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POPULATION STATUS AND CONSERVATION PROBLEMS OF THE MARBLED MURRELET IN CALIFORNIA, 1892-1987

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ABSTRACT

We collated published and unpublished information from 1892 to 1987 on the Marbled Murrelet (*Brachyramphus marmoratus*) in California to determine the past and present status of the breeding population and to document conservation problems. The state breeding population size has been reestimated at 1650 birds for the years 1979-1980. One nest was found in an old-growth Douglas-fir and 17 fledglings have been found in coastal forests. From 1904 to 1987, murrelets were detected at 67 inland localities mainly in three regions: 1) Del Norte and northern Humboldt counties (n=43 localities up to 15 km inland); 2) South-central Humboldt County (n=4 localities from 20 to 40 km inland); and 3) Southern San Mateo and northern Santa Cruz counties (n=16 localities up to 20 km inland). Murrelets have been detected in old-growth forests during the breeding and non-breeding seasons in 17 years since 1946 at Prairie Creek Redwoods State Park, in nine years since 1959 at Big Basin Redwoods State Park, and in four years since 1956 at Portola State Park. Two areas of concentration of murrelets at sea have been identified: 1) the Oregon border to Eureka; and 2) Half Moon Bay to Santa Cruz. These areas occurred adjacent to known nesting regions, although small numbers of birds occurred at sea and may breed between these areas. Cases of loss of nesting habitat in old-growth forests have been recorded in northern and central California. Mortality from gill-net fishing has been recorded in Monterey Bay from 1979 to 1987. Mortality from large oil spills and chronic oiling has been recorded in central and southern California. The current small population size of Marbled Murrelets in California probably reflects a population decline due mainly to the extensive loss of old-growth forests by logging over the past century. With continued logging and eventual liquidation of old-growth forests outside of parks, we expect continued population decline and possible extinction unless extensive management action is taken in the near future.

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INTRODUCTION

Much concern has been expressed recently about the Marbled Murrelet (*Brachyramphus marmoratus*) in the southern parts of its range, primarily because of its use of old-growth forests for nesting and the rapid and extensive removal of these forests by large scale clear-cut logging (Sealy and Carter 1984, Carter and Sealy 1987, Marshall 1988). Since few tree nests of this species have been found, it has been difficult to ascertain to what degree the continued existence of viable populations is threatened. This is particularly perplexing in California, Oregon, and Washington where murrelets occur in smaller numbers and old-growth forests are in shorter supply than in more northerly areas. Currently, the Marbled Murrelet receives no special protection although it has been listed as a species of special concern in California (Remsen 1978). There is an immediate need to make all information on Marbled Murrelets available for assessing the apparent degree of threat posed by the removal of nesting habitat and other mortality factors as well as for deciding what further research and conservation actions are most appropriate. Herein, we summarize published and unpublished information from 1892 to 1987 on breeding chronology, at-sea distribution, breeding population size, use of coastal forests and conservation problems of Marbled Murrelets in California.

METHODS

Published information and unpublished reports were obtained largely from an extensive search of the literature undertaken by Carter in the course of other range-wide summaries of information on murrelets (e.g. Carter and Sealy 1986, 1987) and other studies of seabird mortality from gill-net fishing and oil pollution in California (e.g. Takekawa et al., in press; Page et al., in press). This search was supplemented with some local literature known to Erickson from other studies of the distribution of birds in California plus recent unpublished reports provided by other murrelet researchers. We also examined all specimens of Marbled Murrelets in the California Academy of Sciences, the Humboldt State University Museum, and the Museum of Vertebrate Zoology at the University of California, Berkeley. Unpublished observations of murrelets were obtained from bird record files maintained by Erickson, S. W. Harris, Santa Cruz Bird Club, state parks, the northern California regional editors for American Birds (AB) and field notes housed at the Museum of Vertebrate Zoology. Additional observations were obtained through solicitation of a wide range of bird watchers and seabird researchers in California and elsewhere as part of this and earlier studies. This was supplemented with further contacts for updating and correcting information obtained. In addition, we have included our own extensive sets of unpublished observations on murrelets in California; Erickson has been keeping records on murrelets in northern California since the late 1970's and Carter and T. G. Sander (unpubl. data) have conducted intensive observations of murrelets at Prairie Creek Redwoods State Park and at other sites in 1987. We feel that our compilation of published and unpublished information is as complete as possible.

POPULATION STATUS

Breeding Chronology

Few nests of the Marbled Murrelet have been found anywhere in its breeding range (Day et al. 1983, Carter and Sealy 1987). To determine the timing of breeding elsewhere, researchers have used behavioral observations and information on breeding status obtained from birds collected at sea (Sealy 1974, Carter 1984). In California, there is little information on Marbled Murrelets at sea, other than distributional records. However, by examining the dates on which fledglings have been found at inland localities, we have approximated murrelet breeding chronology in the state (Fig. 1, Table 1).

A total of 15 fledglings have been discovered in California between 12 June and 9 September (Table 1; see Carter and Sealy 1987). By subtracting 28 days for the nestling period and 30 days for the incubation period (Sealy 1974, Simons 1980, Hirsch et al. 1981), we estimated that egg laying ranged from 15 April to 12 July and hatching ranged from 15 May to 10 August.

Specific dates for 13 fledglings fell into two periods: a) 12 June to 4 July (n = 6); and b) 11 August to 9 September (n = 7), which we extended to about 20 September to account for the downy chick (about 75% grown) found on 13 September (Fig. 1, Table 1). It is difficult to interpret this pattern based on the meager evidence available, and it may reflect the low sample size or unknown factors affecting the groundings of fledglings. However, the latest fledgling dates (31 August to 20 September) and the probable late fledging date of the one nest found in the state (Binford et al. 1975) occurred in years of high chick productivity for other alcids in California (i.e., 1974, 1977, 1979, 1985) when late first clutches, replacement clutches, and double brooding occur more frequently (Manuwal 1974, 1979; Ainley and Boekelheide, in press). Early fledgling dates occurred in years of both high and low chick productivity for other alcids in California (i.e., 1971, 1976, 1979). Thus, the second (later) fledging period may represent extended breeding in good years or by certain individuals.

Egg laying begins earlier in California than elsewhere in the breeding range. While egg laying can occur as early as late April in British Columbia and southeastern Alaska, most egg laying there occurs in late May and early June (Sealy 1974, Carter 1984, Carter and Sealy 1987). From California to southern British Columbia, locally-breeding Marbled Murrelets appear to remain near nesting areas during the non-breeding season, based on inland records of birds in the non-breeding season at the same localities where they are detected during the breeding season (Carter and Sealy 1986, 1987; this study). By visiting nesting areas throughout most of the year in California, murrelets may come into breeding condition earlier. To examine this hypothesis further, we examined specimens of after-hatching-year (AHY) murrelets collected between 16 February and 4 April in the Monterey Bay area by R. H. Beck (1907-1911) and C. P. Streator (1936-1941), that are housed in the Museum of Vertebrate Zoology at the University of California, Berkeley, and in the California Academy of Sciences. Of 11 specimens collected between 16 February and 6 March, 63.6% were in complete (or almost complete) basic plumage and 36.4% were undergoing pre-alternate body molt. The earliest date for a molting bird was 18 February (CAS 10163). Of 34 specimens collected between 16 March and 4 April, 23.5% were in basic plumage, 47.1% were molting, and 29.4% were in complete (or almost complete) alternate plumage. The earliest date for a bird

in alternate plumage was 26 March, although several specimens were collected on this date (see Table 2). This timing of pre-alternate body molt supports the earlier timing of breeding in California suggested by fledgling dates and is earlier than the April to May period reported for the U.S.S.R. by Koslova (1957). However, Sealy (1975a) found that adults arrived in breeding areas in late April in "essentially" alternate plumage in northern British Columbia. While we do not know where the Monterey Bay specimens would have bred (since it appears that some migrant birds occur in California waters in the non-breeding season), they most likely belonged to local breeding populations.

Overall, the breeding season of Marbled Murrelets in California is quite protracted (Carter and Sealy 1987). In fact, it is probably even more so than depicted above. For example, juvenal-plumaged, hatching-year (HY) birds have been collected as early as 1 June and as late as 25 October (Table 3). Thus, egg laying can sometimes occur at least as early as 4 April. The latest date of a murrelet collected in alternate plumage was 20 September (Table 2). It is not known how long after fledging that HY birds retain their juvenal plumage or how long after nesting that adults retain their alternate plumage, but it is possible that the nestling period could sometimes extend into October (also see Carter 1984). The overall length of the breeding season of Marbled Murrelets in California is surpassed only by that of Cassin's Auklets (*Ptycoramphus aleuticus*) which breed from March to September on the Farallon Islands (see Ainley and Boekelheide, in press) and also attend colonies for most of the year in California. Similarly, Common Murres (*Uria aalge*) visit colonies during the non-breeding season in California, and breed earlier than birds farther north (Ainley and Boekelheide, in press; Takekawa et al., in press).

At-Sea Distribution

Surveys have not been conducted specifically to determine the distribution of Marbled Murrelets off the coast of California. We have collated available information on their at-sea distribution during the breeding season (1 April to 1 September) that has been obtained either incidentally in the course of other studies, or by the (largely) non-standardized observations of the birdwatching community and reported to the northern California regional editors of AB. We assumed that birds observed during this period belonged to local breeding populations and were not far from their respective nesting areas. We have relied most heavily on observations of murrelets made during the U. S. Fish and Wildlife Service (USFWS) survey of California seabird colonies in 1979 and 1980 (Sowls et al. 1980). Since murrelets tend to occur mainly within one to two kilometers of shore (Carter 1984, Sealy and Carter 1984), where most small islands with nesting seabirds occur in California, USFWS observations along the central and northern California coasts in 1979 have provided the best available picture of overall at-sea distribution to date (see Fig. 2; Tables 4, 5).

Two areas of concentration were identified by Sowls et al. (1980): a) Oregon border to Eureka (76% of 1979 sightings); and b) Half Moon Bay to Santa Cruz (14% of 1979 sightings). All USFWS sightings in 1980 were from these areas only. Reports to AB from 1955 to 1987 (Tables 6, 7) confirmed this general distribution of murrelets in the state and further served to indicate that murrelets are observed consistently from year to year at certain localities (e.g., Año Nuevo, Crescent City, Pigeon Point, Point Santa Cruz) throughout

the breeding season. However, it is evident that the coast between Eureka and southern Sonoma County has not been adequately surveyed by USFWS or others. While we do not expect that large numbers occur in this area, it is likely that more birds occur there than have been found to date. In contrast, there are virtually no breeding season records from southern Sonoma County south to Pillar Point, San Mateo County, or south of Santa Cruz. Murrelets are observed mainly in late August in the latter areas (see Bolander and Parmeter 1978; C. S. Strong and D. A. Croll, unpubl. data) and probably represent some post-breeding dispersal. This is supported by observations of birds undergoing pre-basic molt in these areas (Tables 4, 5). Two areas which need to be examined in greater detail are the vicinity of the Gualala River mouth and the area from Eureka to Shelter Cove. Based on the few observations available for these spots (Tables 5, 7, 8, 9), small, isolated populations may occur in these areas.

Flock sizes of murrelets observed during the USFWS survey were similar to those reported in British Columbia where murrelets are more abundant (see Carter 1984, Sealy and Carter 1984). Of 210 flocks reported (Tables 4, 5), 27.6%, 60.0%, 8.6%, 3.3%, and 0.5% were single birds and flocks of two, three, four, and five, birds, respectively.

Recently, there has been speculation that Marbled Murrelets may breed south of northern Monterey Bay, along the Big Sur coast (McCaskie 1979, Roberson 1985). There is no recent evidence to support this speculation, other than the occasional observation of Marbled Murrelets slightly north of this area during the breeding season (Fig. 2). Since 1980, murrelets have been observed regularly even farther south, especially at Point Sal, Santa Barbara County (Fig. 2). We consider all such recent records south of Santa Cruz County to represent non-breeding birds.

Some interesting observations of Marbled Murrelets (farther from shore than usually noted) have been made by the Point Reyes Bird Observatory during offshore surveys of seabirds in central California during the breeding season (Table 8). Murrelets were observed from 2.7 to 7.3 km from shore on 18 occasions, primarily off the southern area of concentration between Pillar Point and Santa Cruz. In one case, a single bird was observed 33.1 km from the mainland, although this bird may have been a misidentified (D. G. Ainley, pers. comm.). Elsewhere, murrelets also have been observed on occassion farther than one to two km from shore (Sanger 1972, Carter 1984, Sealy and Carter 1984). However, it is unlikely that this behavior occurs to any great degree in California. Extensive aerial surveys of seabirds conducted by the University of California, Santa Cruz, in shelf and slope waters off central and northern California in 1980-1983 did not identify Marbled Murrelets anywhere other than close to shore during the breedings season (Briggs et al. 1987; Table 9). Similarly, boat surveys conducted by the Moss Landing Marine Lab in northern Monterey Bay in the 1980's have not found murrelets far from shore (C. S. Strong and D. A. Croll, unpubl. data). Marbled Murrelets have not been recorded 29 km offshore at Southeast Farallon Island, despite daily observations by the Point Reyes Bird Observatory since 1968 (DeSante and Ainley 1980; PRBO, unpubl. data).

While we have not specifically reported the numbers and distribution of Marbled Murrelets at sea during the non-breeding season in this report, it is evident in AB files and U. C. Santa Cruz survey data (D. B. Lewis, unpubl. data) that they occur close to shore in the same localities as during the

breeding season as well as more widely throughout most of the state, occasionally as far south as Imperial Beach, San Diego County (McCaskie 1980a). However, Marbled Murrelets were twice noted on U. C. Santa Cruz surveys far from shore in water depths of 180-1800 m off Eureka in March 1981 (n = two birds) and off Point Saint George in March 1982 (n = three birds); thus, murrelets may undertake some migratory movements far out to sea. Numbers off nesting areas appear to be only slightly larger than during the breeding season, except during the winter of 1979-1980 when an unprecedented invasion of Marbled Murrelets occurred and they were recorded more frequently than usual in southern California (McCaskie 1980a, Garrett and Dunn 1981). A slight increase in numbers would be expected from all breeding adults plus juveniles occurring at sea during the non-breeding season. Thus, it is not clear if there are any number of migrants from more northerly breeding areas that visit California in the non-breeding season, as is known for some other alcids. Some post-breeding dispersal of local breeders or their young could alone account for the wider distribution of murrelets at this time, at least in most years. We have not discussed the four records of the Asiatic Marbled Murrelet (*B. m. perdix*) for California, all from Mono Lake, Mono County, because these records are being published in detail elsewhere (Jehl and Jehl 1981; Sealy et al. 1982, in prep.).

