FLEDGING BEHAVIOR, FLIGHT PATTERNS, AND FOREST CHARACTERISTICS AT MARBLED MURRELET TREE NESTS IN CALIFORNIA

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ABSTRACT—We discovered 3 active marbled murrelet (*Brachyramphus marmoratus*) nests in the same coast redwood (*Sequoia sempervirens*) tree between 1991 and 1994. The nest tree was in an old-growth redwood–Douglas fir (*Pseudotsuga menziesii*) forest in Big Basin Redwoods State Park, Santa Cruz County, California. Two of the nests, situated on different branches, were monitored intermittently through fledging in 1991 and 1992. The 1994 nest was in the 1991 nest cup. Eggshell fragments with indications of predation were found under the nest tree in 1993, suggesting that the tree may have been used for at least 4 consecutive years. One fragment encompassed almost two-thirds of a complete egg and is described here. Below-canopy flights were common within the nesting stand, but were concentrated along repeatedly used flight routes. Adults accessed nest sites by flying for at least 100 m through the canopy along these routes. Fledging occurred on 3 July 1991 and on 7 June 1992, 19 and 18 min after sunset, respectively. At fledging, murrelets neither vocalized nor behaved conspicuously. Fledging occurred on the first day in which the nestling had lost all or nearly all of its concealing down. On both occasions, the nestling fledged alone and flew a route not used by the adults.

The small (24 cm long) marbled murrelet (*Brachyramphus marmoratus*) is the only member of the alcid family that nests in trees. It nests on high, large-diameter branches of old-growth trees found in coastal coniferous forests (Hamer and Nelson 1995a). In California, logging of such forests has eliminated most murrelet habitat and reduced population levels such that, in 1992, the species was listed as endangered by the state of California, and as threatened throughout California, Oregon and Washington by the U.S. Fish and Wildlife Service (California Fish and Game Commission 1992, U.S. Fish and Wildlife Service 1992, Nelson and Singer 1994). Through 1994, 65 murrelet tree nests have been found in North America, of which only 22 were active (Nelson and Hamer 1995a). Six of these active nests were from Big Basin Redwoods State Park, Santa Cruz County, California (Binford et al. 1975; Singer et al. 1991, 1992; this study).

We conducted field observations of marbled murrelets in Big Basin Redwoods State Park during the breeding seasons of 1991 through 1994. Our primary goal was to observe the fledging of a marbled murrelet from a tree nest, a previously unobserved phenomenon. A secondary goal was to describe behavioral and forest-stand characteristics associated with a successful nest. We report here on the first murrelet nest to be found in a coast redwood (*Sequoia sempervirens*), the first direct observations of fledging from a tree nest, the first reported re-use of a known successful nest, and the first probable instance of murrelets nesting in the same tree for 4 consecutive years.

METHODS

Study Area

The nest tree was 9.1 km inland and within 1 km of headquarters at Big Basin Redwoods State Park (elevation, 305 m). The park contains the largest re-

maining stand of old-growth coast redwood–Douglas-fir (*Pseudotsuga menziesii*) forest (ca. 1700 ha) in the Santa Cruz Mountains, and has been documented to support breeding murrelets since 1960 (Carter and Erickson 1992). The Santa Cruz Mountains are part of California's Outer Coast Range and extend a distance of 119 km from San Francisco to the Pajaro River.

Locating Nests

Nests were located by placing multiple observers around potential nest trees during the dawn activity period (Singer et al. 1991; 1993 Pacific Seabird Group [PSG] survey protocol, Redwood Sciences Laboratory, 1700 Bayview Drive, Arcata, CA, unpubl. rep.) to watch for incoming murrelets. Once a nest was found, it was intermittently observed from semi-concealed observation points on the ground. We determined the location of murrelet flight corridors by using multiple observers in communication with each other through FM transceivers. Data were collected on micro-cassette recorders as events occurred. Observations were aided by spotting scopes, including 1 that was custom-fabricated for viewing in low light conditions. A Marantz portable cassette tape recorder (PMD-221) with a parabolic microphone (omnidirectional Sennheiser ME-20 with Sony 33 cm parabolic dish) was used to record sounds emanating from the nest tree and vicinity on several days, including the time of fledging in 1991.

Nest Observations

In 1991, we made 28 dawn and 6 dusk observations of activity at the nest branch from discovery on 5 May to fledging on 3 July. On the 6 days prior to fledging, we made daily dawn and dusk observations of the site. The nest itself was observed only for the last 6 days because of difficulties in finding and viewing the nest cup. The nest tree was climbed on 31 July to take photographs, collect samples of nest contents, and measure nest-site parameters.

In 1992, we made 5 dawn and 6 dusk observations of the nest, from discovery on 24 May to fledging on 7 June. As in 1991, dawn and dusk observations of the nest branch were made during the 6 days prior to fledging. The nest tree was climbed on 11 September to document the nest site and obtain samples, including eggshell fragments.

