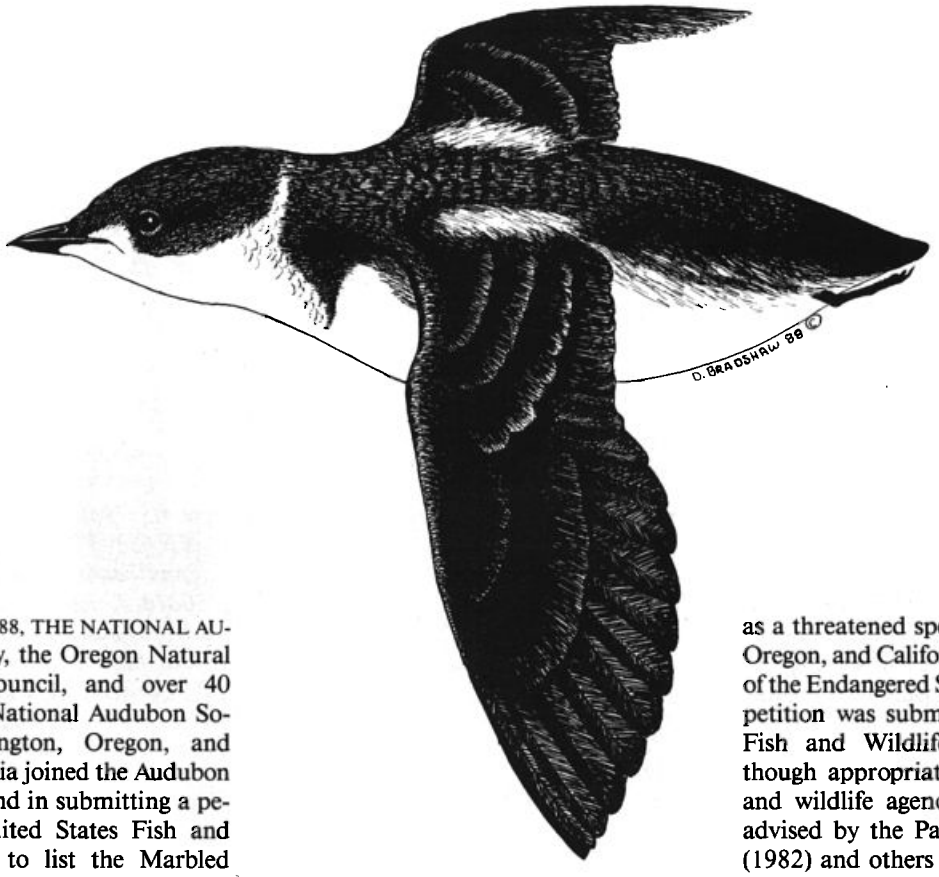
The Marbled Murrelet joins the old-growth forest conflict

David B. Marshall



Illustration/Diana Bradshaw.

IN JANUARY 1988, THE NATIONAL AUdubon Society, the Oregon Natural Resources Council, and over 40 chapters of the National Audubon Society in Washington, Oregon, and northern California joined the Audubon Society of Portland in submitting a petition to the United States Fish and Wildlife Service to list the Marbled Murrelet (*Brachyramphus marmoratus*) as a threatened species in Washington, Oregon, and California under provisions of the Endangered Species Act. A similar petition was submitted to the Oregon Fish and Wildlife Commission. Although appropriate land management and wildlife agencies were previously advised by the Pacific Seabird Group (1982) and others of the likely conflict between timber harvest activities and

the welfare of the Marbled Murrelet, and personnel in these agencies were concerned, the warnings went mostly unheeded by agency administrators. However, state wildlife agencies in Alaska and Oregon did fund limited research on the species. There is now concern that the Marbled Murrelet populations of California, Oregon, and Washington, like the Spotted Owl (*Strix occidentalis*) populations there, are at risk from the continued liquidation of old-growth coniferous forests.

