

Breeding Ecology of the Marbled Murrelet in Washington State

2005 Season Summary

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The Marbled Murrelet (*Brachyramphus marmoratus*) was listed as a Threatened species in Washington, Oregon, and California in 1992 (U.S. Fish and Wildlife Service 1992). Radiotelemetry studies designed to locate an unbiased sample of murrelet nests and monitor nesting attempts have been conducted in central California (Peery et al. 2004a, 2004b), northern California (Hebert and Golightly 2003), British Columbia (Bradley et al. 2004), and Alaska (Whitworth et al. 2000). To date there have not been any murrelet radiotelemetry studies in Washington or Oregon. Additionally, genetic analyses of murrelets rangewide have suffered due to the absence of DNA collected from Washington and Oregon birds (V. Friesen, pers comm.). To better understand the habitat needs, demographic performance, and genetic relatedness of Washington murrelets we initiated a radiotelemetry study in 2004.

The Strait of Juan de Fuca has the highest densities of murrelets in Washington marine waters during the breeding season (Huff et al. 2003). Adjacent forestlands on the Olympic Peninsula provide potential nesting sites for murrelets – especially older forests found within the boundaries of Olympic National Park. It is this region that is the focus of our current Marbled Murrelet breeding ecology research. Beginning in 2004, murrelets were captured at sea, radiotagged, and tracked to inland breeding locations to gain a better understanding of their breeding ecology - including nest initiation rates, success rates, causes of nest failure, individual survival rates, inland and marine space use, and genetic characteristics. This report details the accomplishments and results of the first two field season and discusses our objectives for 2006.

Murrelet Captures

Between 21 April and 11 July, 2004 and from 27 April and 10 June, 2005 we searched for murrelets at night in nearshore waters of the Strait of Juan de Fuca, Admiralty Inlet, Hood Canal, and outer coast of Washington (north of the Hoh River). Most of the effort was focused near Port Angeles (Figure 1) utilizing one or two zodiac inflatable boats with handheld spotlights and dip nets (Whitworth et al. 1997).

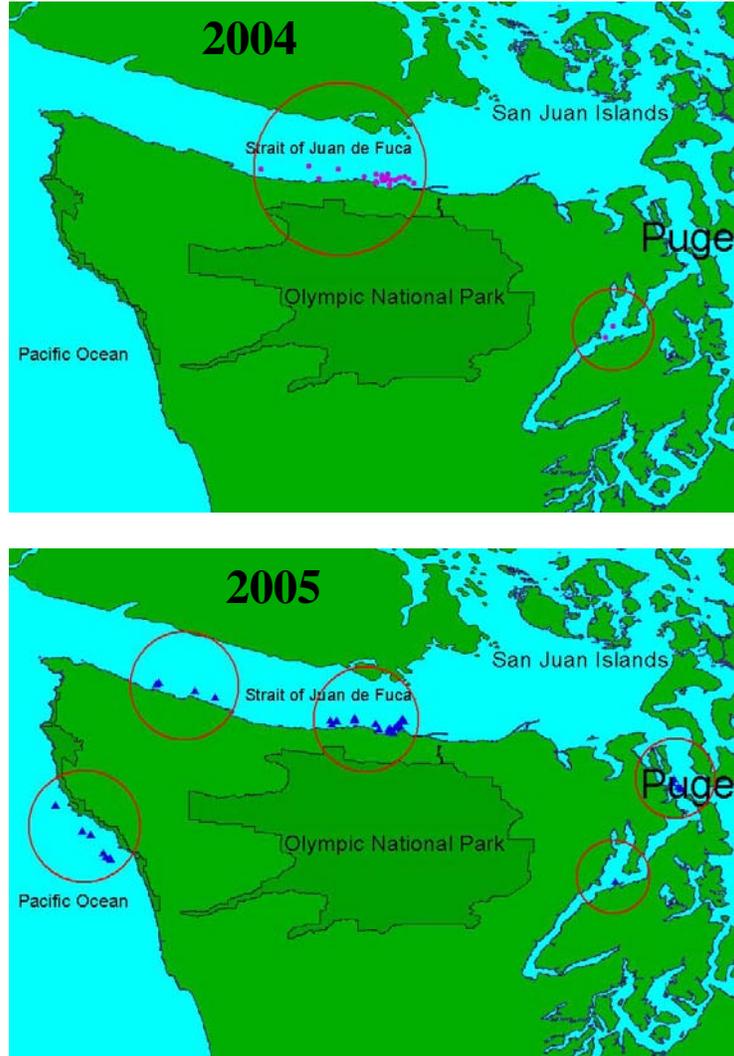


Figure 1. Murrelet capture locations around Washington's Olympic Peninsula during the 2004 and 2005 trapping seasons. Red circles indicate areas where trapping occurred each year.

Twenty-nine Marbled Murrelets were captured and banded in 2004 and 41 in 2005. Radiotransmitters (Advanced Telemetry Systems model # A4360) were placed on 27 adult murrelets in 2004 and 40 in 2005 (following methods of Newman et al. 1999, but without anesthesia or sutures) and blood samples were taken from 28 in 2004 and 41 in 2005. All 69 blood samples (plus 27 samples obtained from Oregon murrelets in summer 2005) have been sent to Vicki Friesen at Queen's University, Canada for analysis. No fatalities occurred during trapping or tagging and all birds behaved normally upon release in 2004 (i.e., flapped away from boat or dove quickly when placed on water). In 2005, one of the birds tagged was lethargic upon release back onto the water, but returned to normal behavior once its mate returned and started calling (approximately five minutes

after release). The bird flew away with its mate and exhibited normal movements throughout the remainder of the season.

Radio tracking

Marine. -- At-sea radio-tracking of tagged murrelets began the day after the first bird was tagged in both years. Most of the tracking was done by aircraft (Rite Bros. Aviation, Port Angeles, WA; 165 hours in 2004, 397 hours in 2005); however, ground-based crews supplemented this effort by tracking from coastline vantage points and from zodiac boats. In 2004, 656 relocation estimates were made of birds while at-sea between 27 April and 1 August (mean number of at-sea relocations per bird = 24, range 5-57). In 2005, 1,456 relocation estimates were made of birds at sea between 28 April and 4 September (mean number of at-sea relocations per bird = 36, range 1-61).

Average marine home range size was about five times larger in 2005 than in 2004 (95% Fixed Kernel Estimates: 2004 = 469 km², 2005 = 2,098 km², $P=0.004$). Murrelets showed widespread use of multiple core areas in 2005, whereas many birds had relatively confined home ranges in 2004 within a single part of the study area. Most birds spent a considerable amount of time in the San Juan Islands in 2005 even though we never tagged any birds there. We never detected any tagged birds in the San Juan's in 2004. In 2005, many seabird species suffered either reduced breeding success and/or reduced survival probably due to unusual oceanographic conditions caused by a lack of upwelling (Bradley et al. 2006, Parrish et al. 2006). This lack of upwelling appeared to be the result of a lack of northwest winds in spring 2005 that typically drive the upwelling pattern. The large home ranges seen in 2005 are likely a result of this phenomenon also.

Inland. – 2004. After the first tagged murrelet was detected inland by aircraft, radio-tracking on foot to locate nests began and became the highest priority. Three active murrelet nests were found in 2004 (all three in Olympic National Park; Figure 2, Table 1, Appendix A). The first two nests (Morse Creek and Boulder Creek) were found early in the incubation stage by searching for the tagged birds inland after detecting an on-off pattern at sea (Bradley et al. 2004). The third nest (Lake Mills) was found during the chick-rearing stage by following the signal of the tagged bird at dawn and dusk as it flew to the nest to feed the chick. This bird only stayed at the nest for 10-30 minutes during each visit, so it took multiple visits by trackers to find the nest tree.

2005. Seven active nests were found in 2005 (four in Olympic National Park, one in Olympic National Forest – The Brothers Wilderness Area, and two on Vancouver Island – Carmanah-Walbran Provincial Park; Figure 2, Table 1, Appendix A). All of the nests found in 2005 were in the incubation stage when initially located. An eighth nest was active in 2005 but the actual tree could not be located before it failed during the incubation stage. This nest was deep in Olympic National Park along the Hayes River. All eleven nests located were monitored remotely using radiotelemetry to track the movements of radiotagged adults from coastlines, ridgetops, and aircraft.