In 1993, we monitored murrelet activity on 16 mornings from 3 April to 1 August, but did not discover a nest. Eggshell fragments were found on the ground below the tree on 8 May, however, this find was not brought to our attention until 12 July. We did not have the tree climbed because of the difficulty in searching such a large tree for a nest site of unknown location. We suspect that the nest failed because no activity was observed in the tree and the eggshell fragments contained puncture marks. The eggshell fragments found in 1992 (250 small fragments) and 1993 (2 large fragments) were photographed, measured, and deposited at the Western Foundation of Vertebrate Zoology (#163730 and #163731).

In 1994, we monitored murrelet activity at the same tree from 2 April to 31 July. On 7 May we discovered a nest and monitored it intermittently until it failed. We did not have the tree climbed.

Forest-Stand Characteristics

Forest-stand characteristics were measured in an irregularly shaped 3.2-ha plot, encompassing the nest tree and the 2 principal flight routes used by adult murrelets to enter and exit the nest tree. Within the plot we identified the species and measured the diameter at breast height (dbh) of each tree ≥ 10 cm. For overstory trees (those extending above the hardwood understory canopy), we also measured the average crown diameter, and the distance and bearing from a known reference point. We prepared a stem map showing the relative position of overstory trees and their crown coverage within the plot. Overstory canopy cover near the nest tree was measured at 4 equidistant points along each of 4 25-m transects extending from the nest tree in the 4 cardinal directions. The average of these measurements was used to represent stand closure, and was compared with stem-map data for accuracy.

RESULTS

The 1991 and 1992 nests were on different branches of the same coast redwood (79.2 m tall, 530 cm dbh), which was healthy with a densely foliated crown. The 1994 nest was located in the 1991 nest cup. The tree was located on a flat alluvial terrace 72 m from a perennial stream, 69 m from a two-lane paved highway and immediately adjacent to a heavily used foot trail (Fig. 1). The nest tree was one of the largest trees in the stand and had many potentially suitable nest sites, including large horizontal branches present in the mid- and upper live crown. Two spur stems, each 0.66 m in diameter, originated from the main stem in the lower part of the live crown on the northwest and southeast sides of the main trunk. They provided screening cover for the nest sites. The live crown extended vertically from 9 to 70 m.

Both nests were in the middle third of the live crown. The 1991 nest (Fig. 2) was on a 61-cm diameter branch 41.1 m above ground, projecting at 45°. The branch was damaged and ended in a 3-way fork. The nest was within a crook formed by the junction of the branch and main trunk. One side of the 8.3 cm long × 7.6