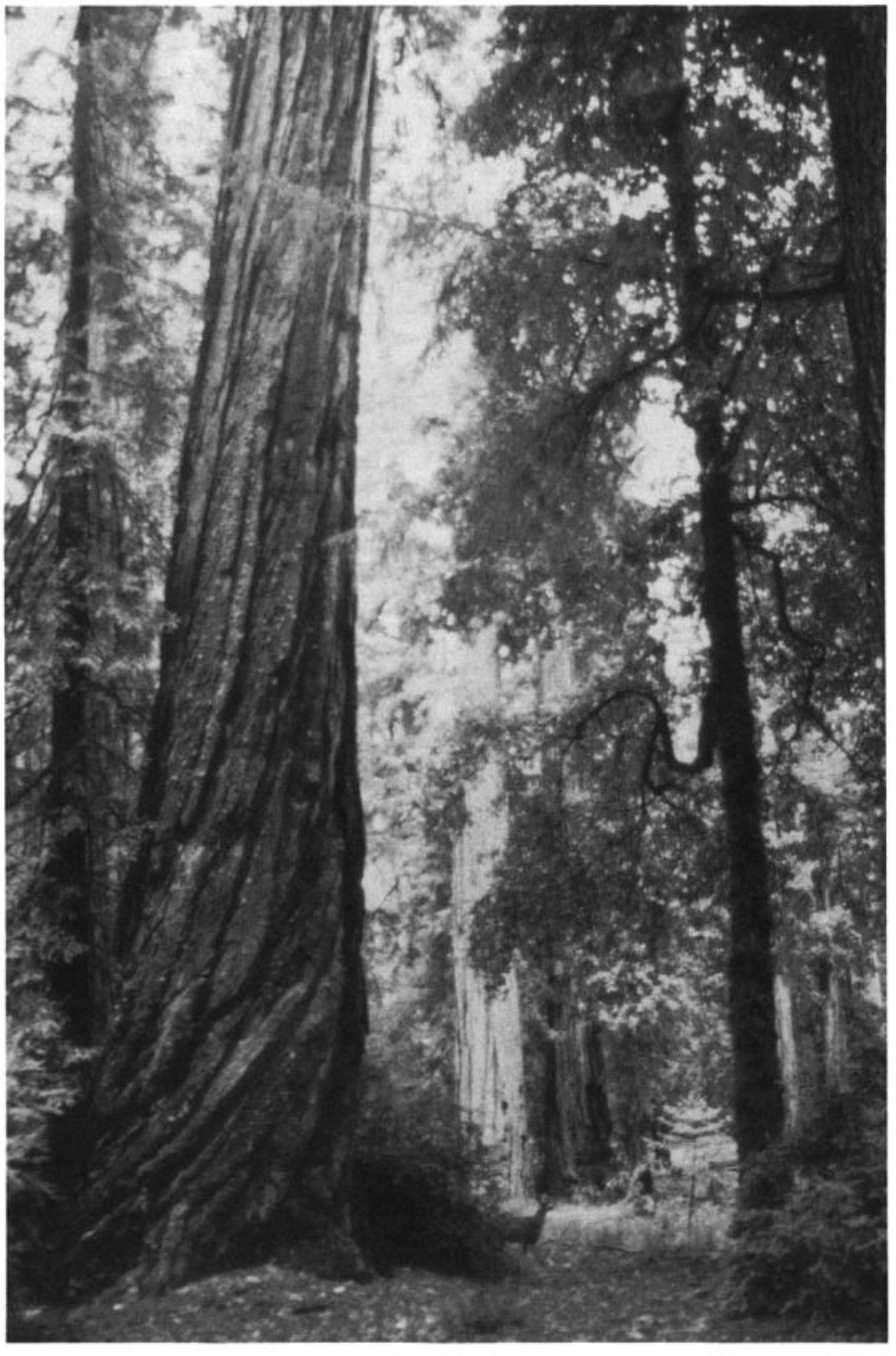
Data on the Marbled Murrelet, a species commonly seen in northwestern waters, were late in coming, especially as related to its nesting behavior. Despite the bird's abundance, it was not until 1974 that the first North American nest, located in a tree, was found (Binford *et al.* 1975; Singer and Verardo 1975). Early ornithologists, many of whom were egg collectors, were perplexed at not finding Marbled Murrelets nesting with other seabirds. They speculated where the bird nested and pursued every lead that might reveal their nest sites. Early ornithological literature carried such titles as "The Mystery of the Marbled Murrelet" and "Does the Marbled Murrelet Nest Inland?" (Brooks 1926, 1928), "The Mystery of the Marbled Murrelet Deepens" (Jewett 1934), and "Enigma of the Pacific" (Guiguet 1956).

Early in this century it became apparent that the Marbled Murrelet might be an inland nester. Reverend William L. Dawson (Dawson and Bowles 1909) wrote of finding the species about 45 kilometers inland in Washington: "At Glacier on the north fork of the Nooksack River, near the foot of Mt. Baker, having risen before daybreak for an early bird walk, on the morning of May 11, 1905, I heard voices from an invisible party of Marbled Murrelets high in the air as they proceeded down the valley as though to repair to the sea for the day's fishing." The early observers also noted that young found at sea could always fly (Willet 1926). Willet concluded, somewhat erroneously that, "this bird will eventually be found nesting in the woods in a cavity in the rocks or under the roots of trees, at a considerable altitude, but not above timberline." Presently this elusiveness continues and partially accounts for this species entering the old-growth controversy well after the Spotted Owl.

What follows summarizes the current state of knowledge on the Marbled Murrelet, the types of information needed for management of the species, and the thrust of current research.

DISTRIBUTION AND POPULATIONS

Two subspecies of the Marbled Murrelet are recognized. The nominate form, *Brachyramphus marmoratus marmoratus,* is found in summer from the outermost Aleutian Islands northeastward to the Gulf of Alaska and south along the eastern Pacific Ocean to Santa Cruz County, California (American Ornithologists' Union 1983). In winter it tends to vacate the northern sections of its range and can occur as far south as San Diego County, California. The Asiatic subspecies, *Brachyramphus marmoratus perdix* occurs from the Sea of Okhotsk, Kamchatka and the Commander Islands south to Korea, Japan, and the Kurile Islands.



The first North American tree nest wasn't discovered until 1974 in the branches of a Douglas Fir. Photo/David Marshall.

Table 1. Summer population estimates in thousands.

State or Region	*Numbers*	*Source*
Alaska Peninsula, AK	6 to 15	Mendenhall and McAllister 1987
Prince Wm. Sound, AK	250	Kessell and Gibson 1978
	15 to 20	Mendenhall and McAllister 1987
Southeast Alaska	250	Kessell and Gibson 1978
	50 to 75	Mendenhall and McAllister 1987
Clayoquot & Barkley Sound, BC*[1]	8.46	Sealy and Carter 1984
Washington*[2]	Between 4.4 and 8.3	Wahl and Speich 1984; Speich *et al.* 1987; Speich and Wahl *in press*
Oregon*[3]	6	Varoujean and Williams 1987
California	2	Sowls *et al.* 1980

*[1] *No estimates available for British Columbia as a whole* *[2] *About two-thirds of this population in inland waters*

*[3] *Actual survey work was done only in central third of coast*

It was assumed that the remainder of the state was populated with the same density of birds. This is believed to be a false assumption because general observations show that the central portion of the coast has the greatest densities.