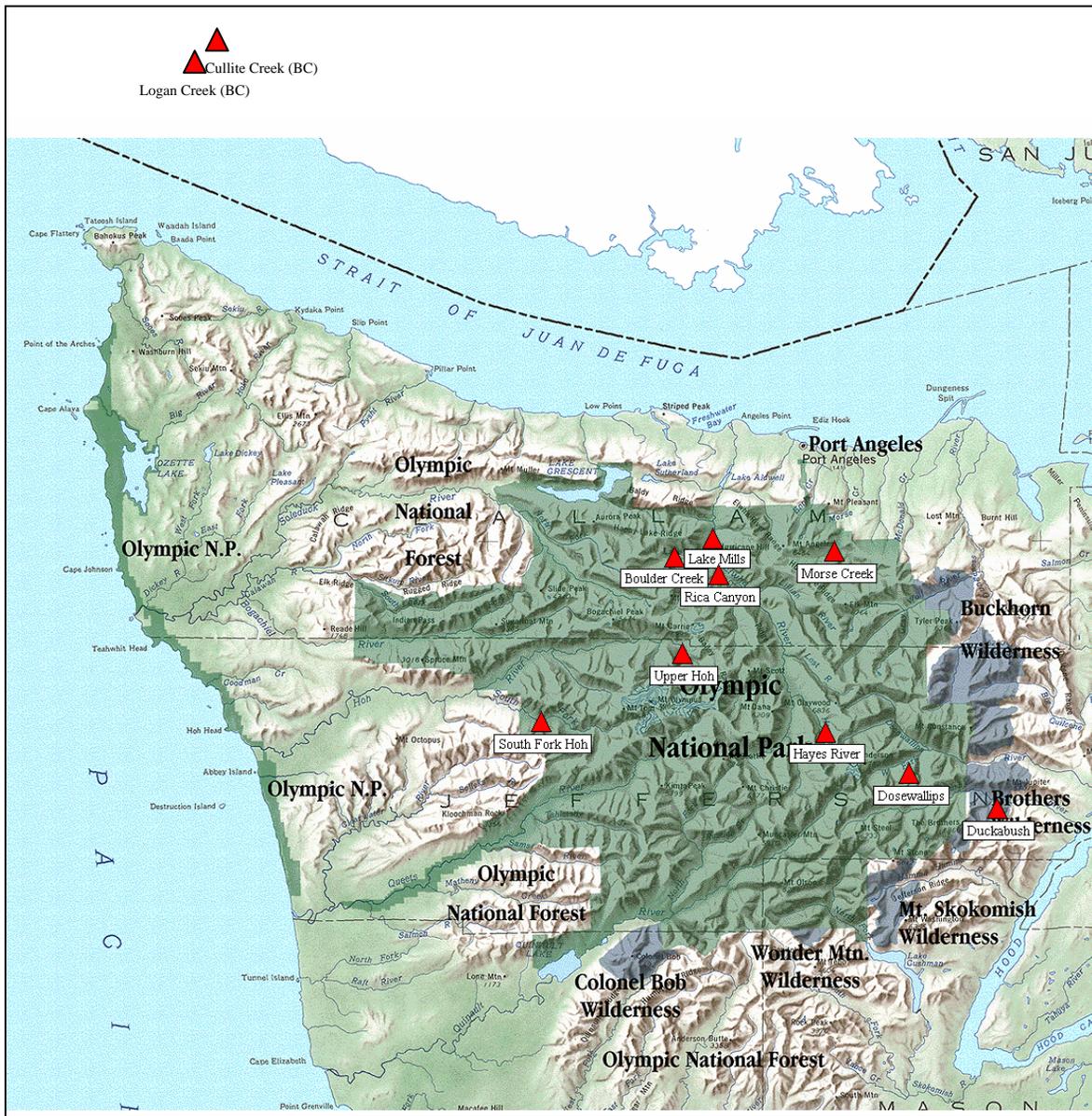


Figure 2. Nest locations of eleven radiotagged murrelets in 2004-2005 on the Olympic Peninsula and Vancouver Island.

Table 1. Characteristics of ten murrelet nests found using radiotelemetry in 2004-2005 and one that was monitored remotely without finding the actual nest tree in 2005.

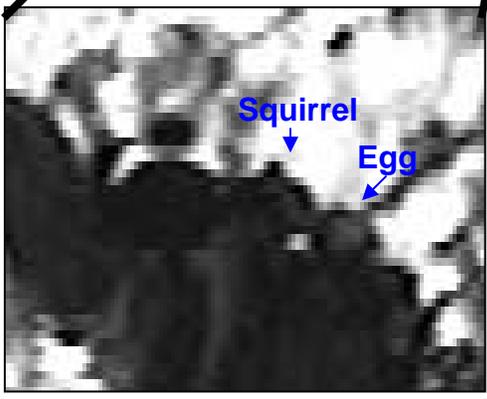
Nest site	Egg-laying date*	Dist. to sea (km)	Tree species	dbh (cm)	Nest fate
2004					
Lake Mills	8 May	15	Douglas-fir	110	Successful
Morse Creek	6 June	14	Douglas-fir	144	Failed – chick (?)
Boulder Creek	8 June	18	Douglas-fir	138	Failed – incubation
2005					
Upper Hoh	27 April	31	Western Hemlock	104	Successful
Hayes River	9 May	37	--	--	Failed – incubation (nest tree never found)
Rica Canyon	17 May	19	Western Hemlock	107	Failed – chick
Cullite Creek (BC)	20 May	9	Western hemlock	100	Failed – chick
Dosewallips	25 May	23	Douglas-fir	170	Failed – incubation
Logan Creek (BC)	29 May	5	Western redcedar	170	Failed – incubation
Duckabush	8 June	10	Douglas-fir	121	Failed – incubation
South Fork Hoh	16 June	39	Sitka Spruce	219	Failed – chick

* Approximate egg-laying date estimated by either radiotelemetry monitoring or by back-dating from hatch/fledge date.

Nest monitoring

In addition to monitoring radio signals of nesting birds, two nests (Boulder Creek in 2004, Rica Canyon in 2005) were also monitored using a video camera and digital video recorder (Sandpiper Technologies, Inc., Sentinel 5 system). A zoom camera was installed on an adjacent tree to record the nest and hard drives/batteries (placed on the ground) were changed every six days.

2004. At the Boulder Creek nest the adults incubated for 35 days then stopped (normal incubation time is about 28-30 days [Nelson 1997]). At least one adult continued visiting the nest at dawn for ten more days - after which no visits were detected (the camera recorded for an additional six days beyond then). A Douglas' squirrel (*Tamiasciurus douglasii*) visited the nest on the afternoon of day nine that the egg was unattended (the day before the murrelet(s) final visit) and rolled the unhatched egg off of the limb using its head (Figure 3). We assume that the disappearance of the egg is the reason why the murrelet(s) stopped visiting the nest.



Close-up of squirrel & egg

Figure 3. Still images (captured from a Digital Video Recorder) of a Douglas' squirrel pushing an abandoned Marbled Murrelet egg out of the nest depression and off the limb at the Boulder Creek site.

2005. At the Rica Canyon nest in 2005, the egg successfully hatched around 17 June and both adults fed the chick (Figure 4) for 20 days until the chick died, apparently from starvation. A Steller's Jay visited this nest within a few hours after the chick apparently died, but it did not attempt to scavenge the chick. A Steller's Jay was seen at the nest again eight days later and picked at the pile of feathers. Prey deliveries to this nest were near either dawn or dusk. The adult male brought a total of 21 fish in 18.5 days of video monitoring (11 at dawn, 10 at dusk, mean total # per day = 1.1) and the female brought 15 (5 at dawn, 10 at dusk, mean total # per day = 0.8).



Figure 4. Both adults feeding fifteen day old chick at the Rica Canyon nest in 2005.

Nesting Success

We climbed all ten known nest trees at the end of the breeding seasons to examine the fecal ring and confirm the nesting attempt and outcome. This evidence, coupled with our radiotelemetry monitoring, made it possible to confirm whether or not each nest made it to the latter part of the chick stage. We do not know, however, if the chick successfully flew from the nest limb and made it to sea. We use the term “successful” here to denote a nest which lasted beyond 20 days into the chick stage.

As described in Table 1, only one nest was successful in each year. The majority of nest failures appear to be related to chick starvation or adults abandoning eggs prior to completion of the incubation period. We did not detect any evidence of nest predation at any nests we have climbed. However, four of the ten nests we have climbed were inconclusive on how they failed. The low observed rate of nest initiation in 2005 (8/40) and high rate of nest failure is likely also due to the poor ocean conditions.

Habitat data collection

During the months of August and September all ten nest sites that we located were visited to collect data on vegetation structure and composition at the scale of the nest depression, limb, tree, nest site (25m radius around nest tree), and nest stand. Nest depression, limb, and tree variables were collected in accordance with Pacific Seabird Group (PSG) methods, while the methods of the Interagency Marbled Murrelet Effectiveness Monitoring Team (Huff et al. 2003) were used to collect nest site and stand-level data.

All ten nests were on large limbs high in the canopy. Most of the nests were in a mossy substrate while some were on bare limb or on collected foliage debris such as needles and cone scales. A full description of habitat characteristics at nest sites will be presented in a future report.