At-Sea Population Size

Sowls et al. (1980) speculated that about 2000 Marbled Murrelets breed in California. This estimate was based on incidental observations of 185 and 390 murrelets in 1979 and 1980, respectively, during the California seabird colony survey by USFWS. Sowls et al. (1980) felt that this population estimate may be conservative because: 1) murrelet breeding habits are poorly known; 2) surveys were not designed to census murrelets in the most accurate fashion; 3) murrelets were observed incidentally while surveying other seabirds; 4) murrelets may have occurred farther from shore than where surveys occurred; and 5) murrelets were difficult to see at sea in other than perfect conditions.

We re-examined the raw data from this study (Tables 4, 5; stored at the California Academy of Sciences) and discussed data collection techniques with A. L. Sowls and G. S. Lester to provide further justification of this population estimate. Both the raw data and estimation method were omitted from Sowls et al. (1980) during publication. It was evident that some double counting occurred where observations were made in the same segments at different times in the breeding season, and at different times of day on 19 May 1980 between the Oregon border and Eureka. We adjusted numbers observed in this area by taking the highest count obtained in a segment at one point in the breeding season (Table 10). It was also clear that coverage was more complete from Point St. George to Trinidad in 1980 and from Trinidad to Eureka in 1979. We combined the highest counts from either year for each coastal segment to determine a total of 270 birds in the area from the Oregon border to Eureka (Table 10). We then totalled observations in four areas of northern and central California. Other areas were not double counted but it was evident that coverage was more complete from Humboldt Bay to Pillar Point in 1979 and south of Pillar Point in 1980. We combined the highest counts from either year for each coastal segment to determine that 383 birds were sighted overall (Table 11). The depiction of the two areas of concentration was not affected by these adjustments, but the relative number of birds sighted

changed from 76.3% and 13.2% to 70.5% and 23.5% for the Oregon border to Eureka and the Pillar Point to Santa Cruz areas, respectively (Table 4).

Sowls et al. (1980) multiplied the numbers of murrelets sighted by a factor of about five to ten times to derive their breeding population estimate of 2000 birds. They felt that this was a more or less "ballpark" estimate that reflected their lack of emphasis on this species. We worked further with murrelet sightings to derive a minimal breeding population estimate. First, we decremented the observed numbers of birds in the three northern areas by 15% to account for non-breeding birds (Sealy 1975a; also see basic-plumaged birds in Tables 4-7). The three birds observed from Santa Cruz to Point Conception were all considered to be non-breeders since murrelets do not appear to breed in this area, at least currently. Second, we multiplied the numbers of birds in the Oregon border to Eureka area by a factor of two because most sightings in this area were made in mid-May 1980 (see Table 5) during the incubation period (Fig. 1) when one member of each breeding pair would be at the nest site. From Eureka to Santa Cruz most sightings were made from mid-June to early July during the chick period Tables 4, 5; Fig. 1). At this time, most birds would be at sea during the day and these numbers were not adjusted (see Sealy and Carter 1984). We derived a minimal breeding population estimate of about 550 breeding birds for California using this method: the Oregon border to Eureka area comprised 83.6% (n = 460 breeding birds); the Eureka to Pillar Point area comprised 2.7% (n = 15); and the Pillar Point to Santa Cruz area comprised 13.6% (n = 75). Certainly, these are minimal estimates, especially for the Eureka to Pillar Point area that was allotted very little coverage (A. L. Sowls, pers. comm.). Since surveys were conducted in all areas where relatively large numbers of murrelets are known to occur, murrelets do not often occur far from shore, largest numbers are usually found very near shore, and G. S. Lester (who had a keen interest in murrelets) made most observations in the two areas of concentration, we feel that the breeding population estimate for California most likely is about three times these minimal breeding population estimates, or 1650 birds. This corresponds roughly to multiplying the 383 sightings by a factor of four times. This method yielded 1380 breeding birds from the Oregon border to Eureka, and 225 breeding birds from Pillar Point to Santa Cruz. The 45 breeding birds determined for Eureka to Pillar Point must be considered to be low but we cannot imagine a way to come up with a better estimate, based on the little data available in this area.

Inland Distribution

Early Records Of Marbled Murrelets At Inland Localities

On 11 May 1905, W. L. Dawson was the first naturalist reported to hear Marbled Murrelets calling as they flew overhead before dawn at Glacier, Washington, 40 to 45 km inland from the nearest salt water (Dawson and Bowles 1909). Shortly thereafter, Dawson was in California and made the second such observation on 18 May 1914 at Majors Creek in the foothills of the Santa Cruz mountains (Dawson 1923). Then on 20 June 1916, he observed them near Trinidad, Humboldt County, followed by another observation farther inland at Carlotta on 1 July 1916, at the home of H. E. Wilder. This apparently was Dawson's last such observation, but he had observed enough to be convinced that Marbled Murrelets

must nest well inland, perhaps in the mountains; he certainly provided the first clues that Marbled Murrelets occurred away from coastal feeding areas at night.

Following Dawson, other scattered observations of Marbled Murrelets in forested areas began to occur. On 16 July 1916, F. L. Smith caught an alternate-plumaged adult alive near Eureka, Humboldt County, and sent it to the Museum of Vertebrate Zoology in Berkeley (Table 2). H. S. Swarth (MVZ field notes) quoted Smith's letter as follows: "...found in a woods in the hills at quite an elevation and inland a long way from the sea coast." Later, Brooks and Swarth (1925) reported two downy chicks found at Gilltoyees Inlet, British Columbia in 1919 (MVZ 101538; only one specimen known), and Jewett (1930) reported a fledgling found near Minerva, Oregon in 1918 (see Carter and Sealy 1987). It is certain that all of these early observations were known to J. Grinnell, working out of the Museum of Vertebrate Zoology, when he made the first extensive series of observations of Marbled Murrelets between 1923 and 1932 at the home of H. E. Wilder in Carlotta. Grinnell's first such entry (23 July 1923) in his field notes aptly describes the experience of finding Marbled Murrelets at an inland locality:

> "Each morning since I've been here, I've heard cries of some sort of birds high overhead in the fog. They would only be heard very early. At first I thought they might be hawks. Then I began to remember some of the same notes years ago, on Pescadero Creek in the Santa Cruz mountains, and, I think, Sitka, Alaska -- Marbled Murrelets!. This morning, the fog was higher than usual and also the producers of the cries were out later than usual, up to 5:35 a.m. And I saw them! Birds with small chunky bodies, and rapidly, continuously beating small wings, like a small duck, very high, sometimes entering the fog. They were invariably in pairs, the two of a pair flying close together. I saw, at once: 2, 4, 2, 4. In the latter two cases Wilder saw them too. Mostly when I heard them, they were hidden in the fog. They swung in great circles overhead, or seemed going straight-away. It would be easy to imagine them passing between the ocean to the west of us and the forested slopes of the mountain within half a mile of us. Truly a mystery!"

Grinnell apparently had been the first to detect Marbled Murrelets at an inland locality at Pescadero Creek, San Mateo County, on 24 August 1904, as reported retroactively in Grinnell and Miller (1944)! Although Grinnell continued to observe murrelets at Carlotta, he did not discover any more about what the murrelets were doing than what he found that first morning. And so the mystery of the Marbled Murrelet eluded perhaps the greatest of California's early ornithologists. In his last inland murrelet entry on 1 January 1936, he noted:

> "Clay has no news of Marbled Murrelet nesting, save for the young bird [brought] him from a tract of redwoods [*Sequoia sempervirens*] a little ways inland from Eureka [See Table 1]. Zerlang and Frazer told me yesterday they had met lumbermen who seemed to know the murrelets well and called them "fog larks"! There is no evidence, though, that the birds ever occur in the redwood trees, as once guessed by someone. The bird men

hereabouts have examined the debris of felled trees, and found nothing pertaining to murrelets -- only eggshells of Raven, etc... ."

Despite their failure to solve the murrelet "mystery," Dawson's and Grinnell's observations sparked the interest of others as other observations of Marbled Murrelets at inland localities, including freshwater lakes, were becoming more common (Brooks 1926, Willet 1926; see Carter and Sealy 1986). Certainly, A. H. Miller of the Museum of Vertebrate Zoology knew of Grinnell's findings when he reported similar observations of murrelets near Elk Grove, Humboldt County (now in Prairie Creek Redwoods State Park) in 1946 and at Big Lagoon in 1949 (Miller, MVZ field notes).

The only other series of observations made prior to the 1970's were those of E. A. Pugh, an avid birder and wife of a California State Park ranger. She reported murrelets at: Portola State Park on 4 July 1956 and 8 February 1957; Big Basin Redwoods State Park on 19 April 1959, July 1959, and 29 July 1960; and Prairie Creek Redwoods State Park during the winter of 1965-1966. She probably identified the fledglings found at Portola State Park in 1957 and at Big Basin Redwoods State Park in 1960 (Table 1). Pugh's observations prompted a long series of murrelet observations in state parks during the 1970's and 1980's.

Interpreting Detections Of Marbled Murrelets

Early observers were puzzled by the activities of Marbled Murrelets at inland localities. Most appeared to assume that murrelets were in transit between nesting areas farther inland and coastal feeding areas when they were observed. In the 1970s, it became clear that murrelet activity at Big Basin Redwoods State Park was associated with a nesting area, evidenced by the findings of the nest and many fledglings in the park (Binford et al. 1975, Singer and Verardo 1975; see Table 1). Murrelets have been detected calling and flying over the park since 1959 and such activity has been recorded in nine years between 1959 and 1987 (Appendix 1). In four years, murrelets have also been detected during winter (January-March) at Big Basin Redwoods State Park. Such activity during the non-breeding season probably represents similar visits to nesting areas and/or nest sites that occurs with other alcids in California and elsewhere (also see Carter and Sealy 1986; Greenwood 1987; Ainley and Boekelheide, in press; M. P. Harris and S. Wanless, unpubl. data). Similarly, winter and summer activity by murrelets has been recorded in four years since 1956 at Portola State Park and in 17 years since 1946 at Prairie Creek Redwoods State Park. At both of these localities, fledglings also have been discovered (Table 1), providing further evidence of the association between murrelet nesting and activity in and over old-growth forests. At Prairie Creek Redwoods State Park, sufficient observations have been made to demonstrate that murrelets can occur inland in every month of the year (Appendix 1; Carter and Sealy 1986). Observations of murrelet activity over many years at several localities suggests strongly that nesting areas are well-established and are used traditionally, as is the rule for other well-studied alcids. While it is not yet clear where murrelets detected at specific localities actually nest, it is reasonable to expect that, where high levels of murrelet activity occur, nests occur nearby. There have been recent observations in Oregon that suggest that low levels of murrelet activity can be detected where murrelets are apparently in transit between nesting areas and the ocean (Nelson et al., unpubl. data). However, this activity has been

described as occurring very high above the forest canopy and birds are only heard briefly and faintly as they pass overhead in a straightline fashion. In this paper, we do not differentiate between these different forms of murrelet activity because many observers did not describe activity in sufficient detail to make this distinction. However, we have provided certain details where possible in Appendix 1, so that the reader can assess this difference. Records of large numbers, visual observations (i.e., flying, circling), low flying (i.e., at, slightly above, or below canopy height), or regular detections of murrelets for a period of time probably reflect activity at nesting areas. This guide to interpreting inland records is only appropriate during the main breeding season from May to July, when murrelet activity is most regular and extensive at nesting areas (Carter and Sander, unpubl. data). During the non-breeding season, inland murrelet activity can be very fleeting or nonexistent on a specific day at the same localities where high levels of activity occur daily during the breeding season. Murrelets also are most active at or before dawn, thus the time of observation can influence the degree of activity detected. Murrelets are much less active at dusk, although they can also be detected at this time of day; but this is almost entirely limited to the breeding season (Appendix 1; Carter and Sander, unpubl. data). To assess this influence on activity reported, we have included the time of observation, when available, in Appendix 1 but have not adjusted times from those reported.

Another important point to consider when interpreting inland records is that it is virtually impossible to determine the numbers of murrelets involved in the observed activity, let alone how many of these actually breed at inland localities. Observers have used a variety of undefined techniques to arrive at estimates of the numbers of birds observed. We have no real faith in these numbers, but large numbers certainly reflect high activity levels. Since murrelets often circle overhead and call in the dark or while out of view, it is often not possible to count individual birds although specific detections of a flock or single bird can be counted (Carter and Sander, unpubl. data). A minimal estimate of the numbers of birds being detected can be obtained by counting the numbers of birds visible and/or calling within the few seconds required to look and listen in all directions. This technique is currently the best repeatable method of arriving at a minimal estimate, and must be determined during an intensive census of an entire dawn's activity by murrelets. We have indicated when such censuses have been conducted in Appendix 1 and the minimal estimate is presented in parentheses. Since subadults and/or non-breeding adults may visit nesting areas with breeders, it is not possible to use observed numbers to derive the numbers of murrelets nesting in the vicinity of the observation locality. We have assumed that all detections of birds calling at and/or flying over inland localities reflect the activities of after-hatching-year birds. Like other alcids, chicks at nests or fledglings in flight probably do not vocalize to any degree, especially in the same loud and distinct manner as after-hatching-year birds. Chicks probably fledge in complete darkness rather than under partly-lit conditions at dawn or dusk (as found in other alcids at this latitude) such that they would not be observed in flight.

By now, it is evident that detections of murrelets at inland localities are difficult to describe, measure, and interpret. In addition, daily, seasonal, and annual variability in murrelet activity occurs (Carter and Sander, unpubl. data), and interpretation is further complicated by differing numbers of murrelets visiting different inland localities. To further demonstrate how

daily patterns of activity vary even among inland localities within a few km of each other, we have presented detailed census data at five nesting areas in central California (Fig. 3). All sites were censused by T. G. Sander between 14 and 22 July 1987 using the same technique (Carter and Sander, unpubl. data). While murrelets were detected at all sites within the 0521-0722 h (PDT) period, very different patterns occurred at each site. Minimal numbers of birds varied little, from three to five birds (Appendix 1). However, more activity was detected in parks containing more old-growth habitat (i.e., Big Basin Redwoods, Butano, and Portola state parks). This suggests that more birds were visiting larger patches of old-growth forest.

