Studies in Avian Biology No. 15:286–292, 1994.

*Case Histories*

# EVIDENCE OF CHANGES IN POPULATIONS OF THE MARBLED MURRELET IN THE PACIFIC NORTHWEST

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*Abstract.* The Marbled Murrelet (*Brachyramphus marmoratus*) occurs along the coasts of the North Pacific. It is unique among the Alcidae in its tree nesting habits. Recent research has revealed that in forested areas it is closely associated with old-growth coniferous forests, most of which have been harvested over the past 100 years. All historical accounts, although fragmentary, indicate a previously higher population of the bird throughout its North American range. Several reasons for the decline have been advanced, including habitat removal, mortality due to capture in fishing nets, and increased predation during nesting. The current population is estimated at about 360,000 birds.

*Key Words:* Marbled Murrelet; *Brachyramphus marmoratus*; Alcidae; population; mortality; predation; demography; old-growth forests.

The Marbled Murrelet (*Brachyramphus marmoratus*) is an alcid breeding along the coasts of the North Pacific (Fig. 1). The better known race (*B. m. marmoratus*), breeds from Alaska south to central California. The other race (*B. m. perdix*) occurs from the Russian Far East south to northern Japan. Although the species is fairly abundant in some areas, it has largely escaped ornithological study until recently, because of its secretive nesting habits and its frequenting of nearshore waters, where oceanic bird surveys miss it.

Increasing concern about its apparent decline has resulted in its being listed as "threatened" in the states of Washington, Oregon, and California by the U.S. Fish and Wildlife Service in 1992, and also by the Province of British Columbia in 1990. I will examine the life history traits of the species that put it at potential risk, the present population size, evidence of habitat affinities, and evidence for decline.

## HABITS OF THE MARBLED MURRELET

Knowledge of the habits of the Marbled Murrelet is essential for understanding the reasons for its population changes over the past century. Many of its habits make it vulnerable to predation on the nest and difficult to study.

On the ocean, the murrelet usually occurs in pairs as it dives for small fish and invertebrates. It does occur in flocks of up to a dozen birds, or even several hundred, especially in Alaska and British Columbia. Such aggregations can occur in tidal rips, the often food-rich boundary between the tidal flow and calmer waters of a channel, fjord, or estuary.

Marbled Murrelet nests are difficult to find and observe because they are high above the ground in large trees, widely scattered, often far inland, involve no nest construction, and are usually visited only once a day. In most of its range the species nests in solitary pairs (or perhaps loose associations) on the wide, upper branches of old conifers, primarily within 50 km of the coast. These habits resulted in its nest being the last to be discovered (in 1974) of a widespread, North American breeding bird (Binford et al. 1975). All of the 38 tree nests found through 1992 have been in coniferous "old-growth" forests, which I define here as those unmodified by timber harvesting, and whose larger trees average over 200 years old. At a few sites in Alaska the bird does nest on the ground above the local tree line, in low-lying mat vegetation (see Mendenhall 1992).

Some aspects of the species' breeding biology reflect its vulnerability to predation, and others result in a low reproductive rate. Birds usually visit the breeding stands within a half hour of dawn at most latitudes,

calling and flying through and over the forest. During these periods the birds may relieve nest duties, feed the young, or merely visit the stand. This is the only time observers can estimate numbers of murrelets in a stand. The breeding plumage, in contrast to its winter plumage of dark above and white below, is the "marbled" plumage, completely mottled dark brown, which provides effective camouflage in a forest environment. Murrelets lay but a single egg per clutch (Sealy 1974). The incubation and nestling periods are about 30 days each (Simons 1980, Hirsch et al. 1981), allowing a long exposure to forest predators, such as jays and ravens. Both parents alternate care of the egg and young chick on a 24-hr rotation. When a nest exchange occurs, the relieving bird flies directly to the nest site, and the incubating bird departs with little or no ceremony. After the chick is a few days old, it is usually left alone while both adults forage, bringing it food once to several times a day.

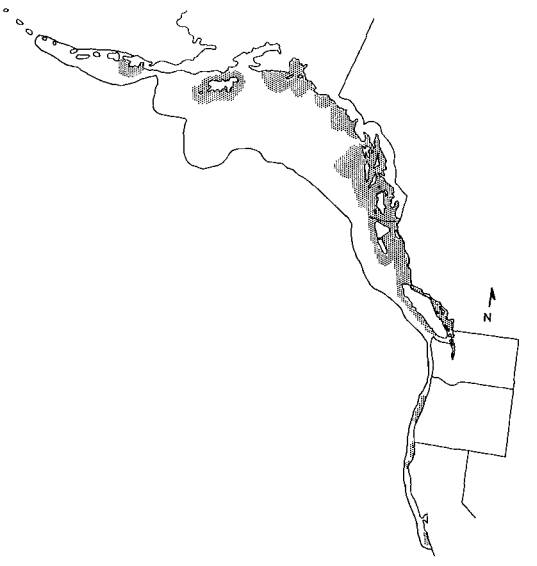


FIGURE 1. The North American range (outlined) of the Marbled Murrelet showing known areas of concentration (stippled).