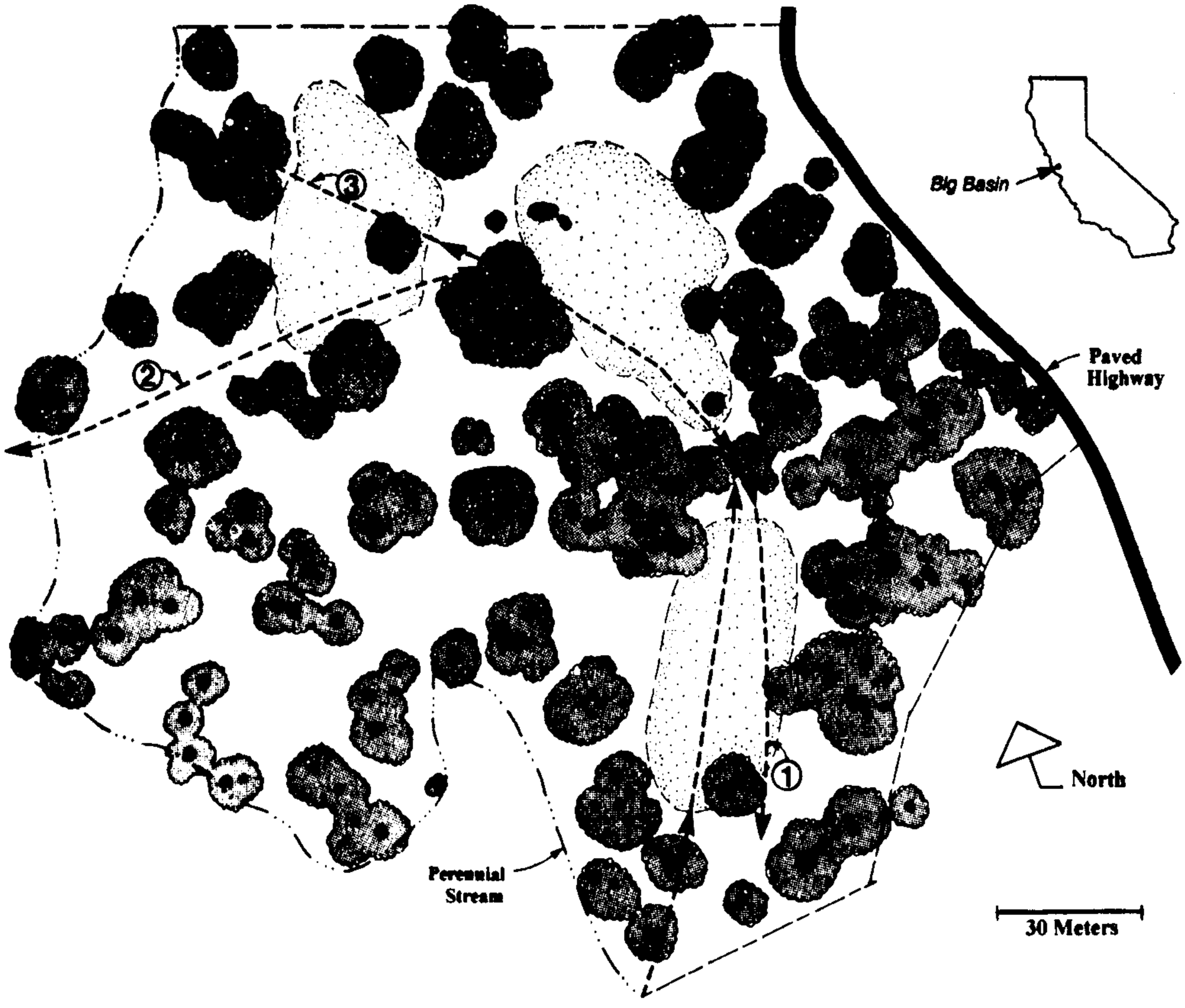

FIGURE 1. Schematic map of overstory trees in the 3.2-ha sample plot showing crown cover and flight routes. ✪ nest ' (1) 1991 adult flight routes; (2) 1992 adult flight routes; (3) 1991 and 1992 fledgling flight route; stippling i ndicates clearings with grass or brush.

cm wide × 2.5–3.2 cm deep nest cup was formed by a stick, 2.5 cm in diameter that was resting on the branch. The 1992 nest (Fig. 3; 10.0×10.0×2.0 cm) was on a 42-cm diameter branch 53.2 m above ground, projecting at 267°. The branch was a stub broken off 2 m from the trunk. The nest was within a furrow that ran length-wise on the branch. Both nests were against the bole of the tree. Neither nest showed any evidence of construction; both were on the branches without additional substrate. Oval rings of fecal material surrounded both nest cups. The 1991 fecal ring measured 20.3×17.8 cm and the 1992 fecal ring measured 25.0×20.0 cm. All evidence of the fecal ring at the 1991 nest was gone when we climbed the tree again in September 1992.

Both nest sites were well concealed by surrounding branches and foliage of the nest tree and by the tree bole (100% cover). The 1991 nest had complete cover from overhead branches and additional lateral cover from the adjacent spur boles. The 1992 nest site was concealed from all directions by 2 heavily foliaged twigs overhead within 50 cm of the nest (Fig. 3). Adults landed at specific spots on both nest branches. The landing site for the 1991 nest was 2 m from the nest. The landing site for the 1992 nest was a worn spot on the branch about 20×30 cm and 1 m from the nest. The adults accessed that nest by walking toward the trunk in the furrow in which the nest was located.

In the 3.2-ha plot surrounding the nest tree, there were 76.5 coast redwood trees per ha (basal area = 152.6 m^2/ha), 16.1 Douglas-fir per ha (15.0 m^2/ha), and 104.6 tan oak (*Litho-*

