The Condor 92:1068–1073

LOCATION AND DESCRIPTION OF A MARBLED MURRELET TREE NEST SITE IN ALASKA[1]

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Key words: Brachyramphus marmoratus; *Marbled Murrelet; nest site; Baranof Island; Alaska.*

Little is known about the nesting habits of Marbled Murrelets (*Brachyramphus marmoratus*) even though they are widely distributed and locally abundant in nearshore waters of the North Pacific from central California to the Aleutian Islands, and from northern Japan to Kamchatka (Sealy 1975, AOU 1983, Sealy and Carter 1984). Only 14 nests of Marbled Murrelets, (excluding the one reported here) have been documented (Day et al. 1983; Carter and Sealy 1986, 1987; Nechaev 1986; Labzyuk 1987). These include eight ground nests (Ornithological Society of Japan 1975, Simons 1980, Day et al. 1983), one ground nest in a shallow cavity (Johnston and Carter 1985), four tree nests (Kuzyakin 1963, Binford et al. 1975, Nechaev 1986, Labzyuk 1987), and one nest of unknown type (Anonymous 1927). Circumstantial evidence exists that tree nesting may be more common than existing nest records indicate. Downy young and fledgling Marbled Murrelets have fallen from trees and have been found in forested areas in southerly parts of their breeding range (Guiguet 1956, Harris 1971, Savile 1972, Singer and Verado 1975, Carter and Sealy 1987). Also, Sowls et al. (1980) observed that, in California, Marbled Murrelets were most abundant at sea adjacent to coastlines of mature coniferous forests. All discoveries of Marbled Murrelet nests, prior to this study, were fortuitous. Intuitively, ground nests seem more likely than tree nests to be discovered by accident (Day et al. 1983). To accurately establish the nest-site characteristics and nesting habitat preferences of Marbled Murrelets, additional nests must be located by some means that would not be biased toward ground nest sites. We attempted to locate Marbled Murrelet nest sites by capturing and radio tagging murrelets at sea during the nesting season, with the intention of tracking tagged birds to their nest sites. We describe a Marbled Murrelet nest site located in a tree on 11 June 1984.

STUDY AREA AND METHODS

This study was conducted at Kelp Bay (57°18'N, 134°55'W), located on the northeastern side of Baranof Island in southeastern Alaska. Kelp Bay is approximately 70 km^2 and consists of three major arms and a bay. It is surrounded by steep mountains rising 610 to 1,280 m above sea level. The mountains are forested by old-growth (uneven-aged, virgin stands of) Sitka spruce (*Picea sitchensis*), western and mountain hemlock (*Tsuga heterophylla, T. mertensiana*), and Alaska cedar (*Chamaecyparis nootkatensis*). About 4 km^2 of forest were clear-cut in 1976 and 1977. Outside the logged areas, large (>0.5 m dbh, >15 m tall) trees occur below 366 m, while small stunted or shrublike trees extend to tree line at 457 to 762 m. The mountain tops are alpine tundra which is covered by snow for most or all of the year.

Fieldwork was conducted 11 May to 17 June 1983 and 4 May to 13 June 1984 to coincide with estimated dates of nest establishment and incubation based upon estimated nesting chronology in British Columbia (Sealy 1974). We captured murrelets using a net gun, and attached 10-g radio tags (transmitter, lithium battery, and coiled antenna in an epoxy resin potting) developed by Advanced Telemetry Systems, Bethel, Minnesota. We glued the radio tags to the birds' back feathers, between the wings, using waterproof "Devcon two-ton, epoxy." We searched for radio-tagged birds from a boat using a Telonic TR-2 receiver with an H-Adcock antenna mounted on a 2-m pole, and using a Cessna 185 fitted with an H-Adcock antenna. More details on capture and radio-tagging techniques are provided in Quinlan and Hughes (in press).

