

Chapter 10

Marbled Murrelet Inland Patterns of Activity: Defining Detections and Behavior

Peter W. C. Paton¹

Abstract: This chapter summarizes terminology and methodology used by Marbled Murrelet (*Brachyramphus marmoratus*) biologists when surveying inland forests. Information is included on the types of behaviors used to determine if murrelets may be nesting in an area, and the various types of detections used to quantify murrelet use of forest stands. Problems with the methodology are also discussed.

Censusing Marbled Murrelets (*Brachyramphus marmoratus*) at inland forest sites presents a relatively unique problem to avian ecologists attempting to assess population trends, determine current population densities, or merely quantify the presence or absence of birds on a specific tract of land. In contrast to most avian species which tend to be relatively sedentary and territorial on their breeding grounds (see Ralph and Scott 1981), murrelets are considerably more difficult to detect near their nests (e.g., Naslund 1993a; Nelson and Hamer, this volume a; Singer and others 1991).

Murrelets tend to be detectable at inland forested sites only at dusk and dawn, and most observations are auditory detections of birds vocalizing while flying overhead (e.g., Naslund and O'Donnell, this volume; O'Donnell 1993; Rodway and others 1993b). In addition, murrelets are non-vocal near their nests (e.g., Naslund 1993a; Nelson and Hamer, this volume a; Singer and others 1991), suggesting that birds heard calling are often not near their own nest. Murrelets have been recorded as far inland as 84 km, with downy chicks found up to 64 km inland (Hamer and Nelson, this volume b; Ralph and others 1994). Therefore, murrelets observed flying overhead may be great distances from their breeding stands. Finally, virtually nothing is known about what percentage of birds visiting inland sites is non-breeding birds; this can be greater than 25 percent at Ancient Murrelet (*Synthliboramphus antiquus*) colonies (Gaston 1990).

Detections provide a relative index to murrelet abundance, and presently have not been used to calculate density estimates. This is because individual murrelets will often circle over the forest canopy for long periods of time, vocalizing (Hamer and Cummins 1990, 1991; Naslund 1993a; Nelson 1989; Rodway and others 1993b). Therefore, a series of calls could represent a single bird or several birds. Unless a bird is under constant observation, it is usually extremely difficult to determine how many birds a series of detections actually represents.

Although biologists have attempted to quantify murrelet use patterns on inland forested sites for about eight years, the biological significance of these data has yet to be determined. Only when an actual nest site is found can one be certain that murrelets are breeding in a particular forest stand. All other types of observations only suggest, with varying degrees of certainty, that murrelets may be nesting in a specific tract of land forest tract. There is no definitive evidence that Marbled Murrelet use inland sites for night roosts. Birds in some areas can be detected at inland sites virtually year-round (Naslund 1993b). Only within the past five years have detailed behavioral observations taken place at nest sites. This information may aid in pinpointing nest sites by determining if murrelets give any unique behavioral clues near nests sites (e.g., Naslund 1993a). Many of those data are summarized for the first time by Nelson and Hamer in this volume a.

The primary objective of this chapter is to give some sense of the types of data ornithologists have collected over the past eight years to quantify murrelet activity levels at inland forested sites. It is hoped that these data, specifically detection rates, can eventually be converted to a relative index to determine the approximate number of murrelets using a forest stand. Given the current state of the art concerning murrelet detection rates, comparisons between forest tracts are best done with data that were collected at the same time of year using similar methodology (e.g., fixed-point count for the entire morning survey period). Given those criteria, areas that have an order of magnitude difference in detection rates (e.g., 10 detections versus 100 detections) probably have different numbers of birds using each area, but exactly how many birds a specific detection rate represents remains uncertain.

Given this brief summary of the problems with surveying murrelets at inland sites, the following summarizes the methodology used by most ornithologists to quantify murrelet activity levels at inland sites:

Definition of Detection

The primary method for censusing Marbled Murrelets at inland forested stands is surveying from fixed points for varying amounts of time: 10 minutes (Paton and Ralph 1990) to 2-3 hours (Naslund 1993a, O'Donnell 1993). The sampling unit of inland surveys is a Detection, defined as *the sighting or hearing of one or more murrelets acting in a similar manner* (Paton and others 1990, Ralph and others 1994). Therefore, only when the observer is certain that vocalizations are coming from the same bird or flock of

¹ Biologist, Utah Cooperative Fish and Wildlife Unit, Utah State University, Logan, UT 84322

birds, is the observation classified as a single detection. Two birds under observation simultaneously, but behaving differently, are categorized as two separate detections. Hamer and Cummins (1990) required a minimum time interval between call notes to classify an observation as two detections. The total number of birds in a detection represents the total group size. Therefore, biologists can quantify detection rates between study sites (e.g., Naslund 1993b), and also determine annual fluctuations in mean total group size at the same site (e.g., Rodway and others 1993b).