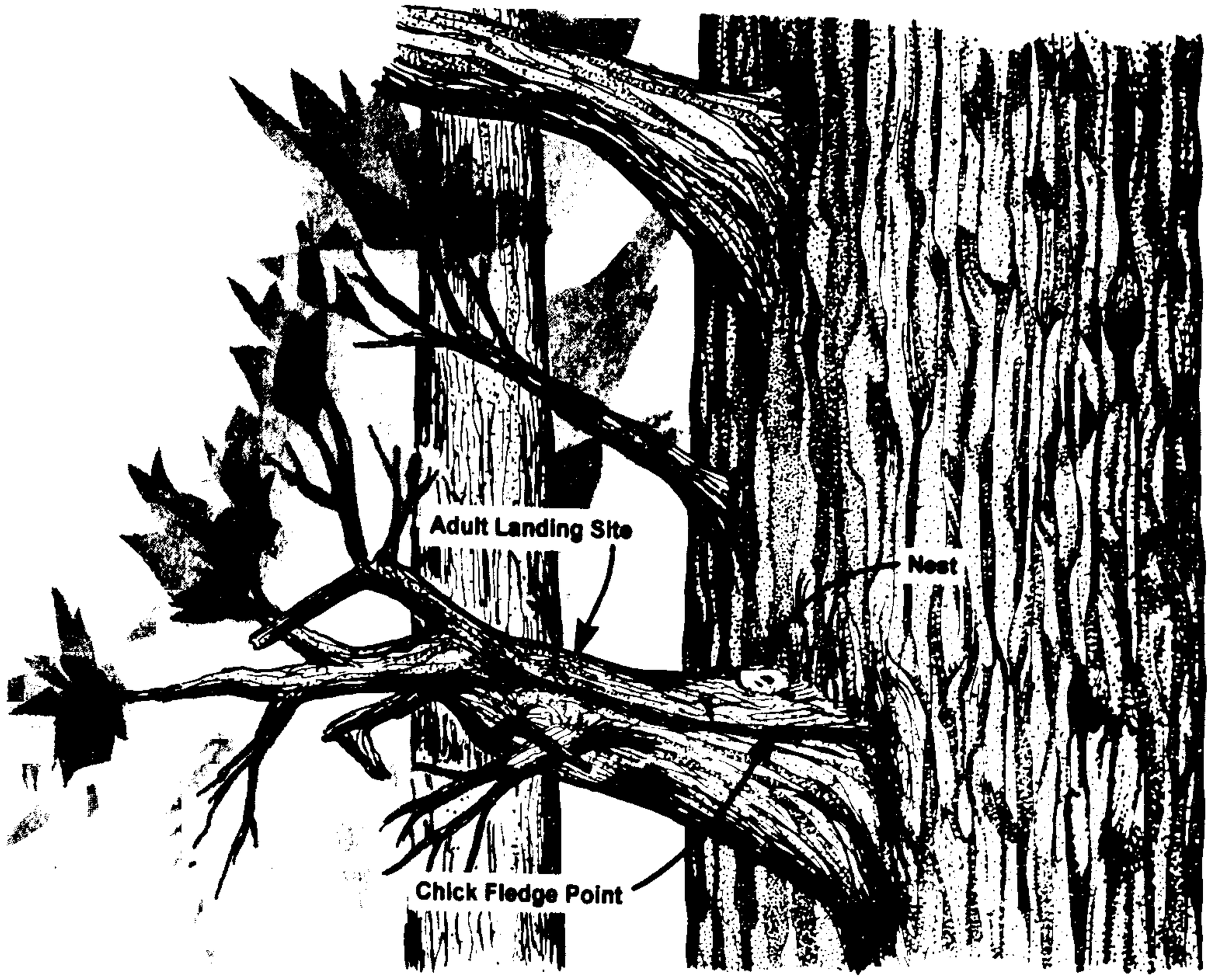

FIGURE 2. Oblique view of 1991 nest branch drawn from photographs, measurements and direct observation.

carpus densiflorus) per ha (9.5 m^2/ha). Three other species, wax myrtle (*Myrica californica*), California bay (*Umbellularia californica*), and coast live oak (*Quercus agrifolia*), together totalled 31.9/ha (1.5 m^2/ha). Overstory tree canopy closure within 25 m of the nest tree and the stand overall averaged 40%. Large gaps between overstory trees were generally occupied by western azalea, California huckleberry (*Vaccinium ovatum*), tan oak, coast live oak, unidentified grasses and bare ground. These gaps formed three-dimensional corridors of space generally 25–75 m deep below the dominant canopy. The principal flight routes used by adult murrelets flying to and from the 1991 and 1992 nests were within such corridors (Fig. 1).

Adult Behavior and Nest Attendance Prior to Fledging Day

1991 Nest.—The 1991 nest was discovered on 5 May. At 0554:30 (PDT, 15.5 min before sunrise) 2 adult murrelets were observed flying silently up into the crown of the tree at about half-canopy height, followed 40 min later by a single adult flying silently out of the tree on the reverse course. Fledging occurred 59 days later, on 3 July. Twelve adult incubation exchanges were observed, between 22.0 min before and 1.5 min after sunrise, with 11 occurring at least 9.0 min before sunrise ($\bar{x}$ = 16.2 min before sunrise, SE = 1.1). Feeding visits were observed on 12 of 15 mornings the nest was watched, with multiple feedings (maximum = 4 visits) on 11 mornings. The first feeding of each day occurred from 31.0–14.5 min before sunrise ($\bar{x}$ = 23.4, SE = 1.7), except for 1 rainy morning when the first feeding did not occur until 21.0 min after sunrise. A single fish was presented to the chick at each of the feedings we were able to view. The chick was fed at least 3 fish each day 2–5 days prior to fledging, and 1 fish on the day before fledging. However, no feedings were

