appendix 1j. Views toward the north at the Rack Creek site, Cedar River Municipal Watershed, summer 2006.



Appendix 1k. View toward the north at the Lindsay site, Cedar River Municipal Watershed, summer 2006.



Appendix 11. Views toward the northwest (top) and southeast (bottom) at the Chester North site, Cedar River Municipal Watershed, summer 2006.



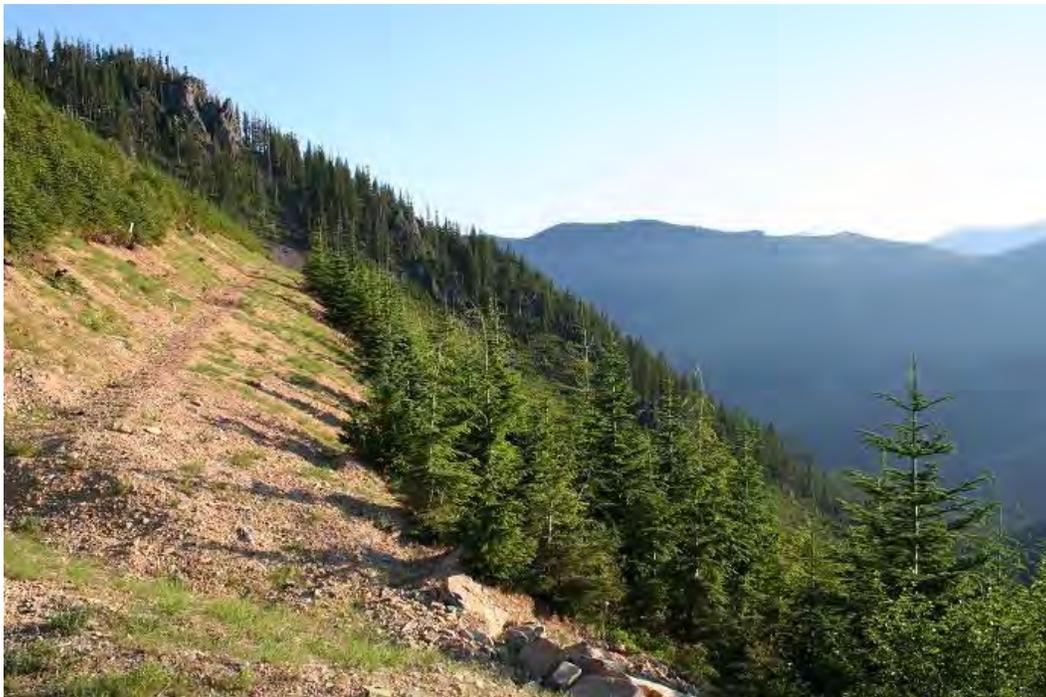
Appendix 1m. View toward the west at the Upper Rex site, Cedar River Municipal Watershed, summer 2006.



Appendix 1n. Views toward the west (top) and east (bottom) at the Rex Stand site, Cedar River Municipal Watershed, summer 2006.



Appendix 1o. View toward the southwest at the Lower Rex site, Cedar River Municipal Watershed, summer 2006.



Appendix 1p. Views toward the southwest (top) and northeast (bottom) at the Findlay site, Cedar River Municipal Watershed, summer 2006.

Appendix 2. Coding information for radar surveys of Marbled Murrelets in the Cedar River Municipal Watershed, Washington, summer 2006.

**GENERAL CODES**

**OBSERVER**

- |                                 |                             |
|---------------------------------|-----------------------------|
| 1 = Brian A. Cooper (BAC)       | 5 = Corey M. Grinnell (CMG) |
| 2 = Richard J. Blaha (RJB)      | 6 = Jon H. Plissner (JHP)   |
| 3 = Peter M. Sanzenbacher (PMS) | 7 =                         |
| 4 = Jeff Barna (JBB)            | 8 =                         |

**STUDY SITE**

- |                        |                       |
|------------------------|-----------------------|
| 1 = Chester Morse      | 11 = Taylor Ridge     |
| 2 = Cedar              | 12 = Site 150         |
| 3 = Power Line South   | 13 = Rex Stand        |
| 4 = Power Line Central | 14 = Rack Creek       |
| 5 = Power Line North   | 15 = Findlay          |
| 6 = South Fork         | 16 = Site 155.1A      |
| 7 = Cedar              | 17 = Lindsay          |
| 8 = Upper Rex          | 18 = Education Center |
| 9 = Lower Rex          | 19 = AV1              |
| 10 = West Point        | 20 = AV2              |
|                        | 21 = Chester North    |

**SESSION NUMBER (IF USED AT ALL)**

(Write as the three-digit Julian date, a decimal point, and a two-digit number counting from 1 through *n* that represents the sequential sample taken. For example, the fifth sampling period on Julian date 182 would be 182.05. Format is XXX.XX; write XXX.00 if the session has to be canceled [e.g., because of weather], then continue the next session with the same number that you had been trying to use.)

**TIME**

(Write in 24-hour clock. Remember--midnight is 0000 h, **not** 2400 h.)

**DATE**

(People writing on forms should enter as, for example, "6 MAR" or "8 APR." Keypunchers should enter as mo/dy/yr, as in 9/30/95.)

**JDATE**

(Enter the Julian date + 2,006,000)

**WIND DIRECTION**

(**Direction** on the ground **from which the wind is blowing**, to the nearest ordinal point. Be sure to use the local declination to correct the compass reading.)

0 = unknown/default

1 = North

2 = Northeast

3 = East

4 = Southeast

5 = South

6 = Southwest

7 = West

8 = Northwest

9 = direction is variable or no wind

**WIND SPEED (mph)**

(Sustained average speed at ground level, -9 = default/unknown)

0 = Calm

1 = 1-5 mph

2 = 6-10 mph

3 = 11-15 mph

4 = 16-20 mph

5 = 21-25 mph

6 = 26-30 mph

7 = 31-35 mph

etc., etc.....

**ESTIMATED CLOUD COVER (to the nearest 5%)**

(Estimated for the area from the coast to the mountains north of the site.)

-9 = unknown/default

**CEILING HEIGHT**

(An average height, taken from where you are in m agl, so either in a particular section or at the radar lab. Haze that allows a distinct shadow to be cast is counted as clear sky, whereas haze that causes indistinct shadows is counted as clouds. The same is true at night, when you can see stars and the moon through the haze.)

-9 = clear sky    -99 = unknown/default

**MINIMAL VISIBILITY**

(Record the minimal distance you can see. If you are high on a ridge, use the minimal horizontal distance, for you may be able to see lower elevations clearly but nothing up high.)

0 = unknown/default

1 = 0-50 m

2 = 51-100 m

3 = 101-500 m

4 = 501-1000 m

5 = 1001-2500 m

6 = 2501-5000 m

7 = >5000 m

**PRECIPITATION**

(Precipitation is considered to occur if it is recorded anywhere within ~5 km of the site.)

99 = unknown/default

0 = none

1 = fog

2 = drizzle (heavy mist)

3 = light rain (continuous drops of rain)

4 = heavy rain

5 = scattered showers

6 = snow flurries

7 = light snowfall

8 = heavy snowfall

9 = sleet

10 = hail

**AIR TEMPERATURE** (to the nearest 1°C)

(Be sure to keep the thermometer out of direct sunlight.)

99 = unknown/default

**RADAR CODES AND MEASUREMENTS**

**TIME**

(Write in 24-hour clock. Remember--midnight is 0000 h, **not** 2400 h.)

**TARGET MULTIPLIER**

(Record the number of targets flying "in a similar direction and fashion" and crossing the same segment. This category will be "1" for times when movement rates are so slow that you can record data for individual targets but will be, for example, "7" for seven targets flying the same direction and fashion during periods of high movement rates.)

0 = default

**DIRECTION OF FLIGHT** (to the nearest 1°)

(Measured on the radar display with the Electronic Bearing Line [EBL].)

999 = default

**TRANSECT CROSSED**

(That primary transect line that a bird did cross or would have crossed if you extrapolated its directional flight pattern. **Transect lines are extrapolated all the way off the screen.**)

0 = default

1 = Northern Transect

3 = Eastern Transect

5 = Southern Transect

7 = Western Transect

**MINIMAL DISTANCE** (to the nearest meter)

(The smallest distance to the radar lab that a target became or would become if you extrapolated its flight direction.) 999 = default

**VELOCITY** (to the nearest 5 mph) Speeds **NOT to be recorded in KPH!!**

(Measured on the radar display with the hand-held speed scales.) 0 = default

Appendix 2. Continued.

