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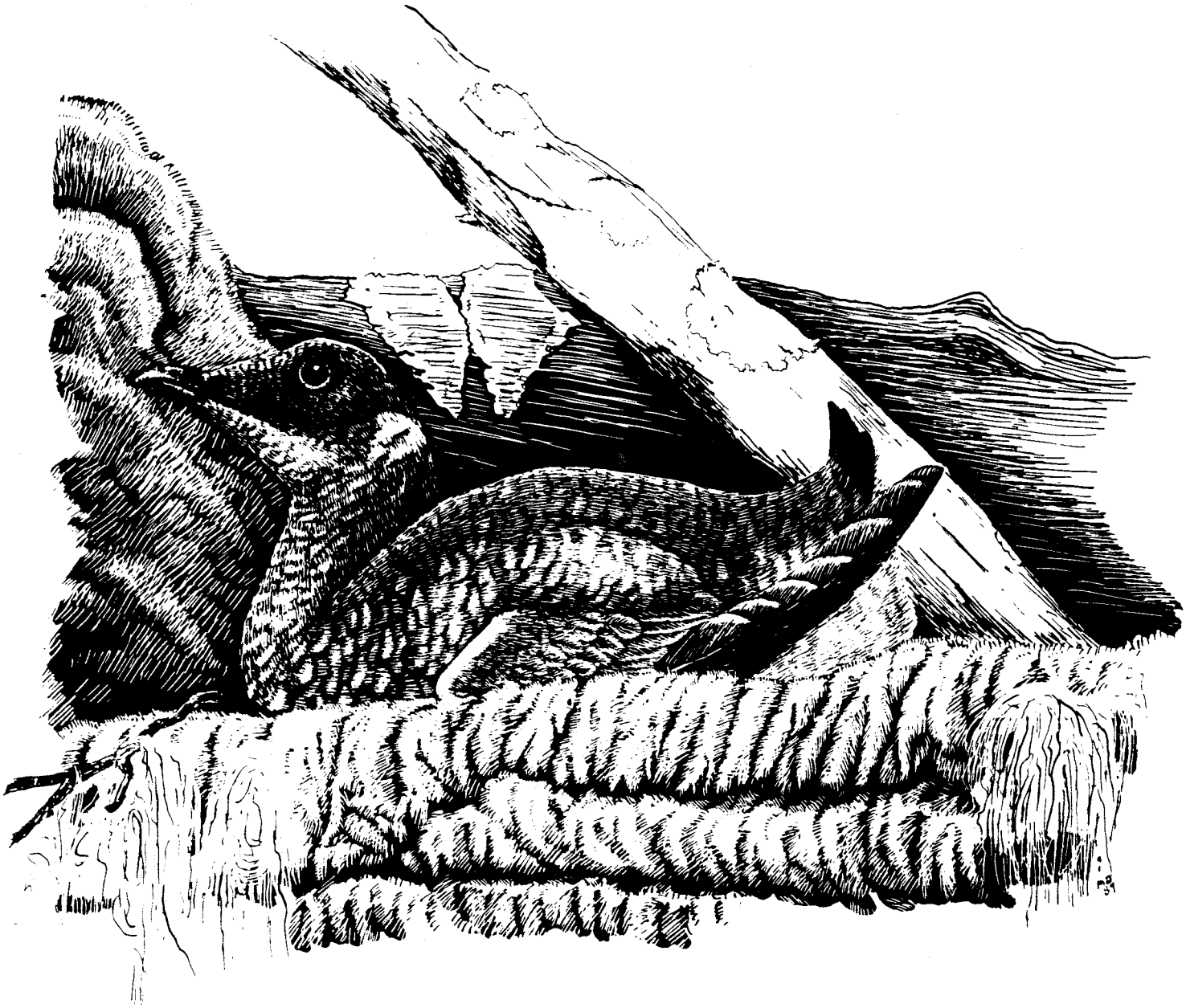
Surveying Marbled Murrelets at Inland Forested Sites: A Guide

Peter W. C. Paton C. John Ralph Harry R. Carter S. Kim Nelson



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The marbled murrelet (*Brachyramphus marmoratus*), a seabird, nests in forested stands from southeast Alaska south to Santa Cruz, California. Because of this species' close association with old-growth forests, researchers and land managers need a method to assess murrelet distribution and use patterns throughout its range. This guide describes a standardized method for surveying marbled murrelets used by researchers in California and Oregon during 1988 and 1989. Transects can be used to assess activity patterns over large blocks of land, such as States or counties. Stationary counts using an intensive inventory method can be used to survey small acreages, such as individual timber sales. In addition to bird counts, vegetation and physical data should be collected at each census point. The guide includes a form that can be used to design studies and determine activity patterns and potential use.