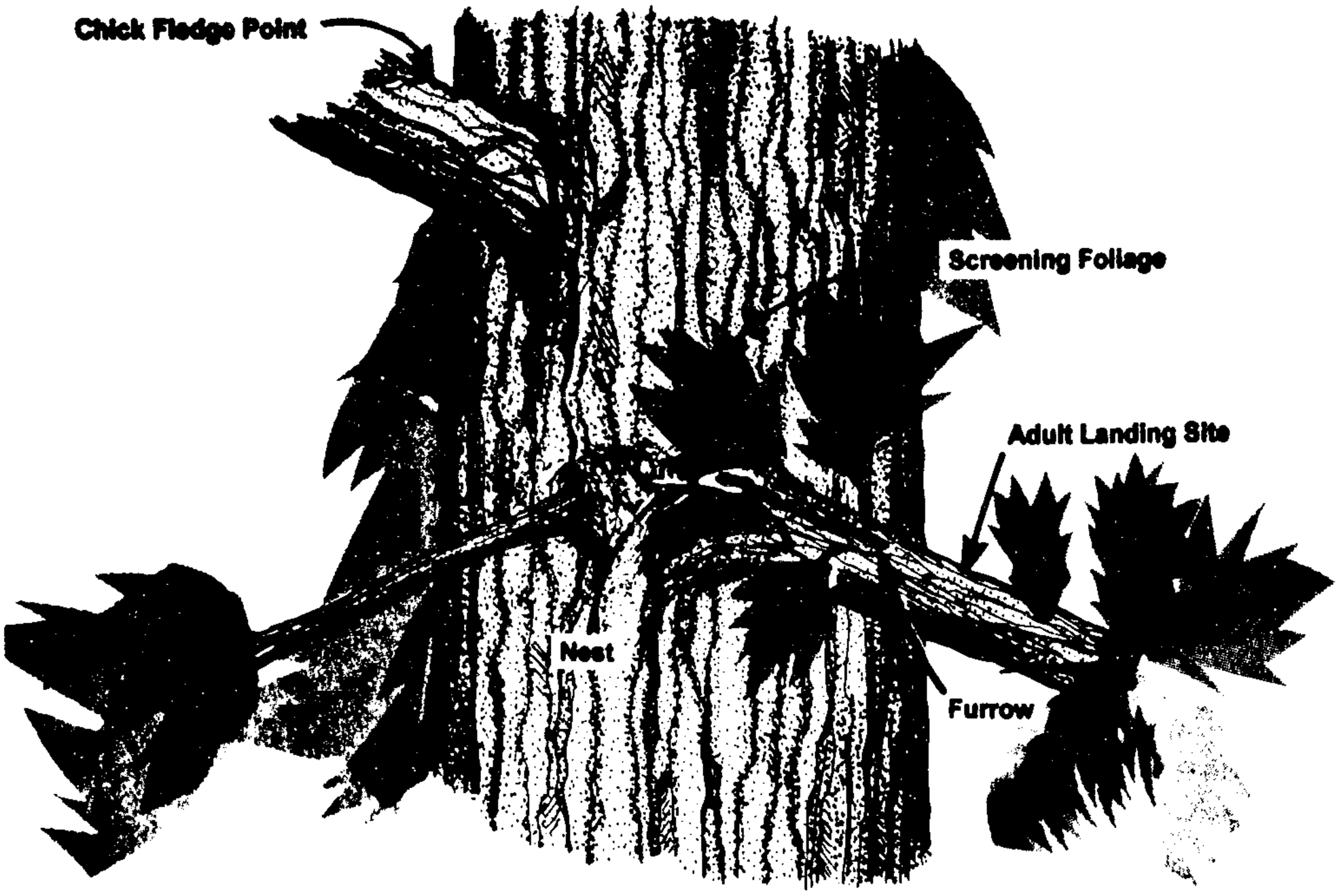

FIGURE 3. Oblique view of 1992 nest branch drawn from photographs, measurements and direct observation.

observed on the 2 mornings prior to fledging. Single evening feeding visits were observed on the 4 days prior to fledging, occurring 7.2–19.3 min after sunset ($\bar{x}$ = 11.9, SE = 2.3).

All of the adult flights to and from the nest tree were along the same route below the forest canopy within gaps created by the distribution of overstory trees. This flight route ran south-southeast from the nest tree over a dense brush field of western azalea (*Rhododendron occidentale*), then veered to the south to the perennial stream, a total distance of about 182 m (Fig. 1). Adults approaching and leaving the tree were always silent, except for occasional audible wingbeats. Adults were usually silent on the nest, however, 4 short soft grunts (sounding phonetically like "eeeuh") were heard on the night of 30 June when a single adult landed on the branch carrying a fish. During both the incubation and nestling periods, a single, silent adult murrelet, believed to be 1 member of the nesting pair, was seen on 25 of 27 mornings flying closely past the nest tree before or after incubation exchanges and feeding visits. Such "fly-bys" occurred at approximately the same height as the nest, and typically differed from the route used to access the nest. After fledging, no murrelet activity was observed at the nest cup or flight route in 1991, 1992, or 1993; although a brief, failed nesting attempt could have occurred in 1993.