Objectives for 2006

In 2006, we will continue capturing and radio-tagging murrelets in Washington marine waters during the breeding season.

Acknowledgments

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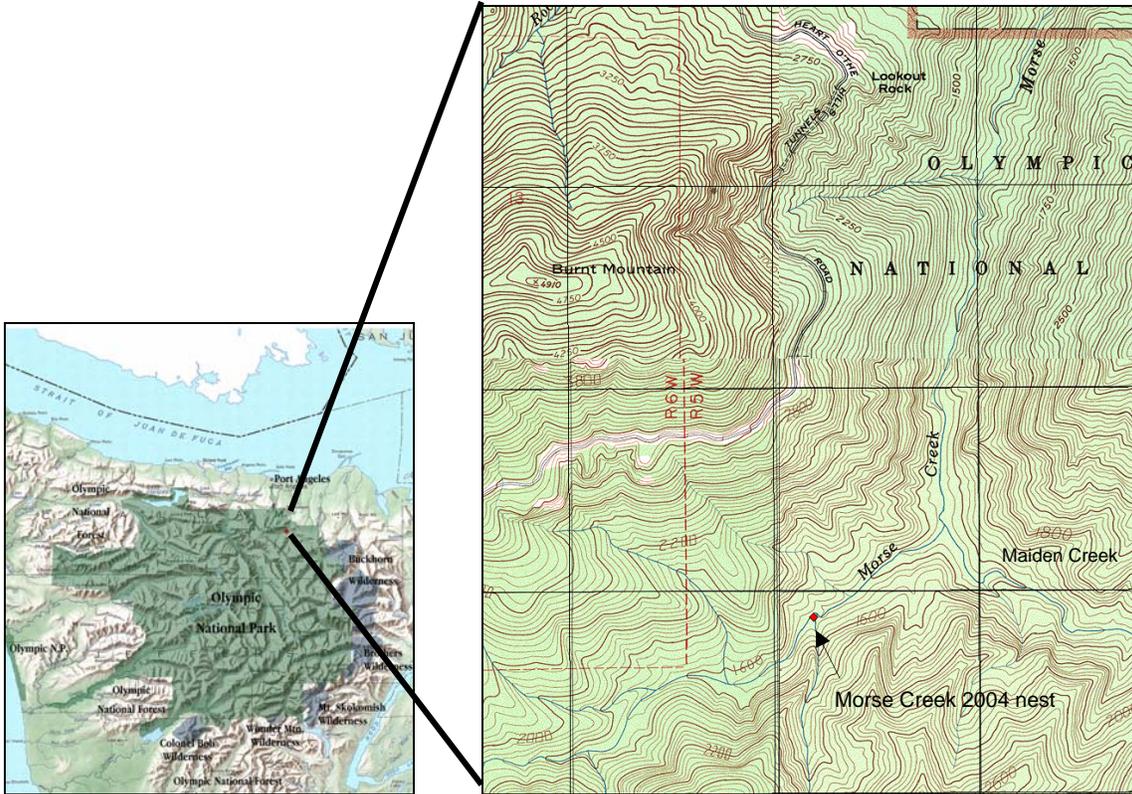
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Appendix A. Maps, photos, and descriptions of the eleven nests monitored in 2004-2005.

Photos by Tom Bloxton, Nick Hatch, Andrew Horton, Kevin Jordan, and Erik Neatherlin.

Morse Creek 2004 (Bird # 562)

- Land ownership: Olympic National Park
- Location: coordinates = 14 km from sea along south side of Morse Creek (800 m upstream from Maiden Creek)
- Topographic position: riparian
- Tree characteristics: 144 cm dbh Douglas-fir
- Nest status: failed during chick-rearing stage (reason unknown)



Base of nest tree



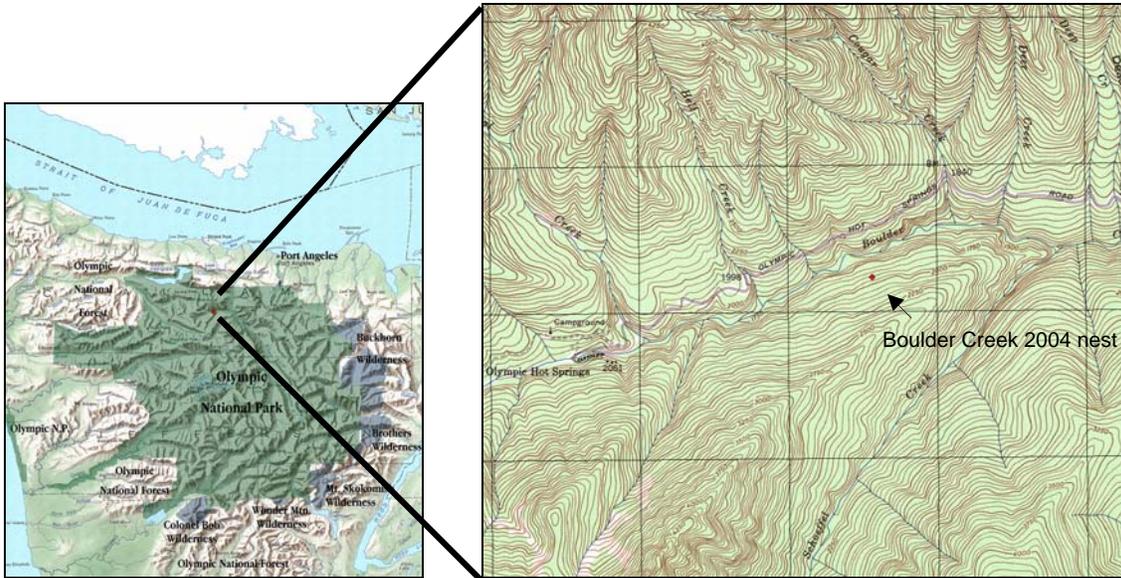
View of nest limb from north side of Morse Creek



35mm film canister lid in nest depression

Boulder Creek 2004 (Bird # 983)

- Land ownership: Olympic National Park
- Location: coordinates = 18 km from sea on south side of Boulder Creek near Olympic Hot Springs.
- Topographic position: mid-slope
- Tree characteristics: 138 cm dbh Douglas-fir
- Nest status: failed during incubation (egg did not hatch after 35 days)



Base of nest tree



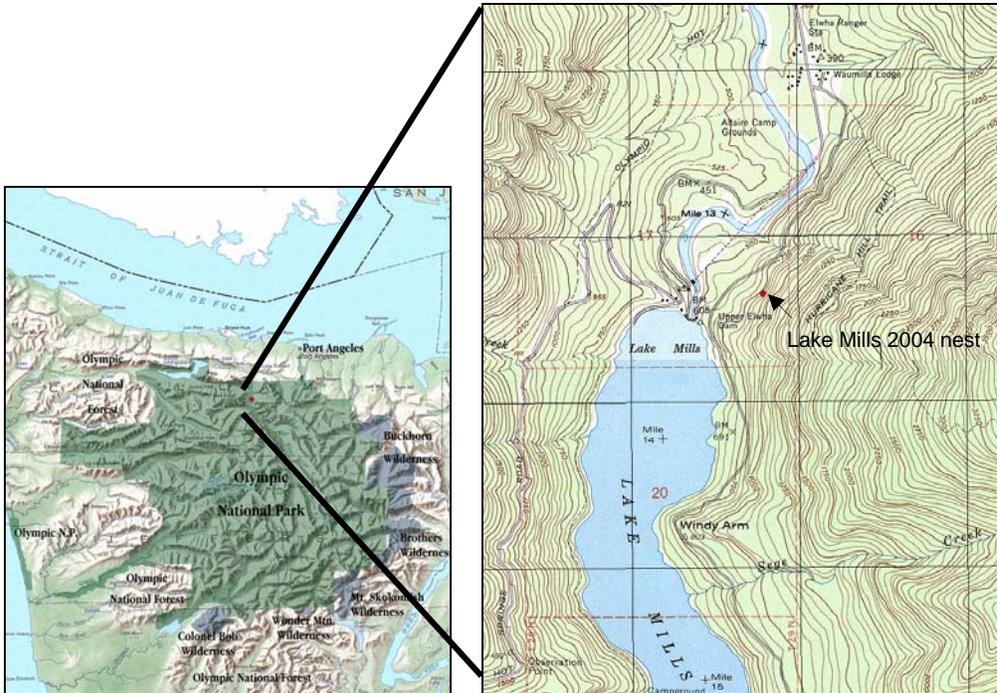
Incubating adult murrelet standing up to reposition on egg



Close-up of nest depression

Lake Mills 2004 (Bird # 021)