FLIGHT BEHAVIOR

(Some erratically-flying or circling birds still may have an overall direction of movement; if so, record that overall direction. Otherwise, their direction is 999.)

- |  |     |
|--|-----|
| 0 = default/unknown                        | 4 = |
| 1 = straight-line (directional)            | 5 = |
| 2 = circling (NOTE: Direction may be 999.) | 6 = |
| 3 = erratic (NOTE: Direction may be 999.)  | 7 = |

OVERLAP

- 0 = default/unknown
- 1 = seen on radar only
- 2 = observed on radar and audiovisually
- 3 = observed audiovisually only

SPECIES (if known)

(Write in the 4-letter code in the field; **If the species is unknown, leave the space blank. If have a target that is fast enough to be a murrelet (i.e., >40 mph), but you have a strong indication by target shape or behavior that it is not, enter "NOMU" and note reasons for classification in margin.**)

NUMBER OF BIRDS IN THAT TARGET (if known)

0 = default (**If the number of birds is not counted, leave the space blank.**)

DATE

JDATE (add a 2006 before the jdate, e.g., 1 Jan 1999 = 2006001)

OBSERVER 1 (BAC = 1, RJB = 2, etc.).

OBSERVER 2 (Enter 0 if only one observer.)

FLIGHT ALTITUDE **If flight altitude is  $\leq 25$  m agl, estimate it as closely as possible to the nearest meter; if it is 26-50 m, estimate it to the nearest 2-3 m; if it is  $> 50$  m agl, your estimate will be more approximate and in categories of at least 5 m.)** 0 = default

HEARSEE

Was bird heard, seen, or both? (0 = default or radar only, S = seen only, H = Heard only, B = Both seen and heard)

Appendix 3. Data file for Marbled Murrelet targets recorded on radar in the Cedar River Municipal Watershed, Washington, during summer 2006. See Appendix 2 for coding information. Also, note that this appendix does not contain the weather data, data on targets that were non-murrelets or that were recorded after sunrise, or data from dates when weather or other factors cancelled sampling.

TIME	MULT	DIR	TRAN	MINDIS	VEL	BEH	OV.LAP	SPP	NO	FLTALT	HEARSEE	DATE	JDATE	SITE
326	0	999	0	-9	0	0	0	WDAT	0	0	0	22-Jun-2006	2,006,173	1
331	1	135	3	698	50	1	1		0	0	0	22-Jun-2006	2,006,173	1
407	1	125	3	667	41	1	1		0	0	0	22-Jun-2006	2,006,173	1
407	1	135	3	810	41	1	1		0	0	0	22-Jun-2006	2,006,173	1
411	1	137	1	767	43	1	1		0	0	0	22-Jun-2006	2,006,173	1
421	1	148	3	477	41	1	1		0	0	0	22-Jun-2006	2,006,173	1
429	1	145	3	536	50	1	1		0	0	0	22-Jun-2006	2,006,173	1
436	2	320	1	617	52	1	1		0	0	0	22-Jun-2006	2,006,173	1
443	1	140	3	681	45	1	1		0	0	0	22-Jun-2006	2,006,173	1
508	1	135	3	446	45	1	1		0	0	0	22-Jun-2006	2,006,173	1
510	1	320	1	840	50	1	1		0	0	0	22-Jun-2006	2,006,173	1
327	0	999	0	-9	0	0	0	WDAT	0	0	0	22-Jun-2006	2,006,173	3
413	1	275	5	1,187	47	1	1		0	0	0	22-Jun-2006	2,006,173	3
444	1	275	5	765	55	1	1		0	0	0	22-Jun-2006	2,006,173	3
452	1	290	1	180	45	1	1		0	0	0	22-Jun-2006	2,006,173	3
506	1	330	1	1,060	50	1	1		0	0	0	22-Jun-2006	2,006,173	3
507	1	245	5	962	50	1	1		0	0	0	22-Jun-2006	2,006,173	3
511	2	240	3	1,033	45	1	1		0	0	0	22-Jun-2006	2,006,173	3
511	1	310	1	394	45	1	1		0	0	0	22-Jun-2006	2,006,173	3
511	1	290	1	642	45	1	1		0	0	0	22-Jun-2006	2,006,173	3
327	0	999	0	-9	0	0	0	WDAT	0	0	0	23-Jun-2006	2,006,174	4
351	1	170	3	864	41	1	1		0	0	0	23-Jun-2006	2,006,174	4
450	1	290	1	675	50	1	1		0	0	0	23-Jun-2006	2,006,174	4
327	0	999	0	-9	0	0	0	WDAT	0	0	0	23-Jun-2006	2,006,174	5
350	1	112	5	805	50	1	1		0	0	0	23-Jun-2006	2,006,174	5
409	1	18	3	800	42	1	1		0	0	0	23-Jun-2006	2,006,174	5
438	1	2	1	645	43	1	1		0	0	0	23-Jun-2006	2,006,174	5
328	0	999	0	-9	0	0	0	WDAT	0	0	0	24-Jun-2006	2,006,175	6
328	0	999	0	-9	0	0	0	WDAT	0	0	0	24-Jun-2006	2,006,175	16
343	1	190	5	435	45	1	1		0	0	0	24-Jun-2006	2,006,175	16
503	1	225	7	531	45	1	1		0	0	0	24-Jun-2006	2,006,175	16
510	1	215	7	281	48	1	1		0	0	0	24-Jun-2006	2,006,175	16
328	0	999	0	-9	0	0	0	WDAT	0	0	0	25-Jun-2006	2,006,176	14
434	1	335	3	956	65	1	1		0	0	0	25-Jun-2006	2,006,176	14
328	0	999	0	-9	0	0	0	WDAT	0	0	0	25-Jun-2006	2,006,176	21
328	0	999	0	-9	0	0	0	WDAT	0	0	0	26-Jun-2006	2,006,177	9
328	0	999	0	-9	0	0	0	WDAT	0	0	0	26-Jun-2006	2,006,177	18
329	0	999	0	-9	0	0	0	WDAT	0	0	0	27-Jun-2006	2,006,178	15
340	1	10	3	1,265	42	1	1		0	0	0	27-Jun-2006	2,006,178	15
348	1	110	5	915	45	1	1		0	0	0	27-Jun-2006	2,006,178	15
421	1	85	1	994	57	1	1		0	0	0	27-Jun-2006	2,006,178	15

Appendix 3. Continued.