1992 Nest.—The 1992 nest was not discovered until late in the nestling stage. We monitored activities at and near the site for 15 days prior to fledging on 7 June. The nest was not visible from the ground, but the adult could be seen perched on the branch and the chick was sometimes partially visible. The first evidence of nesting occurred on 24 May when an adult murrelet was seen flying out of the tree. Subsequent observations revealed multiple visits by adults to the tree each morning, and on 2 June an adult was seen carrying a fish to the nest branch. One to 2 feeding visits per evening were observed on the 5 dusk surveys prior to fledging, with the last feeding occurring from 5.8 min before, to 14.9 min after, sunset ($\bar{x}$ = 5.1 min after sunset, SE = 2.9). On the day prior to fledging, the chick was fed 4 times in the morning (16.0 min before, to 51.0 min after, sunrise)

and once in the evening. All feedings consisted of a single fish. The only vocalizations detected from the nest occurred during a dawn feeding visit on 7 June, when several faint lisping whistles were recorded, followed by 3 loud nasal calls as the adult flew off the nest branch.

Adults flying to and from the tree used a different route in 1992. All 19 observed flights to and from the nest were along the same route to the west of the tree (Fig. 1). As in 1991, flights were below canopy along a natural corridor created by the distribution of overstory trees, and the route intercepted the stream 109 m away. Again, adults flying to and from the nest were silent, except for occasional audible wingbeats. "Fly-bys" (birds flying by the nest tree at nest height) were also seen at this nest on several occasions. After fledging, no murrelet activity was observed at the nest branch or flight route in 1992, 1993 or 1994, although a brief, failed nesting attempt could have occurred in 1993.

1994 Nest.—The 1994 nest was discovered on 7 May when a murrelet was seen using the 1991 flight route to access the tree. The landing pad and nest site were the same as in 1991. We could see the adult on the nest and determined the nest to be in the incubation stage. We observed the nest intermittently through 24 May, recording 5 incubation exchanges between 19.0–8.0 min before sunrise ($\bar{x}$ = 15.9, SE = 1.9). All flights used the same route, and the adults were silent. "Fly-bys" past the nest were seen on several occasions.

On 27 May the adult was not at the nest and no chick was visible. We observed the nest tree during 3 subsequent dawn activity periods, but no murrelets were seen flying in or out of the tree and daytime observations revealed no birds at the nest. No eggshell fragments were found under the tree. We monitored the tree on 7 different days through 31 July for evidence of possible re-nesting, and found none.

Observations on the Day of Fledging

1991 Nest.—The day of fledging (3 July) was warm and clear. Unlike preceding days, the adult murrelets did not visit the nest before 0900 hr to feed the chick. At 0900 hr the chick was still down-covered except for its head and throat. The head retained a strip of down on the mid-crown and nape. By 1900 hr the chick had preened or picked off much of its down, and only fine, short white down on the upper wing coverts was still visible. In contrast to previous evenings when it was usually still, the chick was highly active and spent most of its time variously turning, standing, walking, preening, flapping its wings for extended periods, and pecking at small flying insects.

An adult murrelet flew to the nest via the usual route at 2037:47 hr (2.8 min after sunset) without a fish. It perched on the branch near the nest and generally remained motionless. The adult was lost from view on the branch at 2051 hr due to darkness and its position outside the field of view of our low-light scope. The chick remained visible in the scope until fledging. The chick occasionally bobbed its head while assuming a begging posture. No vocalizations by the adult or chick were detected while the adult was on the branch, although a soft or brief vocalization could have been obscured by occasional noise from cars or airplanes.

The adult flew from the nest at 2053:58 hr following its usual route to the south-southeast. At 2054:10 hr (19.2 min after sunset), the young murrelet hopped silently to the side of the branch in the opposite direction of the exiting adult (Fig. 2), and flew with strong audible wingbeats to the northwest (Fig. 1). No murrelet vocalizations were heard in the vicinity of the nest from the time of the adult's departure until more than 1 min after the fledgling had departed. Twenty-nine other murrelet detections were recorded in the stand between 2025–2100 hr that evening, but none appeared to be associated with the observed nest.

1992 Nest.—The day of fledging (7 June) was completely overcast with a light mist in the morning, and clear in the evening. Adult murrelets visited the nest twice in the morning, bringing at least 1 fish. From our observation station we could view the nest branch, but not the nest itself. Prior to the evening arrival of the adult, we partially glimpsed the chick during brief periods of wing flapping.

An adult murrelet, following its usual flight route (Fig. 1) carried a fish to the nest at 2039:55 hr (10.9 min after sunset). It perched motionless on the nest branch 1 m distal to the nest. At 2042 hr the adult walked toward the chick, and about 3 min later the chick was observed swallowing the fish. The chick then fluttered weakly to a small limb just above the nest branch (Fig. 3), and was observed to be in full

TABLE 1. Ground and marking coloration of marbled murrelet eggshell fragments, Big Basin Redwoods State Park, 1992 and 1993. Color notations are from Smithe (1975, 1976, 1981).