A unique set of data on murrelet activity was gathered at Big Basin Redwoods State Park by S. W. Singer and the Santa Cruz Bird Club that serves to indicate small within-day variability of activity observed at adjacent observation posts within 0.5-2.0 km of each other. On 10 July 1976, observers manned 6 observation posts near the park headquarters and simultaneously recorded detections of murrelets (Fig. 4). We tabulated a total of 350 detections with a range of 33 to 87 detections per post. Times of first and last detection ranged between 0515 and 0534 hr and between 0622 and 0645 hr, respectively. Singer (in litt., 20 September 1987) derived what he considered to be a conservative estimate of at least 100 birds in Big Basin during the 1976 breeding season (as reported by Erickson and Morlan 1978):

> "...If we assume that the birds fly in a straight line from the canyon to their nest trees, then there would be no duplication of sightings made on different compass bearings. Using this line of reasoning, we observed 367 birds on that morning of July 10, 1976. If we assume that each bird was seen twice (coming and going), then we observed 183 individuals. However, some birds reported as "calling" were not also seen. It is likely some of the stations were within earshot of stations on another compass bearing. J camp, Redwood Meadow, and Park HQ are all definitely within earshot of each other. Whereas there is no question that Huckleberry Campground and the Gazos/North Escape Road are so far apart as to eliminate any duplication of heard-only birds. If we use sightings from these two stations only, then 214 birds were observed. Assuming each bird was seen twice, that would translate into 107 individuals."

While we do not feel that this method can be justified as being even roughly appropriate, it is almost certain that more than the minimum of eight birds reported at an instant were present on that day. Also, these observations cannot be compared directly with those made by Sander in 1987 (Fig. 3), even though they were made at about the same location, because of different definitions used for recording detections. Regardless, high murrelet activity certainly was evident in 1976 and 1987.

In the future, murrelet activity in old-growth forests must be described using standardized techniques so that comparisons can be made between different localities, days, times of day, times of year, and years. Carter and Sander (unpubl. data) have developed and field tested such a standardized technique which involves a fixed-point count with unlimited distance of all vocal and/or visual detections that occur during a complete dawn or dusk activity period. They defined a detection as a single call or continuous stream of vocalizations and/or observations that definitely is attributable to a single

bird or a specific flock of murrelets. This technique and detection definition are now widely used by murrelet researchers in California and elsewhere.

Nesting Regions In California

The distribution of Marbled Murrelet nesting areas in California is difficult to outline specifically using the available information on the locations of nests, grounded young, and where calling and/or flying AHY birds have been detected inland. Yet, there is more such information available for California than elsewhere with a total of 67 inland localities documented from 1904 to 1987 (Table 1, Appendix 1). Using these data, we have identified three nesting regions in the state and have uncovered some general characteristics of murrelet nesting behavior in these regions.

Region 1: Del Norte and northern Humboldt counties. Region 1 is comprised of a fairly continuous series of 43 inland localities where murrelets have been recorded that stretch along the coast from the Smith River (Hutsinpillar Creek) to just south of Trinidad at Little River (Fig. 5). Only one grounded fledgling and no nests have been found in this region (Table 1) such that almost all localities refer to calling and/or flying birds (Appendix 1). Marbled Murrelets have been detected most frequently at Prairie Creek Redwoods State Park, the Redwood Experimental Forest, and Jedediah Smith Redwoods State Park. At the former two locations, extensive series of observations have been conducted (Appendix 1; Paton et al., in review; Carter and Sander, unpubl. data). Murrelets have been detected as far as 15 km inland at Bridge Creek in Redwood National Park. The only record of a Marbled Murrelet at a freshwater lake in California was obtained at Lake Talawa.

Several inland localities were found along Prairie Creek, Redwood Creek, and the Klamath River. In these areas, river courses may be used as movement corridors to and from nesting areas and the ocean. However, murrelets appear to fly directly into Prairie Creek Redwoods State Park from many points along Gold Bluffs Beach and into Jedediah Smith Redwoods State Park from points at and south of Crescent City. In these latter areas, Prairie Creek and the Smith River bend parallel to the coast such that murrelets appear to fly the shortest distance from the ocean to nesting areas rather than following the courses of these rivers.

The actual boundaries of this nesting region are not known. Nesting areas appear to thin out north of the Smith River where there is a general change in the nature of coastal forests and redwoods near the northern limit of their range (Griffin and Critchfield 1972). South of Little River, Douglas-fir (*Pseudotsuga menziesii*) and redwood forests occur farther inland opposite Arcata and Humboldt bays. This area has not been adequately checked to determine if murrelets occur there. There are isolated records of a fledgling murrelet at Eureka in 1924 and of grounded adults at Eureka in 1916 and at Freshwater in 1983 (Fig. 5); whether these represent a southward extension of this region or a small isolated nesting area is not clear. However, the distribution of Marbled Murrelets at sea seems to correspond closely with the distribution of inland localities (Fig. 2) such that nesting may not occur to any great degree north of the Smith River or south of Little River.

Region 2: South-central Humboldt County. Region 2 is comprised of an apparently isolated group of four inland localities where murrelets have been recorded on the Van Duzen and upper Eel rivers (Fig. 5). Only one grounded fledgling and no nests have been found in this region. Murrelets have been detected calling and/or flying at three localities on the Van Duzen River but at only two of these three localities in the last 20 years (Appendix 1). All four localities occur between 20 and 40 km inland, representing the farthest inland nesting area known in California.

Movement corridors to and from ocean feeding areas have not been determined for this nesting region. Thus, it is not clear whether murrelets nesting in region 2 feed north of the mouth of Humboldt Bay (where larger numbers occur at sea) or anywhere southward to the Humboldt-Mendocino counties' border (where fewer birds occur at sea) (see Fig. 2). All of these areas are a similar distance from region 2. However, region 2 has been poorly explored to date such that more localities may exist over a wider expanse of forest in this area than indicated by available information. If so, we would predict that murrelets would feed at more northerly areas; thus, region 2 may represent either an extension or a satellite of region 1. Coastal redwood forests occur only far inland in this area (Griffin and Critchfield 1972) so that the lack of reported inland localities closer to the coast in this area may reflect less suitable or less available nesting habitat there.

Region 3: Southern San Mateo County – Northern Santa Cruz County. Region 3 is comprised of a small but well-defined pocket of 16 localities where murrelets have been recorded between La Honda and Santa Cruz (Fig. 5). Fourteen of 17 grounded young and the only nest found in California were discovered in region 3, at Big Basin Redwoods State Park, Portola State Park, Memorial County Park, and Loma Mar. At Big Basin Redwoods State Park, a long series of observations have been made (Appendix 1). Murrelets have been detected as far as 20 km inland at Kings Creek.

Several inland localities are associated with Butano, Pescadero, and Waddell creeks, but widespread movement across the coast at or near Año Nuevo State Reserve suggests that murrelets fly directly to and from nesting areas and ocean feeding areas. Most inland localities occur between La Honda and Waddell Creek, matching the coastal area where murrelets occur in relatively large numbers at sea (Fig. 2) and where most of the remaining old-growth coast redwood and Douglas-fir forests occur (Griffin and Critchfield 1972; S. Viers, pers. comm.). However, D. L. Suddjian (pers. comm.) has noted dawn movements at sea to the south, indicating that some murrelets do not forage immediately adjacent to nesting areas. This finding supports earlier suggestions that at-sea distribution in some areas may only approximately depict nesting in adjacent coastal forests (see Sealy and Carter 1984).

Nesting Records

On 7 August 1974, the only Marbled Murrelet nest to be found in California was discovered in Big Basin Redwoods State Park, Santa Cruz County (Binford et al. 1975, Singer and Verardo 1975). The nest was located on a 45 m-high branch of a 61 m-high old-growth Douglas-fir located within a virgin stand dominated by Douglas-fir and coast redwood. The nest site was a depression in the branch's bark surrounded by a rim of moss (*Isothecium cristatum*) and droppings that was located 6.8 cm from the trunk on the flat base of the 41 cm diameter wide and

15 m long branch. Further details on this nest have been described by Binford et al. (1975) and the nest, eggshell fragments, and the downy chick found in the nest, were deposited in the California Academy of Sciences [specimen nos. CAS 8717, 68895]. This nest is one of four tree nests that have been discovered throughout the breeding range; two other tree nests have been found in the U.S.S.R. (Kuzyakin 1963, Nechaev 1986) and one has been found in southeastern Alaska (Quinlan and Hughes 1984). All of these tree nests shared common characteristics by being located on vegetated branches of conifers with an open crown structure which afforded easy access for adult murrelets and a clear flight path for fledging juveniles. In California, these nest-site characteristics are best provided in the old-growth Douglas-fir and coast redwood forests found along the coast between the Oregon border and southern Monterey County.

Other evidence of the use of old-growth forests for nesting in California is provided by records of downy young and fledglings found on the ground at inland localities (Carter and Sealy 1987; Table 1). Fifteen of 17 records occurred in California State and County parks that are composed of old-growth stands of coast redwood and Douglas-fir, while the Loma Mar record is immediately adjacent to one of these parks (Memorial Park) and Sequoia Park in Eureka was probably composed of old-growth forest at the time the chick was discovered in 1924. In addition, eight fledglings have been found in Big Basin Redwoods State Park in the same general area where the nest was found. The discovery of the nest in 1974 may have heightened awareness and interest in Marbled Murrelets, and this probably accounts for the regular findings of fledglings in Big Basin and in other parts of the state since 1974. The association of all grounded downy young and fledglings with old-growth forests in California supports the contention that murrelets nest only in such habitats in California. However, this does not preclude the use of other forested habitats, because more people visit old-growth parks and would be more likely to identify birds found there as murrelets (or to take birds to park rangers who would be more likely to identify murrelets). It is unlikely that murrelets nest on the ground in California as has been found in the northern Gulf of Alaska (Simons 1980, Hirsch et al. 1981, Day et al. 1983, Johnston and Carter 1985). Few if any alpine areas or islands that provide suitable ground-nesting habitat of the type available in Alaska occur in California.

CONSERVATION PROBLEMS

Loss Of Old-Growth Forests

Loss of old-growth forest nesting habitat has been recognized for some time as the greatest conservation problem facing Marbled Murrelets throughout most of their range, but especially in California (Remsen 1978, Harris et al. 1979, Sowls et al. 1980, Sealy and Carter 1984, Carter and Sealy 1987, Marshall 1988). Extensive logging of coastal old-growth forests in California has occurred since the early 1800's (reviewed in Green 1985). Logging began in central California (Sonoma to Monterey counties), expanding throughout northern California in the mid 1800's. Timber supplies were first exhausted in the San Francisco Bay area, especially in the Oakland Hills and east side of the Santa Cruz Mountains by the 1870's. Lumber production increased steadily until the depression in the 1930's when the industry was affected

severely. Recovery occurred in the 1940's. Production surged in the 1950's and remained at high levels through the 1970's but some decline followed in the early 1980's (Fig. 6).

By 1978, less than 15% of the original 1.9 million acres of old-growth redwood remained (Green 1985). About 30% of remaining old-growth redwood acreage (or about 4% of its original acreage) had been preserved in parks. The first redwood park was established at Big Basin in 1902 by the State of California, followed by the deeding of Muir Woods to the federal government in 1907. The Save-the-Redwoods League was formed in 1917 and acquired old-growth redwood forests for parks mainly from the 1920's to the 1940's. From 1968 to 1978, additional old-growth redwood forest was preserved by the establishment and expansion of Redwood National Park.

About 83% of 1978 old-growth redwood forests in California occurred in Mendocino, Humboldt, and Del Norte counties while about 88% of park acres of old-growth forest occurred in Humboldt and Del Norte counties (Table 12). Parks contained between 1.1% and 40.8% of a counties' old-growth redwood acres; parks in Mendocino, Sonoma, Marin, and Monterey counties only contained between 1.1% and 15.4% of total 1978 old-growth acreage in each county.

Since Marbled Murrelets appear to nest only in coastal old-growth forests, this massive removal of potential nesting habitat must have resulted in removal of actual nesting habitat. Yet, the vast majority of old-growth removal by logging occurred prior to when ornithologists became aware that murrelets nested in this habitat. While there is no direct evidence that murrelet nest trees have been removed in California, we have uncovered some indirect evidence that suggests this has occurred:

1) In July 1923, J. Grinnell (MVZ field notes) noted extensive murrelet activity at Carlotta, Humboldt County. He reported murrelets flying low enough to be seen and heard very clearly several times as well as circling overhead, all activities strongly suggestive of a nesting area as Grinnell suspected (see earlier excerpt). It appears that Grinnell did not return to Carlotta until July 1929 after which the following notes were made:

> "... This morning [15 July 1929], at just 5:30, I heard the well-known notes, "squeeool," of the Marbled Murrelet. The notes came from off over the Van Duzen Valley which was blanketed by high fog. Mr. Wilder says that he has not himself heard these birds since the redwoods were lumbered off the hillsides back of his place - since 1923... . This morning [17 July 1929] heard Marbled Murrelets out over the Van Duzen Valley at 6:20 and again a few minutes later... . At 5:40 a.m. [8 July 1930], lying in bed out-of-doors, I heard the well-known notes of Marbled Murrelets high overhead. There was high fog, higher than usual. So, despite the cutting of timber, on hills back of Wilder's, the murrelets still nest somewhere up the Van Duzen Valley. .... At 4:20 a.m. [3 July 1932], the first fog-blanketed morning since we came, I heard the "wild cries" of Marbled Murrelets going down the Van Duzen Valley -- perhaps two. The fog ceiling was about 300 feet high, judging by its level along the hills.... At 5:37 [same day], again heard murrelets but up in the fog apparently, as from an open lookout I could see nothing."

Murrelet activity reported from 1929 to 1932 (i.e., distant, brief calls) closely depicts behavior of murrelets in transit between the ocean and nesting areas farther inland. This before-and-after-logging series of observations strongly suggests that a Marbled Murrelet nesting area was eliminated or greatly reduced by logging of old-growth forest where murrelets had been detected.

2) On 18 May 1914 while camped on Majors Creek, Santa Cruz County, W. L. Dawson (1923):

> ... roused at early dawn to see a dark meteor crossing the sky and going down the valley...but because the bird was silent, I let the incident pass unchallenged. When, however, some fifteen minutes later I heard cries, meer, meer, as familiar as the voices of childhood, I sprang to my feet. Two pairs of Marbled Murrelets passed overhead in full cry, each going straight down the valley at a height about twice that of the surrounding redwoods. The following morning, Sunday, I believe, as I lay dozing, the cries of Murrelets again aroused me, and I woke up to count six passing parties, all descending. Somewhere on the slopes of Ben Lomond there is a nesting colony of Marbled Murrelets, and these birds were returning to sea-duty after spending the night with their mates or young."