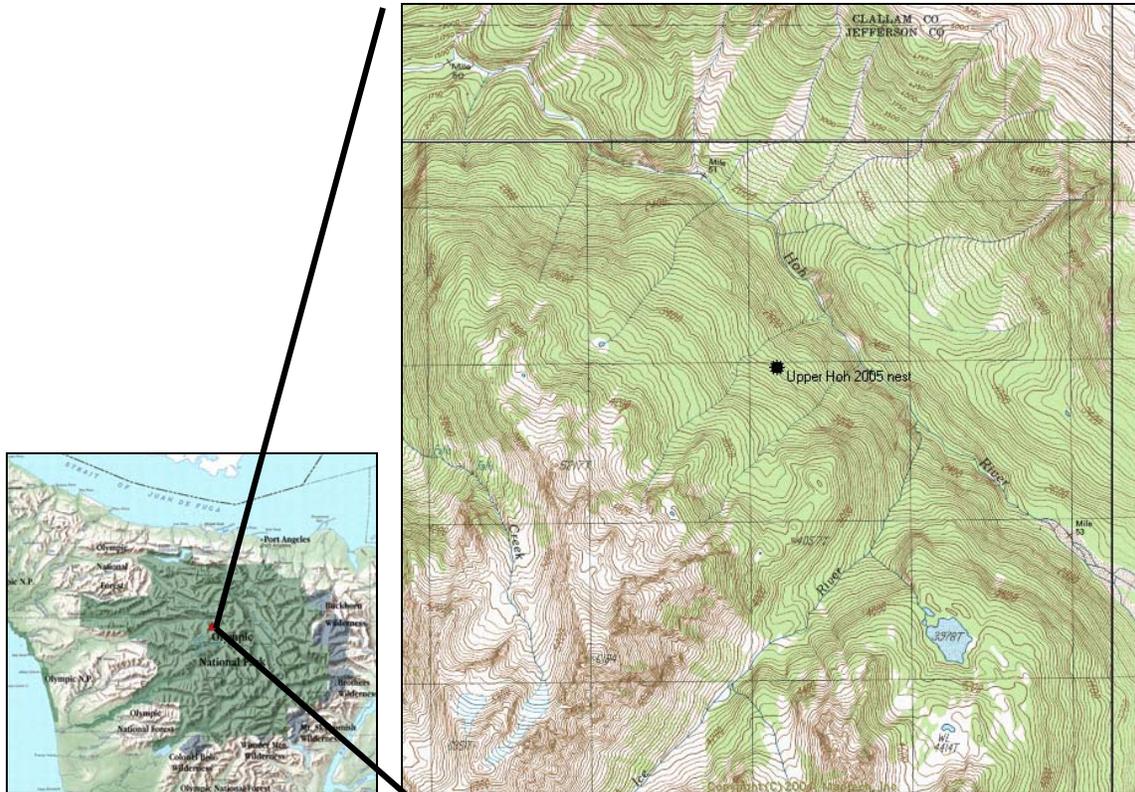
- Land ownership: Olympic National Park
- Location: coordinates = 15 km from sea near Lake Mills Dam.
- Topographic position: mid-slope
- Tree characteristics: 110 cm dbh Douglas-fir
- Nest status: presumed successful



Northern Anchovy found at the base of the nest tree

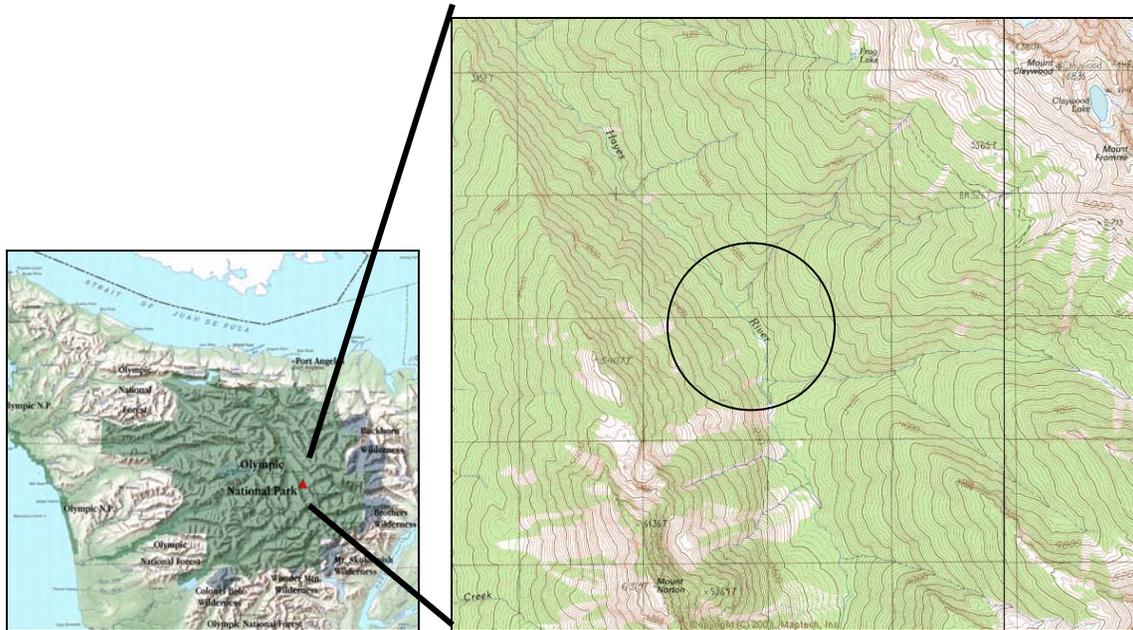
Upper Hoh 2005 (Bird # 932)

- Land ownership: Olympic National Park
- Location: coordinates = 31km from sea on NE side of Mount Olympus (Upper Hoh Valley near Ice River)
- Topographic position: mid-slope
- Tree characteristics: 104 cm dbh Western Hemlock
- Nest status: Successful



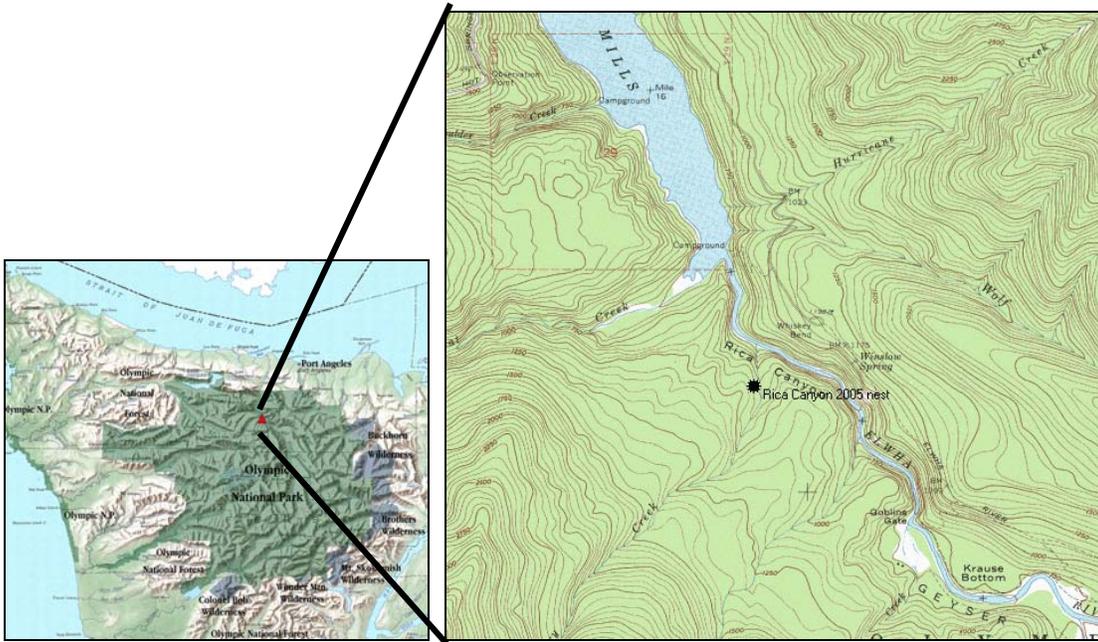
Hayes River 2005 (Bird # 853)

- Land ownership: Olympic National Park
- Location: ~37km from sea in Hayes River valley; nest tree was not found, circle below is approximate location
- Nest status: failed during incubation