	1992	1993
Ground coloration	Slightly paler than #59 "lime green", and more yellow than #162D "opaline green"[a]	Slightly paler than #59 "lime green"[b]
Spot and blotch coloration	Ranged from #82 "blackish neutral gray" to #219 "sepia", and included #89 "jet black", some unidentified brownish colors	#19 "dusky brown", #20 "dark grayish brown", #21 "fuscous", #22 "burnt umber", #89 "jet black", #121A "Prout's brown", #219 "sepia", #223 "raw umber", and some unidentified dark grayish colors

[a] Equivalent to a color intermediate between Munsell color notation 2.5 GY 8.5/4 and 2.5 GY 8/4 (Anonymous 1976).
[b] Similar to Munsell color notation 2.5 GY 8.5/4 (Anonymous 1976).

juvenal plumage with no down visible. After a brief pause it flew to the northwest (Fig. 1) with rapid wingbeats, leaving the nest tree at 2046:58 hr (18.0 min after sunset). The adult departed along its usual route to the west 12 sec after the chick fledged.

No vocalizations were detected while the adult was with the chick. That evening no murrelet vocalizations were heard near the observed nest, and only 2 distant detections (at 2005 and 2036 hr) were noted.

Description of Eggshells and Evidence of 1993 Nesting

We collected approximately 250 eggshell fragments from the 1992 nest, 95% of which were less than 3 mm^2 in size. The largest fragment was a polygonal piece 4 × 5 mm in size. On 8 May 1993, we recovered 2 large fragments from a single subelliptical and moderately marked egg, with the largest comprising almost two-thirds of the egg. It encompassed the full length (58.2 mm) and width (35.5 mm) of the intact egg. The second fragment, affixed inside the narrow end of the larger fragment, was about 25.4 mm × 24.6 mm. The egg was moderately to heavily marked with spots and irregular blotches. The densest areas of markings and largest spots and blotches began about 9 mm from the shell's wide end and ended 22 mm from the narrow end. The colorations of the 1992 and 1993 eggshell fragments (Table 1) were similar to all other Santa Cruz Mountains' eggshells (Becking 1991; Singer et al. 1991) and also appeared to be similar to the few published descriptions from other areas (Kiff 1981; Reed and Wood 1991).

The eggshell fragments found in 1993 were 25.6 m northeast of the nest tree. Based on their proximity to the tree and the lack of other nearby trees with suitable nest branches, the fragments were very likely from a nest in the known nest tree. When found, the large eggshell fragment had some yellow yolk stains present, mostly on the inside surface. There were no bloodstains. The eggshell membrane appeared to be tightly adhered to the shell. Three jagged holes, each roughly 3.6 × 5.7 mm in dimension, were present. These conditions indicated the egg had likely been depredated shortly after being laid (L. F. Kiff, pers. comm.).

Discussion

Fledging

The secretive behavior of nesting marbled murrelets (Guiguet 1956, Nelson and Peck 1995) persists to the moment of fledging, which occurs in semi-darkness with no conspicuous flight behavior or vocalizations. Both fledgings occurred 18–19 min after sunset on the day when the young had lost nearly all of their cryptic downy plumage. Both fledglings left the tree via the same flight route, which differed from the routes used by the adults. Adults did not lead young from the nest, call to young, or encourage them to leave by cessation of feedings.

Nest Approach and Departure

In 1991, 1992, and 1994, consistent below-canopy flight routes were used by adult murrelets flying to and from nest sites. Adult murrelets flying silently below canopy were difficult to detect, due to their dark coloration, high flight speed, and the low light conditions during the majority of their nest visits. A similar flight route extending from a nest to a stream

was used by adult birds at a 1989 murrelet nest in the park (S. W. and S. A. Singer, pers. obs.). Repeatedly used below-canopy flight routes have also been observed at active nests in Oregon (Nelson and Peck 1995) and British Columbia (P. H. Jones, pers. comm.). These below-canopy flight routes may be an important component of murrelet nesting habitat because they may help hide the location of the nest from predators and reduce predation on adults flying to or from the nest. Elsewhere in the Santa Cruz Mountains, a peregrine falcon (*Falco peregrinus*) was observed to kill a murrelet flying above the forest adjacent to nesting habitat (D. L. Suddjian, unpubl. data). Marks and Naslund (1994) reported predation of an adult murrelet at its nest in Alaska by a sharp-shinned hawk (*Accipiter striatus*) and speculated that vegetation and habitat characteristics that reduce susceptibility to predation may increase the quality of a nest site.

The consistent use of nest flight routes by murrelets has implications for detecting them near nest trees, and for detecting behaviors that indicate nesting in an area (see Nelson and Peck 1995). When attempting to observe activity near the nest tree, we soon became aware that below-canopy flights were much more common on 1 side of the tree than the other. On 4 mornings, we had 2 observers situated on opposite sides of the nest tree looking at equal areas of sky but in opposite directions. The first observer saw 7–18 below-canopy flights while the second observer saw 0–3 below-canopy flights. Observations from other days, when only 1 station was used, produced similar respective numbers of below-canopy flights. These observations suggest that the total number of below-canopy detections of murrelets within a stand may be determined as much by observer location as by actual murrelet usage of the stand. Existing murrelet survey procedures (1993 PSG survey protocol), particularly the number of stations recommended per area of forest, do not take this factor into account and may result in zero detections being made in a stand in which a nest is present.