Dawson aptly described murrelets in transit along what appeared to be a regularly-used route. On 25 July 1987, T. G. Sander attempted to duplicate Dawson's observations by conducting a dawn census at the junction of Majors Creek and Smith Grade Road (Carter and Sander, unpubl. data). No murrelets were detected, suggesting that either they no longer use this flight route and/or they no longer nest farther inland. This area of the Santa Cruz mountains has been extensively logged and little old-growth forest remains.

3) From 16 to 24 July 1981, R. A. Erickson (unpubl. data) noted high levels of murrelet activity at Terwer Valley, Del Norte County, including high and low flying, circling and seaward flight, and clear and faint calling. On 21 July, he conducted a census between 0557 and 0745 hr and recorded a total of 42 detections of single or flocks of murrelets (six were visual observations and a maximum of three murrelets were detected at once). This behavior appeared to indicate both activity associated with a nesting area plus murrelets in transit from this and other nesting areas farther inland to the ocean. Even while making these observations, logging was occurring a short distance up the valley. On 10 July 1987, T. G. Sander attempted to duplicate Erickson's observations by conducting a census at the same location (Carter and Sander, unpubl. data). Between 0528 and 0600 hr, he recorded a total of 13 detections, of which four were visual and a maximum of two murrelets were detected at once. This apparently reduced activity was comprised only of high flying, faint calling, and seaward flight; this suggested that murrelets no longer nested in close proximity to the observation location but they still seemed to be using the valley as a flight path while in transit to the ocean from nesting areas farther inland. Between 1981 and 1987, most of the old-growth forest visible from the end of the Terwer Valley Road had been logged. These observations suggest that a nesting area had been lost.

These cases of before-and-after-logging comparisons of murrelet activity substantiate that nesting habitat has been removed by the logging of old-

growth forests in California and provide further indication that murrelets require old-growth forests for nesting habitat. The lack of activity suggestive of nearby nesting after logging suggests that murrelets did not nest in recently-logged areas (examples 1 and 3) and have not recolonized young second-growth forest (example 2). It is not possible to determine whether displaced breeders had joined birds nesting farther inland, that were detected years after logging in cases 1 and 3, but activity was so reduced in both cases that this appears unlikely.

Such comparisons hold promise for examining the effect of future logging of old-growth forests on Marbled Murrelet populations. With more detailed and consistent measurement of murrelet activity before and after logging to take into account daily variation in activity, much could be learned of the effect of logging on murrelets at logged and adjacent sites. We suggest that murrelet censuses be conducted prior to the future logging of forest stands and that follow-up monitoring take place thereafter. Such censuses must be highly standardized for appropriate comparisons to be made.

Gill-net Fishing Mortality

While significant mortalities of Marbled Murrelets in nearshore gill nets have been reported in British Columbia and Alaska (Carter and Sealy 1984, Sealy and Carter 1984), little attention has been paid to known mortality of murrelets in gill nets in California. Extensive nearshore gill-net fishing occurred between Monterey Bay and the Russian River (Sonoma County) in central California between 1979 and 1987, resulting in a heavy mortality of seabirds, especially Common Murres (Evens et al. 1982; Atkins and Heneman 1987; Takekawa et al., in press). Only three Marbled Murrelets were observed in nets during a shipboard bycatch monitoring program conducted by the California Department of Fish and Game (P. W. Wild and C. W. Haugen, unpubl. data). Two murrelets were caught in a net set for white croaker (*Genyonemus lineatus*) at a depth of 19 m off the mouth of the Pajaro River in Monterey Bay on 3 December 1981 (see Sealy and Carter 1984) and one murrelet was caught in a croaker net set at a depth of 27 m about 3 km off San Gregorio Creek, San Mateo County, on 21 November 1986. Despite this seemingly low level of observed gill-net mortality, large numbers of dead Marbled Murrelets were found on Monterey Bay beaches between October 1980 and January 1981. In October 1980, 24 dead murrelets were estimated to have washed ashore on Marina State Beach and at Seaside while 30 and 48 dead murrelets were estimated to have beached in December 1980 and January 1981, respectively, on Sunset and Zmudowski state beaches (CDFG 1981). Also, Stenzel et al. (1988) reported two dead murrelets on Laguna Creek Beach and four dead murrelets on Sunset State Beach in November and December 1980. These six birds comprised about 26% of all Marbled Murrelets found on Point Reyes Bird Observatory beached bird surveys along the California coast from 1971 to 1985, indicating a much higher than normal level of mortality.

The gill-net fishing effort in central California was concentrated in Monterey Bay from 1979 to 1982. In 1982, gill-net fishing was prohibited in waters shallower than 10 fathoms (extended to 15 fathoms in 1984) south of Waddell Creek due to high seabird mortality. By 1983, fishing effort had shifted northward into the Gulf of the Farallones and Bodega Bay areas. Fishing closures in 1982 and 1983 prevented gill-net fishing inside 10 fathoms between Half Moon Bay and Pigeon Point. In 1984, 10-fathom closures were imposed from

Point Montara to Miramontes Point and from Tunitas Creek to Pescadero Point, while a 25-fathom closure was imposed from Franklin Point to Waddell Creek. In 1987, gill-net fishing was prohibited in waters shallower than 40 fathoms from Waddell Creek to Point Reyes and completely prohibited north of Point Reyes. These restrictions have led to the virtual elimination of nearshore gill-net fishing in central California at present (see Atkins and Heneman 1987; Takekawa et al., in press).

Area closures were selected to exclude areas of highest seabird and marine mammal mortality but additional mortality of Marbled Murrelets probably occurred north of Monterey Bay, especially in non-protected shallow waters between Miramontes Point and Tunitas Creek and between Pescadero Point and Franklin Point where murrelets occur in high numbers off the southern nesting region (Fig. 2; see Tables 4,6,8). It is notable that, in the latter area at Pigeon Point (where murrelets have been reported most regularly to AB), no murrelets were reported from 1983 or 1984 (Table 6). However, it is possible that murrelets were observed but not reported (or recorded) since Sterling and Campbell (1985) reported 61 murrelets at Año Nuevo State Reserve on 25 August 1984, whereas no such record appears in the AB files (Table 6).

It is difficult to determine how many Marbled Murrelets were killed in gill nets in central California. We believe that on the order of 150 to 300 birds may have been killed between 1979 and 1987. It is not known what proportion of birds killed were local breeders, since murrelets killed in Monterey Bay in the non-breeding season may belong to local and more distant breeding populations. If 50% (or 75 to 150 birds) were locally breeding adults, gill-net fishing mortality could have eliminated over half of the central California population, estimated at 225 breeding birds in 1980 (see above). However, inland censuses at known nesting areas conducted in 1976 and 1987 at Big Basin and in 1987 at Butano and Portola state parks, indicated little change in activity at Big Basin and at least moderate levels of activity at other areas (Appendix 1, see Figs. 3,4), suggesting that the impact of gill-net mortality was not great. The most likely explanation is that there was substantial impact early on but that this did not continue in a big way up to 1987. The central California population also may have been slightly larger than found in 1979 and 1980, which is supported at least recently by counts of 271 murrelets off the northern Santa Cruz County coast and 110 murrelets off Año Nuevo State Reserve in July 1987 (Table 6; see Campbell et al. 1987).

While the central California population has survived through this era of gill netting, it may have done so only on the "coat-tails" of protective measures aimed at reducing the mortality of other seabirds, especially Common Murres. In fact, concern over the welfare of this population was not expressed during discussions to reduce seabird mortality among state and federal agencies, environmental groups, private research groups, and fishermen (H. R. Carter, pers. obs.). In large part, this was due to the lack of summarized information on Marbled Murrelets at that time.

Oil Pollution

The threat of oil pollution to Marbled Murrelet populations has been little addressed (but see Sealy and Carter 1984) because few instances of oiling have been reported in the northern parts of the range where murrelets are more abundant and have been more extensively studied (Racey 1930, Richardson 1956,

Kazama 1971). In contrast, there are several instances of mortality from oil spills in California (Table 13). After the March 1937 Frank H. Buck oil spill, 14 oiled Marbled Murrelets were found on San Francisco and Bolinas beaches; more may have been killed, since some unidentified murrelets and/or small alcids also were reported, and not all beaches were searched for dead birds (Aldrich 1938, Moffitt and Orr 1938). This was the worst incident of Marbled Murrelet oiling reported. Marbled Murrelets were not recovered in the 1969 Santa Barbara or the 1971 San Francisco oil spills (Straughan 1971, Smail et al. 1972). However, dead beached birds were not enumerated in the latter spill. As with other small alcids, Marbled Murrelets are likely to die shortly after oiling, and thus would be expected to be found dead on beaches for the most part (Page and Carter 1986, Stenzel et al. 1988). Extensive documentation of live and dead beached birds occurred during the November 1984 Puerto Rican and February 1986 Apex Houston oil spills (PRBO 1985; Campbell et al. 1986; Page and Carter 1986; Page et al., in press). Only one and three Marbled Murrelets were found on beaches during these spills, respectively. However, G. J. Strachan (pers. comm.) independently recovered three other murrelets during the latter spill at the Año Nuevo State Reserve such that more were killed than reported.

These records of oiling were obtained during large spills which received some attention by ornithologists. Chronic oiling has occurred in southern and central California since the 1800s and probably several large spills occurred prior to 1937 in which seabird mortality was not examined. Streator (1947) noted "many dead on the beach, oil soaked" in Santa Cruz County and Munro (1957) provided evidence of chronic oiling of Marbled Murrelets in the 1950s at Morro Bay. Since the 1960s, offshore oil development in southern California has probably increased levels of chronic oiling there. Dead oiled murrelets on Las Varas Ranch Beach in 1976 and Hope Ranch Beach in 1986, located near offshore oil rigs in Santa Barbara Channel, probably were victims of chronic oiling.

To date, oil spills and high levels of chronic oiling of seabirds have been restricted to southern and central California (Stenzel et al. 1988). It is not known to what extent oil-related mortality may have affected breeding Marbled Murrelets in California. All oiling records have been obtained during the non-breeding season or outside the breeding range in southern California and thus may have involved local and more distant breeding birds. Only the Apex Houston spill affected birds in coastal areas adjacent to the southern nesting region where local breeders occur in winter (see Page and Carter 1986). However, chronic oiling in central California in the early 1900s has been thought to be responsible for population declines of several seabirds at the Farallon Islands (Ainley and Lewis 1974) and may also have affected Marbled Murrelets to some degree.

Outer continental shelf oil development is proposed for the near future in northern California (Lease Sale 91, February 1989 [postponed]) and central California (Lease Sale 119, 1991). If this development proceeds, the threat of oil pollution to Marbled Murrelets will greatly increase because these tracts are located near coastal regions where murrelets are concentrated at sea. In northern California, oil development has been proposed as far north as Trinidad. Oil spilled south of Trinidad could easily move the short distance northwards throughout the area of largest concentration of murrelets in the state, between Eureka and Crescent City. During the Puerto Rican oil spill, oil slicks travelled an even greater distance north from the site of

the spill (PRBO 1985) than the distance postulated above. Spills from proposed developments off the Mendocino, Santa Cruz, and San Mateo county coasts could result in elimination of the small numbers of murrelets that are thought to breed in these areas.

DISCUSSION

Why Are There So Few Marbled Murrelets In California?

The small numbers of breeding Marbled Murrelets in California causes concern over whether this population is in danger of extinction. To address this concern, we focus on two central questions: 1) Has the murrelet population in California always been small, or has it declined?; and 2) Are current threats to Marbled Murrelets likely to result in decline (or further decline) leading toward extinction? Owing to the little available data on Marbled Murrelets in California and elsewhere, especially for how populations respond to perturbations, we try to answer these questions to the best of our ability through speculating on patterns that have arisen from our examination of the data.

There are little historical data on the numbers and distribution of Marbled Murrelets at sea in California to compare with present day information to determine if a decline has occurred or is occurring (see Sealy and Carter 1984). We have uncovered only some evidence which may indicate that a decline has occurred:

1) Marbled Murrelets may have bred south of Point Lobos, Monterey County, where they are not thought to breed currently. Substantial numbers of juveniles and adults, probably well over one hundred, were collected during the breeding and non-breeding seasons near this area between 1890 and 1940 (Tables 2,3). Specimen collecting for museums may have contributed to the elimination of a small population there. Such activities apparently contributed to the disappearance of nesting Rhinoceros Auklets (*Cerorhinca monocerata*) on the Farallon Islands in the 1860s, and Common Murres on Prince Island in Santa Barbara Channel in the early 1900s (Ainley and Lewis 1974, Hunt et al. 1979).

2) Murrelets were quite common in the late 1800s and early 1900s in northern Monterey Bay (Loomis 1896, Mailliard 1904; see Tables 2,3). Today, few murrelets occur along this coast during the breeding season and they have been recorded at only two inland localities in this area, although they are regularly seen there during the winter. Almost all old-growth forests have been removed from this part of the coast, especially behind Soquel and Capitola. Loss of old-growth nesting habitat may have resulted in decline, possibly augmented by early specimen collecting.

3) Murrelets may have bred previously in the vicinity of the Golden Gate (presumably Marin County but possibly in the Oakland Hills) where they are not thought to nest currently. J. Grinnell (MVZ field notes) noted "large numbers of unidentifiable murrelets, [etc.] ..." as he neared San Francisco Bay on 7 September 1896 while returning from a trip to Alaska. In addition, the numbers of murrelets found dead on beaches near the Golden Gate after the March 1937 oil spill were much higher than would be expected today where it is

difficult to find murrelets any time of year. Elimination of a small population in this area may have resulted from oil pollution and/or removal of old-growth nesting habitat in the late 1800s and early 1900s. It is doubtful that the numbers of murrelets here were ever large due to the apparent lack of specimens from this area in museums (although the California Academy of Sciences collection was destroyed by fire during the 1906 earthquake). There do not appear to be any historical observations in the Golden Gate area or inside San Francisco Bay during the middle part of the breeding season (see Mailliard 1904, Grinnell and Wythe 1927, Stephens and Pringle 1933) but small numbers could have been overlooked.

4) Although there does not appear to be any historical information on murrelets along the coast of Mendocino County, there does not seem to be any reason why they would not have occurred there in much larger numbers than is currently known. At present, almost all old-growth forests in this area have been removed. The removal of old-growth nesting habitat in these areas may have led to declines or extinction there before being established as nesting areas by ornithologists. This area was one of the most inaccessible along the coast and was visited little by early ornithologists that recorded birds on the ocean or who were aware of murrelets in forests.