## POPULATION TRENDS AND PRESENT SIZE

Nowhere in its range has there been a report of an increase in numbers of Marbled Murrelets. All accounts note fewer birds.

### *Asia*

There is no information on trends of *B. m. perdix* offshore of its breeding grounds in the Russian Far East and south to the northern Japanese islands. Russian biologists (e.g,. N. Konyukhov, pers. comm.) have found the race to be quite uncommon.

### *Alaska*

Data from Christmas Bird Counts in a few areas showed an overall decline of at least 50% in absolute abundance from the early 1970s to the late 1980s, despite a 50% increase in observer effort (J. Piatt and N. Naslund, pers. comm.). The species reaches its greatest densities in Alaska, occurring sparsely in the western Aleutian Islands, and more commonly along the coasts of central and southeastern Alaska (Kessel and Gibson 1978, Piatt and Ford 1993). Mendenhall (1992) reported an estimate of 250,000, based on ocean surveys by M. McAllister. Piatt and Ford (1993) estimated the population at around 200,000, based on other extensive surveys.

### *British Columbia*

Historical accounts suggest an overall decline. Brooks (1926) noted, without details, that wintering murrelets had declined between 1920 and 1925 along the east coast of Vancouver Island. Pearse (1946) reported a decline in the Comox area between 1917 and 1944, which he attributed to the removal of old-growth forests. Finally, Kelson et al. (in press) surveyed an area in 1992 and found a decline of 40% from a 1982 survey. Rodway et al. (1992) stated that the bird occurs today in most coastal areas, and they estimated the population at 45,000–50,000 birds.

### *Washington*

Whereas previous observers (Rhoads 1893, Edson 1908, Rathbun 1915, Miller et

al. 1935) described the murrelet as common, abundant, and numerous, Speich et al. (1992) felt that it was "now only locally common." They suggested a breeding population of about 5000, distributed mainly in northern Puget Sound.

*Oregon*

Nelson et al. (1992) noted that since 1970 murrelet distribution has been similar to historic accounts (e.g., Gabrielson and Jewett 1940), but the density was lower. For instance, Nelson noted that "large numbers are now rarely reported from the mouth of Columbia River, at Yaquina Bay, and Tillamook County," where they were formerly more common. The statewide population was estimated at "less than 1000 pairs" from a variety of sources (Nelson et al. 1992).

*California*

Evidence of declines has accumulated in the state. Carter and Erickson (1992) noted three specific areas in Del Norte, Humboldt, and Santa Cruz counties where birds largely disappeared from probable breeding sites after timber harvesting. This includes the observation by Joseph Grinnell (field notes of July 1923 at the Museum of Vertebrate Zoology at the University of California, Berkeley) that "Mr. Wilder says that he has not himself heard these birds since the redwoods were lumbered off the hillsides back of his place." Another observation is that of Dawson (1923), who was camping in June 1916 about a kilometer from the coast in Trinidad, Humboldt County, and noted that "some birds passed quite low over our camp," a behavior typical of birds nesting nearby. Today, no murrelets are heard in the forests near Trinidad (Paton and Ralph 1990). Additional evidence of a decline comes from a 1937 oil spill, when Aldrich (1938) found 14 dead Marbled Murrelets on San Francisco and Marin county beaches. Today the species is rare in this area (Carter and Erickson 1988, Paton and Ralph 1990), and in more recent spills, only a very few were found (e.g., Stenzel et al. 1988, Page et al. 1990).

The state's population has been estimated at 1600–2000 (Sowls et al. 1980, Carter and Erickson 1992), based on some coastal surveys in the two regions of concentration. From more extensive work in recent years, we now estimate the population in excess of 5000 individuals (Ralph and Miller, unpubl. data).

## HABITAT ASSOCIATIONS

Prior to the 1970s, the only reference to the species' actual nesting habitat was an Indian account, reported and discounted by Dawson (1923), that murrelets nested inland in "hollow trees." Today, this seems interpretable as large, old trees containing hollows.