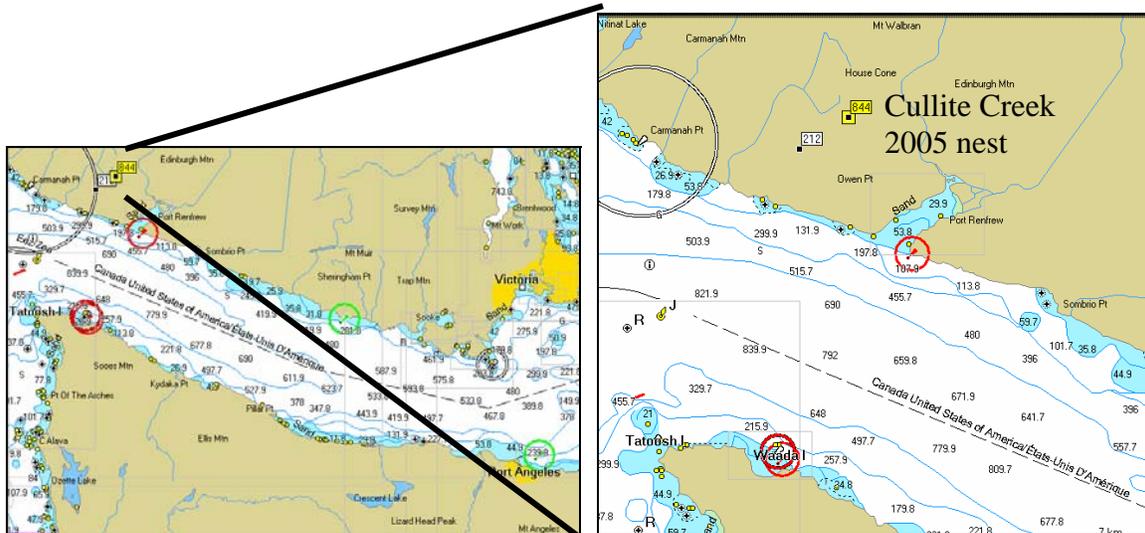
Rica Canyon 2005 (Bird # 619)

- Land ownership: Olympic National Park
- Location: coordinates = 19 km from sea along Fitzhenry Creek south of Lake Mills in Elwha Valley
- Topographic position: riparian
- Tree characteristics: 107 cm dbh Western Hemlock
- Nest status: Failed during chick-rearing stage (apparently starvation)



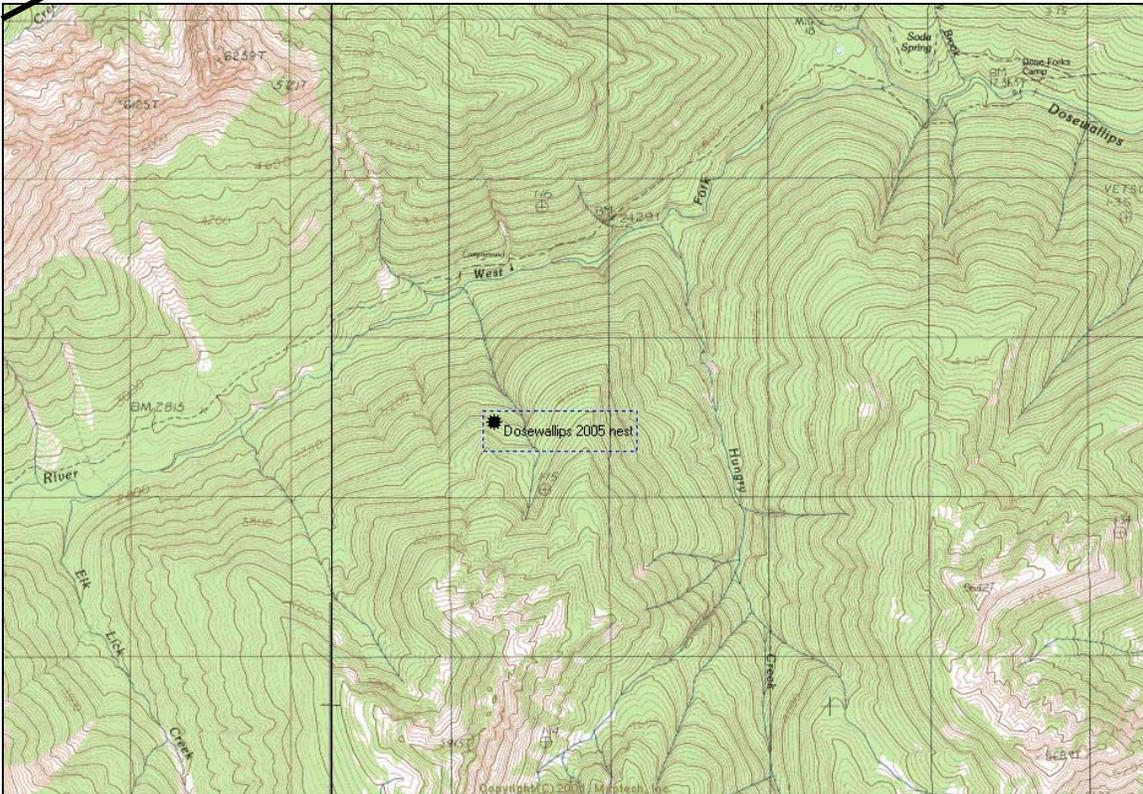
Cullite Creek 2005 (Bird # 844)

- Land ownership: Carmanah-Walbran Provincial Park (BC)
- Location: coordinates = 9 km from sea near Port Renfrew
- Topographic position: riparian
- Tree characteristics: 100 cm dbh Western Hemlock
- Nest status: Failed during chick-rearing stage (reason unknown but chick remains were found on ground below nest)



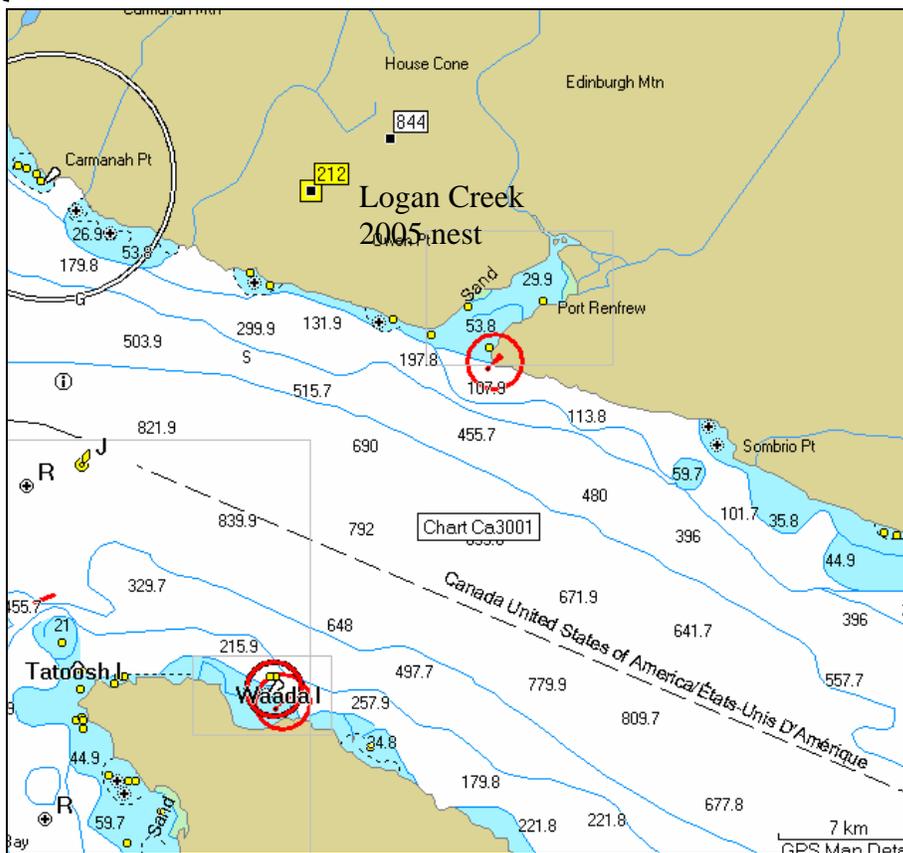
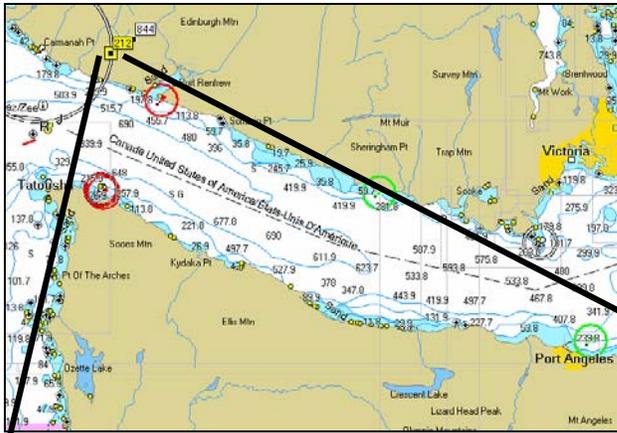
Dosewallips 2005 (Bird # 070)