Retrieval Terms: marbled murrelet, *Brachyramphus marmoratus,* seabird, census tech niques, old-growth forests, California, Pacific Northwest

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Cover: Drawing by Michelle Davis of marbled murrelet nesting in an old-growth Douglas fir tree, Big Basin State Park, central California.

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INTRODUCTION

The marbled murrelet (*Brachyramphus marmoratus*) has recently become a species of particular concern to land managers in the Pacific Northwest because of its close association with old-growth forests. Its range extends from southeast Alaska south to Santa Cruz, in northern California. The U.S. Fish and Wildlife Service includes this seabird in Category II, and is considering it for listing as a threatened species.

Unique among the alcids, the marbled murrelet is the only species that nests in trees. Seven tree nests have been described: three in Siberia in the U.S.S.R. (Kuzyakin 1963, Labzyuk 1987, Nechaev 1986) and four in North America (Binford and others 1975, Quinlan and Hughes 1984, Singer and others 1990). Although much still needs to be learned about the species, data gathered over the past 10 years show the murrelets to be closely associated with old-growth coniferous forests in the southern parts of its range (Carter and Erickson 1988, Nelson 1989, Paton and Ralph 1988, Sealy and Carter 1984).

Until the late 1980's, work on censuring marbled murrelets primarily focused on their at-sea abundance, and a systematic method to census this species over large areas at sea has been developed (Sealy and Carter 1984). Murrelet surveys at inland sites were limited before 1984. Paton and others [in press] and Nelson and others [in press] detected marbled murrelets during field work in 1985-86 to quantify the abundances of all diurnal birds in selected stands throughout northwestern California and Oregon. They stood at fixed census points and counted birds for 8-minute periods, then moved on. Each morning, they visited 12 census points. These censuses often started as late as 15 to 20 minutes after official sunrise. Carter and Sander[1] tested a survey method in 1987 designed solely for censusing marbled murrelets at a fixed point in the morning and evening during the breeding and non-breeding seasons in Prairie Creek Redwoods State Park, Humboldt County, California. This technique was standardized so that detection rates could be compared between days, time of day, seasons, and years.

In 1988, Nelson (1989) tested a combination of road and walking transects in Oregon and different types of fixed station counts. She also tested the use of murrelet tape recordings to elicit responses from birds, which did not increase murrelet detection rates. In California, Paton and Ralph (1988) established a series of walking and road transects by using 10-minute counts at 8 to 12 stations per transect to determine the distribution of murrelets throughout the State in 1988-89. They found murrelets had a patchy distribution corresponding to the distribution of remnant old-growth stands, with murrelets detected on 44 percent of 170 transects. In Oregon, murrelets were detected on 20 of 30 (67 percent) transects in 1988 (Nelson 1989) and on 88 of 137 (64 percent) road transects surveyed in 1989 (Nelson 1990). This recent work suggests that it is possible to determine murrelet use patterns of inland sites.

The Pacific Seabird Group, a professional scientific organization, has taken a lead role in coordinating and promoting research on marbled murrelets, and in providing researchers and land managers with standardized techniques to determine murrelet use of inland sites. Until recently, little was known about murrelet activity patterns in forested areas. In 1987, researchers at the Group's meeting at Asilomar, California, emphasized that standardized census techniques needed to be developed to survey murrelet activity, and we were asked to produce census protocols. The original version was drafted in 1988 and used for transect surveys in California (Paton and Ralph 1988). Nelson (1989) field tested various census methods in Oregon in 1988. As a result of this new information, the guide was revised in 1989. These methods are by no means exhaustive and modifications will need to be incorporated as new information becomes available from different regions. But this report provides a concrete basis on which to further our knowledge of marbled murrelets-especially during this period of rapid growth in murrelet research.

This guide defines systematic methods for surveying marbled murrelets and for quantifying their geographic distribution and activity levels in inland forested sites. These surveys are intended to provide insights into the relative activity levels, breeding biology, and seasonal and daily activity patterns of this important seabird.

SURVEYING

Types of Surveys

To survey marbled murrelets at inland forested sites, we used three types of surveys: (1) General, (2) Intensive Inventory, and (3) Vegetation Data.