While this evidence suggests that decline or local extinction has occurred in some areas, there is no evidence to suggest that numbers of murrelets at sea opposite known present-day nesting areas have declined or are declining. But it is curious that there are not more murrelets in these areas. Certain other alcids with similar breeding ranges in the North Pacific reach large population sizes in California: Common Murre - 363,000; Pigeon Guillemot (*Cepphus columba*) - 15,000; and Cassin's Auklet - 132,000 (Sowls et al. 1980). Conversely, other alcids occur in California in small numbers: Rhinoceros Auklet - 360; and Tufted Puffin (*Fratercula cirrhata*) - 250. However, these latter species appear to be limited by the availability of suitable nesting habitat and have been undergoing range contraction and expansion along the west coast during historical times and at present (Ainley and Lewis 1974; Sowls et al. 1980; Ainley and Boekelheide, in press).

We suspect that prey resources do not limit the Marbled Murrelet population in California to its current small size, but little is known of murrelet diet in the state. R. H. Beck (MVZ field notes) noted that: on 24 November 1910 "...the Marbled Murrelets yesterday [had in their stomachs] 2, 3, 4, or 5 small sardines [*Sardinops sagax*] about 3 inches long"; on 28 November 1910, Marbled Murrelets had "sardines 2 to 3 inches long in stomachs"; on 16 February 1911, "a six inch needle fish [possibly Sandlance *Ammodytes hexapterus*] swallowed by Marbled Murrelet inside bill when picked up, fish just caught"; and on 1 March 1911, a Marbled Murrelet was collected with a "6 1/2 inch fish in stomach." These notes were made by Beck while collecting birds in the vicinity of Point Pinos, Monterey County (see Beck 1910). Sardines and sandlance are midwater schooling fish that serve as the chief part of the diet of the Marbled Murrelet elsewhere during the breeding season (Sealy 1975b, Carter 1984). While sardines were once more abundant off the California coast, they have been replaced by Northern Anchovy (*Engraulis mordax*) which murrelets probably largely feed on at present. Ten murrelets collected in early fall from northern Monterey Bay in the late 1970's were noted as feeding mainly on anchovy and to a lesser extent on sandlance (P. R.

Kelly, pers. comm.). Anchovy have been found in the diet of Marbled Murrelets in southern British Columbia and Washington (see Carter 1984), where sardines were also more abundant.

While we are unable to establish firmly whether a decline has occurred in the Marbled Murrelet population in California, the removal of vast areas of old-growth forest nesting habitat certainly could have caused a dramatic decline. While some evidence exists for mortality of Marbled Murrelets from oil pollution and gill-net fishing in central California, the levels of mortality experienced to date appear to be low enough for this small population to persist. On the other hand, removal of old-growth forest nesting habitat could easily account for the current distribution and small numbers of murrelets in central and northern California. This conclusion leads us to consider the effects of continued removal of old-growth forests on the continued viability of the Marbled Murrelet population in California.

Future Of The Marbled Murrelet In California

Marbled Murrelets currently appear to be dependent on old-growth forests for nesting habitat in California and in other southerly parts of their breeding range (Sealy and Carter 1984, Carter and Sealy 1987). However, there is insufficient data on the distribution of nest sites or the variety of nest sites used in old-growth forests to determine if they are restricted to specific parts of or are distributed widely in these forests. In the former case, it could be possible that significant proportions of the population occur in small areas of forest and if these patches of nesting habitat are preserved, the population may persist near current population levels. However, in the latter case, continued removal of nesting habitat would probably result in a decline in the population size, possibly proportional to the amount of habitat lost. In very rough terms, about half of remaining old-growth redwood forests in California are currently preserved in parks (Green 1985). Murrelets have been detected in many of these parks and probably nest there in some number. The question arises as to whether sufficient habitat occurs in parks to provide for the continued existence of a viable breeding population of Marbled Murrelets in the state.

We cannot estimate the minimal viable population size nor the probability of extinction at different population sizes for Marbled Murrelets due to the lack of information on demography and dispersal. But it is evident that the smaller the population size is, the greater the probability of extinction is. Habitat fragmentation further affects population viability by separating and isolating parts of the population into even smaller local populations with greater probabilities of extinction. In California, Marbled Murrelets clearly occur in two main populations. These populations are separated by a distance of at least 350 km and, in both areas, murrelets appear to be year-round residents and visit nesting areas in the breeding and non-breeding seasons. It is likely that little immigration or emigration occurs in these breeding populations.

The central California population of a few hundred birds appears to breed in a small fragmented patchwork of old-growth forest contained mainly in Big Basin Redwoods, Portola, and Butano state parks. While this very small population currently persists, it is highly susceptible to extinction from natural catastrophes (e.g., fire, blowdown), man-induced mortality (e.g., oil

pollution, gill-net fishing), and/or demographic and genetic problems. It is also likely that a significant proportion of this population may occur in small satellite patches of nearby old-growth forest (e.g., Memorial and Sam McDonald parks), and murrelets may be nesting in all remaining old-growth forests in this area. Some birds may not be able to find nest sites and non-breeding birds may occur at sea or over land in greater proportions than found elsewhere (Sealy 1975a). If so, this breeding population would have been estimated to be even smaller.

It is not clear to what degree nesting habitat is fragmented in northern California. Murrelets appear to nest somewhat continuously along the coast between Crescent City and Orick within a strip of old-growth forest formed by Jedediah Smith, Del Norte Coast, and Prairie Creek Redwoods State Parks and Redwood National Park. In addition, murrelets are known outside of parks in the vicinity of Crescent City and near the mouth of the Klamath River (e.g., Terwer Valley, Redwood Experimental Forest). Substantial numbers of murrelets probably occur outside of parks in this area. Evidence of fragmentation of nesting habitat is provided by a geographic pocket of inland records well south of Redwood National Park, along the Van Duzen and Eel rivers (i.e., Carlotta, Cheatham Grove, Grizzly Creek Redwoods State Park, and Humboldt Redwoods State Park). There is a virtual gap of inland records between these areas (Figs. 2,5). The isolated nature of the Van Duzen-Eel rivers population, the relatively small numbers of birds known off coasts near this area, and the low levels of activity noted at inland localities in the recent past suggest that this part of the northern population already could be nearing extinction. North of Trinidad appears to be the only area of the state where there is, as yet, no suggestion that the murrelet population is currently nearing extinction. However, murrelets persist there in low numbers of probably around 1000 birds. Further reduction in numbers probably will put this population in a much greater danger of extinction.

Our assessment is that continued removal of old-growth forests outside of parks undoubtedly will cause decline in the murrelet population. The very small sizes (low hundreds) and isolated nature of the central California and Van Duzen-Eel rivers populations at present may mean that they are approaching the threshold where small populations have difficulty maintaining themselves (Lacy 1987). This leads us to believe that they probably will not persist far into the future if they become any smaller. Additional removal of old-growth forest nesting habitat in these areas will shorten the time to extinction and increase the probability of extinction from other factors. While the Trinidad to Crescent City population probably will persist farther into the future, it faces a similar eventual fate. We feel that the Marbled Murrelet population in California is headed for extinction and that intensive management efforts are required to prevent this from occurring or from inevitably occurring in the not too distant future. Such efforts should be focused on the northern California population which appears at this point to have the greatest chance of persisting into the future and where substantial old-growth forests still occur outside of parks.

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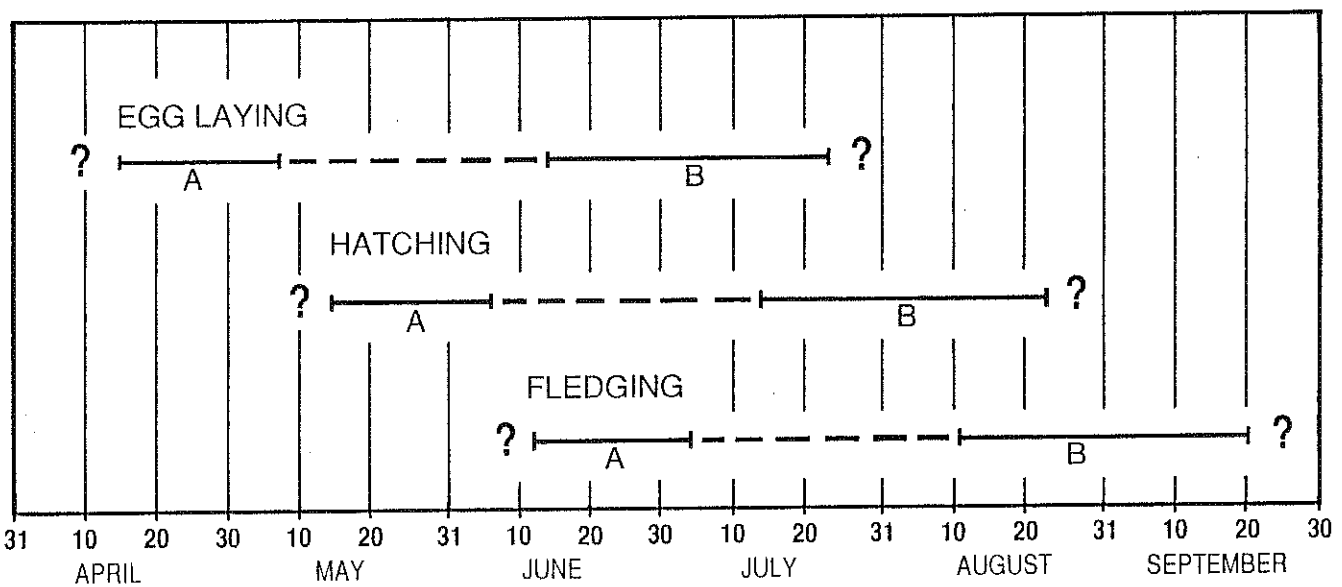

Figure 1. Estimated timing of breeding of Marbled Murrelets in California based on inland records of fledglings (see Table 1). Dates of fledgling records fell into two groups: Group A (n=7 records) and Group B (n=6 records). Ranges of egglaying and hatching dates were backdated from fledgling dates (see text). Question marks indicate that ranges may be greater than indicated (see text).

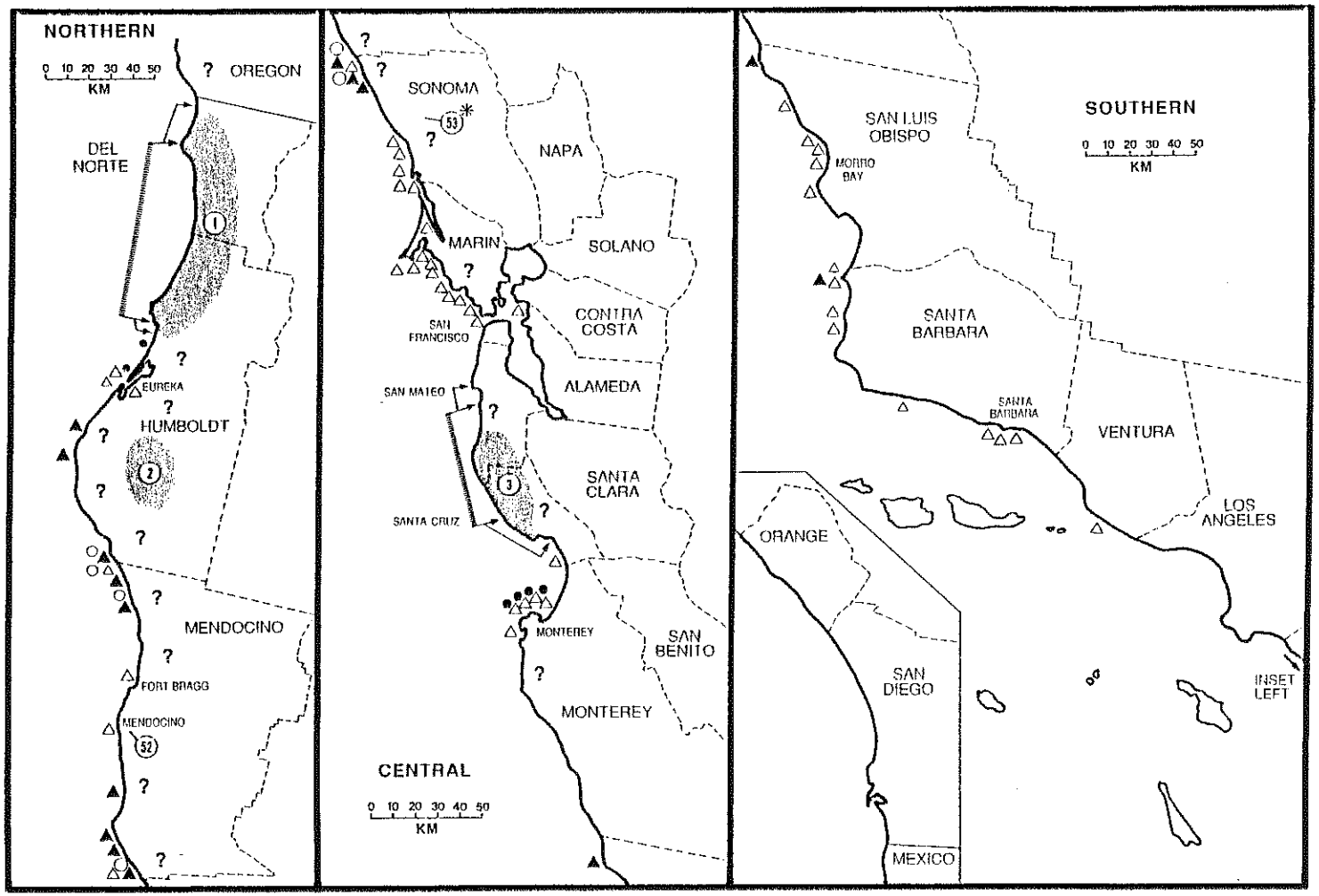

Figure 2. At-sea distribution and nesting regions of the Marbled Murrelet in California. Bracketed coastlines indicate where relatively large (thick portion) and relatively small (thin portion) numbers of birds are known to occur regularly during the breeding season (see Tables 4,5,6,8,9). For other coastal areas, symbols refer to localities where birds have been recorded during the breeding season: solid triangles (see Tables 4,5); open triangles (see Tables 6,7); solid circles (see Table 2); and open circles (see Tables 8,9). Known nesting regions are shaded and two inland localities in Mendocino (52) and Sonoma (53) counties listed in Appendix 1 are noted (see Figure 5 for details). Possible nesting areas (where murrelets have not been detected inland but where potential old-growth forest nesting habitat exists) are indicated by question marks.