TIME	MULT	DIR	TRAN	MINDIS	VEL	BEH	OV.LAP	SPP	NO	FLTALT	HEARSEE	DATE	JDATE	SITE
436	1	110	5	644	50	1	1		0	0 0		27-Jun-2006	2,006,178	15
328	0	999	0	-9	0	0	0	WDAT	0	0 0		27-Jun-2006	2,006,178	17
421	1	328	1	435	42	1	1		0	0 0		27-Jun-2006	2,006,178	17
435	1	27	1	410	49	1	1		0	0 0		27-Jun-2006	2,006,178	17
329	0	999	0	-9	0	0	0	WDAT	0	0 0		28-Jun-2006	2,006,179	10
425	1	155	3	729	42	1	1		0	0 0		28-Jun-2006	2,006,179	10
329	0	999	0	-9	0	0	0	WDAT	0	0 0		28-Jun-2006	2,006,179	11
408	1	20	3	223	52	1	1		0	0 0		28-Jun-2006	2,006,179	11
500	1	160	3	565	45	1	1		0	0 0		28-Jun-2006	2,006,179	11
330	0	999	0	-9	0	0	0	WDAT	0	0 0		29-Jun-2006	2,006,180	1
420	1	150	1	565	44	1	1		0	0 0		29-Jun-2006	2,006,180	1
504	1	320	1	285	50	1	1		0	0 0		29-Jun-2006	2,006,180	1
330	0	999	0	-9	0	0	0	WDAT	0	0 0		29-Jun-2006	2,006,180	13
438	1	210	7	908	47	1	1		0	0 0		29-Jun-2006	2,006,180	13
439	1	210	7	512	47	2	1		0	0 0		29-Jun-2006	2,006,180	13
446	1	170	7	323	50	2	1		0	0 0		29-Jun-2006	2,006,180	13
330	0	999	0	-9	0	0	0	WDAT	0	0 0		30-Jun-2006	2,006,181	3
340	1	285	1	988	41	1	1		0	0 0		30-Jun-2006	2,006,181	3
358	1	340	7	969	45	1	1		0	0 0		30-Jun-2006	2,006,181	3
330	0	999	0	-9	0	0	0	WDAT	0	0 0		30-Jun-2006	2,006,181	8
418	1	85	5	550	45	1	1		0	0 0		30-Jun-2006	2,006,181	8
429	1	190	7	877	45	1	1		0	0 0		30-Jun-2006	2,006,181	8
441	0	999	0	-9	0	0	0	WDAT	0	0 0		30-Jun-2006	2,006,181	8
331	0	999	0	-9	0	0	0	WDAT	0	0 0		01-Jul-2006	2,006,182	4
331	0	999	0	-9	0	0	0	WDAT	0	0 0		01-Jul-2006	2,006,182	5
346	1	40	7	689	43	1	1		0	0 0		01-Jul-2006	2,006,182	5
510	1	280	1	965	55	1	1		0	0 0		01-Jul-2006	2,006,182	5
336	0	999	0	-9	0	0	0	WDAT	0	0 0		08-Jul-2006	2,006,189	6
336	0	999	0	-9	0	0	0	WDAT	0	0 0		08-Jul-2006	2,006,189	16
344	1	320	7	1,490	56	1	1		0	0 0		08-Jul-2006	2,006,189	16
400	1	235	5	1,021	41	1	1		0	0 0		08-Jul-2006	2,006,189	16
416	1	270	5	587	63	1	1		0	0 0		08-Jul-2006	2,006,189	16
337	0	999	0	-9	0	0	0	WDAT	0	0 0		09-Jul-2006	2,006,190	17
402	1	85	1	646	45	1	1		0	0 0		09-Jul-2006	2,006,190	17
446	1	180	3	79	47	1	1		0	0 0		09-Jul-2006	2,006,190	17
336	0	999	0	-9	0	0	0	WDAT	0	0 0		09-Jul-2006	2,006,190	21
357	1	130	5	1,167	45	1	1		0	0 0		09-Jul-2006	2,006,190	21
338	0	999	0	-9	0	0	0	WDAT	0	0 0		11-Jul-2006	2,006,192	11
338	0	999	0	-9	0	0	0	WDAT	0	0 0		11-Jul-2006	2,006,192	14
516	2	130	3	370	50	1	1		0	0 0		11-Jul-2006	2,006,192	14
339	0	999	0	-9	0	0	0	WDAT	0	0 0		12-Jul-2006	2,006,193	13
411	1	130	1	584	41	2	1		0	0 0		12-Jul-2006	2,006,193	13
420	0	999	0	-9	0	0	0	WDAT	0	0 0		12-Jul-2006	2,006,193	13
424	0	999	0	-9	0	0	0	WDAT	0	0 0		12-Jul-2006	2,006,193	13
341	0	999	0	-9	0	0	0	WDAT	0	0 0		14-Jul-2006	2,006,195	18
412	0	999	0	-9	0	0	0	WDAT	0	0 0		14-Jul-2006	2,006,195	18
418	0	999	0	-9	0	0	0	WDAT	0	0 0		14-Jul-2006	2,006,195	18

Appendix 3. Continued.

TIME	MULT	DIR	TRAN	MINDIS	VEL	BEH	OV.LAP	SPP	NO	FLTALT	HEARSEE	DATE	JDATE	SITE
423	0	999	0	-9	0	0	0	WDAT	0	0	0	14-Jul-2006	2,006,195	18
430	0	999	0	-9	0	0	0	WDAT	0	0	0	14-Jul-2006	2,006,195	18
522	1	345	3	761	55	1	1		0	0	0	14-Jul-2006	2,006,195	18
345	0	999	0	-9	0	0	0	WDAT	0	0	0	18-Jul-2006	2,006,199	8
347	1	170	7	800	50	1	1		0	0	0	18-Jul-2006	2,006,199	8
429	1	160	7	1,000	50	1	1		0	0	0	18-Jul-2006	2,006,199	8
345	0	999	0	-9	0	0	0	WDAT	0	0	0	18-Jul-2006	2,006,199	10
350	1	50	1	252	41	1	1		0	0	0	18-Jul-2006	2,006,199	10
402	1	230	7	887	41	1	1		0	0	0	18-Jul-2006	2,006,199	10
420	1	100	1	216	41	1	1		0	0	0	18-Jul-2006	2,006,199	10
429	1	190	3	596	41	1	1		0	0	0	18-Jul-2006	2,006,199	10
447	1	65	7	584	55	1	1		0	0	0	18-Jul-2006	2,006,199	10
451	1	195	7	600	42	1	1		0	0	0	18-Jul-2006	2,006,199	10
454	1	130	3	158	60	1	1		0	0	0	18-Jul-2006	2,006,199	10
510	0	999	0	-9	0	0	0	WDAT	0	0	0	18-Jul-2006	2,006,199	10
346	0	999	0	-9	0	0	0	WDAT	0	0	0	19-Jul-2006	2,006,200	15
409	1	130	3	931	42	1	1		0	0	0	19-Jul-2006	2,006,200	15
417	1	230	7	1,000	58	1	1		0	0	0	19-Jul-2006	2,006,200	15
446	1	130	3	688	42	1	1		0	0	0	19-Jul-2006	2,006,200	15
346	0	999	0	-9	0	0	0	WDAT	0	0	0	19-Jul-2006	2,006,200	16
403	1	315	5	700	55	1	1		0	0	0	19-Jul-2006	2,006,200	16
347	0	999	0	-9	0	0	0	WDAT	0	0	0	20-Jul-2006	2,006,201	6
347	0	999	0	-9	0	0	0	WDAT	0	0	0	20-Jul-2006	2,006,201	9
439	1	145	7	415	45	1	1		0	0	0	20-Jul-2006	2,006,201	9
447	1	300	7	410	42	1	1		0	0	0	20-Jul-2006	2,006,201	9
513	1	5	7	783	43	1	1		0	0	0	20-Jul-2006	2,006,201	9
349	0	999	0	-9	0	0	0	WDAT	0	0	0	21-Jul-2006	2,006,202	4
434	1	190	3	600	45	1	1		0	0	0	21-Jul-2006	2,006,202	4
444	1	150	3	600	50	1	1		0	0	0	21-Jul-2006	2,006,202	4
447	1	20	7	900	45	1	1		0	0	0	21-Jul-2006	2,006,202	4
510	1	20	7	700	45	1	1		0	0	0	21-Jul-2006	2,006,202	4
526	1	45	1	1,000	55	1	1		0	0	0	21-Jul-2006	2,006,202	4
349	0	999	0	-9	0	0	0	WDAT	0	0	0	21-Jul-2006	2,006,202	5
401	1	200	3	484	42	1	1		0	0	0	21-Jul-2006	2,006,202	5
416	1	295	5	796	44	1	1		0	0	0	21-Jul-2006	2,006,202	5
511	1	250	5	503	50	1	1		0	0	0	21-Jul-2006	2,006,202	5
350	0	999	0	-9	0	0	0	WDAT	0	0	0	22-Jul-2006	2,006,203	1
421	1	135	1	900	45	1	1		0	0	0	22-Jul-2006	2,006,203	1
432	1	135	1	800	45	1	1		0	0	0	22-Jul-2006	2,006,203	1
435	1	330	1	900	50	1	1		0	0	0	22-Jul-2006	2,006,203	1
454	1	160	3	500	50	1	1		0	0	0	22-Jul-2006	2,006,203	1
350	0	999	0	-9	0	0	0	WDAT	0	0	0	22-Jul-2006	2,006,203	3
451	0	999	0	-9	0	0	0	WDAT	0	0	0	22-Jul-2006	2,006,203	3
511	1	290	1	93	45	1	1		0	0	0	22-Jul-2006	2,006,203	3
525	1	340	3	1,005	41	1	1		0	0	0	22-Jul-2006	2,006,203	3

Appendix 4. Data sheets for all audio-visual surveys for Marbled Murrelets in the Cedar River Municipal Watershed, summer 2006 (attached).

# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y [initials]

Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or N

Month 06 Day 22 Year 06

Area Name: Cedar River Site Name / Number: Last Creek Station Number: 1

Station Location - T 22 N, R 8 (circle one) E or W, S 11, QQ (1/16) SW, of Q (1/4) SW

UTM zone: 10 E (x) coordinate: 594882 N (y) coordinate: 5250301 Source: GPS Datum: NAD83 FOM: -

Observer (s) Name: Peter Szentpeter Initials: PMs Affiliation: ABR, Inc Phone: (508) 359-7525

Station Elevation: 739 Ft M Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, Upper 1/3, Ridgetop

Station Placement (circle one): Inside, Outside

Distance from Survey Site Boundary: - Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25%, 2 = 26 to 50%, 3 = 51 to 75%, 4 = 76 to 100%

### ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0512 Table: North Bend Begin Survey Time: 0427 End Survey Time: 0627

Temperature at Sunrise: 9 ° Temperature at End of Survey: 9 ° (circle one) C or F revised: 2/2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0427	UL	0	Y	Y	Y	N	N	-	1	N	start survey
0512	UL	0	Y	Y	Y	N	N	-	1	N	sunrise
0627	UL	0	Y	Y	Y	N	N	-	1	N	end survey

**Ceiling:** UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤ 2.0 canopy height, LO = ≤1.25 canopy height, U = Unknown.  
**Cloud Cover:** 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
**Vertical Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Horizontal Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Audibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
**Precipitation - Rain & Fog:** N = None, L = Light, M = Moderate, H = Heavy. **Other:** H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
**Wind:** 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
**Noise:** N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No. _____	Data Point No. _____	Sequence No. _____	Reference No. _____
Quad Code _____	Photo Code _____	General Location _____	
Data Entry Initials _____	Data Entry Date _____	Data QC Initials _____	Data QC Date _____
Protocol Review Initials _____	Review Date _____	Highest Biological Status _____	
** WDFW DATABASE USE ONLY **			

\* potential predators = STJA















# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y (ML)

Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or (N)

Month 07 Day 20 Year 2006

Area Name: Cedar River Site Name / Number: Taylor Ridge Station Number: 3

Station Location - T 22 N, R 8 (circle one) (E) or W, S 26, QQ (1/16) NW, of Q (1/4) NE

UTM zone: 10 E (x) coordinate: 594 696 N (y) coordinate: 594 7009 Source: GPS Datum: NAD 83 FOM: —

Observer (s) Name: Alden J. Miller Initials: AJM Affiliation: ABR Inc. Phone: (803) 359-7525

Station Elevation: 1063 Ft / (M) Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, (Upper 1/3), Ridgetop

Station Placement (circle one) (Inside) Outside

Distance from Survey Site Boundary: \_\_\_\_\_ Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25%, (2 = 26 to 50%), 3 = 51 to 75%, 4 = 76 to 100%

**ENVIRONMENTAL CONDITIONS:**

Official Sunrise Time: 0532 Table: North Bend Begin Survey Time: 0436 End Survey Time: 0647

Temperature at Sunrise: 11 ° Temperature at End of Survey: 11 ° (circle one) (C) or F revised: 2 / 2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0436	UL	0	Y	Y	Y	N	N	N	1	N	Begin Survey
0532	UL	0	Y	Y	Y	N	N	N	1	N	Sunrise
0647	UL	0	Y	Y	Y	N	N	N	1	N	End Survey

Ceiling: UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤2.0 canopy height, LO = ≤1.25 canopy height, U = Unknown.  
 Cloud Cover: 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
 Vertical Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
 Horizontal Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
 Audibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
 Precipitation - Rain & Fog: N = None, L = Light, M = Moderate, H = Heavy. Other: H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
 Wind: 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
 Noise: N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No.	Data Point No.	Sequence No.	Reference No.
Quest Code	Photo Code	General Location	
Data Entry Initials	Data Entry Date	Data QC Initials	Data QC Date
Protocol Review Initials	Review Date	Highest Biological Status	

\*\* WDFW DATABASE USE ONLY \*\*







# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y cal

Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or (N)

Month 07 Day 24 Year 2006

Area Name: Cedar River Site Name / Number: Taylor Ridge Station Number: 3

Station Location - T 22 N, R 8 (circle one) (E) or W, S 26, QQ (1/16) NW, of Q (1/4) NE

UTM zone: 10 E (x) coordinate: 594696 N (y) coordinate: 5247009 Source: GPS Datum: NAD 83 FOM: —

Observer (s) Name: Alden J Miller Initials: ASM Affiliation: ABR Inc. Phone: (503) 359-7525

Station Elevation: 1063 Ft / (M) Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, (Upper 1/3), Ridgetop

Station Placement (circle one): (Inside) Outside

Distance from Survey Site Boundary: — Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25%, 2 = 26 to 50%, 3 = 51 to 75%, 4 = 76 to 100%

## ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0537 Table: North Bend Begin Survey Time: 0437 End Survey Time: 0652

Temperature at Sunrise: 11 ° Temperature at End of Survey: 11 ° (circle one) C or F revised: 2/2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0437	UL	0	Y	Y	Y	N	N	N	2	N	Begin survey
0456	UL	0	Y	Y	Y	N	N	N	3	N	<del>S</del>
0537	UL	0	Y	Y	Y	N	N	N	3	N	Sunrise
0652	UL	0	Y	Y	Y	N	N	N	3	N	End survey

Ceiling: UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤2.0 canopy height, LO = ≤1.25 canopy height, U = Unknown.  
 Cloud Cover: 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
 Vertical Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
 Horizontal Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
 Audibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
 Precipitation - Rain & Fog: N = None, L = Light, M = Moderate, H = Heavy. Other: H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
 Wind: 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
 Noise: N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No.	Date Point No.	Sequence No.	Reference No.
Order Code	Plot Code	Site Allocation	
Date Entry Initials	Date Entry Date	Date of Initials	Date of Data
Date of Review Initials	Review Date	Original Plot Point Status	

WDFW DATABASE USE ONLY







# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): N/Cmk

Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or N

Month 07 Day 10 Year 2006

Area Name: Cedar River Site Name / Number: Rack Creek Station Number: 1

Station Location - T 22 N, R 8 (circle one) E or W, S 24, QQ (1/16) NE, of Q (1/4) SW

UTM zone: 10 E (x) coordinate: 0596219 N (y) coordinate: 5248719 Source: GPS Datum: NAD83 FOM: -

Observer (s) Name: Alden J. Miller Initials: ATM Affiliation: ABR Inc. Phone: (503) 359-7525

Station Elevation: 934 ft (M) Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, Upper 1/3, Ridgetop

Station Placement (circle one): Inside, Outside

Distance from Survey Site Boundary: 20 m Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25% 2 = 26 to 50%, 3 = 51 to 75%, 4 = 76 to 100%

## ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0522 Table: North Bend Begin Survey Time: 0437 End Survey Time: 0637

Temperature at Sunrise: 8 ° Temperature at End of Survey: 8 ° (circle one) C or F revised: 2/2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0437	L0	3	N	N	Y	L	M	N	2	N	Begin Survey
0522	L0	3	N	<del>N</del>	Y	L	L	N	2	N	Sunrise
0529	L0	3	<del>N</del>	Y	Y	L	N	N	2	N	Fog lifted
0600	L0	3	N	N	Y	L	H	N	2	N	Thick Fog
0637	L0	3	N	N	Y	N	H	N	2	N	End Survey

**Ceiling:** UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤2.0 canopy height, LO = ≤1.25 canopy height, U = Unknown.  
**Cloud Cover:** 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
**Vertical Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Horizontal Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Audibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
**Precipitation - Rain & Fog:** N = None, L = Light, M = Moderate, H = Heavy. **Other:** H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
**Wind:** 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
**Noise:** N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No. _____	Data Point No. _____	Sequence No. _____	Reference No. _____
Quad. Code _____	Photo Code _____	General Location _____	
Data Entry Initials _____	Data Entry Date _____	Data QC Initials _____	Data QC Date _____
Protocol Review Initials _____	Review Date _____	Highest Biological Status _____	

\*\* WDFW DATABASE USE ONLY \*\*



# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): y (initials)

Total Detections: 0

Species of Concern (circle one, details on last pg.): (Y) or N

Month 07 Day 11 Year 2006

Area Name: Cedar River Site Name / Number: Rack creek Station Number: 1

Station Location - T 22 N, R 8 (circle one) (E) or W, S 24, QQ (1/16) NE, of Q (1/4) SW

UTM zone: 10 E (x) coordinate: 0596219 N (y) coordinate: 5248719 Source: GPS Datum: NAD 83 FOM: —

Observer (s) Name: Alden J. Miller Initials: ASM Affiliation: ABR Inc. Phone: (503) 359-7525

Station Elevation: 934 Ft / M Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, (Upper 1/3), Ridgetop

Station Placement (circle one): Inside, (Outside)

Distance from Survey Site Boundary: 20 Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): (1 = 0 to 25%), 2 = 26 to 50%, 3 = 51 to 75%, 4 = 76 to 100%

### ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0523 Table: North Bend Begin Survey Time: 0438 End Survey Time: 0638