A General Survey is a transect method to determine the geographic distribution over a wide, area of the species (i.e., a state or a drainage). If transects are surveyed a minimum of four times during the breeding season (May 15-August 15, with at

[1]Carter, Harry; Sander, Tom. [letter to authors]. 1988 April 15. 1 leaf. Located at pacific Southwest Research Station, USDA Forest Service, Arcata, Calif.

least three visits between June 20 and August 15) information on relative activity levels, and the probable absence of murrelets could also be determined.

An Intensive Inventory is designed to be useful to monitor murrelet activity levels at specific forest stands (i.e., for pre-harvest inspection for land management agencies or timber companies). Data gathered using the Intensive Inventory method could be used to monitor activity levels at the site over time, determine the quantity of detections, duration and timing of activity. The Intensive Inventory method is also useful to determine murrelet presence at specific sites with suspected low levels of activity.

Vegetation Data should be recorded at each General Survey or Intensive Inventory site.

Data Collection

The unit of measure in both the General Survey and Intensive Inventory methods is "Detection" of a single bird or flock, defined as *the sighting or hearing of a single bird or a flock of birds acting in a similar manner.* For example, an unseen bird flying around in a circle overhead for 3 minutes continuously calling would be a single detection. If that bird stopped calling for more than a few seconds and then started to call again in an unexpected area, then the observer should count it as two detections, as the observer was uncertain if it was the same bird or a different bird calling. Only when you are reasonably certain that it is the same individual should you count it as a single detection. Since most murrelets generally remain unseen to the observer--about 75 percent of the detections on transects conducted in California and Oregon are in this category (Nelson 1989, Paton and Ralph 1988)--knowing the various calls is vital. When you see a flock split into two groups, the observation is treated as a single detection. If two smaller flocks coalesce, the flocks should also be counted as two detections.

GENERAL SURVEY

The objectives of the General Survey in order of priority, are:

•Determine the geographic distribution of marbled murrelets over a wide area of the species range at inland forested sites. This transect method is primarily designed for forested sites that are readily accessible with roads or trails. In rugged areas where it is difficult to move through the forest, we suggest using the fixed station survey methods of the Intensive Inventory Survey.

•Determine if the birds appear to be using the specific sites for nesting or roosting, or merely flying over the site to (or from) another inland site. Knowledge about the vocalizations and behavior of murrelets in nest groves is limited, however recent work by Naslund and others (1990a, 1990b) has given researchers insights. Indications of potential nesting areas include birds flying below the forest canopy silently and birds landing on tree limbs. Some areas have birds actively circling and calling over the stand for over 2 hours after dawn, while at other places the birds simply fly in a straight line high over the forest canopy. These differences in behavior might indicate nesting areas and flight corridors, respectively. Therefore, the intensity and timing of calling, flight behavior of birds, flight altitude (i.e., flying below or above the forest canopy), and landing behavior could possibly identify nest groves.

•Determine relative murrelet activity levels over a broad area of the species range. A minimum of four visits to each transect station should be completed during the murrelet breeding sea son, May 15-August 15, with at least three visits from June 15 to August 15, to determine presence or absence in the area of interest. We know of no correction factor available to determine the actual number of birds using the area from the number of detections in an area. Therefore, we can now only measure levels of murrelet activity (detection rates) and hypothesize that areas with low detection levels probably have fewer birds than areas with high detection levels at the same time of the year. However, an area with high detection rates one morning does not necessarily mean more birds are using the stand, as murrelets tend to circle over forested stands (Nelson 1989, Paton and Ralph 1989).

Repeated observations (detections) of many birds at a single site probably indicate more birds than at a site with a few detections occasionally. Furthermore, data from one stand in May cannot be compared with data from another stand surveyed in July. Finally, stands with low murrelet activity levels may not have detections every census during the peak of the breeding season (Nelson 1989). Therefore, information on the probable absence of murrelets in a stand is difficult to determine, which is why we suggest at least four surveys per transect before observers can conclude that murrelets are probably not using an area that year.

Methods

On the basis of these priorities and known information on the occurrence of murrelets at inland sites, we have developed criteria for surveying a transect, a group of stations that will be visited in a single morning:

•Visit stands within 60 km of salt water in California and Oregon, and up to 75 km in Washington, British Columbia, and Alaska.

•Begin 45 minutes before official sunrise and continue 75 minutes after sunrise.

•Survey each transect station for 10 minutes, then move on to the next station. Try to maximize the number of stations visited on the transect, being sure to visit the same number of stations on each visit to the transect. Census 8 to 10 stations each morning during the 120-minute census period.