RESULTS AND DISCUSSION

NEST LOCATION

We captured and radio tagged 17 murrelets during our study (eight in 1983 and nine in 1984). We were only able to track one bird to a site on land (Fig. 1). We originally tagged the bird on 18 May 1984, and relocated it on the water on 19 and 21 May. On 22 May we picked up its signal from a location on land while radio tracking from a boat. The signal was detected emanating from the same on-land location on 22, 24, 26, 30 May, and 7 June. On 23 and 27 May, we located the bird on the water 2.4 and 3.2 km (straight-line distance) from the site where we later located the nest.

[1] Received 15 December 1989. Final acceptance 28 June 1990.

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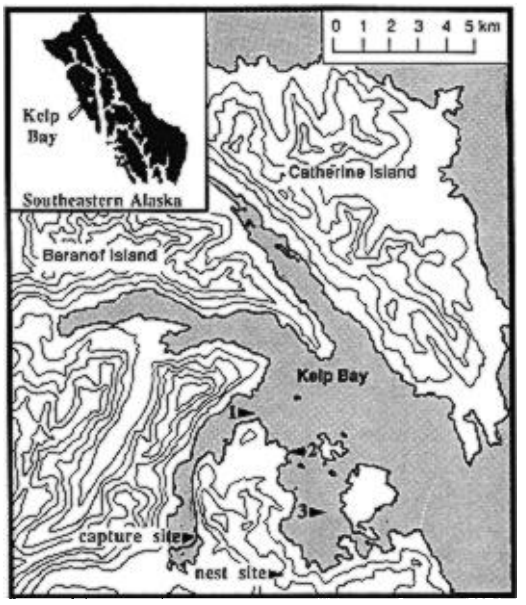

FIGURE 1. Relocations of a radio-tagged Marbled Murrelet tracked to its nest on Baranof Island, Alaska. The bird was captured and tagged at 15:00 on 18 May. We released it at about 16:00, 18 May. It flew off immediately, but we relocated it at 20:00, 18 May at relocation site 1. It was with one other murrelet. On 19 May, 13:30, we tracked it to relocation site 2. It was again with one other murrelet. We relocated the bird at relocation site 1 again, on 21 May. On this sighting, it was with two other birds. The bird was relocated at the capture site on 23 May (with a group of about 40 murrelets), and found at relocation site 3 on 27 May (relocated from the air only). We picked up the radio signal from the nest site on 22, 24, 26, 30 May, and 7 June.

We did not detect the bird's radio-tag signal in Kelp Bay or adjacent areas on 2, 8, and 9 June when we searched by air, or on 6 June when we searched Kelp Bay by boat.

Eight days elapsed between the initial discovery of a signal emanating from the on-land site (22 May) and identification of the specific nest tree (30 May). Isolation of the specific tree was hampered by steep terrain, dense vegetation, confusing echoes of the radio signal within the mountain cirque, and the presence of the signal only on alternate days (presumably when the radio-tagged bird was incubating, see Simons 1980). SEQ located the nest tree by searching for the signal on foot using the H-Adcock antenna mounted on a 2-m pole. After locating the tree on 30 May, we hauled tree-climbing equipment up to the site on 4 June, but the large diameter of the tree initially prevented climbing. SEQ and JHH returned to the site via helicopter on 11 June with additional equipment; the tagged bird was not present on this day. JHH, an experienced tree-climber, was then able to climb the tree and spotted a murrelet sitting on a limb (see Fig. 2). This murrelet

FIGURE 2. Photograph of Marbled Murrelet on its nest on a moss-covered limb of a mountain hemlock tree in Kelp Bay, Alaska.

(see Fig. 3) was presumably the mate of the tagged bird and was sitting on an apparent nest. JHH could not reach the bird. The bird remained almost motionless during the 1 hr JHH spent observing and photographing it. Due to the inaccessibility of the nest site and lack of funds for extended fieldwork, we were unable to make further observations of the nest. JHH revisited the site on 20 June 1985, but the nest site was not reoccupied.