Marbled Murrelet populations are difficult to inventory compared to colonial, island nesting alcids. At-sea inventories have been the main method employed. These have been conducted according to the different logistical situations in the area inventoried. However, a standardized at-sea technique designed specifically for ascertaining Marbled Murrelet populations has been proposed and field tested by Sealy and Carter (1984). Because all inventory work has been relatively recent, there has been insufficient time to record population changes.

Numerous local counts of Marbled Murrelets have been reported. Most of these have been opportunistic in nature. Table 1 indicates current estimates of North American populations. They are not fully comparable because different techniques were used.

Marbled Murrelets have delayed sexual maturity and maximum production from a pair is only one young per year (Sealy 1974, 1975b). Sealy (1975a) found that subadults made up 15% of the population off Langara Island, British Columbia. Obviously, this kind of situation requires low mortality rates and long-lived adults that reproduce with a high degree of success, as is typical for the family Alcidae. No work has been done elsewhere on population structure.

BIOLOGY AND HABITAT

The Marbled Murrelet is a near-shore feeder. It and Kittlitz's Murrelet (*B. brevirostris*) are North American alcids that range substantial distances inland, but the Marbled Murrelet is the only alcid that nests in trees. Where trees are absent or sparse in the Gulf of Alaska, it nests on the ground or in rocky cavities. While five ground and one cavity nest have been identified, only four tree nests have actually been described, two from Siberia and two from North America. From British Columbia south, the evidence points to Marbled Murrelets being solely an old-growth and possibly mature forest nester (Nelson 1986). This conclusion is not only based on the four described nests, but other significant observations discussed herein which have been made over an extended period.

Tree nests in old-growth forests

The first North American tree nest was discovered by Hoyt Foster, an alert tree surgeon who was removing damaged limbs from a Douglas Fir (*Pseudotsuga menziesii*) in a campground in Big Basin Redwoods State Park in California's Santa Cruz Mountains 10 kilometers from the coast (Binford *et al.* 1975; Singer and Verardo 1975). The tree, which stands today, was at the time of the nest discovery 61 meters high and 167 centimeters in diameter. The nest, which contained a downy young, was on a limb 41 centimeters in diameter at the base and located 45 meters off the ground. It consisted of a depression in the bright green moss (*Isothecium cristatum*) that covers the limbs of old-growth Douglas Firs. No nesting material was brought in, and it was suspected that the nest had to have been used over a period of years because of wear and the amount of excrement around its edge (Binford *et al.* 1975). The nest site is located in an old-growth forest composed of generally smaller Douglas Firs and mostly larger Coast Redwoods (*Sequoia sempervirens*). Significant habitat factors include the fact that this forest, like other Pacific coast old-growth stands, has an open crown structure, and the nest was positioned high above the ground at a point that allowed easy access to the exterior of the forest. Considering the low aerial buoyancy (high wing load) of the Marbled Murrelet, the need for the nest to be positioned as described above is evident. To remain airborne, the Marbled Murrelet flies at a high speed using a rapid wingbeat. Like other alcids, landings probably resemble high speed controlled stalls. It is assumed these flight characteristics would make landings and take-offs in dense forests difficult, if not impossible.

Unknown to Americans at the time of the Big Basin Redwoods finding was a tree nest reported by Kuzyakin (1963) near the City of Okhotsk in Siberia. This nest was a similar distance from the sea on the branch of a larch (*Larix dahurica*); made of dendroid lichen (*Bryopogon* sp.), the nest contained one egg. A second Siberian nest was reported by Nechaev (1986) on Sakhalin Island, again in a larch, but this time on a broken tree top. Characteristics of the forests in which these nests were found are unknown to us, and details on the nest in the broken tree top were not provided.

A more recently reported nest was found in 1984 1.2 kilometers from saltwater on the steep slopes of Baranof Island in southeast Alaska (Quinlan and Hughes 1984). This nest was 15.5 meters above the ground in a Mountain

Hemlock (*Tsuga mertensiana*) The site is an open, uneven-aged stand of Mountain Hemlocks. Like the others, this nest did not contain nesting material, the birds having relied on the moss to form a nest.

The use of moss for the nests has special significance since, as reported by Franklin *et al.* (1981), lush moss does not appear on conifers of the northwest until the forest is 150 or more years of age.