•Maximize the distance between stations to survey as large an area as possible. .Have survey points placed on transects 0.5 to 1 km (0.3 to 0.6 mile) apart, depending on road conditions. Locate transects on trails, with a spacing of 250 m between

stations, to minimize detecting the same birds from different stations. Spacing between stations can either remain constant or varied, depending on the objectives of your study. Paton and Ralph (1988) used even spacing in large stands of relatively homogeneous habitat. Nelson [in press] used uneven spacing in the fragmented Oregon landscape to keep all stations along a transect in the same habitat type (e.g., young, mature, old growth stands).

•If possible, locate stations where the view of the sky is unobstructed (e.g., a clearing in the forest), so as to maximize the chance of seeing as well as hearing birds. The silhouette of a bird flying directly overhead against the sky is easier to spot, than observing from a high point trying to see birds flying over the canopy.

•Vary station order between visits to avoid surveying stations at the same time each census. Reversing station order is the best way to avoid this problem.

•If birds are detected at a station during a 10-minute census, and more detailed information on murrelet activity in the area is needed, use the intensive inventory method.

Factors to be Considered

In surveying murrelet activity, several factors must be considered by the observer, including these:

•**Time of Year**: Murrelets can be heard at certain sites during most months of the year, but they are most effectively surveyed during the summer months when activity levels are greater, and attendance is more consistent and longer in duration each morning. Murrelet detectability at inland sites appears to have a pre-peak level of moderate intensity (possibly during incubation) and a peak level of high activity (possibly during the chick period) (Paton and Ralph 1988, Nelson 1989). After the peak period, the number of detections inland decreases markedly, presumably because birds are undergoing a flightless molt at sea. In California, the *pre-peak* period extends from May 1 to June 15 and the *peak* period from June 15 to August 15 (Carter and Erickson 1988, Paton and Ralph 1988). **In Oregon**, the *pre-peak* period lasts from May 15 to July 1 and the *peak* period from July 1 to August 15 (Nelson 1989). Definitive information is not yet available on the timing of murrelet detectability in Washington and areas farther north, although it is likely that pre-peak and peak periods occur at roughly the same times of year over a shorter number of days. We suggest that transects can be surveyed either during the pre-peak or peak periods, although birds will probably be more consistently detected during the peak periods.

•**Environmental Conditions:** Avoid placing transect sta tions near loud noise sources, such as loud creeks or busy roads, if possible. About 75 percent of murrelet detections are usually of birds heard calling (Nelson 1989, Paton and Ralph 1988), so it is vital to place stations away from loud noise sources. Also, if it is raining hard or the wind is blowing hard, do not attempt to census. It is not worthwhile to census under adverse weather conditions when the probability of hearing a calling murrelet is diminished. Surveys can be done on overcast days with a light rain or foggy mornings, as murrelets tend to call for longer periods and at higher rates on drizzly days than on clear mornings.

•**Moon Cycle:** During winter months, moon phase may affect murrelet detections at a specific site, with murrelets less likely to be detected on nights with a full moon.

•**Time of Day to Start/Stop Survey**: Murrelets are more likely to be detected at higher levels during the morning than at sunset (Nelson 1989, Paton and Ralph 1988). The number of murrelet detections at the same site on the same day can be five to six times greater during the morning hours. Therefore, we suggest only using morning counts for transect surveys.

During the pre-peak and peak periods of the breeding season, start your census 45 minutes before official sunrise and census for 75 minutes after sunrise for a 120-minute census period. Use the Nautical Almanac to determine sunrise/sunset times for your area, do not rely on tide tables, the local newspaper, or the local television station, which can be 15 minutes different from the Nautical Almanac. Surveys in 1988 lasted 90 minutes after sunrise, but this appears to be too long a period of time for most stands, so we suggest reducing the time by 15 minutes. Mur relets can be detected inland for up to 3 hours during the peak of the breeding season at selected sites (Nelson 1989, Paton and Ralph 1988).

During the winter months, murrelets can be heard prior to sunrise only on certain days. The duration of detections is shorter than during the breeding season, and calling can start earlier (1 hour) than in the summer. Due to the short period of detectability of murrelets during the winter months, only the Intensive Inventory Method should be used from August 15 to May 1.

If information on evening use of an area is desired, we suggest a census period from 30 minutes before sunset to 60 minutes after sunset. Various surveys have shown murrelets to come in after dark (Carter and Erickson 1988, Nelson 1989, Paton and Ralph 1988).