NEST-SITE DESCRIPTION

The nest tree (Fig. 4) was a mountain hemlock, 3.9 m in circumference, 1.2 m in diameter, and approximately 25 m tall. The top 3 m of the tree was dead. We attempted to age the tree by coring, but the heartwood had rotted. The tree was about 18 m below a ridge that extended down the northeastern slope of the tallest mountain in the immediate vicinity. The nest tree was on a southeast-facing, 25° slope of a cirque, at 348 m elevation. The slope of the land increased to 80° about 90 m below the tree. The tree was 1.2 km from the nearest salt water and 3.2 km from where we captured the murrelet. The snow line had receded to 10 m below the nest tree by 4 June; about 0.5 to 1 m, or more, of snow covered all ground below the tree and at higher elevations on the mountain on this date. The tree was in an old-growth, uneven-aged stand of mountain hemlock. The mean diameter of the 11 trees within a 20-m radius of the nest tree was 0.6 m (SD

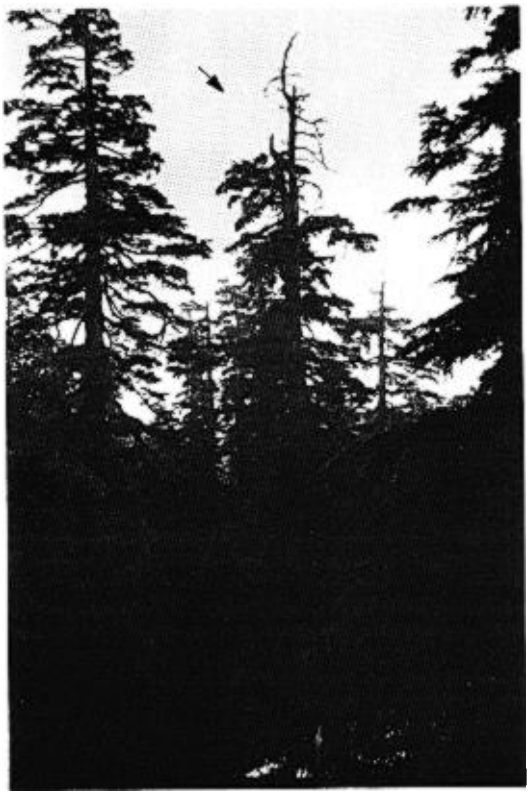

FIGURE 3. Photograph of the nest tree in Kelp Bay, Alaska. Note dead and broken top.

FIGURE 4. Photograph of JHH climbing the nest tree and the Marbled Murrelet on the nest. This photo was taken with a 200 mm telephoto lens from the hillside above the nest tree. The bird is located to the right of JHH on the large limb.

= 0.6, n = 11, range = 0.06–1.6 m). Their estimated heights ranged from 6 to 30 m. Huckleberry (*Vaccinium ovalifolium*) was the main ground cover plant. A rivulet of water from melting snow formed the beginning of a stream about 50 m north of the nest tree.

The nest was 15.5 m up and 124 cm out on a 3.5-m long, 18-cm diameter (at the base), moss-covered branch. No nest material or evidence of nest construction was apparent; the olive green bed of moss (*Antitrichia curtipendula*) beneath the bird was about 10 cm thick. The nest was on the eastern and downhill side of the tree and was sheltered by overhanging branches 46 cm above the nest. The nest limb sloped steeply down from the trunk but leveled out just before the nest. It appeared that the birds using the nest had an unobstructed flight path to the exterior of the forest and the bay, due to the steep slope of the hill below the tree.

DISCUSSION

The variety of nest sites used by Marbled Murrelets, including tree branches, ground, and ground cavities (Day et al. 1983, Johnston and Carter 1985) indicates this species is plastic in its nesting-habitat requirements. However, the data do not indicate whether or not individual birds can or will use a variety of sites. Nest-site selection likely depends upon a variety of factors, including the availability of various nesting substrates, the distribution, numbers and types of predators in the area, as well as other factors such as food availability (which could affect the distance traveled to a nest site), or environmental factors (the need for protection from wind, heavy rains, or snow). These factors may cause murrelets to select different kinds of nest sites in different parts of their range.