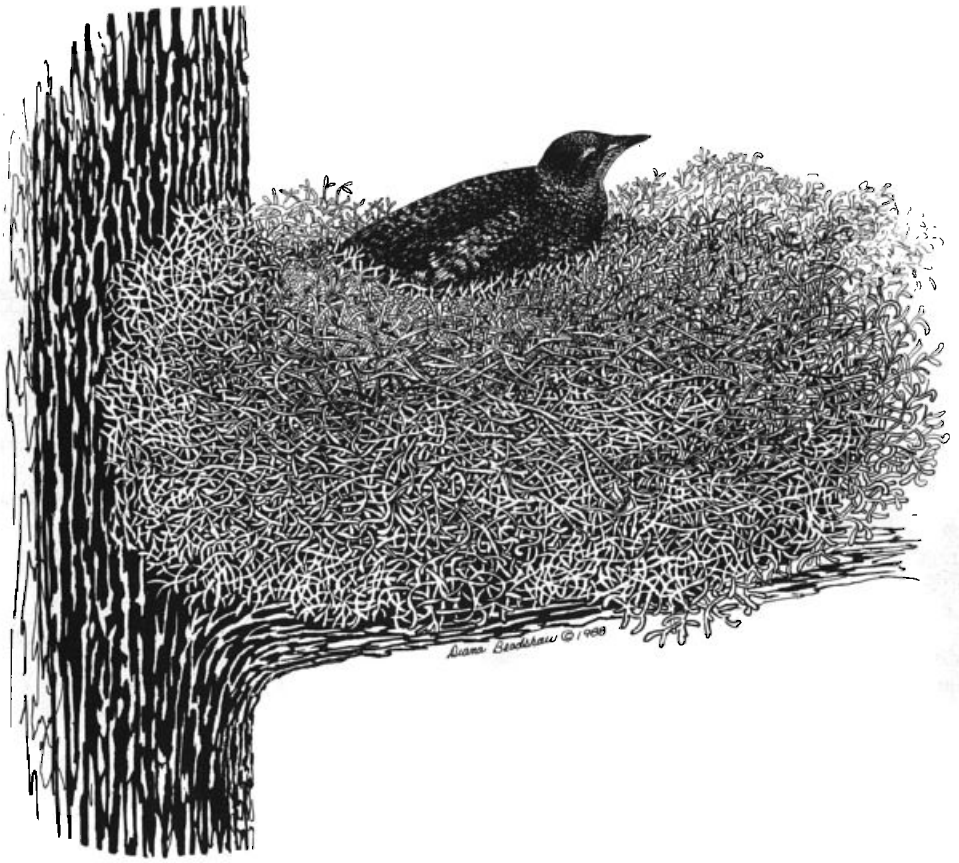
Other evidence of old-growth forest nesting and use

Inland sight and aural detections: A succession of early ornithologists, including Willet (1926), followed Dawson (Dawson and Bowles 1909) in noting that Marbled Murrelets flew inland from the sea to forested areas. Brooks (1926) mentioned their presence year round at Cowichan Lake in the interior of Vancouver Island, British Columbia; and reported that the well-known California ornithologist, Joseph Grinnell, heard and saw pairs of this bird flying at daybreak over the trees 32 kilometers inland in Humboldt County, California. Brooks (1928) later wrote of having examined a female collected on April 28, 1928, from seven or eight pairs in British Columbia at Harrison Lake between the Coast and Cascade ranges. The collected female was carrying two eggs (only one is laid—the other is absorbed). This lake is a minimum of 75 kilometers from saltwater. Subsequent observers (Webster 1941; Guiguet 1956; Drent and Guiguet 1961; Savile 1972) commented on seeing murrelets carrying fish at dusk as they headed inland from the sea. Some of the early writers noted this occurred particularly opposite shores supporting coniferous forests (Brooks 1926; Bent 1946; Jewett *et al.* 1953).

Today's investigators are making similar observations. Now that the composition of the forests has changed mainly to a patchwork of successional stages, various observers have detected murrelets primarily in old-growth forests (Sowls *et al.* 1980; McAllister 1983, 1986; Nelson 1986; Pacific Seabird Group 1986a; Carter *et al.* 1987; Sander and Carter 1987, Paton *et al* 1987, Varoujean and Williams 1987). Their investigations consist of at-sea observations and mostly aural detections at inland points. Inland detections are most often made before or just after sunrise. Off the Oregon and Washington coasts, Marbled Murrelets can be seen flying up rivers at dusk (McAllister 1983). In other cases they gain elevation rapidly and fly directly inland from the sea (McAllister 1986).

Paton *et al.* (1987) discussed numerous Marbled Murrelet records made in 1985 and 1986 during censuses of other birds two kilometers inland in the Redwood Experimental Forest located between Crescent City and Eureka, California. Almost all detections were made by sound as the murrelets were "extremely difficult to observe." Murrelets were detected on 31 different days in an old-growth plot from April through July and in October and November. They were detected 30 times in a shelterwood plot that adjoined an old-growth plot, but only once in a seed tree plot.

Sander and Carter (1987) conducted an extensive study of Marbled Murre-



Illustration/Diana Bradshaw.

lets at an inland site in Prairie Creek Redwoods State Park, California. At Elk Prairie in this park, murrelets were detected between January 15 and March 11, 1987, on 66% of 53 dawn censuses and none of 22 dusk censuses; between May 14 and 26, 1987, on all of 11 dawn and six dusk censuses; and between June 25 and July 7 on all of 10 dawn and 10 dusk censuses. This study is unique since it is the first census designed specifically to study Marbled Murrelets inland, and where data can be compared between days, seasons, and years. At all times of the year murrelets flew over and through the same old-growth forest areas, strongly suggesting that this is a nesting area.

Marbled Murrelets are regularly detected inland at several state parks in California set aside to protect redwood groves. Big Basin and Prairie Creek Redwoods state parks are the best examples, but others include Jedediah Smith Redwoods and Portola state parks (Becking 1987; Carter *et al.* 1987; Carter and Sealy 1987). Remsen and Gaines (1973) reported the species 30–35 kilometers inland at Grizzly Creek Redwoods State Park, Humboldt County, California.

Nelson (1986) wrote of observations made in Oregon during the course of circular plot censuses for forest birds as follows: "During the spring and early summer (28 April to 3 July) of 1985 and 1986, Marbled Murrelets were seen or heard in old-growth (200–400 yrs) and mature (80–200 yrs) forest stands in the Oregon Coast Range, up to 47 km from the ocean." This was in five of six old-growth study sites, and in two of four mature forest study sites distributed from Mary's Peak, Benton County to Cummins Creek, Lane County. No murrelets were detected in three young stands, including one located only three kilometers inland.