Rodway and others (1993) also suggested an alternative method to quantify murrelet activity patterns would be to count all vocalizations and visual detections, rather than keep track of total detections.

Type of Detection

Murrelet detections are generally classified into one of three categories: (1) the bird was only heard and not seen (i.e., an audio detection); (2) the bird was seen and not heard (a visual detection); or (3) the bird was both seen and heard (see Ralph and others 1994). Audio detections are usually subdivided into separate types of vocalizations and mechanical sounds, in the hope that future researchers will be able to determine the context when a specific vocalization is given. As far as I know, there is no unique vocalization given only at the nest that would aid researchers in finding nests (Nelson and Hamer, this volume a). Listed below are the current categories for types of vocalizations and visual detections.

Types of Audio Detections

(1) Keer calls—two-syllable, high-pitched vocalization, similar to the vocalizations of many gulls (*Larus* spp.) (O'Donnell 1993). When properly trained, there appears to be little observer bias in quantifying the number of keer calls given by murrelets (Rodway and others 1993b). During the summer months in northern California, 91.1 percent of the detected birds vocalized, compared to 98.7 percent during the winter months (O'Donnell 1993). In addition, O'Donnell (1993) found in the summer that murrelets flying above the canopy were significantly more likely ($P < .001$) to vocalize than birds flying below the canopy. Rodway and others (1993) found the number of detections increased on cloudy days, but the number of calls per detection was not affected by weather.

(2) Non-keer calls—A low, two-part, guttural vocalization, which some researchers believe is associated with reproductive behavior. However, O'Donnell (1993) heard murrelets give non-keer vocalizations all months of the year, although at a reduced rate from December through February. In addition, O'Donnell (1993) found in his study of nine forest stands, that an average of 12 percent of murrelet detections had one or more non-keer vocalization (range = 7.5–21.9 percent). For further details, see Nelson and Hamer (this volume a) who have subdivided non-keer vocalizations into whistle- and groan-like calls.

(3) Stationary calls—Detections with three or more calls that are 100 m or less from the observer, where the observer believes the bird has not moved, are classified as a Stationary Detection (Ralph and others 1994).

(4) Wing beats—A tremulous, fluttering sound presumably generated by movement of a murrelet's wings through the air. Singer and others (1991) heard wing beats near active nest sites, and wing beats were also heard every morning near an active nest in northern California (Fortna, pers. comm.). Wing beats were heard on 0.5 percent of detections at nine sites in northwestern California (O'Donnell, pers. comm.).

(5) Jet dive—Little is known about the origin or function of the jet dive, or power dive, which makes a sound somewhat similar to the roar of a jet engine. It is heard rarely, comprising only 10 of 21,437 detections at nine sites in northwestern California (O'Donnell, pers. comm.). This sound is presumably a mechanical sound made by murrelet's feathers while in a steep dive above the forest canopy. Nelson and Hamer (this volume a) report in Oregon on the rare occasions when this sound is heard, it is usually near a nest tree.

Visual Detections

Rodway and others (1993) found significant variation between observers in the proportion of murrelets that were visually detected. This suggests that biologists doing field work should be screened and trained to insure that there is minimal observer bias (see also Ralph and others 1994 for training details). Categories for visual detections include:

(1) Birds flying above the canopy—This includes both straight-line flight and circling over a forest stand. This was the most frequently observed type of detection in a study of nine study areas in northwestern California, ranging from 8 to 33 percent of all detections (O'Donnell 1993). In British Columbia, 75–89 percent of all detections were birds flying over the canopy (Rodway and others 1993b).

(2) Birds flying below the canopy—This refers to murrelets both flying through a forest stand and adjacent to the stand. O'Donnell (1993) found that at Lost Man Creek in northern California, 25 percent of murrelet detections during the summer months (April–August) were birds flying below the canopy, compared to 0.4 percent during the winter months (September–March). Rodway and others (1993b) found that more birds flew below the forest canopy in June than during other times of the year.