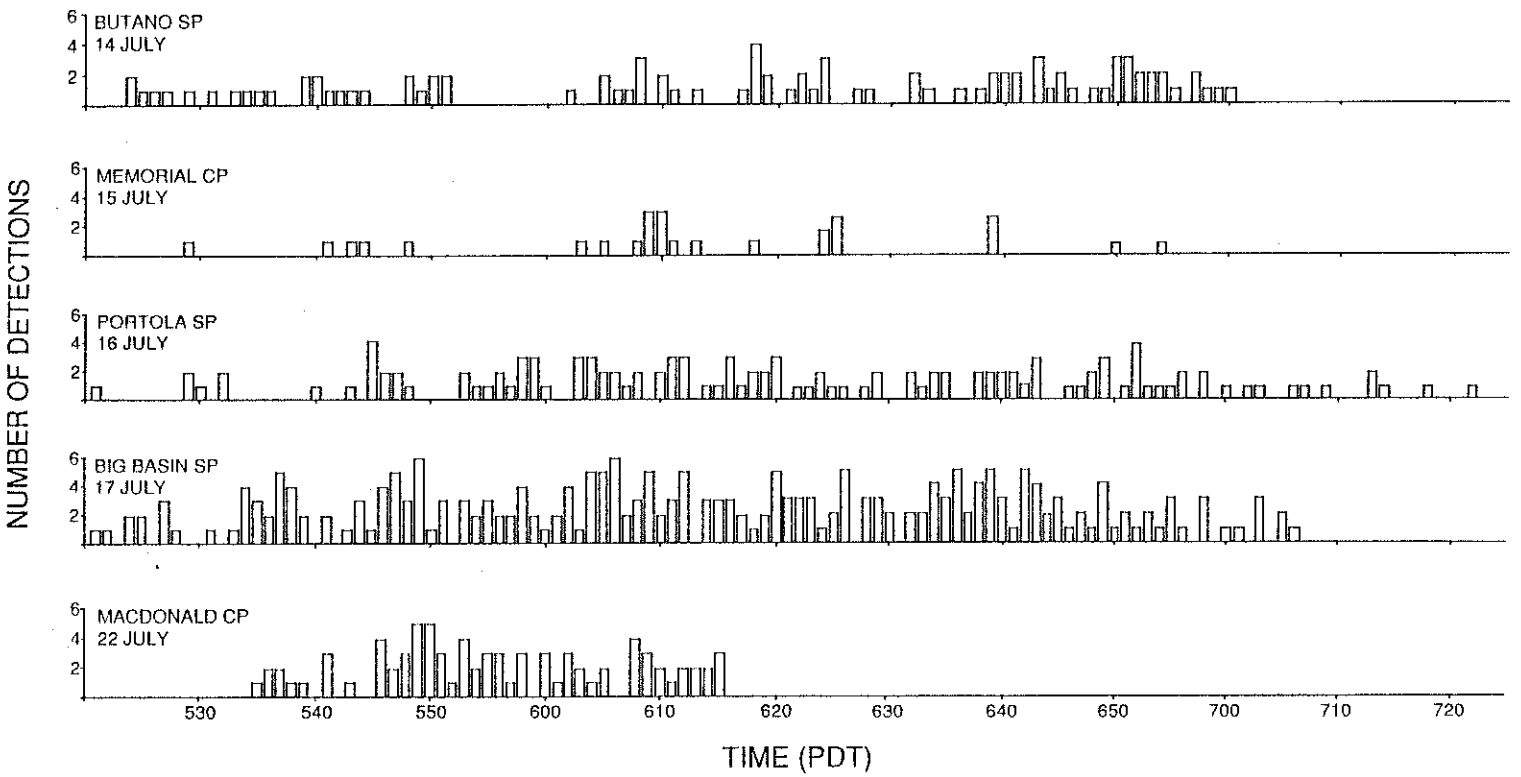

Figure 3. Times and numbers of detections of Marbled Murrelets at 5 inland localities in central California in July 1987 (Carter and Sander, unpubl. data).

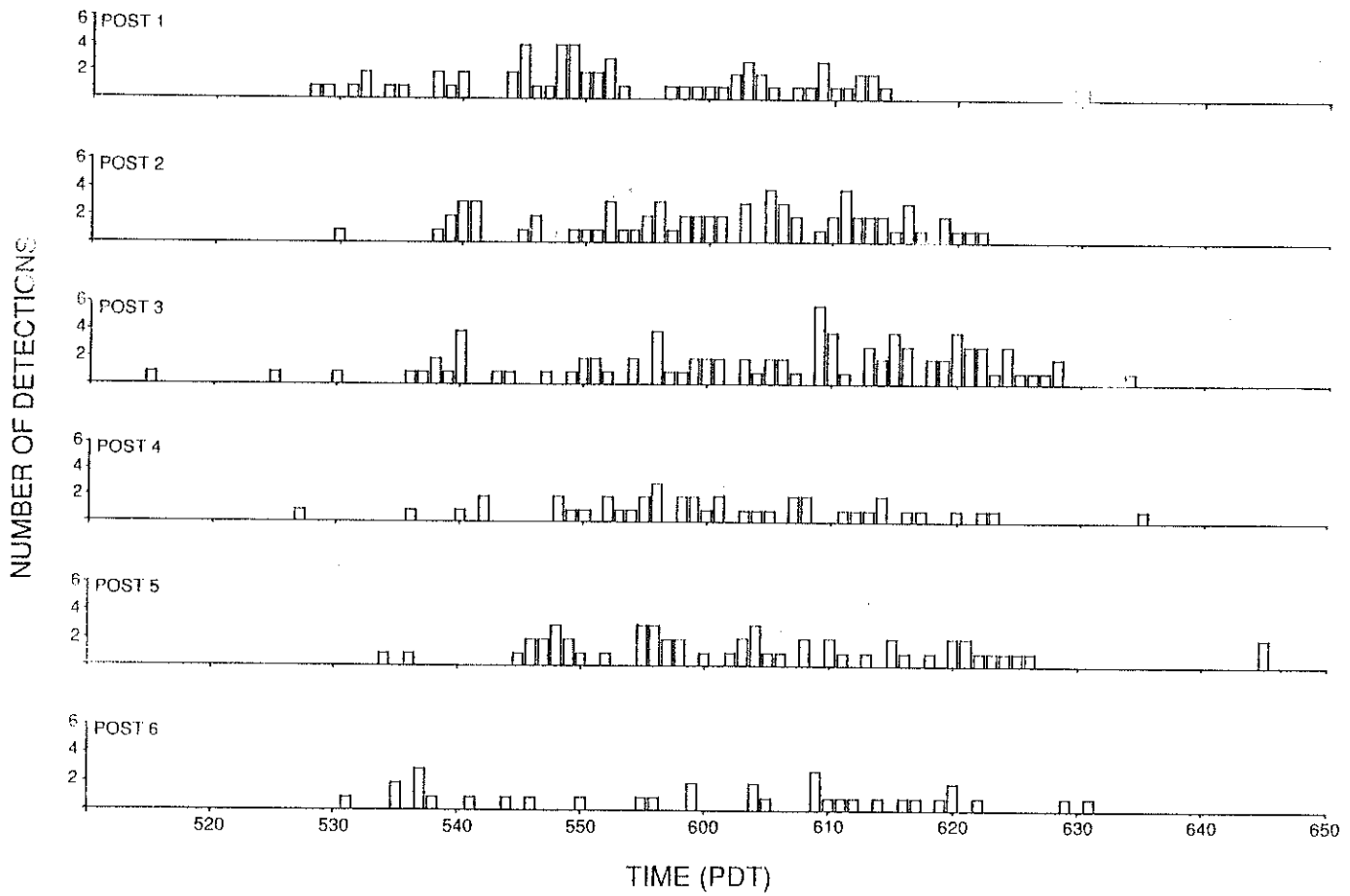

Figure 4. Times and numbers of detections of Marbled Murrelets at 6 observation posts in Big Basin Redwoods State Park on 10 July 1976 (S. W. Singer and the Santa Cruz Bird Club, unpubl. data). Individual posts were all located near park headquarters: 1 - Sewage plant; 2 - Redwood Meadow; 3 - Park Headquarters; 4 - J camp; 5 - Gazos Creek Road; and 6 - Huckleberry Camp.

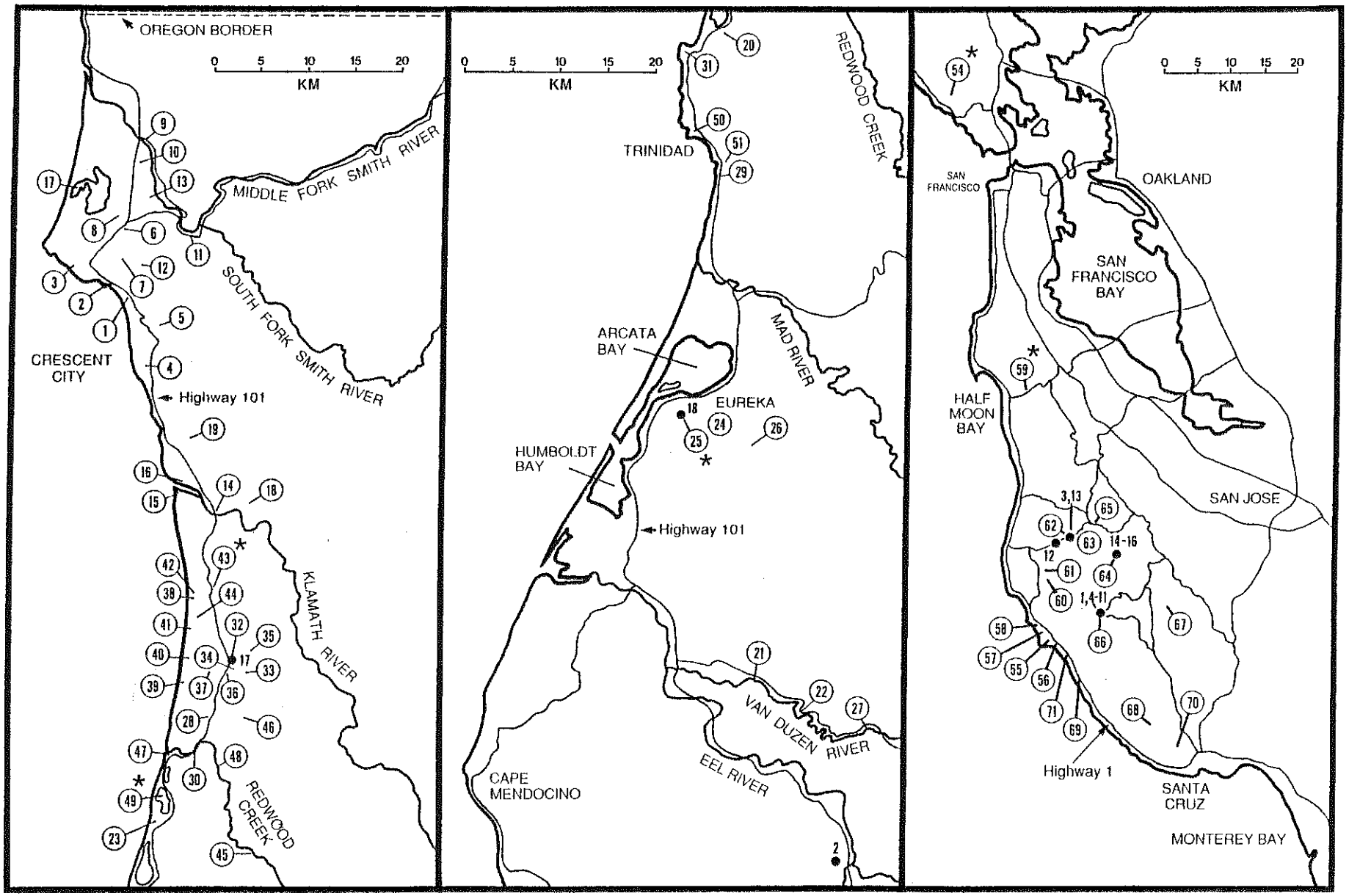

Figure 5. Distribution of inland localities where Marbled Murrelets have been detected in three nesting regions in California (see Figure 2). Numbered localities where after-hatching-year birds have been detected calling and/or flying overhead are indicated by open circles with a pointer (when possible); all records for these localities are summarized in Appendix 1. Localities with an asterisk indicate where censuses have been conducted but murrelets have not yet been detected. Two localities in Mendocino and Sonoma counties are indicated on Figure 2. Numbered localities where the nest with a downy young and/or fledglings have been found are indicated by solid circles (see Table 1).

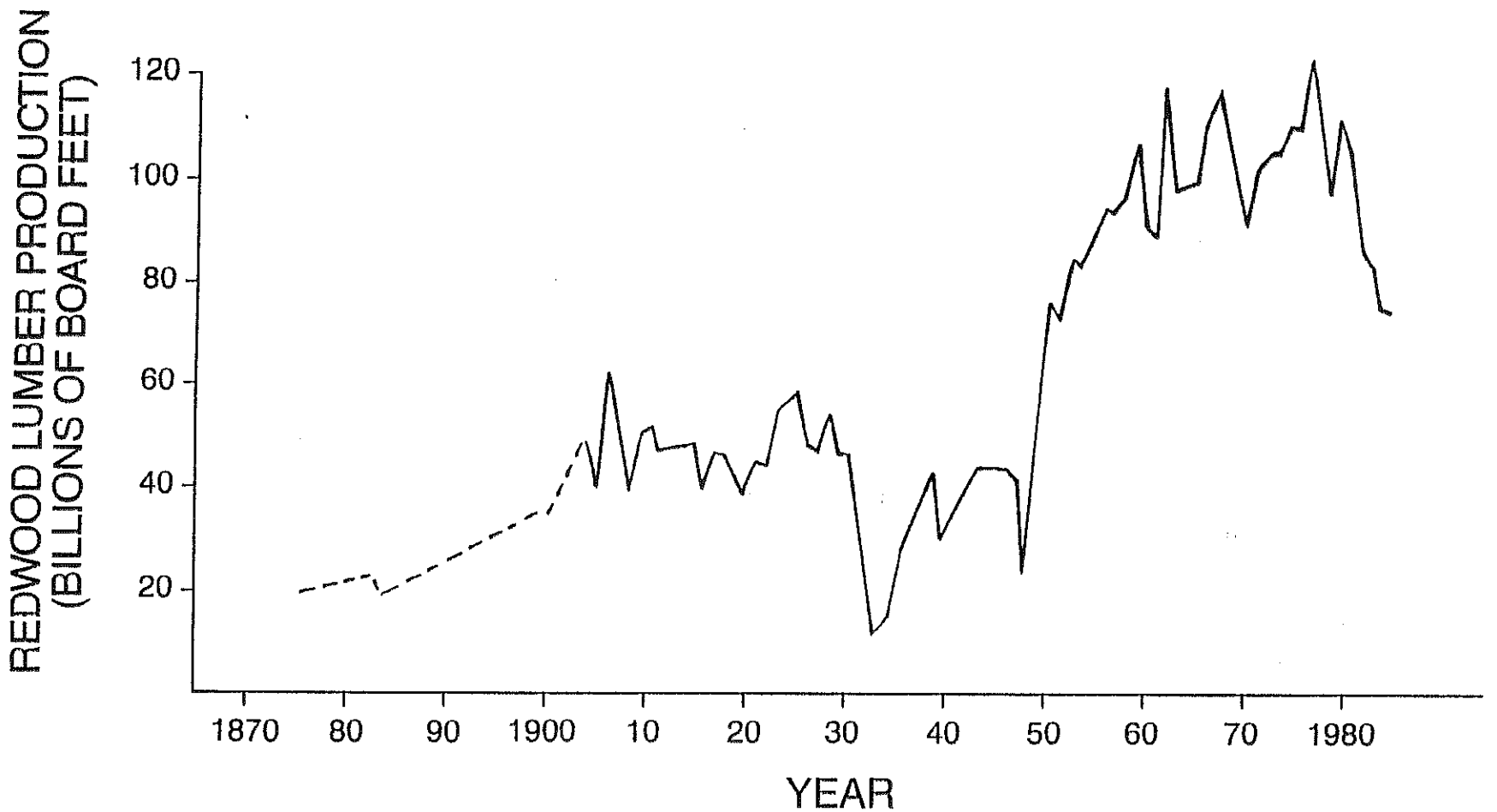

Figure 6. Redwood lumber production (in billions of board feet) in California from the 1870's to 1980's (from Green 1985).