There are numerous other inland Marbled Murrelet records, but the above represent some of the most detailed and significant. Many of the inland detections indicate the Marbled Murrelet may nest in small aggregations, and it is common to hear two or more birds at a time. The inland records take two forms. One situation involves obvious use of a grove of trees whereas the other involves detection along flight corridors. Similar observations have been made of the Asiatic subspecies of the Marbled Murrelet. Independently of American workers, Nechaev (1986) has written of inland observations in Soviet Siberia. He reported Marbled Murrelets nesting in mountains in coniferous and mixed-stand forests near the coast and inland on Sakhalin Island. He noted the species by sight and sound as far inland as 30–40 kilometers from the Okhotsk Sea and up to 600–700 meters elevation.

Marbled Murrelets frequent freshwater lakes up to 75 kilometers inland, especially in British Columbia (Carter and Sealy 1986). Forty or more Marbled Murrelets can be found at one time on Lake Quinault, Grays Harbor County, Washington, which is 32 kilometers inland (S.M. Speich *pers. comm.*). Carter and Sealy (1986) reported that 22.4% of 67 records of Marbled Murrelets at lakes were from the non-breeding season, October to March.

Grounded young found inland: Another type of evidence of old-growth association has been an accumulation of records involving young found inland These come from all four states and British Columbia. This evidence, consisting mostly of stranded young found on the ground, was summarized by Carter and Sealy (1987). They accounted for over 40 records of grounded downy young and fledglings. Eight out of ten records of downy young and 20 out of 31 fledglings were obtained in old-growth forests.

Among records not known to Carter and Sealy (1987) are: a downy chick found in 1986 on the ground inside a grove of old-growth Sitka Spruce (*Picea sitchensis*) in Kodiak, Alaska (M.L. McAllister *pers. comm.*); a fledgling found grounded in 1987 in a parking lot of the town of Siletz, Lincoln County, Oregon (R. Lowe, *pers comm.*); and a young bird found in downtown Chilliwack, British Columbia, in 1987 (H.R. Carter *pers. comm*).

Some of the occurrences recorded by Carter and Sealy (1987) involve what were almost certainly nests. Two cases, one in Washington and one in British

Table 2. Tree nests and other evidence of tree nesting.

Location	*Date*	*Tree species where known*
Described forest nests		
Okhotsk, Siberia	June 17, 1961	Larch
Sakhalin Is., Siberia	June 19, 1976	Larch
Baronof Is., AK	1984	Mt. Hemlock
Big Basin Redwoods S.P., CA	Aug. 7, 1974	Douglas Fir
Stunned adult w/brood patch and eggshells found in fallen tree debris		
Masset, BC	June 4, 1953	W. Hemlock
Young found on ground following tree falling		
Holberg, BC—2 chicks	Aug. 24, 1967	W. Red Cedar
Sultan River Basin, WA—2 chicks	1950	
Downy young found on ground in forests		
Kodiak, AK	1986	S. Spruce
Gilltoyees Inlet BC	Aug. 26, 1919	
Franklin River, BC	Aug. 13, 1987	
Rugged Ridge, WA	1982 or 1983	
Aberdeen, WA	Aug. 7, 1983	
Devil's Lake, OR	Sept. 4, 1933	S. Spruce
Coos River, OR	July 22, 1940	
Humboldt Redwoods S.P., CA	Sept. 13, 1979	
Sun Mateo Co. Mem. Park, CA	July 11, 1982	

(Over 30 records of grounded fledglings not included. Adapted from Carter and Sealy (1987).)

Columbia, involved two chicks each found on the ground following tree falling. Another case involved a stunned adult with brood patch and eggshells found in the debris of a newly fallen Western Hemlock (*Tsuga heterophylla*). A similar report of this nature originated with E.J. Booth (Anonymous 1927), who obtained a Marbled Murrelet egg at a logging camp office in Whatcom County, Washington. It was found 24 kilometers inland near Saxon on the south fork of the Nooksack River on June 19, 1925, in a bed of moss, but there was no further explanation. Table 2 provides a listing of described tree nests and other situations which denote tree nesting.

There is a report from Japan of an incubating female taken June 15, 1961, in the forest of Mt. Mokoto, 24 kilometers from the Okhotsk Coast in eastern Hokkaido (Hasegawa 1984). Details of this have not been obtained.

Dates of the numerous records of stranded young show that Marbled Murrelet nesting occurs over an extended period. Egg laying can start as early as April 15 and fledging occurs as late as September 21.

The accumulated records show nesting occurs from near shorelines to distances that are far greater than would be expected of a seabird. Compilations made by Carter and Sealy (1987) include four records of downy young being picked up between 35 and 40 kilometers inland, and fledglings up to 55 kilometers from saltwater.