(3) Landing and perching in a tree—O'Donnell (1993) found 0.4 percent of the total summer detections (April–August) at Lost Man Creek were of birds landing in trees ($n = 10,154$), although no nests were found in this area. At two active nests, Naslund (1993a) observed birds flying to the nest for incubation exchanges 31 minutes before sunrise to 3 minutes after sunrise (see also Nelson and Hamer, this volume a). Adults typically took predictable flight paths to the nest (Nelson and Hamer, this volume a). Murrelets incubate for 24-hour bouts (Naslund 1993a, Nelson and Hamer, this volume a, Singer and others 1991). Nest exchanges and feedings generally took place 17–24 minutes before sunrise, with two

daytime feedings 82 and 150 minutes after sunrise (Naslund 1993a, see also Nelson and Hamer, this volume a).

Below are some relevant definitions useful to biologists studying Marbled Murrelets, based on Ralph and others (1994):

Potential Nesting Habitat—(1) mature or old-growth coniferous forests; mature forest can be with and without an old-growth component (see Ralph and others 1994, Raphael and others, this volume); (2) younger coniferous forests that have large, deformed trees or structures suitable for nesting.

Forest Stand—a group of trees that forms a continuous, relatively homogeneous, potential nesting habitat with no gaps >100 m.

Survey—The process of determining the presence, absence, and occupancy of Marbled Murrelets in a forest stand. Surveys generally are conducted during the morning hours, when detection rates are greatest (Paton and others 1990; Ralph and others 1994; Rodway and others 1993b). In addition, surveys generally occur from May through July when detection rates peak (e.g., Rodway and others 1993b); however, murrelets are known to visit inland forest stands throughout the year (Naslund 1993b; O'Donnell 1993; O'Donnell and Naslund, this volume).

Intensive Survey—Designed to determine the probable presence, absence, or occupancy of Marbled Murrelets in a specific tract of land. When conducting an intensive survey, the observer surveys from one point for the entire morning survey period. Under most forest conditions, observers can see murrelets within 100 m, and hear them within 200 m (Ralph and others 1994). Therefore, approximately 12 ha ($\pi \times [200 \text{ m}]^2 = 12.6 \text{ ha}$) can be adequately surveyed from a single point for auditory detections, while only 3.14 ha can be monitored for visual detections. Under certain conditions, visual and auditory ranges are reduced (e.g., next to a stream or under a dense forest canopy). Surveys generally are conducted from 45 minutes before sunrise to 75 minutes after sunrise (Paton and others 1990, Ralph and others 1994), although surveys at northern latitudes start and end earlier (e.g., Kuletz and others, this volume; Rodway and others 1993b). The exact methodologies for Intensive and General Surveys are detailed in Ralph and others (1994).

General Survey—A survey designed to determine the geographic distribution of Marbled Murrelets over large tracts of land (e.g., states, counties, basins). General surveys are exploratory in nature and cannot be used to confirm murrelet absence from specific forest stands. These surveys consist of a transect of 8-10 stations surveyed during a 2-hour period each morning. Stations are spaced 0.5-1.0 km apart, depending on terrain, with each station surveyed for 10 minutes.

Survey Area—the entire area being surveyed.

Survey Visit—a single morning's visit.

Survey Site—an area containing ≥ 1 survey station.

Survey Station—the exact location where an observer stands to survey murrelets.

Occupied Stand—a forest stand, consisting of potential nesting habitat, where murrelets were observed exhibiting

subcanopy behaviors associated with nesting. Quantitative information on murrelet behavior near nests is scarce; however, some data are available from Naslund (1993a), and Nelson and Hamer (this volume a). Data collected by Naslund (1993a) suggests that only 6–21 percent of the detections ≤ 100 m from known active nests represent “occupied behaviors” (see below), while most detections near nests were birds flying above the canopy. The proportion of detections which were categorized as occupied behaviors was not affected by weather conditions (i.e. cloud cover, ceiling), although the total number of detections increased significantly on cloudy days (Naslund 1993a, Rodway and others 1993b).

Evidence for Nesting:

Seven different categories are considered indicators of nesting. They are listed below with varying degrees of certainty that murrelets are nesting in a particular forest stand. Only categories 1–3 listed below provide confirmation of breeding, whereas categories 4–7 are occupied behaviors, which are behaviors that suggest that murrelets could be nesting in a specific forest stand.