Temperature at Sunrise: 8 ° Temperature at End of Survey: 8 ° (circle one) (C) or F revised: 2 / 2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0438	HI	1	Y	Y	Y	N	N	N	0	N	Begin Survey
0523	HI	1	Y	Y	Y	N	N	N	0	N	Sunrise
0638	HI	1	Y	Y	Y	N	N	N	1	N	End Survey

**Ceiling:** UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤ 2.0 canopy height, LO = ≤ 1.25 canopy height, U = Unknown.  
**Cloud Cover:** 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
**Vertical Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Horizontal Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Audibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
**Precipitation - Rain & Fog:** N = None, L = Light, M = Moderate, H = Heavy. **Other:** H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
**Wind:** 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
**Noise:** N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No. _____	Data Point No. _____	Sequence No. _____	Reference No. _____
Quad Code _____	Photo Code _____	General Location _____	
Data Entry Initials _____	Data Entry Date _____	Data QC Initials _____	Data QC Date _____
Protocol Review Initials _____	Review Date _____	Highest Biological Status _____	

\*\* WDFW DATABASE USE ONLY \*\*











# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y (1/6)

Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or **(N)**

Month 07 Day 21 Year 2006

Area Name: Cedar River Site Name / Number: Rack Creek Station Number: 3

Station Location - T 22 N, R 8 (circle one) **(E)** or W, S 24, QQ (1/16) NW, of Q (1/4) NE

UTM zone: 10 E (x) coordinate: 596403 N (y) coordinate: 5248698 Source: GPS Datum: NAD 83 FOM: -

Observer (s) Name: Alden J. Miller Initials: AJM Affiliation: ABR Inc Phone: (803) 359-7525

Station Elevation: 887 Ft **(M)** Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, **(Upper 1/3)**, Ridgetop

Station Placement (circle one) **(Inside)** Outside

Distance from Survey Site Boundary:        Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25%, **(2 = 26 to 50%)**, 3 = 51 to 75%, 4 = 76 to 100%

## ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0534 Table: North Bend Begin Survey Time: 0440 End Survey Time: 0649

Temperature at Sunrise: 18 ° Temperature at End of Survey: 19 ° (circle one) **(C)** or F revised: 2 / 2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0440	UL	0	Y	Y	Y	N	N	N	1	N	Begin Survey
0534	UL	0	Y	Y	Y	N	N	N	1	N	Sunrise
0649	UL	0	Y	Y	Y	N	N	N	1	N	End Survey

Ceiling: UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤2.0 canopy height, LO = ≤1.25 canopy height, U = Unknown.  
 Cloud Cover: 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
 Vertical Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
 Horizontal Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
 Audibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
 Precipitation - Rain & Fog: N = None, L = Light, M = Moderate, H = Heavy. Other: H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
 Wind: 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
 Noise: N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No.	Data Point No.	Sequence No.	Reference No.
Grid Code	Photo Code	General Location	
Data Entry Initials	Data Entry Date	Data QC Initials	Data QC Date
Protocol Review Initials	Review Date	Highest Biological Status	

\*\* WDFW DATABASE USE ONLY \*\*



# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y CM

Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or N

Month July Day 24 Year 2006

Area Name: Cedar River Site Name / Number: Rauh Creek Station Number: 2

Station Location - T 22 N, R 8 (circle one) E or W, S 13, QQ (1/16) SW, of Q (1/4) SE

UTM zone: 10 E (x) coordinate: 596282 N (y) coordinate: 5248774 Source: LPS Datum: NAD83 FOM: -

Observer (s) Name: Corey M. Guinnell Initials: CMG Affiliation: ABR, Inc. Phone: (503) 359-7525

Station Elevation: 914 Ft (M) Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, Upper 1/3, Ridgetop

Station Placement (circle one): Inside, Outside

Distance from Survey Site Boundary: - Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25%, 2 = 26 to 50%, 3 = 51 to 75%, 4 = 76 to 100%

### ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0537 Table: North Bend Begin Survey Time: 0437 End Survey Time: 0652

Temperature at Sunrise: 8 ° Temperature at End of Survey: 9 ° (circle one) C or F revised: 2/2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0437	UL	0	Y	Y	Y	N	N	N	0	N	Begin Survey
0652	UL	0	Y	Y	Y	N	N	N	0	N	End Survey

**Ceiling:** UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤2.0 canopy height, LO = ≤1.25 canopy height, U = Unknown.  
**Cloud Cover:** 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
**Vertical Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Horizontal Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Audibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
**Precipitation - Rain & Fog:** N = None, L = Light, M = Moderate, H = Heavy. **Other:** H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
**Wind:** 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
**Noise:** N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No. _____	Data Point No. _____	Sequence No. _____	Reference No. _____
Quad. Code _____	Photo Code _____	General Location _____	
Data Entry Initials _____	Data Entry Date _____	Data QC Initials _____	Data QC Date _____
Protocol Review Initials _____	Review Date _____	Highest Biological Status _____	

\*\* WDFW DATABASE USE ONLY \*\*



# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y CM

Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or (N)

Month 06 Day 26 Year 06

Area Name: Cedar River Site Name / Number: Chester North Station Number: 3

Station Location - T 22 N, R 9 (circle one) (E) or W, S 16, QQ (1/16) NE, of Q (1/4) SW

UTM zone: 10 E (x) coordinate: 600811 N (y) coordinate: 5249252 Source: GPS Datum: NAD83 FOM: -

Observer (s) Name: Peter Sanzenbacher Initials: PMS Affiliation: ABR, Inc. Phone: (503) 359 7525

Station Elevation: 723 Ft (M) Position on Slope (circle one): Bottom/plain, (Lower 1/3) Mid 1/3, Upper 1/3, Ridgetop

Station Placement (circle one): (Inside) Outside

Distance from Survey Site Boundary: - Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25%, (2 = 26 to 50%) 3 = 51 to 75%, 4 = 76 to 100%

### ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0513 Table: North Head Begin Survey Time: 0428 End Survey Time: 0628

Temperature at Sunrise: 11.5 ° Temperature at End of Survey: 11.5 ° (circle one) (C) or F revised: 2/2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0428	UL	0	Y	Y	Y	N	N	-	1	N	start survey
0513	UL	0	Y	Y	Y	N	N	-	1	N	sunrise
0628	UL	0	Y	Y	Y	N	N	-	1	N	end survey

**Ceiling:** UL = Unlimited (clear), HI =>2.0 canopy height, MID =>1.25 to ≤2.0 canopy height, LO = ≤1.25 canopy height, U = Unknown.  
**Cloud Cover:** 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
**Vertical Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Horizontal Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Audibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
**Precipitation - Rain & Fog:** N = None, L = Light, M = Moderate, H = Heavy. **Other:** H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
**Wind:** 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
**Noise:** N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No.	Data Point No.	Sequence No.	Reference No.
Qual. Code	Photo Code	General Location	
Data Entry Initials	Data Entry Date	Data QC Initials	Data QC Date
Protocol Review Initials	Review Date	Highest Biological Status	

\*\* WDFW DATABASE USE ONLY \*\*















# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y CM6

Total Detections: 0

Species of Concern (circle one, details on last pg.): (Y) or N

Month 07 Day 22 Year 2006

Area Name: Cedar River Site Name/Number: Chester North Station Number: 3

Station Location - T 22 N, R 9 (circle one) (E) or W, S 16, QQ (1/16) NE, of Q (1/4) SW

UTM zone: 10 E (x) coordinate: 600811 N (y) coordinate: 5249252 Source: GIPS Datum: NAD83 FOM: —

Observer (s) Name: Alden J. Miller Initials: ASM Affiliation: ABR Inc. Phone: (503) 359-7525

Station Elevation: 723 Ft / (M) Position on Slope (circle one): Bottom/plain, (Lower 1/3), Mid 1/3, Upper 1/3, Ridgetop

Station Placement (circle one): (Inside), Outside

Distance from Survey Site Boundary: — Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25%, (2 = 26 to 50%), 3 = 51 to 75%, 4 = 76 to 100%

## ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0535 Table: North Bend Begin Survey Time: 0449 End Survey Time: 0650

Temperature at Sunrise: 21.5 ° Temperature at End of Survey: 18.5 ° (circle one) (C) or F revised: 2 / 2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0449	HI	2	Y	Y	Y	N	N	N	0	N	Begin Survey
0511	HI	3	Y	Y	Y	N	N	N	0	N	
0535	HI	2	Y	Y	Y	N	N	N	0	N	Sunrise
0549	HI	1	Y	Y	Y	N	N	N	0	N	
0650	HI	1	Y	Y	Y	N	N	N	0	N	End Survey

Ceiling: UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤2.0 canopy height, LO = ≤1.25 canopy height, U = Unknown.