Evidence has accumulated recently that the species requires old-growth forests for nesting. In the 1970s observers began to note that its offshore range was contiguous with inland old-growth (Sowls et al. 1980, Carter and Erickson 1992, Nelson et al. 1992). From anecdotal observations several authors have also associated this species' presence inland with older forests (see summaries in Marshall 1988 and in Carter and Morrison 1992). Systematic surveys have confirmed this in California (Paton and Ralph 1990), Oregon (Nelson 1990), Washington (T. Hamer, pers. comm.), British Columbia (Rodway et al. 1991), and Alaska (K. Kuletz, pers. comm.). Despite extensive observations by numerous observers in forests of various ages, all forest nests have been found in old-growth.

Old-growth coniferous forests were formerly continuous in much of the species' present range. By all estimates, at least 80% of the old-growth forests have been removed in California, Oregon, and Washington (e.g., Morrison 1988). In British Columbia and Alaska, less has been harvested, although the rate is increasing. In southeast Alaska, although probably less than 10% of the former forest cover has been harvested, much of this includes the largest trees which occur within a few kilometers of shore, where they are more easily harvested (C. Iverson, pers. comm.).

## BREEDING SUCCESS

A low or declining reproductive rate could have contributed to the historical reduction of the species' population. The reproductive rate has several components. The proportion of the population breeding has only been documented by Sealy (1974), who found that about 85% of the birds in a large sample collected from the ocean in British Columbia had brood patches (both sexes incubate). This is within the normal range for other alcids (Hudson 1985). In contrast, the fledging success appears to be low. Data compiled by K. Nelson (pers. comm.) revealed that of the 43 nests found through the 1992 season, the outcome of 17 (including all the Alaskan ground nests) was unknown, 19 nests failed, and only seven fledged a young bird. Of these 26 with a known outcome, the success rate was then only 27%, as compared to about 70% in other alcids (Hudson 1985).

Another measure of reproductive success is the proportion of young in the offshore population. In the past five years off the California coast during late July and early August, murrelets in juvenal plumage were usually less than 3% of the population (Ralph et al., unpubl. data). Similarly, C. Strong (pers. comm.), off Oregon, found 1.2–3.5% in 1992. Surveying at three headlands on the Oregon coast from 1988–1991, Nelson and Hardin (pers. comm.) found young averaging 3.2% (range 2–5%) of the population. However, we do not know when birds molt into a plumage similar to an adult in winter. If this occurs rapidly, perhaps half of the young would be overlooked. Even so, this would only double the percentage to a maximum of 10%, still quite low. In a variety of other alcids normal production would result in 25–30% young (Hudson 1985, Ainley and Boekelheide 1990), with the early fledging Ancient Murrelet (*Synthliboramphus antiquus*) at more than 40% (Gaston 1992). It is of interest that a demographic model based on the average of 27% nest success discussed above predicts a very low proportion of young on the water, after dilution with non-breeders and some early mortality (S. Beisinger, pers. comm.). This lends corroboration to the offshore ratio of less than 5%. It seems very likely that the current recruitment rate is not adequate to maintain the population and that it was much higher in the past.

## POSSIBLE CAUSES OF POPULATION DECLINES

### *Habitat removal*

The absence of murrelets in areas that have lost their old-growth forests, and their occurrence today only in the remaining old-growth, are presumptive evidence that declines have occurred due to the extensive removal of these forests. The most direct evidence of the effect of habitat loss is the 40% decline of a British Columbia population reported by Kelson et al. (in press), coinciding with the removal of about 5–10% of the old-growth between 1982 and 1992. This followed a decade in which approximately 7–10% of the old-growth had been harvested. Since alcids commonly live 10 years or more (Hudson 1985), the population's response to the removal of nesting habitat might well have been delayed.

### *Fishing activities*

In parts of its range, incidental catch of murrelets in nets set by fishermen can be a significant source of mortality. Carter and Erickson (1992) summarized gill-net deaths in central California. They estimated that 150–300 murrelets were lost between 1979 and 1987 from a population at present estimated to be a few hundred birds. In British Columbia, Carter and Sealy (1984) found that 6% of the breeding adults in a population were caught in a year's gill-net operation in Barkley Sound. In addition, Sealy and Carter (1984) reported hundreds of birds killed over several years by gill-netting in Prince William Sound, Alaska, and probably also in southeast Alaska, based on information from P. Isleib. Commercial fishermen in Alaska have told me that they have at times netted several murrelets a day in gill and purse seine nets. This, multiplied

by the many hundreds of fishing boats within the murrelet's range, could have had significant effects. J. Piatt and N. Naslund (pers. comm.) found in Prince William Sound that net mortality was 923 in 1990 and 714 in 1991. Based on netting permits throughout Alaska, they estimated that some 3300, or about 2.1%, of the population, dies each year from this cause. The many years of netting in Alaska waters in this century could have resulted in a substantial loss, especially in recent years with the advent of the less visible monofilament nets.