- Land ownership: Olympic National Park
- Location: coordinates = 23 km from sea in West Fork Dosewallips Valley (3,800 feet elevation)
- Topographic position: mid-slope
- Tree characteristics: 170 cm dbh Douglas-fir
- Nest status: Failed during incubation (nest limb/depression was not found)



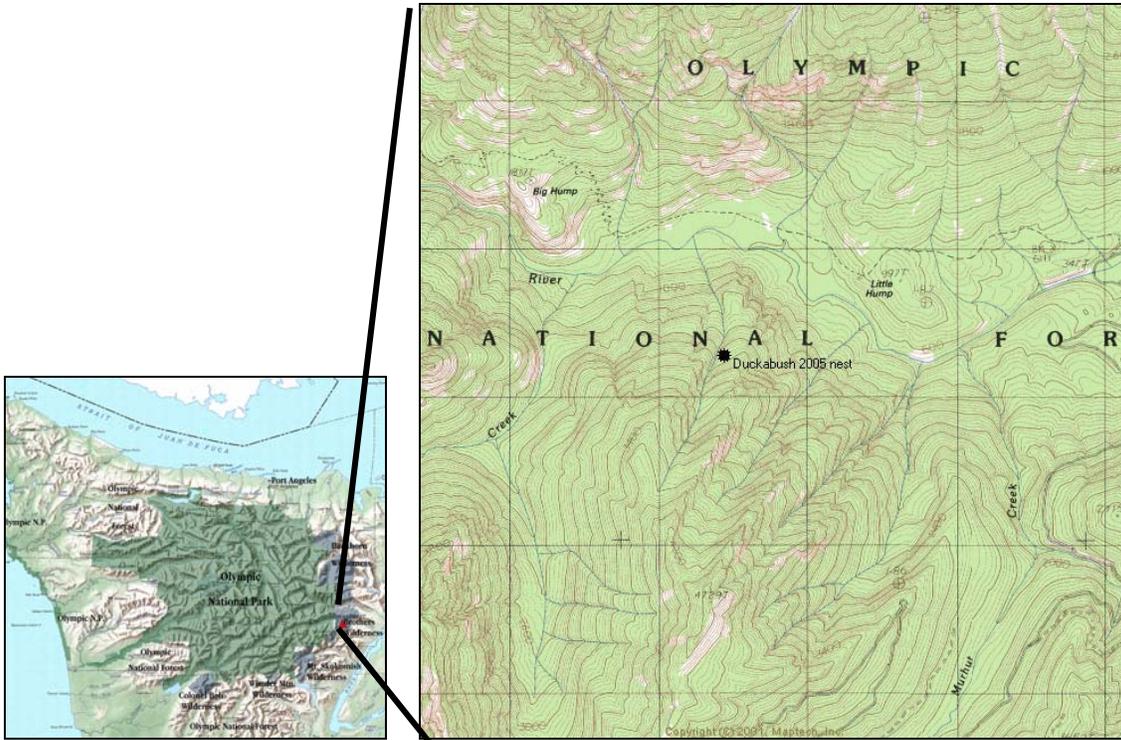
Logan Creek 2005 (Bird # 212)

- Land ownership: Carmanah-Walbran Provincial Park (BC)
- Location: coordinates = 5 km from sea near Port Renfrew
- Topographic position: lower 1/3 of slope
- Tree characteristics: 170 cm dbh Western redcedar
- Nest status: Failed during incubation (nest limb/depression was not found)



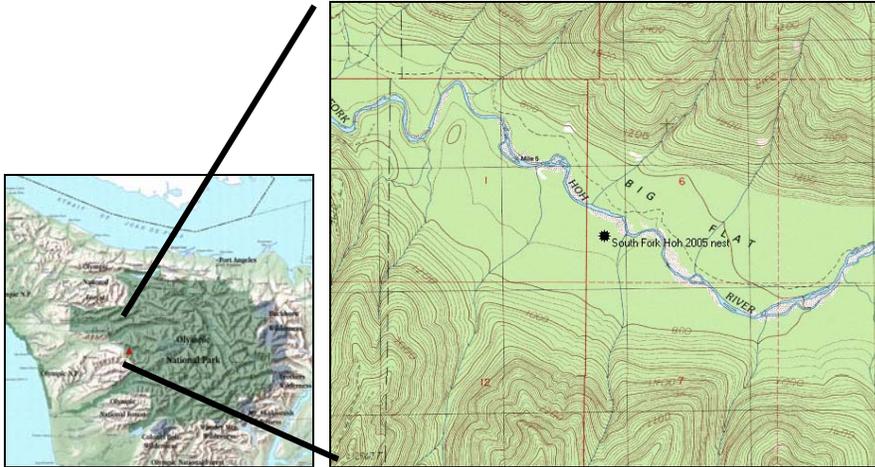
Duckabush 2005 (Bird # 141)

- Land ownership: Olympic National Forest (The Brothers Wilderness Area)
- Location: coordinates = 10 km from sea in Duckabush Valley
- Topographic position: mid-slope
- Tree characteristics: 121 cm dbh Douglas-fir (broken top)
- Nest status: Failed during incubation (egg was abandoned)



South Fork Hoh 2005 (Bird # 302)

- Land ownership: Olympic National Park
- Location: coordinates = 39 km from sea in “Big Flat” area of South Fork Hoh Valley
- Topographic position: bottom, riparian
- Tree characteristics: 219 cm dbh Sitka Spruce
- Nest status: Failed during chick-rearing stage (apparently starvation)