•**Survey Location-Habitat Type**: The primary objective of this first phase of the survey is to get an accurate picture of the distribution of marbled murrelets in California, Oregon, Washington, British Columbia, and Alaska. Information on habitat association patterns is limited, although data collected to date suggest a close association with mature and old-growth forests. Transects can be used to begin to gather information on habitat use, but researchers need to be cautioned that patterns suggested by transects or intensive surveys could be hard to interpret. Birds detected flying over a large rocky mountain might be simply flying farther inland to their nest grove 5 miles away. Surveying efforts should not be limited to single habitat types, but the range of available habitat types should be visited to determine habitat use patterns. Detailed habitat analyses should probably be limited to actual nest sites or suspected nest groves based on murrelet behavior (i.e., landing in trees or flying through the canopy).

•**Survey Location-Distance From Salt Water**: Marbled murrelets have been recorded as far as 75 km inland in British Columbia (Carter and Sealy 1986,1987), although most records of murrelets are generally within 20 km of the ocean. Nelson (1990) recorded marbled murrelets 55 km inland in Oregon, but

found that they were significantly more abundant within 20 km of the coast than areas farther inland. Murrelets are known to use Grizzly Creek Redwoods State Park, in northern California, 39 km inland (Carter and Erickson 1988). In California and Oregon, there are probably inland sites farther than 20 km inland that the birds use, but the majority of the surveys should focus on sites less than 20 km from the ocean or salt water, except where murrelets are strongly suspected to occur farther inland. Evidence suggests that murrelets may follow major river drainages, so old-growth and mature stands along large rivers could be one type of area on which to focus your attention. In Washington, British Columbia, and southeastern Alaska, murrelets may oc cur farther inland on average than farther south.

•**Areas with Low Activity Levels:** The General Survey Method is designed to identify population concentrations of murrelets. In Oregon, Nelson (1989) reported probable nesting aggregations, which included only a few individuals calling for short periods (20 minutes or less) in the morning. In these situations, the Intensive Inventory would probably be the most effective technique to use to maximize the probability of detecting birds in the area. Another choice would be to increase the number of repetitions of each transect in the area.

•**Equipment Needed:** Equipment for surveying should in clude: a clipboard, pencil, data forms, a light source (i.e., a headlamp is most useful as it frees up hands, or a flashlight), binoculars, compass, and a tape recorder (optional, but ex tremely useful in areas of high activity). For estimating vegeta tion (optional), you *will* need a pencil, clipboard, compass (optional), and a way to measure or estimate tree diameters and distances.

Survey Form

Locate the census stations on a 7-1/2 minute U.S. Geological Survey map, write the station numbers on the map, and indicate the locations with an "X". Write on the top of each form the following (*figs. 1,2*):

Circle one: Transect or stationary count
Observer's Name: Full name of the observer
Transect: Name of the transect
First line:
Columns

1-3 First, middle, and last initials of observer
4-9 Month, day, and year
10 State/Province: A=Alaska, C=California, O=Oregon, W=Washington, B=British Columbia
11-14 Four-letter code for location of census transect (any letters can be used).
15-17 Percent cloud cover, (i.e., 0=none, 100=all cloudy)
18 Precipitation: 0 = none, F = low fog, M = mist/ drizzle, R = rain (survey should be discontinued).
19-22 Official sunrise for that date and location (24-hour clock, e.g., 5:00 a.m. = 0500, or 6 p.m. = 1800).

Second and remaining lines (each line represents one detection):
Columns

23-24 Census station number. For each transect you *will* have one or more census stations. Number each station and mark each with a flag or stake for future reference.
25-26 Minutes of observation. Length of time of census (usually 10 minutes).
27-30 Time started at the census station, or time of detection if after the first minute at the station. For example, if you started at 0608 and did not hear any birds for 1 minute, then saw a bird at 0609, then the 0608 line would remain blank after time, but the 0609 line would have data recorded in Num. birds).
31-32 The best estimate of the number of birds in the detection. (Num. birds).
33-35 Lowest height the bird(s) are observed flying above the ground (only to be used for visual detections). If you record in feet, indicate this at the top of form.
36-38 Direction in degrees to where the murrelet(s) were first detected from the observer.
39 The birds' behavior (Beh.) during the detection (**F** = fly over canopy; **C** = circle stand above the canopy, **B** = circle below canopy, **T** = fly through the stand below the canopy top, **L** = landing in a tree (seen), **S** = call from a stationary point.
40 Type (Typ.) of observation: (**1-9 or M** = number of "keer" call notes heard, with **M** for more than 9 (multiple) call notes heard; **W** = wing beats only; and **V** = visual with no calls.
41 Vocalization (voc.) type, **B** = both seen and heard; **A** = alternate vocalization (not a "keer" call); **C** = alternate vocalization and seen; **H** = heard only; **S** = seen only; **W** = wing beats only; and **J** =jet sound, a murrelet power dive.
42-44 The flight path, the final direction the murrelets were headed, in degrees.
45-47 Closest horizontal distance from the observer to the murrelet, a bird flying directly overhead at 100 m height would have a horizontal distance of zero.
48 Optional: The number of Vaux's Swifts at the census station. 0= no swifts observed, 1=1-10 birds, 2=11-50 birds, 3=>50. Vaux's Swifts are another species closely associated with old-growth forests, nesting in hollow snags. Little is known about their distribution and any additional data gathered by murrelet observers would be extremely useful.