Cloud Cover: 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.

Vertical Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.

Horizontal Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.

Audibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).

Precipitation - Rain & Fog: N = None, L = Light, M = Moderate, H = Heavy. Other: H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.

Wind: 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).

Noise: N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No.	Data Point No.	Sequence No.	Reference No.
Quad Code	Photo Code	General Location	
Data Entry Initials	Data Entry Date	Data QC Initials	Data QC Date
Protocol Review Initials	Review Date	Highest Biological Status	

\*\* WDFW DATABASE USE ONLY \*\*







# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y cmc

Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or (N)

Month 06 Day 30 Year 06

Area Name: Cedar River Site Name / Number: Lindsay Creek North Station Number: 2

Station Location - T 21 (N) R 9 (circle one) (E) or W, S 4, QQ (1/16) NW, of Q (1/4) SE

UTM zone: 10 E (x) coordinate: 601032 N (y) coordinate: 5243132 Source: GPS Datum: NAD 83 FOM: -

Observer (s) Name: Peter Sanzenbacher Initials: PMS Affiliation: ABR, Inc. Phone: (503) 359 7525

Station Elevation: 826 Ft (M) Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, (Upper 1/3), Ridgetop

Station Placement (circle one): (Inside) Outside

Distance from Survey Site Boundary: - Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25%, 2 = 26 to 50%, 3 = 51 to 75%, 4 = 76 to 100%

### ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0530 0515 Table: North Bend Begin Survey Time: 0430 End Survey Time: 0630

Temperature at Sunrise: 9.5 ° Temperature at End of Survey: 12 ° (circle one) (C) or F revised: 2 / 2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0430	HI	1	Y	Y	Y	N	N	-	1	N	start survey
0515	UL	0	Y	Y	Y	N	N	-	1	N	sunrise
0630	UL	0	Y	Y	Y	N	N	-	1	N	end survey

**Ceiling:** UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤ 2.0 canopy height, LO = ≤ 1.25 canopy height, U = Unknown.  
**Cloud Cover:** 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
**Vertical Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Horizontal Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Audibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
**Precipitation - Rain & Fog:** N = None, L = Light, M = Moderate, H = Heavy. Other: H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
**Wind:** 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
**Noise:** N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No.	Data Point No.	Sequence No.	Reference No.
Quad Code	Photo Code	General Location	
Data Entry Initials	Data Entry Date	Data QC Initials	Data QC Date
Protocol Review Initials	Review Date	Highest Biological Status	

\*\* WDFW DATABASE USE ONLY \*\*







# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): N cut

Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or N

Month 07 Day 13 Year 2006

Area Name: Cedar River Site Name / Number: Lindsey Creek North Station Number: 2

Station Location - T 21 N, R 9 (circle one) E or W, S 4, QQ (1/16) NW, of Q (1/4) SE

UTM zone: 10 E (x) coordinate: 601032 N (y) coordinate: 5243132 Source: GPS Datum: NAD 83 FOM: —

Observer (s) Name: Alden J. Miller Initials: AJM Affiliation: ABR Inc. Phone: (503) 359-7525

Station Elevation: 826 Ft / M Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, Upper 1/3, Ridgetop

Station Placement (circle one): Inside, Outside

Distance from Survey Site Boundary: — Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25%, 2 = 26 to 50%, 3 = 51 to 75%, 4 = 76 to 100%

## ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0525 Table: North Bend Begin Survey Time: 0438 End Survey Time: 0640  
 Temperature at Sunrise: 11 ° Temperature at End of Survey: 11 ° (circle one) C or F revised: 2 / 2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0438	HI	3	Y	Y	Y	M	N	N	2	N	Begin Survey
0451	HI	3	Y	Y	Y	L	N	N	2	N	
0525	MID	3	N	N	Y	L	L	N	1	N	Sunrise
0541	MID	3	N	Y	Y	M	L	N	1	N	
0544	MID	3	N	N	N	L	L	N	1	T	
0640	MID	3	N	N	Y	N	L	N	1	N	End survey

**Ceiling:** UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤2.0 canopy height, LO = ≤1.25 canopy height, U = Unknown.  
**Cloud Cover:** 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
**Vertical Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Horizontal Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Audibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
**Precipitation - Rain & Fog:** N = None, L = Light, M = Moderate, H = Heavy. **Other:** H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
**Wind:** 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
**Noise:** N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No.	Data Point No.	Sequence No.	Reference No.
Quest. Code	Photo Code	General Location	
Data Entry Initials	Data Entry Date	Data QC Initials	Data QC Date
Protocol Review Initials	Review Date	Highest Biological Status	

\*\* WDFW DATABASE USE ONLY \*\*



# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol Page 1 of 2

(Y or N, initials): Y | CMG Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or (N)

Month 07 Day 18 Year 2006

Area Name: Cedar River Site Name / Number: Lindsay Creek North Station Number: Z

Station Location - T Z1 N, R 9 (circle one) (E) or W, S 4, QQ (1/16) NW, of Q (1/4) SE

UTM zone: 10 E (x) coordinate: 601032 N (y) coordinate: 5243132 Source: GPS Datum: NAD83 FOM: ---

Observer (s) Name: Alden J. Miller Initials: ASJM Affiliation: ABR Inc. Phone: (503) 359-7525

Station Elevation: 826 Ft / (M) Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, (Upper 1/3), Ridgetop

Station Placement (circle one): (Inside), Outside

Distance from Survey Site Boundary: --- Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25%, (2 = 26 to 50%), 3 = 51 to 75%, 4 = 76 to 100%

### ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0530 Table: North Bend Begin Survey Time: 0442 End Survey Time: 0645

Temperature at Sunrise: 8 ° Temperature at End of Survey: 9 ° (circle one) (C) or F revised: 2 / 2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0442	HI	3	Y	Y	Y	N	N	N	0	N	Begin Survey
0514	HI	3	Y	Y	Y	N	N	N	1	N	
0530	HI	3	Y	Y	Y	N	N	N	1	N	Sunrise
0554	HI	2	Y	Y	Y	N	N	N	1	N	
0645	HI	2	Y	Y	Y	N	N	N	1	N	End survey

Ceiling: UL = Unlimited (clear), HI =>2.0 canopy height, MID =>1.25 to <= 2.0 canopy height, LO =<=1.25 canopy height, U = Unknown.  
 Cloud Cover: 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
 Vertical Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
 Horizontal Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
 Audibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
 Precipitation - Rain & Fog: N = None, L = Light, M = Moderate, H = Heavy. Other: H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
 Wind: 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
 Noise: N = Nonc, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No	Data Point No	Sequence No	Reference No
Quad Code	Photo Code	General Location	
Data Entry Initials	Data Entry Date	Data QC Initials	Data QC Date
Protocol Review Initials	Review Date	Highest Biological Status	

\*\* WDFW DATABASE USE ONLY \*\*











# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y CM

Total Detections: 0

Species of Concern (circle one, details on last pg.): (Y) or N  
(Findley) Month 07 Day 12 Year 2006

Area Name: Cedar River Site Name / Number: Lower Rex East Station Number: 1  
Station Location - T 21 N, R 10 (circle one) (E) or W, S 6, QQ (1/16) NW, of Q (1/4) SW  
UTM zone: 10 E (x) coordinate: 0606326 N (y) coordinate: 5243160 Source: GPS Datum: NAD83 FOM: —  
Observer (s) Name: Alden J. Miller Initials: AJM Affiliation: ABR Inc. Phone: (503) 359-7525

Station Elevation: 958 Ft / (M) Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, (Upper 1/3) Ridgetop  
Station Placement (circle one): Inside, (Outside)  
Distance from Survey Site Boundary: 20 Units of Measure for ALL Horizontal Distances: Meters  
Station Canopy Cover (circle one): (1 = 0 to 25%), 2 = 26 to 50%, 3 = 51 to 75%, 4 = 76 to 100%

### ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0524 Table: North Begin Survey Time: 0437 End Survey Time: 0639  
Temperature at Sunrise: 10 ° Temperature at End of Survey: 10 ° (circle one) (C) or F revised: 2/2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0437	MID	3	Y	Y	Y	L	N	N	0	N	Begin Survey
0513	HI	3	Y	Y	Y	N	N	N	0	N	<del>Sunrise</del>
0524	HI	3	Y	Y	Y	N	N	N	0	N	Sunrise
0552	HI	3	Y	Y	Y	N	N	N	1	N	
0639	HI	3	Y	Y	Y	N	N	N	1	N	End survey
											Note: first 1/2 hour ceiling was at , or just above, 2 canopies.