We hypothesize that the use of trees for nesting may be related to snow cover and timing of snowmelt. Marbled Murrelets seemed unlikely to nest on the ground in alpine areas of Kelp Bay because there were few, if any, snow-free alpine areas during mid- to late May when murrelets were laying eggs (as evidenced by well-developed brood patches in captured birds, a fully shelled egg in the oviduct of a collected bird, and this nest). According to the data summarized by Day et al. (1983) nest and egg records of Marbled Murrelets are generally earlier (mid-May to early July) than those of Kittlitz's Murrelets (*B. brevirostris*) (mid-June to late July). Kittlitz's Murrelets are apparently restricted to ground nests in alpine areas. Use of trees for nesting by Marbled Murrelets could reflect the scarcity of snow-free alpine areas in parts of their range during the time they are selecting nest sites and laying eggs. If this is so, one might expect Marbled Murrelets to nest in trees in areas with heavy snowfall and late (relative to murre-

TABLE 1. Characteristics of known tree nests of the Marbled Murrelet.

	Nest				
	1	2	3	4	5
Date found	17 June 1961	19 June 1976	7 August 1974	21 June 1984	11 June 1984
Location	Okhotsk, USSR	Sakhalin, USSR	Big Basin Redwoods State Park, California	Bay or Ol'ga, USSR	Baranof Island, Alaska
Site description					
Distance inland (km)	6–7	2	10	Coastal cliff	1.2
Elevation (m)	—	—	310	25	348
Slope	—	—	—	~90°	25°
Tree					
Species	Larch sp. *Larix dahurica*	Larch sp. *Larix* sp.	Douglas fir *Pseudotsuga menziesii*	Larch sp. *Larix* sp.	Mountain hemlock *Tsuga mertensia*
Height (m)	12.0	5.0	61.0	—	25.0
Diameter (cm)	17.0	—	167.0	—	120.0
Condition	—	Broken top	Dead crown	—	Dead crown Rotten core
Nest branch description					
Height (m)	6.8	5.0	45.0	2.5	15.5
Diameter (cm)	—	—	41.0	—	18.0
Length (m)	—	—	15.0	—	≈5.
Aspect	—	—	S	—	E
Nest description					
Distance from trunk (cm)	25.0	—	6.8	250.0	124.0
Bowl type	Twig/lichen	Twig/lichen	Moss/bark	Dense branches	Moss
Bowl dimensions					
length (cm)	9.0	5.5	9.5	—	—
width (cm)	6.0	3.5	6.5	—	—
depth (cm)	2.0–2.5	—	1.0–3.0	—	—
Source	Kuzyakin (1963)	Nechaev (1986)	Binford et al. (1975)	Labzyuk (1975)	This study

let nest-site selection) snowmelt, while those in areas of light snowfall or early snowmelt could nest on the ground. We could not obtain the needed information on the snow depths and snowmelt dates at the various murrelet nest sites to test this hypothesis.

The five tree-nest records for Marbled Murrelets are summarized in Table 1. These data suggest the Asiatic subspecies, *B. m. perdix*, and the nominate race, *B. m. marmoratus*, may use different cues when selecting sites for tree nesting. The three Asiatic nests were on beds of twigs and lichens and located in small trees, while the two North American nests were placed on moss-covered branches in large, old-growth trees.

Our nest record is most similar to the tree nest found in Big Basin State Park, California (Binford et al. 1975), the only other North American tree nest. That nest and the one we found were both high up on moss-covered branches of old coniferous trees, at high elevations, and in locations allowing access to the exterior of the forest. The nest tree in Kelp Bay was shorter (only 25 m vs. 61 m) and the nest site was lower (15.5 m vs. 45 m), but the trees were similar in diameter (1.24 and 1.67 m). Both trees were among the largest trees in the vicinity of the nests. As indicated by the dead crown and rotten core of the Kelp Bay tree, and dead branch on the Big Basin tree, both were decadent. Both nests were sheltered from above by overhanging branches. In contrast to the Big Basin nest, the Kelp Bay nest was not positioned next to the trunk, so the adult did not blend in with its immediate surroundings. The murrelet's red-brown back may still have provided camouflage from above or the sides, however, as the bird resembled a piece of exposed limb or bark. When viewed from the ground through 10 × 40 binoculars, the bird on the nest looked like a broken branch. The Kelp Bay nest was much closer (1.2 km) to the coast than the Big Basin nest (10 km). Binford et al. (1975) hypothesized that fledgling murrelets might use a stream near the nest to move out to sea. The small stream adjacent to the tree nest in this study was not likely to provide a travel route for adult or fledgling murrelets because of the small amount of water in the stream headwaters and the lower portion's torrential waterfalls. This suggests that fledgling Marbled Murrelets fly to the sea.