Circle one: Transect Stationary Count Grid Count Pg _____of_____

Name:_____ Transect:_____

	Observers initials	Month	Day	Year	St / PV	Transect	Percent Cloud Cover	Prec.	Official Sunrise or Sunset
1									

Sta. No.	Min. Obs.	Time	Num. birds	Bird Height	Initial Direct. Det.	Beh	Voc	Typ	Depart. Direction	Closest Dis. to Bird	Swift

Precipitation (Prec.): N=None, F=Fog, D=Drizzle, R=Rain
Beh. (Behavior): F=Fly over, C=Circle, B=circle Below, T=fly Through, L=Land or stationary, U=Unknown
Voc. (vocalization): V=Visual-silent, 1-9=Number of 'keer' calls notes heard, M=Multiple 'keer' calls (>9)
Typ. (type): B=Both seen and heard, A=Alt. voc., C=Alt. voc. & seen, W=wings only, J=Jet sound
H=Heard only, S=Seen only-silent
Swift: Vaux's Swift numbers at station: 0=none,1=1-10,2=11-50,3=>50

Notes:_____

4/15/89

Figure 1-This form records data in the General Survey and Intensive Inventory of marbled murrelets.

Circle one: (Transect) Stationary Count Grid Count Pg 1 of 1

Name: PETER PATON Transect: LOST MAN CREEK

1	Observers initials	Month	Day	Year	St / PV	Transect	Percent Cloud Cover	Prec.	Official Sunrise or Sunset
	PWP	04	15	89	C	LOST	0	N	0653

Sta. No.	Min. Obs.	Time	Num. birds	Bird Height	Initial Direct. Det.	Beh	Voc	Typ	Depart. Direction	Closest Dis. to Bird	Swift
1	10	0608									
		0609	1	100	340	F	2	H	160	20	
		0613	2	110	200	C	M	B	120	0	0
2	10	0621	3	60	300	F	V	S	120	150	
		0624	2	70	30	B	2	C	30	10	1

Precipitation (Prec.): N=None, F=Fog, D=Drizzle, R=Rain
Beh. (Behavior): F=Fly over, C=Circle, B=circle Below, T=fly Through, L=Land or stationary, U=Unknown
Voc. (vocalization): V=Visual-silent, 1-9=Number of 'keer' calls notes heard, M=Multiple 'keer' calls (>9)
Typ. (type): B=Both seen and heard, A=Alt. voc., C=Alt. voc. & seen, W=wings only, J=Jet sound
H=Heard only, S=Seen only-silent
Swift: Vaux's Swift numbers at station: 0=none,1=1-10,2=11-50,3=>50

Notes:

4/15/89

Figure 2-A completed data form shows the following: *06:08*--started census at Station 1, but no bird detected. *06:09*--one bird flying over canopy called twice but was not seen. *06:13*-two birds seen flying together circling over canopy, calling more than nine call notes. *06:21*-detected birds while starting at next station-a flock of three silently over tops of trees about 150m away. *06:34*-pair circling below canopy, called twice, one call "alternate vocalization" and pair was seen; flock of four swifts seen at Station 2, but none at Station 1.

INTENSIVE INVENTORY SURVEYS

Carter and Sander[2] and Nelson (1989) tested an intensive inventory technique for measuring the amount and types of murrelet activity at a single site. As with General Surveys, this is a census method that can be used throughout the species' range. Observers should fill out a census form *after* the day's observations, if data have been recorded on tape (see Methods).

The Intensive Inventory is designed to:

•Determine murrelet activity levels at a specific site. The best way to measure the actual activity level at a specific site is to record all detections from a single point. Variation in the times of high, low, and no activity within a dawn or dusk census period can affect the level of activity noted if only a portion of the detection period is sampled.