**Ceiling:** UL = Unlimited (clear), HI =>2.0 canopy height, MID =>1.25 to <=2.0 canopy height, LO =<=1.25 canopy height, U = Unknown.  
**Cloud Cover:** 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
**Vertical Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Horizontal Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Audibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
**Precipitation - Rain & Fog:** N = None, L = Light, M = Moderate, H = Heavy. **Other:** H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
**Wind:** 0 =<1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
**Noise:** N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No. _____	Data Point No. _____	Sequence No. _____	Reference No. _____
Quad Code _____	Photo Code _____	General Location _____	
Data Entry Initials _____	Data Entry Date _____	Data QC Initials _____	Data QC Date _____
Protocol Review Initials _____	Review Date _____	Highest Biological Status _____	

\*\* WDFW DATABASE USE ONLY \*\*



# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y CM

Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or (N)

Month July Day 19 Year 2006

Area Name: Cedar River Site Name / Number: Lower Rex East (Findley) Station Number: 2 audio\*

Station Location - T 21 N, R 10 (circle one) (E) or W, S 6, QQ (1/16) NW, of Q (1/4) SW

UTM zone: 10 E (x) coordinate: 606438 N (y) coordinate: 5243247 Source: GPS Datum: NAD83 FOM: -

Observer (s) Name: Cory M. Grinnell Initials: CMG Affiliation: ABR Inc. Phone: (503) 359-7525

Station Elevation: 897 Ft / (M) Position on Slope (circle one): Bottom/plain, (Lower 1/3), Mid 1/3, Upper 1/3, Ridgetop

Station Placement (circle one): (Inside) Outside

Distance from Survey Site Boundary: - Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25%, 2 = 26 to 50%, (3 = 51 to 75%), 4 = 76 to 100%

### ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0531 Table: North Head Begin Survey Time: 0446 End Survey Time: 0647

Temperature at Sunrise: 14 ° Temperature at End of Survey: 14 ° (circle one) (C) or F revised: 2 / 2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0446	UL	0	Y	Y	Y	N	N	N	0	N	Begin Survey
0647	UL	0	Y	Y	Y	N	N	N	0	N	End Survey
											* done in tandem w/ AJM at 2 vis-ol

**Ceiling:** UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤ 2.0 canopy height, LO = ≤ 1.25 canopy height, U = Unknown.  
**Cloud Cover:** 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
**Vertical Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Horizontal Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Audibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
**Precipitation - Rain & Fog:** N = None, L = Light, M = Moderate, H = Heavy. **Other:** H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
**Wind:** 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
**Noise:** N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No.	Data Point No.	Sequence No.	Reference No.
Grid Code	Photo Code	General Location	
Data Entry Initials	Data Entry Date	Data QC Initials	Data QC Date
Protocol Review Initials	Review Date	Highest Biological Status	

\*\* WDFW DATABASE USE ONLY \*\*











# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y (CM)

Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or **(N)**  
(Findley) Month 07 Day 23 Year 2006

Area Name: Cedar River Site Name / Number: Lower Rex East Station Number: 1

Station Location - T 21 N, R 10 (circle one) **(E)** or W, S 6, QQ (1/16) NW, of Q (1/4) SW

UTM zone: 10 E (x) coordinate: 606326 N (y) coordinate: 5243160 Source: GPS Datum: NAD 83 FOM: —

Observer (s) Name: Alden J. Miller Initials: AJM Affiliation: ABR Inc. Phone: (503) 359-7525

Station Elevation: 958 Ft / **(M)** Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, **(Upper 1/3)**, Ridgetop

Station Placement (circle one): Inside, **(Outside)**

Distance from Survey Site Boundary: 20 Units of Measure for ALL Horizontal Distances: Meters

Station Canopy Cover (circle one): **(1 = 0 to 25%)** 2 = 26 to 50%, 3 = 51 to 75%, 4 = 76 to 100%

### ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0536 Table: North Bend Begin Survey Time: 0446 End Survey Time: 0651

Temperature at Sunrise: 17 ° Temperature at End of Survey: 18 ° (circle one) **(C)** or F revised: 2/2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0446	UL	0	Y	Y	Y	N	N	N	1	N	Begin Survey
0536	UL	0	Y	Y	Y	N	N	N	1	N	Sunrise
0651	UL	0	Y	Y	Y	N	N	N	1	N	End Survey

Ceiling: UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤2.0 canopy height, LO = ≤1.25 canopy height, U = Unknown.  
 Cloud Cover: 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
 Vertical Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
 Horizontal Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
 Audibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
 Precipitation - Rain & Fog: N = None, L = Light, M = Moderate, H = Heavy. Other: H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
 Wind: 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
 Noise: N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Observer No.	Date Point No.	Station No.	Reference No.
Point Code	Photo Code	Observer Initials	
Date Entry Initials	Date Entry Date	Observer Initials	Date of Entry
Observer Review Initials	Review Date	Observer Initials	Highest Biological Status

WDFW DATABASE USE ONLY



# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol Page 1 of 2  
 (Y or N, initials):  Y CM Total Detections: 0  
 Species of Concern (circle one, details on last pg.): Y or  N  
 Month June Day 29 Year 2006

Area Name: Cedar River Site Name / Number: South Fork South Station Number: 1  
 Station Location - T 21 N, R 10 (circle one)  E or W, S 10, QQ (1/16) NE, of Q (1/4) SW  
 UTM zone: 10 E (x) coordinate: 611156 N (y) coordinate: 5241522 Source: GPI Datum: NAD 83 FOM: -  
 Observer (s) Name: Corey M. Grinnell Initials: CM Affiliation: ABR, Inc. Phone: (503) 359-2525

Station Elevation: 665 Ft /  M Position on Slope (circle one): Bottom/plain Lower 1/3, Mid 1/3, Upper 1/3, Ridgetop  
 Station Placement (circle one):  Inside Outside  
 Distance from Survey Site Boundary: - Units of Measure for ALL Horizontal Distances: meters  
 Station Canopy Cover (circle one): 1 = 0 to 25%,  2 = 26 to 50%, 3 = 51 to 75%, 4 = 76 to 100%

**ENVIRONMENTAL CONDITIONS:**  
 Official Sunrise Time: 0515 Table: North Bend Begin Survey Time: 0429 End Survey Time: 0630  
 Temperature at Sunrise: 8 ° Temperature at End of Survey: 9 ° (circle one)  C or F revised: 2 / 2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0429	HI	1	Y	Y	N	N	N	N	0	C	Begin Survey
0630	HI	2	Y	Y	N	N	N	N	0	C	End Survey

Ceiling: UL = Unlimited (clear), HI =>2.0 canopy height, MID =>1.25 to <=2.0 canopy height, LO = <=1.25 canopy height, U = Unknown.  
 Cloud Cover: 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
 Vertical Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
 Horizontal Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
 Audibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
 Precipitation - Rain & Fog: N = None, L = Light, M = Moderate, H = Heavy. Other: H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
 Wind: 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
 Noise: N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No.	Data Point No.	Sequence No.	Reference No.
Quad Code	Photo Code	General Location	
Data Entry Initials	Data Entry Date	Data QC Initials	Data QC Date
Protocol Review Initials	Review Date	Highest Biological Status	

\*\* WDFW DATABASE USE ONLY \*\*



# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y CM

Total Detections: 0

Species of Concern (circle one, details on last pg.): (Y) or N

Month 07 Day 08 Year 2006

Area Name: Cedar River Site Name / Number: South Fork South Station Number: 1 Audio

Station Location - T 21 N, R 10 (circle one) (E) or W, S 10, QQ (1/16) SE, of Q (1/4) SE

UTM zone: 10 E (x) coordinate: \_\_\_\_\_ N (y) coordinate: \_\_\_\_\_ Source: GPS Datum: NAD 83 FOM: -

Observer (s) Name: Alden J. Miller Initials: AJM Affiliation: ABR Inc. Phone: (503) 359-7525

Station Elevation: 687 Ft / (M) Position on Slope (circle one): (Bottom/plain) Lower 1/3, Mid 1/3, Upper 1/3, Ridgetop

Station Placement (circle one): (Inside) Outside

Distance from Survey Site Boundary: \_\_\_\_\_ Units of Measure for ALL Horizontal Distances: Meters

Station Canopy Cover (circle one): 1 = 0 to 25%, 2 = 26 to 50%, 3 = 51 to 75%, (4 = 76 to 100%)

**ENVIRONMENTAL CONDITIONS:**

Official Sunrise Time: 0521 Table: North Bend Begin Survey Time: 0436 End Survey Time: 0636