Table 1. Inland records of downy young and fledgling Marbled Murrelets in California (see Figure 5 for locations).

Rec. No.	Location	Date	Notes	Sources
DOWNY YOUNG				
1	Big Basin Redwoods SP	7 Aug 1974	in nest	Binford et al. (1975); Singer & Verardo (1975) [CAS 68895]
2	Humboldt Redwoods SP (Rockefeller Grove)	13 Sep 1979	on ground[1]	S. W. Harris (in litt.) [HSUM 6752]
3	Memorial Park	11 Jul 1982	on ground	C. Kemnitz (pers. comm.)
FLEDGLINGS				
4	Big Basin Redwoods SP	18 Aug 1960	on ground	Cutler & Pugh (1960); Anderson (1972); Singer & Verardo (1975)
5	" " "	17 Jun 1973	on creek	Park records
6	" " "	9 Sep 1974	on ground	Singer & Verardo (1975)
7	" " "	12 Jun 1976	on ground	Park records
8	" " "	4 Jul 1976	on ground	" "
9	" " "	31 Aug 1977	on ground	Erickson & Morlan (1978) [CAS 69960]
10	" " "	14 Jun 1979	on ground	Park records [CAS 71228]
11	" " "	11 Aug 1982	on ground	Park records
12	Loma Mar	31 Aug 1985	on ground	C. Kemnitz (pers. comm.)
13	Memorial Park	Jul 1973	on ground	" "
14	Portola SP	15 Jun 1957	on creek	Anderson (1972)
15	" "	27 Jun 1971	on ground	DeSante & LeValley (1971)
16	" "	summer 1972	on ground	B. G. Elliot (Amer. Birds files)
17	Prairie Creek Redwoods SP	13 Aug 1984	on ground	Park Records
18	Sequoia Park (Eureka)	4 Jul 1924	on ground	S. W. Harris (in litt.) [HSUM 2557]

[1] Died in captivity in juvenal plumage on 20 October 1979.

Table 2. Specimens of Marbled Murrelets from California in complete (or almost complete) alternate plumage housed in the Museum of Vertebrate Zoology, California Academy of Sciences, and Humboldt State University Museum.

Specimen No.	Date	Locality	Collector	Source
1	26 Mar 1907	Monterey Bay	R. H. Beck	CAS 10140
2	26 Mar 1907	"	"	" 10141
3	26 Mar 1907	"	"	" 10143
4	26 Mar 1907	"	"	" 10144
5	26 Mar 1907	"	"	" 10145
6	26 Mar 1907	"	"	" 10146
7	26 Mar 1907	"	"	" 10147
8	26 Mar 1907	"	"	" 10148
9	26 Mar 1907	"	"	" 10149
10	27 Mar 1911	"	"	MVZ 17679
11	2 May 1915	Pescadero	C. Littlejohn	CAS 75190
12	8 May 1976	Humboldt Bay[1] (end of N. spit)	T. Harris	HSUM 3672
13	18 May 1929	Crescent City	F. J. Smith	" 2558
14	24 May 1970	Trinidad	T. O. Osborne	" 6747
15	24 May 1970	"	"	" 6748
16	27 May 1976	Mad River Beach[1]	T. G. Evans	" 3746
17	30 May 1896	Santa Cruz	E. B. Towne, Jr.	CAS 75188
18	22 Jun 1907	Monterey Bay	R. H. Beck	" 10142
19	27 Jun 1899	Santa Cruz	J. Mailliard	" 43117
20	16 Jul 1916	Eureka[2]	F. J. Smith	MVZ 27096
21	Jul 1983	Freshwater[3]	Unknown	HSUM 5484
22	1 Aug 1892	Monterey	L. M. Loomis	CAS 75165
23	1 Aug 1892	"	"	" 75166
24	8 Aug 1896	Santa Cruz	E. B. Towne, Jr.	" 75184
25	15 Aug 1896	Monterey Bay	"	" 75176
26	17 Aug 1895	Pacific Grove	J. Mailliard	" 43111
27	21 Aug 1896	Monterey Bay	"	" 43097
28	21 Aug 1896	"	"	" 43106
29	21 Aug 1896	"	"	" 43107
30	21 Aug 1896	"	"	" 43109
31	21 Aug 1896	"	"	" 43116
32	21 Aug 1896	"	"	" 43119
33	1 Sep 1970	Trinidad	T. O. Osborne	HSUM 2106
34	15 Sep 1940	"	C. I. Clay	" 2562
35	16 Sep 1896	Monterey Bay	E. B. Towne, Jr.	CAS 75182
36	20 Sep 1909	"	R. H. Beck	" 15814

[1] Found dead on beach.
[2] Bird was caught alive inland from Eureka.
[3] Bird fell out of tree being felled by loggers.

Table 3. Specimens of Marbled Murrelets in juvenal plumage collected at sea in California. Specimens are housed in the Museum of Vertebrate Zoology, California Academy of Sciences, and Humboldt State University Museum.

Specimen No.	Date	Locality	Collector	Source
1	1 Jun 1896	Monterey Bay	E. B. Towne, Jr.	CAS 75183
2	29 Jun 1907	"	R. H. Beck	" 10174
3	8 Jul 1892	Monterey	L. M. Loomis	" 75168
4	8 Jul 1892	"	"	" 75170
5	8 Jul 1892	"	"	" 75171
6	12 Jul 1907	Monterey Bay	R. H. Beck	" 10172
7	12 Jul 1907	"	"	" 10173
8	17 Jul 1983	Half Moon Bay	W. Lieber	" 75100
9	27 Jul 1897	Pacific Grove	J. Mailliard	" 43104
10	28 Jul 1892	Monterey	L. M. Loomis	" 75167
11	1 Aug 1892	"	"	" 75169
12	28 Aug 1938	Trinidad	C. I. Clay	HSUM 2560
13	30 Aug 1909	Monterey Bay	R. H. Beck	CAS 15544
14	13 Sep 1909	"	"	" 15599
15	22 Sep 1909	"	"	" 15815
16	22 Sep 1909	"	"	" 15816
17	22 Sep 1909	"	"	" 15817
18	25 Sep 1938	Trinidad	C. I. Clay	HSUM 2559
19	5 Oct 1909	Monterey Bay	R. H. Beck	CAS 10165
20	15 Oct 1922	"	R. Ellis	MVZ 145347
21	25 Oct 1909	"	R. H. Beck	CAS 15818

Table 4. At-sea records of Marbled Murrelets in central California (San Mateo Co. to Santa Barbara Co.) during the 1979-1980 California seabird nesting survey (USFWS unpubl. data; see Sowls et al. 1980).

Rec. No.	Location	Date	No.	Notes[1]
1	San Gregorio Beach to Pescadero Beach	5 Jul 1979	12	6(2)
2	Pescadero Beach to Bolsa Point	5 Jul 1979	2	2(1)
3	Pigeon Point to Franklin Point	5 Jul 1979	5	1(1),2(2); 1 holding fish
4	Franklin Point to Año Nuevo Island	5 Jul 1979	2	1(2)
5	Año Nuevo Island to Greyhound Rock	5 Jul 1979	3	1(3)
6	Davenport	15 Jul 1979	1	1(1)
7	Pillar Point to Miramontes Point	13 Jun 1980	8	1(1),1(3),1(4)
8	Miramontes Point to Eel Rock	13 Jun 1980	41	3(1),10(2),3(3), 1(4),1(5)
9	Tunitas Beach to Pescadero Beach	13 Jun 1980	19	5(1),3(2),2(4)
10	Pescadero Beach to Bean Hollow Beach	13 Jun 1980	2	1(2)
11	Bean Hollow Beach to Pigeon Point	13 Jun 1980	2	1(2)
12	Pigeon Point to Año Nuevo Island	13 Jun 1980	5	1(1),2(2); 1 basic plumage
13	Año Nuevo Island to Greyhound Rock	13 Jun 1980	2	2(1)
14	Greyhound Rock to El Jarro Point	13 Jun 1980	2	1(2)
15	Table Rock to Point Santa Cruz	13 Jun 1980	1	1(1)
16	Off Santa Cruz	14 Jun 1980	3	1(3)
17	Piedras Blancas Point to La Cruz Rock	15 Jul 1980	1	molting
18	Point Sal	15 Jul 1980	2	1(2); alternate plumage
19	Point Sal	16 Jul 1980	2	1(2); alternate plumage

[1] Number of flocks by flock size are indicated (e.g., 2(3) = 2 flocks of 3 birds).

Table 5. At-sea records of Marbled Murrelets in northern California (Del Norte Co. to Sonoma Co.) during the 1979-1980 California seabird nesting survey (USFWS unpubl. data; see Sowls et al. 1980).

Rec. No.	Location	Date	No.	Notes[1]
1	Trinidad to Little River Rock	4 May 1979	4	2(2)
2	N.E. of Castle Rock	7 May 1979	6	3(2)
3	Trinidad to Patrick's Point	10 May 1979	7	1(1),3(2)
4	off Wedding Rock	15 May 1979	2	1(2)
5	Steamboat Rock	21 May 1979	3	1(3)
6	Tolowa Rock	21 May 1979	1	1(1)
7	Whaler Island	22 May 1979	2	1(2)
8	Enderts Beach	22 May 1979	2	2(1)
9	Sisters Rocks	22 May 1979	5	1(2),1(3)
10	S. of Last Chance Rock	22 May 1979	36	2(1),14(2),2(3)
11	Crescent City to False Klamath Rock[2]	22 May 1979	(3)	
12	Cone Rock	3 Jun 1979	5	1(2),1(3)
13	E. of Cone Rock	4 Jun 1979	2	1(2)
14	False Klamath Cove to Chert Headlands	5 Jun 1979	3	1(3)
15	S. of Klamath River mouth	5 Jun 1979	3	1(3)
16	Split Rock to Johnson Creek mouth	5 Jun 1979	44	
17	Bridgeport Landing	22 Jun 1979	1	1(1)
18	Gualala River mouth	24 Jun 1979	4	2(2)
19	Black Point	24 Jun 1979	1	1(1)
20	Stewarts Point	24 Jun 1979	2	1(2)
21	off Big Flat	18 Jul 1979	1	basic plumage
22	Point No Pass	19 Jul 1979	1	1(1)
23	Usal Bay	19 Jul 1979	4	2(1),1(2)
24	Shelter Cove to Juan Creek	19 Jul 1979	1	1(1)
25	False Cape Rocks	26 Jul 1979	2	1(2)
26	Scotty Point	1 Aug 1979	4	1(4)
27	Palmers Point to Scotty Point	1 Aug 1979	1	1(1)
28	Rocky Point	1 Aug 1979	10	1 HY bird
29	Flatiron Rock	1 Aug 1979	4	1(4)
30	Patrick's Point to Little River Rock[3]	1 Aug 1979	(1)	
31	Ossagon Rocks to Home Creek	5 May 1980	15	4(1),4(2),1(3)
32	Home Creek to Espa Lagoon	5 May 1980	13	3(1),5(2)
33	Espa Lagoon to Redwood Creek	5 May 1980	41	1(1),15(2),2(3), 1(4)
34	Redwood Creek to Stone Lagoon	5 May 1980	21	3(1),9(2)
35	Stone Lagoon to Big Lagoon	5 May 1980	14	1(1),5(2),1(3)
36	off Whaler Island	May 1980	80	
37	Whaler Island	19 May 1980	47	
38	Whaler Island to Sisters Rocks	19 May 1980	10	1(1),3(2),1(3)
39	Sisters Rocks	19 May 1980	5	1(1),2(2)
40	False Klamath Cove	19 May 1980	2	1(2)
41	False Klamath Rock to Stratified Rock	19 May 1980	12	2(1),5(2)
42	Split Rock	19 May 1980	2	1(2)
43	False Klamath	19 May 1980	2	1(2)

Table 5. Continued.

44	False Klamath to Footsteps	19 May 1980	3	1(1),1(2)
45	Footsteps to Sisters	19 May 1980	11	1(1),5(2)
46	Sisters to Rock R	19 May 1980	2	1(2)
47	Rock R	19 May 1980	2	1(2)
48	Rock R to Crescent City breakwater	19 May 1980	3	1(1),1(2)
49	Crescent City breakwater to Castle Rock	19 May 1980	32	mostly pairs
50	Cone Rock to Hunter Rock	2 Jul 1980	12	4(1),4(2)
51	Prince Island	2 Jul 1980	2	2(1)
52	Gutchell Gulch	13 Jul 1980	1	1(1)
53	Bourns Landing	13 Jul 1980	2	1(2)
54	False Klamath Rock to Green Rock	21 Aug 1980	20	

[1] Number of flocks by flock size are indicated (e.g., 2(3) = 2 flocks of 3 birds).