*Oil spills*

Historically, the species has been a common victim of oil spills (e.g., Racey 1930, Burger in press), probably due in part to its nearshore distribution. It has been estimated that the *Exxon Valdez* spill in Prince William Sound resulted in a loss of approximately 6500 individuals, or a toll of about 3% of the total Alaskan population (Piatt et al. 1990, Piatt, pers. comm.).

*Predation*

Unlike most burrow and crevice-nesting alcids, Marbled Murrelets suffer high rates of nest predation, at least in recent years. Of the 19 documented failures, 14 (74%) were due to avian predators (Nelson, pers. comm.), including Steller's Jay (*Cyanocitta stelleri*), Common Raven (*Corvus corax*), and possibly Great Horned Owl (*Bubo virginianus*). (Of the other failures, chicks fell out of three nests, one chick suffered a burst aorta just prior to fledging, and one was abandoned by the adults.) Of the 26 nests with a known outcome, then, 54% were lost to predation: a rate that is almost unmatched in other alcids (e.g., Hudson 1985; but for exceptions see Murray et al. 1983, Gaston 1992). I suspect that this reflects a recent development in the species' life history. It seems unsustainable given the murrelets low intrinsic rate of reproduction.

There is, of course, the possibility that the nests located by investigators are in sites easily located by predators. Many of the nests have been on the edges of older stands or in stands fragmented by timber harvest, where predators are possibly more abundant than in continuous old-growth. However, low numbers of young at sea indicate that the low reproductive rate probably applies to all nests.

## DISCUSSION

Three lines of evidence indicate that Marbled Murrelet populations are declining. 1) All historical, anecdotal, or quantitative reports are of declines; none of increases. 2) Nest records and habitat surveys find a close association of the species with old-growth forests, which have been reduced by more than 80% over the past 150 years. 3) Current rates of recruitment do not appear to be high enough to sustain the species.

Even though no one has reported increases in murrelet populations, we must consider the possibility that murrelets disappearing from one area have merely moved to another. It seems likely that a long-lived bird, finding its nesting grove destroyed, would move elsewhere, aggregating in the remaining nest stands. In extreme northern California, relatively large stands of old-growth redwoods in parks are islands amidst oceans of clear cuts and young second growth. There, in the Lost Man Creek area of Redwood National Park, we (Paton and Ralph 1990) found the highest rate of murrelet activity anywhere in the species' range, with an average of 150–250 detections per morning during the breeding season. The seasonal peaks usually exceeded 350, and we recorded 399 on one morning in July 1991. This concentration could: 1) be due to especially favorable offshore resources; 2) represent once-common densities on the north coast of California; or 3) be an aggregation of birds displaced by harvesting. It is not yet clear which of these alternatives (or combination of alternatives) is correct, but I think that the first two are much more probable.

It seems likely that the species now has a very low reproductive rate, by the measure of fewer than 5% of juvenile birds offshore. This is very troubling for the species' long-term survival. Even if this is an underestimate, it is unlikely that even a rapid passage through juvenal plumage could account for the difference between this and the proportion of juveniles in most alcids (25–30%).

The high predation on nests seems unsustainable, given the apparent low intrinsic reproductive rate. It is possible that increased fragmentation of the historically more continuous old-growth forests has resulted in increased numbers of predators, such as ravens, crows, and jays. If so, predation is likely a very pervasive factor that cannot be easily reversed. The effect of predation would be greatly compounded by a constant drain at sea of young, and especially adults, in fishing nets.

The evidence strongly suggests that over the past century Marbled Murrelet populations have declined throughout their entire range. Their nesting areas have been much reduced, and they are suffering high mortality from predation and fishing nets. The identification and protection of critical nesting and foraging habitats is essential for the long term maintenance of the species as a part of the avifauna of the Pacific Northwest.

ACKNOWLEDGMENTS

I thank the members of the interagency Marbled Murrelet Conservation Assessment Team who have contributed many ideas and data to our ongoing appraisal of the species. K. Nelson shared her compilation of the known nests of the species. J. Piatt and H. Carter were especially helpful in contributing their experiences and insights. I am also grateful to Mike Horton, J. R. Jehl, Jr., N. K. Johnson, K. Nelson, M. McAllister, S. Miller, and especially Carol Pearson Ralph for their helpful comments on drafts of the manuscript.

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