Temperature at Sunrise: 6 ° Temperature at End of Survey: 6 ° (circle one) (C) or F revised: 2 / 2000

TIME	VERTICAL VIEWING		HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER			VISIBILITY TO 2 CANOPY	RAIN	FOG			
0436	UL	0	Y	Y	N	N	N	0	N	Begin Survey
0521	UL	0	Y	Y	N	N	N	0	N	Sunrise
0636	UL	0	Y	Y	N	N	N	0	N	End Survey
										* Survey conducted in tandem w/ CM6 at 1 visual

**Ceiling:** UL = Unlimited (clear), HI =>2.0 canopy height, MID =>1.25 to <=2.0 canopy height, LO =<=1.25 canopy height, U = Unknown.  
**Cloud Cover:** 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.  
**Vertical Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Horizontal Visibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.  
**Audibility:** N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).  
**Precipitation - Rain & Fog:** N = None, L = Light, M = Moderate, H = Heavy. **Other:** H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.  
**Wind:** 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).  
**Noise:** N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

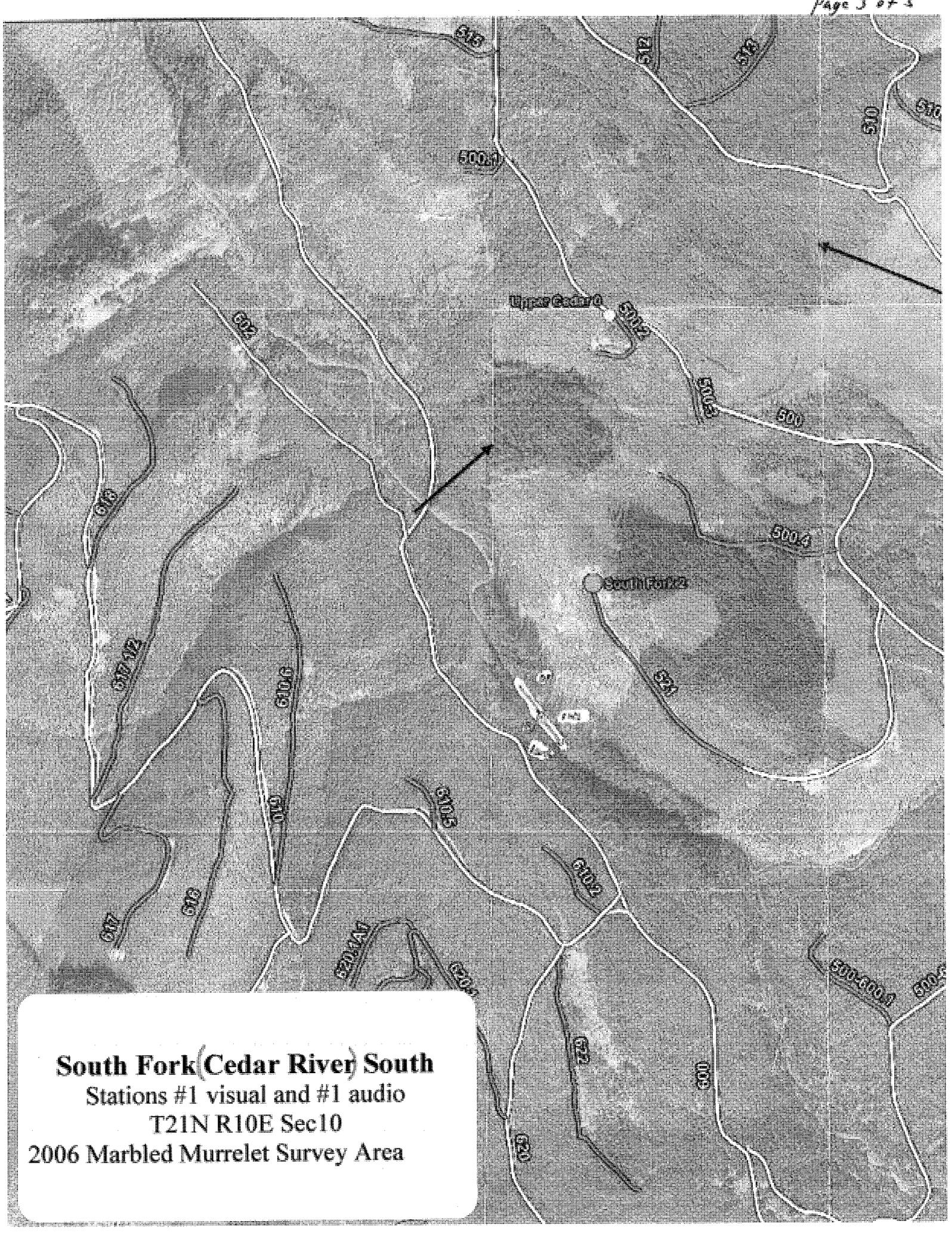
Occurrence No. _____	Data Point No. _____	Sequence No. _____	Reference No. _____
Quad. Code _____	Photo Code _____	General Location _____	
Data Entry Initials _____	Data Entry Date _____	Data QC Initials _____	Data QC Date _____
Protocol Review Initials _____	Review Date _____	Highest Biological Status _____	

\*\* WDFW DATABASE USE ONLY \*\*









# WASHINGTON MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol

Page 1 of 2

(Y or N, initials): Y/GA

Total Detections: 0

Species of Concern (circle one, details on last pg.): Y or N

Month 06 Day 28 Year 06

Area Name: Cedar River Site Name / Number: South Fork North Station Number: 1

Station Location - T 21 N, R 10 (circle one) E or W, S 10, QQ (1/16) NW, of Q (1/4) NW

UTM zone: 10 E(x) coordinate: 611067 N(y) coordinate: 5242333 Source: GPS Datum: MAD83 FOM: \_\_\_\_\_

Observer (s) Name: Peter Sauerbacher Initials: PMS Affiliation: ABR, Inc Phone: (503) 359 7525

Station Elevation: 659 Ft. M Position on Slope (circle one): Bottom/plain, Lower 1/3, Mid 1/3, Upper 1/3, Ridgetop

Station Placement (circle one): Inside, Outside

Distance from Survey Site Boundary: \_\_\_\_\_ Units of Measure for ALL Horizontal Distances: meters

Station Canopy Cover (circle one): 1 = 0 to 25%, 2 = 26 to 50%, 3 = 51 to 75%, 4 = 76 to 100%

### ENVIRONMENTAL CONDITIONS:

Official Sunrise Time: 0514 Table: North Bend Begin Survey Time: 0429 End Survey Time: 0629

Temperature at Sunrise: 7 ° Temperature at End of Survey: 7 ° (circle one) C or F revised: 2 / 2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			
0429	UL	0	Y	Y	Y	N	N	-	1	N	begin survey
0514	HI	1	Y	Y	Y	N	N	-	1	N	sunrise
0629	UL	0	Y	Y	Y	N	N	-	1	N	end survey

Ceiling: UL = Unlimited (clear), HI = >2.0 canopy height, MID = >1.25 to ≤ 2.0 canopy height, LO = ≤ 1.25 canopy height, U = Unknown.

Cloud Cover: 0 = 0%, 1 = 33%, 2 = 66%, 3 = 100%.

Vertical Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.

Horizontal Visibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection), U = Unknown.

Audibility: N = Impaired (detections may be missed due to conditions), Y = Unimpaired (conditions allow for reliable detection).

Precipitation - Rain & Fog: N = None, L = Light, M = Moderate, H = Heavy. Other: H = Hail, S = Snow. Indicate intensity using same codes for rain & fog.

Wind: 0 = <1 mph (calm), 1 = 1-3 mph (leaves barely move), 2 = 4-7 mph (leaves rustle, sm. twigs move), 3 = 8-12 mph (leaves & sm. twigs in constant motion), 4 = 13-18 mph (sm. branches move), 5 = 19-24 mph (lg. branches & sm. trees start to sway), 6 = 25-31 mph (lg. branches in constant motion), 7 = 32-38 mph (whole trees move), 8 = 39-46 mph (twigs & sm. branches break).

Noise: N = None, A = Aircraft, B = Bird song/calls, C = Creek/water drainage, M = Machinery, P = Rain/hail, T = Tree drip, V = Vehicle, W = Wind, O = Other (explain in Notes).

Occurrence No.	Data Point No.	Sequence No.	Reference No.
Quad Code	Photo Code	General Location	
Data Entry Initials	Data Entry Date	Data QC Initials	Data QC Date
Protocol Review Initials	Review Date	Highest Biological Status	
WDFW DATABASE USE ONLY			

species of concern = OSFL