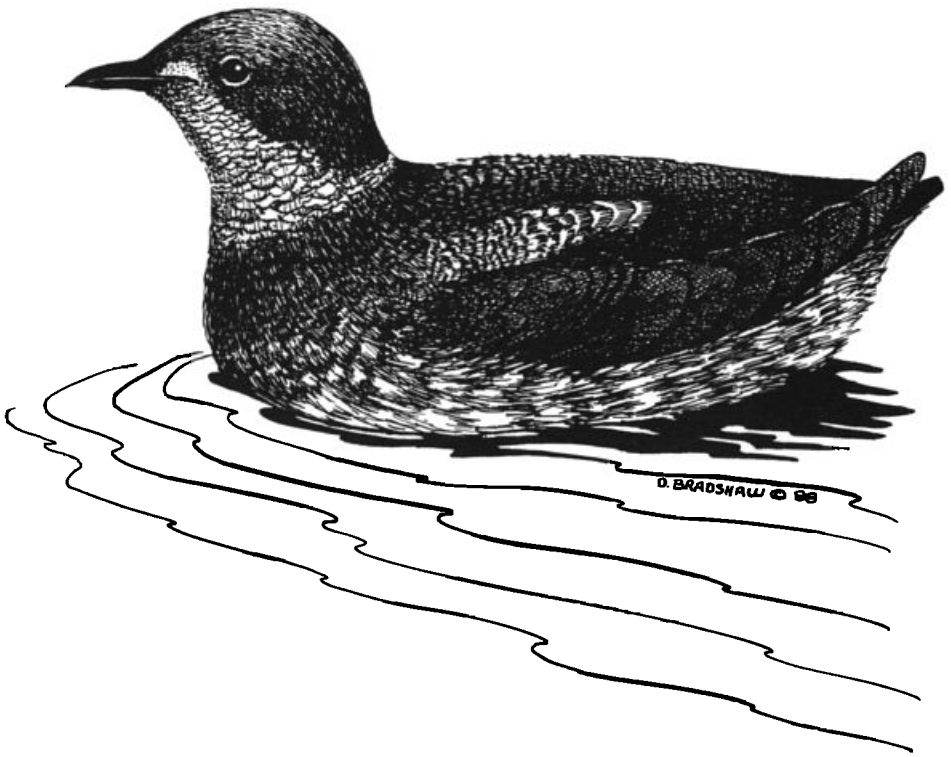
Distribution patterns: Other evidence of old-growth association includes distributional patterns. On the Oregon coast the species is most numerous opposite the remaining old-growth and mature forest stands. Sowls *et al.* (1980) reported that along the California coast, Marbled Murrelets occur in two distinct areas, from the Oregon-California border south to Eureka and from Half Moon Bay south to Santa Cruz opposite the largest tracts of coastal old-growth redwood in the state.

Morphological characters: Structural characteristics possessed by the Marbled Murrelet are worthy of consideration and fit into the pattern described above. The leg structure is not adapted to burrowing or walking (Storer 1945). Although Marbled Murrelets have been observed taking off from a level surface (Becking 1987), there are many reports of their not being able to take flight from level ground. This is certainly the situation with grounded fledglings. Alcids that nest on rocks and cliffs use elevation as an assist for gaining flight speed, and one would assume Marbled Murrelets obtain the same advantage by nesting high in trees or on steep slopes. It is also significant that the summer plumage of the Marbled Murrelet blends with conifer bark.

Because of their low aerial bouyancy, Marbled Murrelets must nest high in the treetops. The lush moss used to create a Marbled Murrelet nest does not appear on conifers in the northwest until the forest is at least 150 years old. Photo/David Marshall.

Ground nesting

Ground nesting occurs along steep, tundra edged coasts in Alaska. Six positive ground nests, including one that was in a rocky cavity, have been found in the general region of the Alaska and Kenai peninsulas along the Gulf of Alaska (Simons 1980; Day *et al.* 1983;



Illustration/Diana Bradshaw.

Johnston and Carter 1985). Outside this region, no ground nests have been reported with the exception of one on Chicagof Island in southeast Alaska (Gabrielson and Lincoln 1959; Drent and Guiguet 1961). The validity of this identification has not been confirmed (Kiff 1981).

At-sea behavior and food habits

At sea the Marbled Murrelet occurs mainly in near-shore shallow waters and in inland waters as found in Puget Sound, Washington, and through the inland passage of British Columbia to southeast Alaska.

In the Queen Charlotte Islands, Sealy (1975b) found Sand Lance (*Ammodytes hexapterus*), various other fish, and two invertebrates (*Euphausia pacifica* and *Thysanoessa spinifera*) to be important foods. Carter (1984) found that Pacific Herring (*Clupea harengus*) and Sand Lance were the principal prey in Barkley Sound, British Columbia. Collections from Alaska showed some of the same species plus Capelin (*Mallotus villosus*) (Sanger and Jones 1981; Sanger 1987). This prey is taken within two meters of the surface (Carter and Sealy 1984).

Marbled Murrelets do not feed in large flocks like other alcids, although loose aggregations occur in winter. According to Sealy (1975b), Marbled Murrelets, while feeding during the breeding season, "invariably occur in pairs or single individuals. Subadults feed singly; but in early July, when pairs of adults are still feeding young in the nest site, mixed flocks of adults begin to form." Subadults occur at sea throughout the summer since they do not breed until after their second year or later (Sealy 1975b; Carter 1984).

FACTORS AFFECTING CONTINUED EXISTENCE

Three threats to the species were identified by Sealy and Carter (1984) and the Pacific Seabird Group (1986b): old-growth habitat destruction, mortality from gill-net fisheries, and oil pollution. S.M. Speich (*pers. comm.*) considers disturbance caused by boating traffic to be a possible factor in Puget Sound, but this is extremely hard to quantify. Habitat destruction and gill-net mortality, when combined with the low reproductive rates of this species, are of special concern, particularly in those portions of the bird's range where population numbers are already low and where remaining nesting habitat is threatened. Although our knowledge of these factors is less than desirable, the available evidence points to a strong possibility of extinction within major portions of the bird's range if conservation measures are not undertaken, including a concerted research program to better identify the species' habitat requirements.