Confirmation of breeding:

(1) Discovery of an active nest—either with an incubating adult, brooding adult and chick, or pre-fledged chick.

(2) Obvious signs of recent nesting activity—such as fecal rings surrounding the nest or eggshell fragments in a nest scrape.

(3) Discovery of a chick or eggshell fragments on the forest floor—see Becking 1991, and Ralph and others 1994 for detailed information on the characteristics of murrelet eggs.

Occupied behaviors:

(4) Birds flying below the top of the forest canopy (also called subcanopy behaviors; Ralph and others 1994)—This refers to murrelets either flying through the stand, into or out of the stand, or adjacent to a forest stand, the weakest evidence in this category (O'Donnell and Naslund, this volume; Rodway and others 1993b). Because tree heights can vary, a bird observed at or below the height of the top of the tallest tree visible to the observer would be classified as a subcanopy detection. Based on observations at active nests, only silent birds are probably near an active nest (Naslund 1993a, but see Nelson and Hamer, this volume a). This category includes birds flying over or along roads, young stands, or recently harvested areas adjoining potential nesting habitat. In these latter two instances, only the adjacent potential nesting habitat should be classified as occupied. Subcanopy behaviors are currently thought to be the strongest indirect evidence of nesting in a stand (Ralph and others 1994).

(5) Birds circling above the forest canopy at any radii—Circling is common flight behavior over occupied sites. However murrelets have also been observed circling over young or non-forested habitats (Hamer and Cummins 1990,

1991; Nelson 1989, 1990a). In most instances, these areas of apparently unsuitable nesting habitat were near or adjacent to potential nesting habitat. Circling is currently believed to be fairly strong evidence that a stand is occupied (Ralph and others 1994).

(6) Birds seen perching, landing, or attempting to land on tree branches—There are a total of six flight behaviors recorded near known active nests (Naslund 1993a; Nelson and Hamer, this volume a; Singer and others 1991). Birds landing in trees could indicate nest sites, although I know of no evidence to suggest that murrelets commonly perch in trees near active nests. Therefore, perching is currently not definitive evidence there is a murrelet nest in the area. During observations of two nests in Big Basin State Park, California, Naslund (1993a) found that, during incubation exchanges, the adults always flew directly to the nest branch without vocalizing (with one exception), landed directly on the nest branch, and then walked to the nest (see also Nelson and Hamer, this volume a).

(7) Birds calling from a stationary location within the stand.—This category only applies to detections with ≥ 3 calls heard and a bird < 100 m away. Adult and juvenile murrelets are generally quiet while on the nest limb (Nelson and Hamer, this volume a). Naslund (1993a) never heard adults give loud vocalizations from the nest while incubating or brooding. Because adults and juveniles tend to be relatively quiet on the nest, this category is probably weak evidence for an active nest in the area, at least for the murrelet giving the vocalizations. Further research is needed to quantify the types of behaviors given at active nests.

Presence

When murrelets are detected, but no occupied behaviors are observed, then observation is categorized simply as “presence”.

Discussion

Most biologists conducting murrelet surveys use detections, defined as the sightings or hearing of individuals or flocks behaving similarly, as the independent sampling unit. The primary variable when comparing studies is the amount of time observers remain at survey stations, which can range from 10 minutes to 3 hours. Most inland surveys conducted to date have concentrated on the breeding season (April through August). However, a recent paper by Naslund (1993b) suggests that surveys during the winter months may be more useful for monitoring long-term population trends. This was because variability in detection rates is relatively low in the winter months compared to breeding season surveys. Currently, we have no basis to convert detection rates into density estimates, and it is unclear when ornithologists will be able to determine an accurate conversion factor. However, Ralph (pers. comm.) and Miller (pers. comm.) recently have been working on determining a conversion factor, using a combination of offshore survey data and intensive inland surveys. Data that have been gathered to date will provide baseline data for future researchers, and can be used for comparative purposes across studies to provide relative indices to murrelet activity patterns.

Acknowledgments

I thank Peter Connors, Steve Courtney, Dave Fortna, Anne Harfenist, Gary Kaiser, Brian O'Donnell, C.J. Ralph, Lynn Roberts, Michael Rodway, and Fred Sharpe for useful comments on earlier drafts of this paper.