CAPTURES 2004

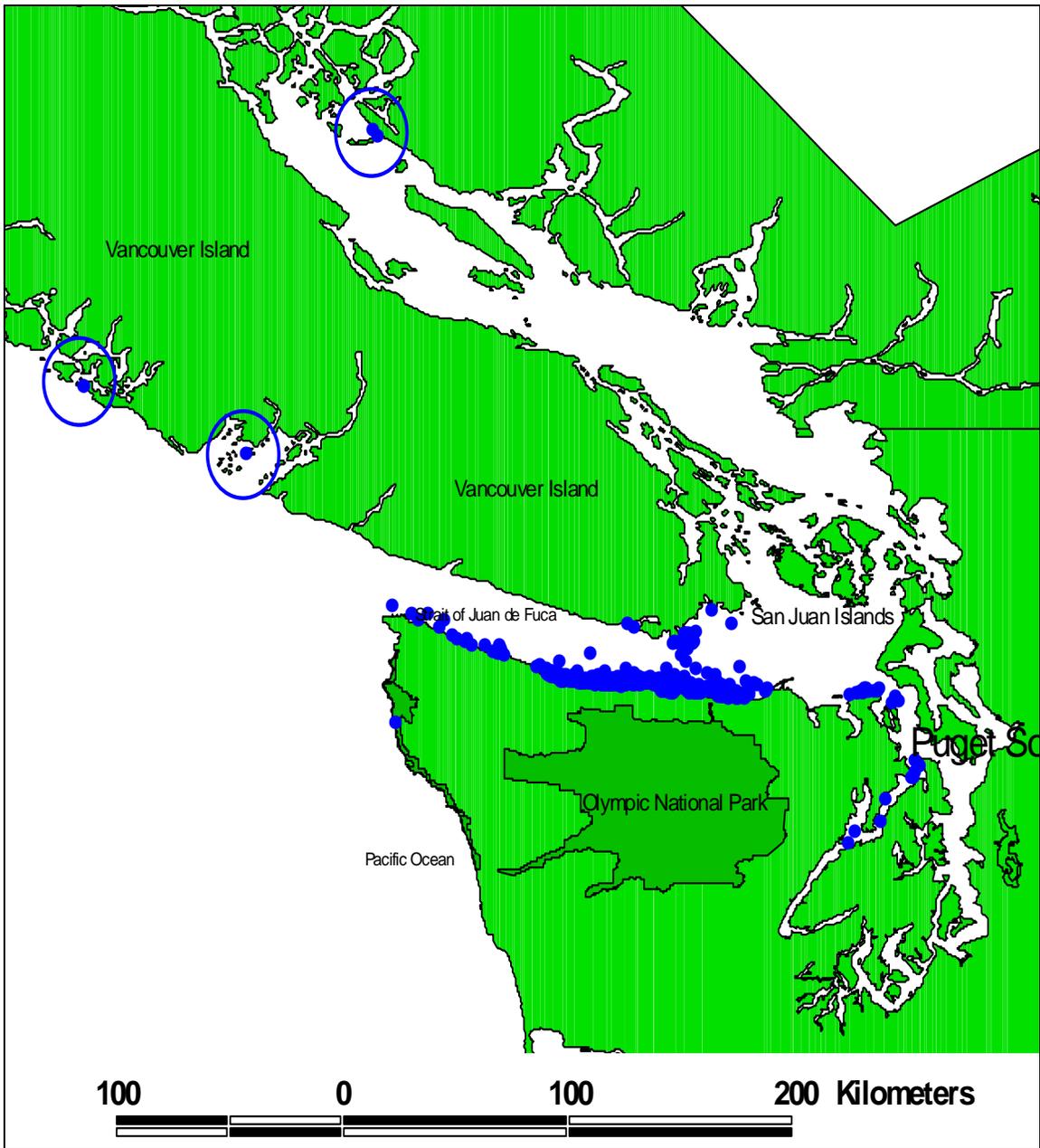
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						LATD	LATM	LATSEC	LOND	LONM	LONSEC	Tracking start date	Tracking end date	Days tracked	# at-sea relocations	# inland relocations	Last known status	Last date detected		
2003-91306	MAMU	165.044	ASY	F	26-Apr	48	10	42.4	123	36	52.3	4/26/2004	5/17/2004	22	23	0	Alive	5/17/2004	dispersed far?	
2003-91308	MAMU	none	ASY	F	26-Apr	48	10	41.7	123	40	34.5									
2003-91309	MAMU	165.753	ASY	Unk	6-May	48	8	42.9	123	35	25.3	5/6/2004	6/20/2004	46	48	0	Alive	7/20/2004	Found near Savary Island (Str. Georgia) on 7-20-04	
2003-91310	MAMU	165.983	ASY	F	13-May	48	9	48.2	123	31	38.9	5/13/2004	6/20/2004	39	36	11	Alive	7/14/2004	Transmitter signal weakened in mid-June	
2003-91311	MAMU	165.132	ASY	F	19-May	48	9	20.6	123	38	5.4	5/19/2004	7/15/2004	58	57	0	Alive	7/15/2004		
2003-91312	MAMU	165.061	ASY	F	20-May	48	9	40.7	123	34	17.1	5/20/2004	7/20/2004	62	54	3	Alive	7/20/2004		
2003-91313	MAMU	165.221	ASY	F	24-May	48	9	36.9	123	36	47.5	5/24/2004	6/20/2004	28	27	0	Alive	6/20/2004	dispersed far?	
2003-91314	MAMU	165.271	ASY	F	24-May	48	10	55.1	123	38	5.5	5/24/2004	7/13/2004	51	47	0	Alive	7/13/2004	dispersed far?	
2003-91315	MAMU	165.344	ASY	F	25-May	48	9	44.9	123	36	20.9	5/25/2004	6/22/2004	29	25	0	Alive	6/22/2004	dispersed far?	
2003-91316	MAMU	165.412	ASY	F	26-May	48	9	40.8	123	36	20.7	5/26/2004	6/11/2004	17	15	0	Alive	7/20/2004	Found near Savary Island (Str. Georgia) on 7-20-04	
2003-91317	MAMU	165.953	ASY	F	1-Jun	48	11	46.8	124	0	40.5	6/1/2004	7/1/2004	31	27	0	Alive	7/1/2004	dispersed far?	
2003-91318	MAMU	165.853	ASY	M	2-Jun	48	10	19.3	123	32	31.4	6/2/2004	7/2/2004	31	30	0	Alive	7/2/2004	dispersed far?	
2003-91319	MAMU	165.562	ASY	M	4-Jun	48	9	2.7	123	30	35.7	6/4/2004	7/30/2004	57	21	22	Alive	7/30/2004		
2003-91320	MAMU	165.021	ASY	M	8-Jun	48	9	51.2	123	36	39.9	6/8/2004	7/11/2004	34	34	6	Alive	7/11/2004	dispersed far?	
2003-91321	MAMU	165.511	ASY	M	8-Jun	48	9	27.1	123	38	22.2	6/8/2004	6/12/2004	5	5	0	Alive	6/12/2004	dispersed far?	
2003-91322	MAMU	165.490	ASY	F	9-Jun	48	9	9.3	123	37	58	6/9/2004	7/1/2004	23	19	0	Alive	7/4/2004	Found on WA coast near Lake Ozette on 7-4-04	
2003-91323	MAMU	165.613	ASY	M	9-Jun	48	9	8.6	123	38	7.7	6/9/2004	6/22/2004	14	14	0	Alive	6/22/2004	dispersed far?	
2003-91324	ANMU*	none	AHY	Unk	11-Jun	48	10	20.8	123	35	34.9									
2003-91325	MAMU	165.722	ASY	M	12-Jun	48	9	37.6	123	35	14.8	6/12/2004	6/30/2004	19	18	0	Alive	6/30/2004	dispersed far?	
2003-91326	MAMU	165.772	ASY	M	15-Jun	48	10	3.9	123	36	53.9	6/15/2004	6/29/2004	14	13	0	Alive	6/29/2004	dispersed far?	
2003-91327	MAMU	165.233	SY	F	17-Jun	48	10	18.5	123	35	54	6/17/2004	6/21/2004	5	6	0	Alive	7/17/2004	Found near Tofino (w Vancouver Is) on 7-17-04	
2003-91328	MAMU	165.453	ASY	M	17-Jun	48	10	48.6	123	35	46.6	6/17/2004	6/23/2004	7	8	0	Dead	6/23/2004	Predation - transmitter in Agate Bay Bald Eagle nest	
2003-91329	MAMU	165.653	ASY	M	17-Jun	48	10	14.8	123	33	28.6	6/17/2004	7/15/2004	29	20	1	Alive	7/15/2004		
2003-91330	MAMU	165.263	ASY	M	18-Jun	48	11	47.1	123	45	28.2	6/18/2004	7/21/2004	34	26	6	Alive	8/13/2004		
2003-91331	MAMU	165.303	ASY	M	18-Jun	48	12	30.6	123	51	13.8	6/18/2004	7/17/2004	30	26	2	Alive	7/17/2004		
2003-91332	MAMU	165.844	ASY	F	23-Jun	47	41	0.8	122	51	32.1	6/23/2004	7/20/2004	28	17	0	Alive	7/20/2004		
2003-91333	MAMU	165.071	ASY	M	23-Jun	47	38	45.6	122	53	3.1	6/23/2004	7/11/2004	19	14	0	Alive	7/17/2004	Found in Barkley Sound, B.C. on 7-17-04	
2003-91334	MAMU	none	HY	M	1-Jul	48	8	59.7	123	37	26									
2003-91335	MAMU	165.091	ASY	M	11-Jul	48	10	17.0	123	40	21.3	7/11/2004	8/1/2004	22	8	4	Alive	8/1/2004		
2003-91336	MAMU	165.864	ASY	F	11-Jul	48	10	37.5	123	48	2.5	7/11/2004	7/20/2004	10	8	1	Alive	7/20/2004		

* Ancient Murrelet (*Synthliboramphus antiquus*)

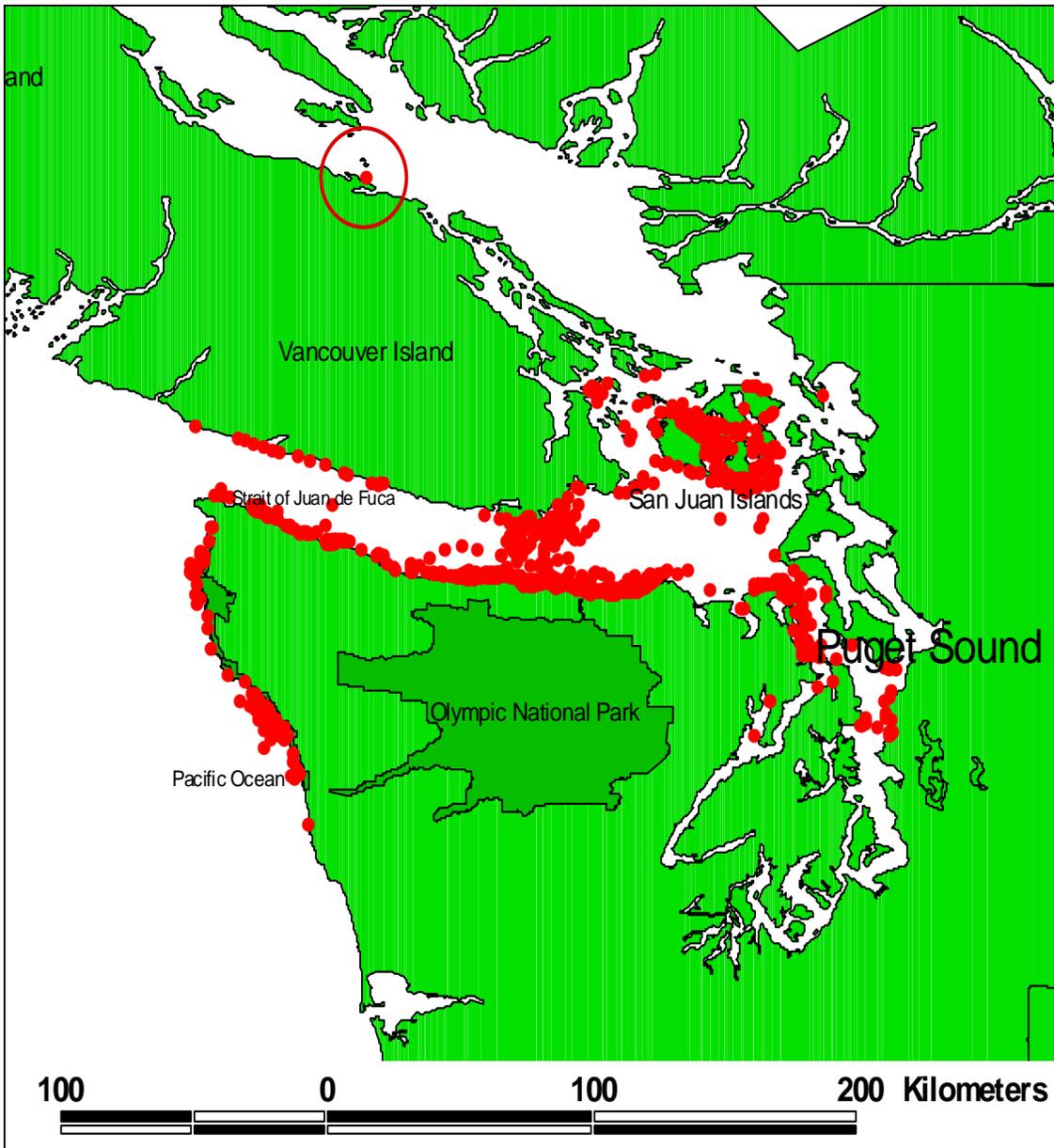
Appendix B. Summary of murrelets captured during the 2004 field season.