Old-growth forest destruction

As is the case with the Spotted Owl, logging of old-growth is believed to be the biggest threat to the Marbled Murrelet. Old-growth forest destruction in the Pacific Northwest was reviewed by Wilcove (1987) in his Spotted Owl paper (*AB*:41:3). However, the situation differs from the owl in that the Marbled Murrelet has a larger overall population, occurs further north than the Spotted Owl, but does not occur as far inland. The murrelet may also nest in late successional stages of mature forest stands, and it may not require the large stands of old trees needed by the owl or use the interior of the denser stands. Slope and exposure could be factors. In fact the murrelet may demonstrate that the Forest Service's indicator species concept wherein the Spotted Owl is used as an indicator species for old-growth does not work. Regardless of the outcome of such questions, old-growth destruction has been heavier in coastal forests than in the Cascade Range; and current timber harvest techniques, particularly short rotation ages (<80 years), do not allow conifers to develop large diameter flat limbs with thick moss layers used for nesting.

Most old-growth, within the range of the Marbled Murrelet in Washington and Oregon, is subject to cutting. Exceptions include Olympic National Park, state parks, Spotted Owl habitat areas, stream protection areas, and the Cummins Creek, Drift Creek, and Rock Creek wilderness areas of Oregon's Siuslaw National Forest. The three wilderness areas total 9078 hectares (22,431 acres), but only about one-third of this total is in old-growth. Old-growth trees in state parks, at least in Oregon, have been subject to logging in the past and are still not exempt from cutting. Over the next three years, the Bureau of Land Management expects to sell

20,963 hectares (51,800 acres) of old-growth and 10,725 hectares (26,500 acres) of mature forest in western Oregon (Morrison 1987a). In California, less than 10% of the original old-growth redwood forests remain. Approximately 28,300 to 30,400 hectares (70,000 to 75,000 acres) have been preserved in parks, although no new parks have been created since 1978. The outlook for old-growth preservation in British Columbia and Alaska is similar, but liquidation of stands will take somewhat longer (*e.g.* 50 years on Vancouver Island, British Columbia [see Sealy and Carter 1984]).

Mortality from gill-net fisheries

Carter and Sealy (1984) first identified a salmon gill-net mortality problem with Marbled Murrelets during a study conducted in 1979 and 1980 in Barkley Sound off Vancouver Island, British Columbia. They found the Marbled Murrelet was the most frequently killed alcid. They estimated a total of 380 Marbled Murrelets were killed by gill-nets in 1980 almost exclusively at night, and within two meters of the surface. This accounted for 7.8% of the potential fall population in the area. Sealy and Carter (1984) also reported that 600–800+ murrelets were killed annually in Prince William Sound, Alaska. Conservation measures recommended included changes in areas where the gill-net fishery takes place and prohibition of night fishing. H.R. Carter (Pacific Seabird Group 1986a) mentioned that 100 Marbled Murrelets washed ashore in Monterey Bay, California, in 1980 were probably gill-net casualties. Gill-net fishing does not occur off the Oregon coast, but is widespread in Puget Sound where there are 1200 current gill-net permits (Speich *et al.* 1987). Bird mortalities are not being monitored there, but casual observations indicate alcid losses.

Mortality from oil pollution

Sealy and Carter (1984) noted that King and Sanger (1979) rated the Marbled Murrelet as having the highest oil vulnerability index of any seabird in southeast Alaska. This is based in part on their feeding in local concentrations close to shore. Despite this, murrelets have been reported oiled only once each in British Columbia, Washington, and Japan and sporadically in small numbers in California (H.R. Carter *pers. comm.*). The proposed outer Continental Shelf developments off the California, Oregon, and Washington coasts will increase the threat of oiling mortalities and could have a dramatic adverse effect on small populations of murrelets in these areas (Carter *et al.* 1987).

Inadequacy of existing regulatory mechanisms

The petition to list the Marbled Murrelet as threatened in Washington, Oregon, and California is based on criteria delineated in the Endangered Species Act. Included is the ongoing and threatened destruction of habitat described above, mortality from gill-net fisheries, the increased potential for oiling and finally the inadequacy of existing regulatory mechanisms. Under the latter, it is noted that the Marbled Murrelet has not been placed in any special categories by state or federal agencies except in California where it is considered a species of special concern by the California Department of Fish and Game. This is an administrative category which contains species that may face extirpation, but information is considered inadequate for listing or the listing process has not been completed. No management considerations are required for a species in this category. Therefore throughout its range, Marbled Murrelet habitat is not at the time of this writing being protected or designated for special consideration by land management agencies, except what might occur through decisions related to other species or factors. Even if the petition to the Fish and Wildlife Service is denied, the species could be considered sensitive by the Forest Service. Such designation is likely to occur if a state so requests, and will occur in Oregon if the petition now being considered by the Fish and Wildlife Commission is acted upon favorably. If the latter occurs, the Bureau of Land Management may give it some consideration in the planning process, and the bird would be provided consideration in Forest Service timber sales. Sensitive status designation was first requested by the Pacific Seabird Group (Pacific Seabird Group 1986a).

The absence of protection for Marbled Murrelet nesting habitat contrasts with almost full nesting habitat protection provided other seabirds in Alaska, Washington, Oregon, and California through designation of their island nesting sites as national wildlife refuges or other protective categories.