Successful Versus Depredated Nests

Nelson and Peck (1995) suggest that concealment may be the murrelet's best defense against nest predation, as is true for other seabirds that nest at low densities (Birkhead 1985, Wittenberger and Hunt 1985). Unlike the 2 1989 nests in the same stand that were unsuccessful (Singer et al. 1991), the 1991 and 1992 nests abutted the tree trunk and had more horizontal and vertical cover. A common raven (*Corvus corax*) depredated 1 of the 1989 nests, and although ravens were active near the nest tree, they apparently did not locate either nest in 1991 or 1992. In 1989, a Steller's Jay (*Cyanocitta stelleri*) depredated a young chick on a nest situated 61 cm out from the trunk of a Douglas-fir (Singer et al. 1991). Jays visited the 1991 and 1992 nests several times and on 7 June 1992, 2 jays called and postured aggressively at a large chick in the nest. The jays could only approach the nest from 1 side because the nest abutted the trunk, and after several seconds they left. Nestling murrelets may be able to defend themselves from jays if the nest is protected on at least 1 side. Concealing cover and location of the nest on the tree limb likely decreases chances of nest detection by aerial predators (Singer et al. 1992, Nelson and Hamer 1995b).

Murrelets may vary in their response to nest disturbance, but murrelets at Big Basin Redwoods State Park nested successfully near a well-traveled park road and above a trail used by more than 25,000 people each year. In the Santa Cruz Mountains, most of the remaining old-growth habitat occurs in heavily visited state and county parks. During many observations of incubating adults in 1989 and 1994, we saw no visible reaction to loud talking, yelling, or passenger vehicle noise near the nest tree. In contrast, calls of the common raven always elicited an immediate and visible reaction (S. W. Singer and S. A. Singer, pers. obs.). Of more concern than noise are food scraps left by campers or picnickers. We have frequently observed ravens and jays feeding from overturned garbage cans and being fed by park visitors. This food source attracts corvids and is likely responsible for their elevated numbers in developed areas of the park (pers. obs.; D. L. Suddjian, unpubl. data).

Re-use of Nests and Site Fidelity

Circumstantial evidence and the known nest-site fidelity in other alcids (Murray et al. 1983, Harris and Birkhead 1985, Hudson 1985, Roby and Brink 1986) suggests that the same pair may have nested in the tree each year. The 1994 re-use of the 1991 flight route, landing

area, and nest cup supports this view, as does the fact that the tree has supported only 1 nest each season.

The long-term fidelity that murrelets apparently have for breeding stands (Divoky and Horton 1995) has not yet been demonstrated for nest trees or nest cups, although in Oregon, where the greatest number of nests have been found, it is not uncommon for murrelets to re-use the same nest tree (Nelson and Peck 1995). Apart from this study, there has been only 1 instance where marbled murrelets have nested in the same nest cup for 2 consecutive yr. That nest was in the Caren Range in British Columbia, where re-use of the nest cup was accompanied by re-use of the same below-canopy flight route (P. H. Jones, pers. comm.). Fidelity to nest cups may indicate a more suitable nesting environment than nest cups only used once. This is known to be true for seabirds in general (Gaston 1992). If this is the case for murrelets, then monitoring nesting activities and documenting environmental conditions at nests re-used in successive years will be valuable for identifying optimal murrelet nesting sites.

ACKNOWLEDGMENTS

Special thanks for key observations or assistance are due to Z. Ahnstrom, B. Bedzin, R. Cull, M. Danzenbaker, S. Douthit, L. Fisher, C. Kempf, K. Moore, R. Norden, and R. Vlasak. We also appreciate the field assistance provided by M. Allaback, B. Dolman, C. Hauser, B. Larison, S. Littlefield, B. Merrill, B. Mori, C. Nieukirk, K. Reeves, A. Senuta, and H. Wehpmeyer. S. Littlefield prepared the figures for this paper. K. Hanneman climbed the tree in 1991 and 1992. The 1993 eggshell fragment was found by L. Yule, and safeguarded by Big Basin Park Naturalist R. Seymour. The manuscript benefitted by comments from M. Harris, K. Kuletz, K. Nelson, S. Sealy, and an anonymous reviewer. This work was made possible by the California Department of Parks and Recreation, especially B. Getty, G. Cook, K. Gray, G. Gray and the staff at Big Basin Redwoods State Park; and the California Department of Fish and Game, especially E. Burkett and J. DeWald. Funding assistance was provided by the Sempervirens Fund, Santa Cruz Bird Club, BioSystems Analysis Inc., and The Habitat Restoration Group.