CAPTURES 2005												
USFWS Band #	Species	Trans Freq.	Age	Sex	Capture Date	Capture Location		Tracking summary				Comments
						Latitude	Longitude	Tracking start date	Tracking end date	# at-sea relocations	Last known status	
2003-91337	MAMU	165.932	ASY	M	27-Apr	48.15765	-123.62622	4/30/2005	8/19/2005	44	Alive	Upper Hoh breeder - successful
2003-91338	MAMU	165.692	ASY	F	28-Apr	48.17008	-123.56323	4/29/2005	7/3/2005	57	Dead	Probably bald eagle predation
2003-91339	MAMU	165.020	ASY	M	28-Apr	48.16949	-123.56590	4/29/2005	7/1/2005	57	Alive	
2003-91340	MAMU	165.853	ASY	F	28-Apr	48.16534	-123.56633	4/29/2005	8/3/2005	61	Alive	Hayes River breeder - failed in incubation
2003-91341	MAMU	No Tx	ASY	M	28-Apr	48.16276	-123.57246					
2003-91342	MAMU	165.619	ASY	M	28-Apr	48.16237	-123.57232	4/29/2005	6/27/2005	29	Alive	Rica Canyon breeder - failed in chick stage
2003-91343	MAMU	165.221	ASY	F	28-Apr	48.16795	-123.56697	4/29/2005	6/14/2005	40	Alive	
2003-91344	MAMU	165.491	ASY	M	29-Apr	48.15853	-123.59091	4/29/2005	6/18/2005	41	Alive	
2003-91345	MAMU	165.420	ASY	F	29-Apr	48.15715	-123.58707	4/29/2005	7/9/2005	51	Alive	
2003-91346	MAMU	165.110	ASY	M	29-Apr	48.16737	-123.55781	4/29/2005	6/5/2005	34	Alive	
2003-91347	MAMU	165.873	ASY	F	29-Apr	48.18698	-123.70553	4/30/2005	6/27/2005	51	Alive	
2003-91348	MAMU	165.212	ASY	F	29-Apr	48.19390	-123.70611	4/30/2005	7/27/2005	46	Alive	Logan Creek breeder - failed in incubation
2003-91349	MAMU	165.883	ASY	F	30-Apr	48.18375	-123.76246	4/30/2005	7/4/2005	43	Alive	
2003-91350	MAMU	165.270	ASY	F	1-May	47.65977	-122.85141	5/16/2005	8/11/2005	40	Alive	Could not locate for the first couple of weeks after tagging
2003-91351	MAMU	165.141	ASY	M	4-May	47.96187	-122.63484	5/5/2005	7/27/2005	48	Alive	Duckabush breeder - failed in incubation
2003-91352	MAMU	165.321	ASY	F	4-May	47.97048	-122.64611	5/5/2005	7/17/2005	47	Alive	
2003-91353	MAMU	165.070	ASY	M	4-May	47.98357	-122.66777	5/5/2005	6/2/2005	18	Alive	Dosewallips breeder - failed in incubation
2003-91354	MAMU	165.982	ASY	M	5-May	48.30577	-124.35439	5/5/2005	6/14/2005	36	Alive	
2003-91355	MAMU	165.844	ASY	F	5-May	48.30991	-124.34494	5/5/2005	7/9/2005	45	Alive	Cullite Creek breeder - failed in chick stage
2003-91356	MAMU	165.232	ASY	F	5-May	48.28308	-124.22876	5/6/2005	7/19/2005	56	Alive	
2003-91357	MAMU	165.042	ASY	F	6-May	48.26071	-124.16100	5/6/2005	7/19/2005	47	Alive	
2003-91358	MAMU	165.310	ASY	F	11-May	47.91008	-124.68336	5/12/2005	8/19/2005	28	Alive	Sat in a tree in Bogachiel valley occasionally but did not have a mate
2003-91359	MAMU	165.922	ASY	M	12-May	47.82344	-124.59710	5/13/2005	6/29/2005	33	Alive	
2003-91360	MAMU	165.822	ASY	F	13-May	47.81176	-124.57011	5/13/2005	5/13/2005	1	Alive	Single bird still in winter plumage when captured
2003-91361	MAMU	165.302	ASY	F	13-May	48.18968	-123.70413	5/15/2005	7/22/2005	31	Alive	South Fork Hoh breeder - failed in chick stage
2003-91362	MAMU	165.863	ASY	F	25-May	48.18531	-123.78467	5/25/2005	7/3/2005	35	Alive	
2003-91363	MAMU	165.672	ASY	F	27-May	48.17690	-123.63581	5/31/2005	8/3/2005	49	Alive	
2003-91364	MAMU	165.412	ASY	F	28-May	48.18268	-123.55324	5/29/2005	7/4/2005	36	Alive	
2003-91365	MAMU	165.712	ASY	F	28-May	48.18269	-123.54395	5/29/2005	7/10/2005	42	Alive	
2003-91366	MAMU	165.053	ASY	F	28-May	48.19314	-123.54897	5/29/2005	6/27/2005	20	Alive	
2003-91367	MAMU	165.120	ASY	F	29-May	47.99539	-122.65971	5/29/2005	7/12/2005	37	Alive	
2003-91368	MAMU	165.062	ASY	F	1-Jun	48.14639	-123.57847	6/1/2005	7/12/2005	38	Alive	
2003-91369	MAMU	165.151	ASY	F	1-Jun	48.15004	-123.59249	6/1/2005	7/5/2005	23	Alive	
2003-91370	MAMU	165.590	ASY	M	2-Jun	47.98226	-122.66543	6/4/2005	6/5/2005	2	Alive	
2003-91371	MAMU	165.463	ASY	M	3-Jun	47.96317	-122.63848	6/4/2005	7/19/2005	34	Alive	
2003-91372	MAMU	165.092	ASY	F	6-Jun	48.18279	-123.76568	6/6/2005	7/11/2005	31	Alive	
2003-91373	MAMU	165.131	ASY	F	6-Jun	48.17243	-123.77840	6/6/2005	7/3/2005	27	Alive	
2003-91374	MAMU	165.992	ASY	M	9-Jun	47.73617	-124.50479	6/9/2005	8/19/2005	36	Alive	
2003-91375	MAMU	165.952	ASY	F	9-Jun	47.73032	-124.50246	6/9/2005	6/29/2005	9	Alive	
2003-91376	MAMU	165.833	ASY	M	10-Jun	47.75106	-124.52861	6/11/2005	7/27/2005	24	Alive	
2003-91377	MAMU	165.192	SY	F	10-Jun	47.73836	-124.51924	6/12/2005	8/19/2005	29	Alive	

Appendix C. Summary of murrelets captured during the 2005 field season.



Appendix D. Map of 656 marine relocation estimates of 27 radiotagged murrelets in 2004. Large circles are used to highlight locations outside the primary study area.



Appendix E. Map of 1,456 marine relocation estimates of 40 radiotagged murrelets in 2005. Large circles are used to highlight locations outside the primary study area.