The nest discovered in this study lends credence to the concern that extensive clear-cut logging of North America's Pacific coast rainforest threatens Marbled Murrelet nesting habitat and populations (McKnight and Knoder 1979, Sowls et al. 1980, Pacific Seabird Group 1982, Sealy and Carter 1984, Marshall 1988). Binford et al. (1975) hypothesized that the habitat characteristics critical for Marbled Murrelet tree nests include: (1) large trees with an open crown structure and (2) moss-covered limbs large enough to support and camouflage a nest. The nest site we located also suggests that these characteristics are important. In the coastal rain forests of the Pacific Northwest, large, old trees with open crowns and large moss-covered limbs occur only in high volume old-growth forests (Franklin et al. 1981). The second-growth forests that return to clear-cut sites 30 to 40 years after logging generally consist of dense stands of relatively small, even-aged trees with dense crowns and smaller, steeply sloped branches with little moss development (Franklin et al. 1981). Such forests do not provide sites with the characteristics required for nesting by Marbled Murrelets of the eastern North Pacific, at least as indicated by current information. As past, current, and planned logging of coastal forest throughout Oregon, Washington, British Columbia, and Alaska is changing extensive areas of old-growth forests into a mixture of clear-cuts and second-growth stands, suitable tree-nesting habitat for Marbled Murrelets may become limiting. Further radiotelemetry studies may be helpful in identifying additional nest sites so that the tree-nesting habitat of Marbled Murrelets can be delineated and, if necessary, protected.

This project was funded by the Nongame Wildlife Program, Game Division, Alaska Department of Fish and Game. Special thanks to W. A. Lehnhausen, P. D. Arneson, R. M. Gronquist, J. M. Burr, and D. Williamson for spirited help, despite the rain and frustration. We are grateful to D. M. Hardy and others in the Sitka office, Alaska Department of Fish and Game, and to U.S. Forest Service, the Department of Public Safety, Fish and Wildlife Protection Division, the Hidden Falls Fish Hatchery, and the U.S. Fish and Wildlife Service for loans of equipment and logistical support. H. R. Carter and R. H. Day provided helpful criticism of earlier drafts of this manuscript.

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The Condor 92:1073–1075

WIND AS A FACTOR IN THE ORIENTATION OF ENTRANCES OF CACTUS WREN NESTS[1]

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Key words: Cactus Wren; Troglodytidae; nest-site selection; nest-entrance orientation; thermoregulation; microclimate; wind.

The Cactus Wren (*Campylorhynchus brunneicapillus*), an inhabitant of the southwestern deserts of the United States, constructs a closed nest of twigs and fine grass using fur or feathers for lining material. Access to the interior is gained through a long passageway from the side of the nest structure (Woods 1948). Temperatures in the nest interior have been reported to be as much as 6°C warmer than the ambient temperature when the nest is exposed to direct sunlight (Ricklefs and Hainsworth 1969). Though high temperatures could be advantageous in winter when past-season nests are used by young of the year and adults for roosting (Woods 1948, Anderson and Anderson 1957), in June, second brood nestlings may be exposed to temperatures in excess of 46°C (Ricklefs and Hainsworth 1969). Because such temperatures are several degrees higher than normal nestling body temperatures (Ricklefs and Hainsworth 1968), nestling survival may depend on nest placement and construction.

Bailey (1922) suggested that southwesterly (208–263°) entrance orientations of Cactus Wren nests found near the Santa Rita Mountains, Arizona were influenced by the prevailing direction of the winds and storms that arose in the Gulf of California. Although Ricklefs and

[1] Received 22 January 1990. Final acceptance 22 May 1990.

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