•Monitor relative abundance of murrelet activity levels over time at a specific site; year-to-year, for example. If a series of intensive inventories on different days at the same site can be done within a relatively short period (e.g., 15 days), the mean activity level (or detection index) can be calculated for that period. Because murrelet activity varies somewhat from day to day, especially in relation to weather and lighting, a series of intensive censuses is required to obtain a detection index which can be used to compare murrelet activity within the breeding season, between the breeding and non-breeding season, and between years. In particular, murrelet activity over a series of years should be compared for monitoring purposes.

•Determine the actual detection period (from first to last detection) and actual numbers of detections (audio and visual separately) at a specific site.

•Detect populations of low densities of murrelets or the absence of murrelets at a given site. Where murrelets activity levels are low, they may be detected only during a short period of time. Only a few detections may occur at a specific site within a dawn or dusk activity period, and they may not be detected each census during the peak activity period of the breeding season. Where murrelets are thought to be absent, a minimum of three censuses should be conducted over the range of the peak activity period before murrelets are considered absent from that site for the year.

•Determine if the birds appear to be using the site for nesting or are merely flying over the site to and from other sites. As in the General Survey Method, except that a more detailed assessment of use of a particular site can be determined over the entire activity period. Variation in the types of detections and activities which occur within the detection period at the same site can be measured.

[2]Carter, Harry; Sander, Tom (Letter to authors]. 1988 April 15. 1 leaf. Located at Pacific Southwest Research Station, USDA Forest Service, Arcata, Calif.

•Determine murrelet activity levels over a broad area of the species' range. The Intensive Inventory Survey can be used to compare murrelet activity levels between stations. The only drawback to using this method is that only one station can be surveyed per observer morning. However, if stations are spaced at wide intervals (i.e., several km apart) or are placed in specific habitat types, then activity levels can be determined over broad areas. When designing surveys, one must determine whether it is more important to measure actual activity levels at less localities (using the Intensive Inventory Method) or to obtain 10-minute samples of activity at more localities (the General Survey).

Methods

Select intensive inventory stations with a clear view of the sky, such as the edge of the forest or a clearing. This will maximize your chances of seeing, as well as hearing murrelets. Stand selection and other aspects of the protocol should follow the General Survey Method.

Begin census 45 minutes before official sunrise and continue for at least 75 minutes after sunrise. Continue to census for longer than 75 minutes after sunrise, if less than 15 minutes has elapsed since the last detection. Continue until no detections have occurred for 15 minutes.

Use a hand-held tape recorder to record detections. Keep your eyes on the sky and shift your angle of view constantly to ensure that all areas visible are covered. Use a tape recorder to help prevent from missing murrelet detections and to assist in recording simultaneous detections. If a recorder is not available, you might miss some detections during periods of high murrelet activity.

Equipment Needed in the Field

The following equipment is needed: tape recorder (optional), watch with lighted digital display, spare tape recorder batteries, extra cassette tapes for recorder, compass, binoculars and clipboard, forms, pencil in case of tape recorder failure.

Data Collected

1. Use as the unit of measure a "detection" of a single bird or flock of murrelets (as for General Survey).
2. Collect data on variables the same way as done in the General Survey.
3. Make verbal notes and later mark on map the areas which were most extensively used (e.g., "lots of flying NE up gap in forest above streams," or" lots flying into gap in forest about 100 m NNW of the census site"). Transcribe notes on the back of the data form.

Intensive Inventory Data Form

The form for the Intensive Inventory is the same as that for the General Survey. Collect all variables as described in the General Survey Methods.

Vegetation Data Form (Optional)