RESEARCH, SURVEY AND PROTECTION NEEDS

Lack of knowledge in itself is a threat to the species. Considering that as few as 10 to 50 years remain before most old-growth habitat is eliminated (according to existing plans) within 75 kilometers of the coasts of Washington, Oregon, and California, immediate needs are to protect nesting areas. However, outside Big Basin Redwoods State Park, California, the evidence is only circumstantial that the forest areas in which Marbled Murrelets are detected by sound actually constitute nesting sites. At Big Basin, in addition to the previously described nest tree, eight fledglings have been found on the ground (Carter and Sealy 1987; Carter *et al.* 1987). In addition, the two tree nests described in North America do not fully provide the necessary parameters to characterize nesting sites, or to precisely predict where nesting may occur, especially in the Douglas Fir forests of British Columbia, Washington, and Oregon. Knowledge of distribution and numerical grouping of nests within the nesting areas will be required for proper management. The role forests play in winter for activities other than nesting is also unknown and must be determined. It must be determined if birds displaced by habitat loss use replacement habitat, and what impact continued fragmentation of old-growth forests has on the population.

Such information is essential before adequate protection can take place in light of pressures to remove old-growth and mature timber. Research of this nature could be costly considering the short period of the day inland murrelet activity takes place, attendant lighting conditions, and the fact that it has been difficult to date, because of lighting conditions, to even identify an actual

tree from which murrelets egress or ingress.

Standardized population monitoring procedures must be developed, implemented, and coordinated between agencies. Demographic characteristics of the species must be determined. This includes obtaining data on reproductive success, longevity, size of the population actually breeding, mortality rates, and reproductive rates necessary to sustain the population.

The extent of gill-net mortalities, especially in Alaska and British Columbia in summer and in Puget Sound, where large numbers of Marbled Murrelets gather in winter, needs to be determined. Such information may be difficult to obtain, especially because Indian tribes, under treaty or other legal provisions, play a major part in some fisheries.

CURRENT EFFORTS

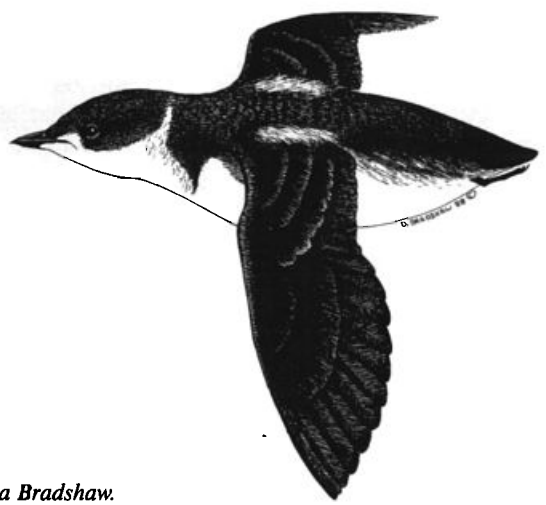
While the outcome of the listing petition is unknown at the time of this writing, it has generated interest in the species among government agencies, scientists, the press, and the general public. Government sponsored research specifically directed to the species is taking place for the first time in Washington and California this year, and Oregon's effort is being expanded. Past work in Alaska and Oregon concentrated on radio-telemetry. A radioed bird directed Alaska Fish and Game researchers to the Baranof Island nest. Researchers in Oregon, working under contract with the Oregon Department of Fish and Wildlife, will again attempt to locate Marbled Murrelet nests with radio-telemetry. Oregon also plans to refine inland detection methods utilizing 12 inland sites in which Marbled Murrelets have been detected in the past. Once methodology is completely developed, it is hoped funds can be obtained to make a complete inventory of coastal forests of Oregon. This needs to occur in all types of forests to avoid industry criticism over conducting work in only old-growth as was the case with the Spotted Owl. In addition to the state Department of Fish and Wildlife, Oregon's work is being funded by the U.S. Forest Service, U.S. Fish and Wildlife Service, and the Bureau of Land Management, the National Fish and Wildlife Foundation, and the National Council of the Paper Industry for Air and Stream Improvement.

Washington's effort this year is being directed to locating inland use areas along the Olympic Peninsula, San Juan Islands, and near the mouth of the Columbia River. Like Oregon, Washington wants to concentrate on developing methodology before undertaking a large scale effort. Testing of different radio types and configurations is planned using captive Marbled Murrelets in tanks. The National Council of the Paper Industry for Air and Stream Improvement and the Washington Department of Wildlife are participating in this research.

A cooperative effort between the California Department of Fish and Game, the Forest Service, Point Reyes Bird Observatory, U.S. Fish and Wildlife Service and possibly other groups is underway in redwood forests of California. It is utilizing detection techniques already developed in California as described by Paton *et al.* (1987) and Sander and Carter (1987). This statewide survey will attempt to locate and characterize forested areas used by Marbled Murrelets, examining all forests of all ages, but is not directed to locating actual nests. R.W. Becking of Arcata, California, is conducting research in state parks where Marbled Murrelets are regularly detected.

At the 14th annual meeting of the Pacific Seabird Group held in December 1987 at Pacific Grove, California, researchers from Alaska to California presented papers that reviewed Marbled Murrelet status and current research on inland detection and at-sea studies. In addition, a workshop on management of the species was held, following up on a similar workshop held at the Pacific Seabird Group meeting in La Paz, Mexico, in December 1986. Workshop summaries can be found in the *Pacific Seabird Group Bulletin.* Researchers are currently preparing papers presented at the 1987 meeting for combined publication in the *Proceedings of the Western Foundation of Vertebrate Zoology,* and will meet in Portland, Oregon, in September to review results of 1988 work.

The above represents only the beginning of the massive research effort needed to assure continued existence of healthy populations of Marbled Murrelets along the Pacific Coast. Considering the complex biology of the bird, its crepuscular nature inland, and the fact that in the Pacific Northwest it apparently nests high in trees located in forests having the greatest biomass of any in the temperate world, we have before us a major research challenge which far exceeds the Spotted Owl.



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