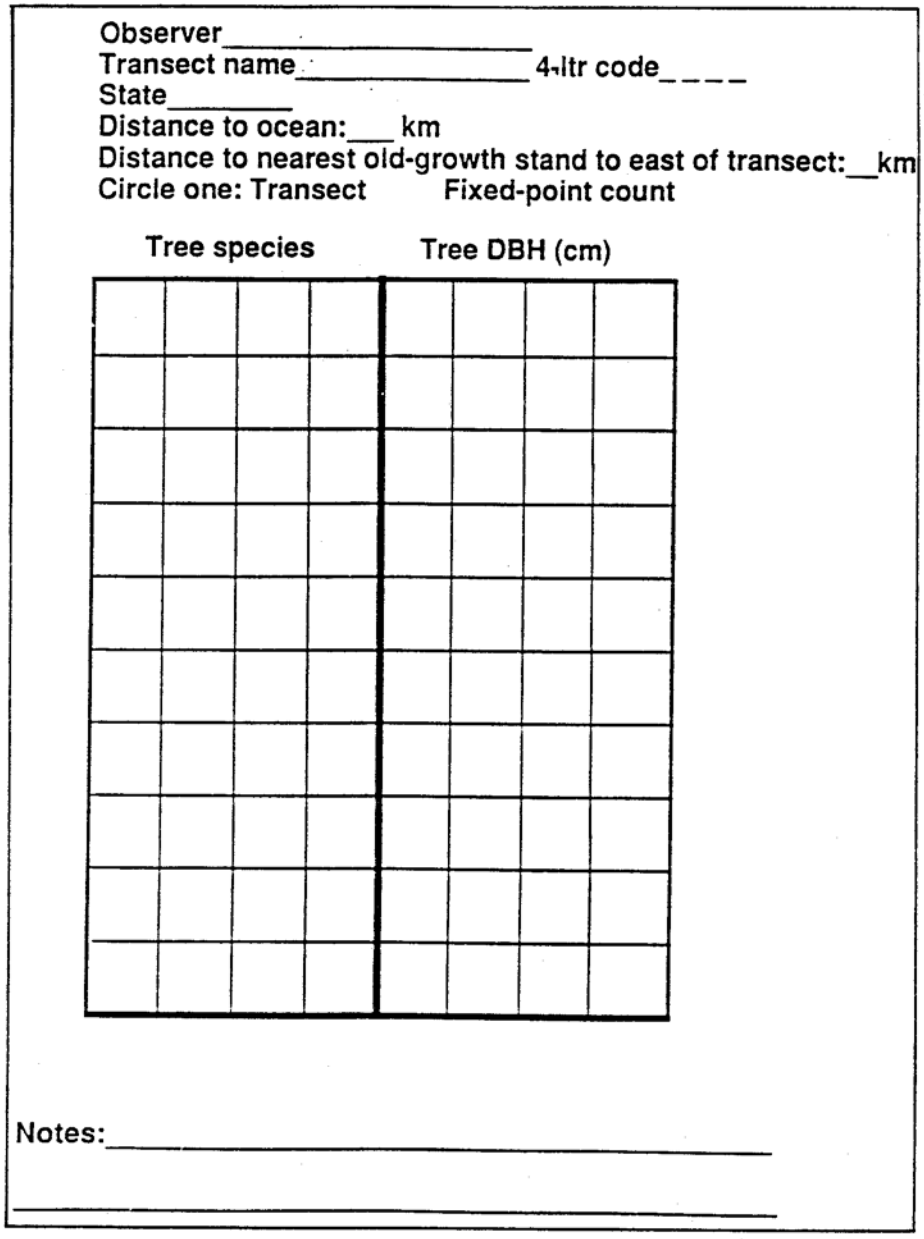
If no vegetation maps are available for your area, some

vegetation data should be collected to provide researchers some idea of the type of forest in your area. Only a few minutes are needed to collect vegetation data at each station once you get used to the form (*fig. 3*).

Locate the census station on a 7-1/2 minute U.S. Geological Survey map, write the number on the map, indicating the location with an "X".

Record on the form: (a) Observer's full name; (b) transect name and corresponding 4-letter code for the transect or fixed census point; (c) State or Province; (d) straight-line distance from the middle of the transect or the fixed census point to the nearest salt water; and (e) estimated distance to the nearest "old-growth" stand. If the transect is in the middle of an old-growth stand, then the distance would equal zero.

The following data are to be recorded: Record the tree species and diameter at breast height (d.b.h.) of the 10 closest *canopy* trees to each census point, up to 100 m from the census point. Record vegetation data for each census point on the transect. Use a 4-letter code to record tree species designations. Record d.b.h. to the nearest 10 cm. Only record the d.b.h. of canopy trees, not smaller trees in the mid-canopy. Information on the d.b.h. of the largest trees within 100 m of the census points is needed, but do not select trees, just record the d.b.h. of the canopy trees closest to the census point. If there are not 10 canopy trees within 100 m of the census point, then only record the d.b.h. of those canopy trees within the 100-m radius.


Observer_____
Transect name_____ 4-ltr code_ _ _ _
State_____
Distance to ocean:___ km
Distance to nearest old-growth stand to east of transect:__km
Circle one: Transect Fixed-point count

Tree species				Tree DBH (cm)			

Notes:_____

_____

Figure 3-This form records Vegetation Data recorded as part of the census of marbled murrelets.

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