[2] In the Species Notes, 48 birds were reported from Crescent City to False Klamath Rock but only 45 birds could be accounted for in the Colony Status Records (record nos. 7-10).

[3] In the Species Notes, 20 birds were reported from Patrick's Point to Little River Rock but only 19 birds could be accounted for in the Colony Status Records (record nos. 26-29).

Table 6. At-sea records of Marbled Murrelets in California near known nesting regions during the breeding season from 1 April to 1 September (from Amer. Birds files)

Rec. No.	Location	Date	No. Birds	Notes
DEL NORTE COUNTY				
1.0	Castle Rock	18 Jul 1976	1	
2.0	Crescent City	18 Jul 1976	3	2 basic plumage
2.1	" "	12 Apr 1979	2	
2.2	" "	18 Jul 1979	25-30	calling and chasing each other
2.3	" "	13 May 1980	150	
2.4	" "	19 Apr 1981	9	
2.5	" "	18 May 1981	6	
2.6	" "	17 Apr 1983	6	1 basic plumage
2.7	" "	26 Jul 1987	1	seen on pelagic trip
3.0	Point St. George	8-10 Apr 1981	10	pairs
3.1	" " "	17 May 1981	5	
3.2	" " "	14 Aug 1983	6	
HUMBOLDT COUNTY				
4.0	Elk Head	5 May 1979	6	pairs
5.0	Gold Bluffs Beach	18 Apr 1983	25	pairs
6.0	Humboldt Bay offshore	26 Apr 1970	30+	observed from boat
6.1	" "	spring 1973	-	common
6.2	" "	6 May 1973	10+	pairs, observed from boat
7.0	Humboldt Bay (King Salmon)	17 May 1974	30	
7.1	" "	3 Jul 1976	8	high count
7.2	" "	11 Jun 1976	10	
7.3	" "	12 Jun 1976	12	
7.4	" "	31 Jul 1976	2	
7.5	" "	5 May 1979	4	pairs
8.0	Humboldt Bay (North Jetty)	29 Apr 1979	15	
9.0	Patrick's Point SP	26 Jul 1962	2	basic plumage
10.0	Samoa	22 Jul 1972	6	
11.0	Trinidad	3 May 1969	4	pairs
11.1	"	22 Jul 1972	1	basic plumage
11.2	"	5 May 1979	2	pair
11.3	"	28 Apr 1979	6	
SAN MATEO COUNTY				
12.0	Año Nuevo SR	27 Jun 1969	1	alternate plumage
12.1	" " "	13 Jul 1970	6	alternate plumage
12.2	" " "	21 Jul 1970	4	3 basic plumage
12.3	" " "	28 Aug 1970	4	1 alternate, 3 basic plumage
12.4	" " "	31 Jul 1971	10	combined total with Pigeon Point
12.5	" " "	8 Jul 1972	2	pair
12.6	" " "	28 Jun 1973	4	

Table 6. Continued.

12.7	Año Nuevo SR	19 Aug 1973	6	
12.8	" " "	31 Aug 1974	1	
12.9	" " "	3 Aug 1975	3	
12.10	" " "	31 Jul 1976	23	
12.11	" " "	18 Jun 1977	2	pair, courtship flight
12.12	" " "	25 Jul 1977	30	
12.13	" " "	29 May 1978	2	
12.14	" " "	6 Aug 1979	40	
12.15	" " "	23 Aug 1979	3	
12.16	" " "	18 Jul 1980	30+	
12.17	" " "	9 Aug 1980	3	
12.18	" " "	22 Aug 1980	6	
12.19	" " "	14 Aug 1981	28	
12.20	" " "	23 Aug 1981	2	
12.21	" " "	22 Jun 1982	70+	within 1 km of shore
12.22	" " "	14 Aug 1982	6	"highest count this year is low"
12.23	" " "	9 Jun 1983	2	
12.24	" " "	4 Jul 1983	8	
12.25	" " "	8 Aug 1983	1	
12.26	" " "	20 Aug 1983	8	
12.27	" " "	13 Jun 1986	12	alternate plumage
12.28	" " "	Jul 1987	many	"high numbers of young with adults"
12.29	" " "	5 Jul 1987	110	few juvenal plumage, 1 basic plumage
13.0	Gazos Creek	10 Jul 1977	8	pairs
14.0	Half Moon Bay	23 Aug 1963	1	juvenal plumage
14.1	" " "	23 Jun 1973	20+	
14.2	" " "	6 Jul 1973	5	1 basic plumage
14.3	" " "	9 Jul 1975	12	
14.4	" " "	19 Jul 1975	15	
14.5	" " "	13 Jul 1976	4	
14.6	" " "	7 Jul 1983	8	alternate plumage
15.0	Highway 1 (at milepost 0.30)	23 Apr 1986	2	
15.1	" "	26 Apr 1986	2	
16.0	Pescadero Creek/ Point	21 Jul 1962	3	
16.1	" "	6 Jul 1973	3	
16.2	" "	26 Jun 1975	10	
16.3	" "	4 Jul 1976	18	
16.4	" "	3-4 Jul 1977	6	pairs
16.5	" "	28 Jul 1987	many	
17.0	Pigeon Point	4 Jul 1963	4	3 alternate, 1 basic plumage
17.1	" "	24 Apr 1965	3	alternate plumage
17.2	" "	13 Jun 1965	2	
17.3	" "	10 Jul 1965	4	
17.4	" "	22 Aug 1965	2	
17.5	" "	23 Jul 1966	3	basic plumage
17.6	" "	8 Apr 1967	3	alternate plumage
17.7	" "	1 Jul 1967	2	

Table 6. Continued.

17.8	Pigeon Point	15 May 1968	6	pairs
17.9	" "	16 Jun 1968	2	alternate plumage
17.10	" "	25 Aug 1968	25	
17.11	" "	3 Aug 1969	4	alternate plumage
17.12	" "	27 Apr 1971	2-4	alternate plumage
17.13	" "	22 May 1971	2-4	alternate plumage
17.14	" "	27 May 1971	2-4	alternate plumage
17.15	" "	13 Jul 1971	4	
17.16	" "	31 Jul 1971	10	combined total with Año Nuevo SR
17.17	" "	14 Apr 1972	3	alternate plumage
17.18	" "	8 Jul 1972	5	
17.19	" "	5 May 1973	2	
17.20	" "	17 Jun 1973	3	
17.21	" "	6 Jul 1973	4	alternate plumage
17.22	" "	7 May 1975	45	2 basic plumage
17.23	" "	10 Jul 1975	7	
17.24	" "	21 Apr 1976	41	high number of 20 day census
17.25	" "	9 May 1976	26	
17.26	" "	12 Jun 1976	9	
17.27	" "	15 Jun 1976	3	
17.28	" "	29 Jun 1976	2	
17.29	" "	15 Jul 1976	5	
17.30	" "	7 May 1977	4	alternate plumage
17.31	" "	30 May 1977	2	
17.32	" "	13 Jun 1977	2	pair
17.33	" "	5 May 1979	2	
17.34	" "	8 Jun 1979	5	
17.35	" "	25 Mar-13 May 1980	83	"spring total"
17.36	" "	9 Aug 1980	2	
17.37	" "	14 Aug 1982	6	"highest count this year is low"
17.38	" "	4 Apr 1986	10	
17.39	" "	9 Apr 1986	2	
17.40	" "	11 Apr 1986	23	16 on water, 7 flying N, 2 basic plumage
17.41	" "	18 Apr 1986	10	
17.42	" "	23 May 1986	7	4 on water, 3 flying N
17.43	" "	13 Jun 1986	5	alternate plumage
17.44	" "	12 Jul 1986	9	alternate plumage
17.45	" "	15 Aug 1986	5	1 juvenal plumage
17.46	" "	11 Apr 1987	2	
17.47	" "	7 Jun 1987	4	
17.48	" "	Jul 1987	many	"high numbers of young with adults"
18.0	Pillar Point	11 Jul 1965	1	basic plumage
18.1	" "	17 Jul 1965	6	
18.2	" "	30 Jul 1979	6	

Table 6. Continued.

SANTA CRUZ COUNTY				
19.0	Capitola	10 Aug 1974	3	1 basic plumage
20.0	Davenport	13 Jun 1986	7	alternate plumage
21.0	El Jarro Point	26 Mar-13 Apr 1987	2-20	"on 10 of 10 sea-watches; 90% alternate plumage; most basic-plumaged birds paired with alternate-plumaged birds."
21.1	" " "	15-29 Apr 1987	0-2	"on 3 of 7 watches; all alternate plumage"
21.2	" " "	1-31 May 1987	0-45	"on 10 of 11 sea-watches"
22.0	" "	5 May 1974	1	central bay
22.1	" "	5 Apr 1982	-	present
22.2	" "	14 Aug 1983	35	
23.0	Natural Bridges SB	21 May 1986	3	on water, diving
23.1	" " "	8 Jul 1986	3	flying S into area
23.2	" " "	15 Jul 1986	5	flying S into area
23.3	" " "	22 Jul 1986	28	flying S into area
23.4	" " "	25 Jul 1986	33	flying S into area
24.0	New Brighton SB	6 Aug 1986	1	alternate plumage; "rare and irregular this far in the Bay"
25.0	Santa Cruz	13 Jul 1955	1	alive, on beach
25.1	" "	31 Jul 1956	6	
25.2		5 Aug 1956	6	
25.3	" "	7 Aug 1956	1	
25.4	" "	21 Jul 1957	2	basic or juvenal plumage
25.5	" "	14 Jun 1965	3	
25.6	" "	25 Jul 1972	8	pairs
25.7	" "	15 Aug 1972	2	
25.8	" "	11 Jun 1973	12	observed from boat
25.9	" "	8 May 1976	30	
25.10	" "	summer 1976	2	"summered"
25.11	" "	summer 1977	-	"fairly common"
25.12	" "	19 Apr 1978	4	
25.13	" "	18 May 1980	3	alternate plumage
25.14	" "	1 May 1982	4	pairs
25.15	" "	28 Aug 1982	1	
25.16	" "	15 May 1983	6	alternate plumage
25.17	" "	30 Jul 1983	6	
25.18	" "	11 May 1986	10	pairs, alternate plumage
25.19	" "	21 May 1986	1	on water, diving
25.20	" "	28 Jun 1986	2	alternate plumage
25.21	" "	17 Aug 1986	31	5 juvenal plumage
26.0	Scott Creek	24 Jul 1986	13	alternate plumage
27.0	Waddell Creek	23 Jul 1967	2	

Table 7. At-sea records of Marbled Murrelets in California outside of known nesting regions during the breeding season from 1 April to 1 September.

Rec. No.	Location	Date	No. Birds	Notes	Source
MENDOCINO COUNTY					
1.0	Bear Harbor	24 Apr 1982	24	pairs	Amer. Birds files
2.0	Gualala River	6-8 Jun 1980	6-12	alternate plumage	" "
3.0	McKerricker Beach SP	5 Apr 1977	2	1 alternate, 1 basic plumage	" "
4.0	Mendocino	9 Jul 1976	1		" "
SONOMA COUNTY					
5.0	Bodega Bay	15 Aug 1967	1		Amer. Birds files
5.1	" "	12 Aug 1973	3		" "
5.2	" "	13 Aug 1976	2	1 alternate, 1 basic plumage	" "
5.3	" "	23 Apr 1978	3		" "
6.0	Bodega Harbor	13 Apr 1984	2	basic plumage	" "
7.0	Bodega Head	10 Jul 1963	1		" "
7.1	" "	11 Aug 1965	1	basic plumage	" "
7.2	" "	23 Aug 1981	6		" "
8.0	Doran Beach	11 Apr 1980	1	found dead on beach	Stenzel et al. (1988)
9.0	Goat Rock	31 Jul 1966	3	2 alternate plumage	Amer. Birds files
9.1	" "	18 Aug 1973	2		" "
9.2	" "	24 Aug 1974	2		" "
9.3	" "	10 Aug 1975	7		" "
10.0	Jenner	25 Jul 1970	10	alternate plumage	" "
10.1	"	13 Aug 1977	2	alternate plumage	" "
10.2	"	4 Aug 1979	2	alternate plumage	" "
11.0	Russian River mouth	12 Jul 1987	2		R. Marlowe (pers. comm.)
12.0	Sonoma coast	19 Jul 1962	6		Amer. Birds files
MARIN COUNTY					
13.0	Bolinas	8 Aug 1987	2	molting	D. G. Ainley (pers. comm.)
14.0	Chimney Rock	1 Jul 1977	1	basic plumage	Amer. Birds files
15.0	Coast Camp	20 Aug 1985	2	molting	" "
16.0	Drake's Beach	1 Jul 1981	1	alternate plumage	" "
17.0	Duxbury Pt.	14 Jul 1973	2	molting	" "
18.0	Inverness	Jul 1964	3	juvenal plumage	" "
19.0	Limantour	1 Sep 1978	1		" "
19.1	"	23 Apr 1980	1	basic plumage	" "
19.2	"	1 May 1980	1	basic plumage	" "
19.3	"	6 Apr 1981	2		" "
19.4	"	17 Aug 1981	4		" "
19.5	"	19 Jul 1987	8		" "
20.0	Palomarin	5-7 Aug 1966	4-8	at least 4 basic plumage	" "
20.1	"	22 Aug 1966	2		" "

Table 7. Continued.

20.2	Palomarin	19 Aug 1981	5		" "
20.3	Palomarin	3-6 Aug 1987	3	molting	R. Moore (pers. comm.)
21.0	Pt. Bonita	2 Jul 1975	2		Amer. Birds files
22.0	Pt. Reyes	1 Sep 1968	2		" "
22.1	"	12 Aug 1971	1		" "
22.2	"	28 Aug 1976	-	present	" "
SAN FRANCISCO COUNTY					
23.0	Baker's Beach	21 Aug 1980	-	present	Amer. Birds files
24.0	Land's End	15 Aug 1965	1		" "
ALAMEDA COUNTY					
25.0	Berkeley dump	22 Jul 1976	1		Amer. Birds files
MONTEREY COUNTY					
26.0	Asilomar	28 May to 4 Jun 1983	2		Amer. Birds files
27.0	Carmel	19 Jul 1962	1		" "
28.0	Monterey	3 May 1963	1		" "
28.1	"	15 Aug 1965	3		" "
28.2	"	27 Jun 1975	1	basic plumage	" "
28.3	"	11 Aug 1985	1		" "
29.0	Pacific Grove	14 Jul 1969	1		" "
30.0	Pajaro River mouth	24 Aug 1974	1	molting	" "
30.1	" "	"19 Jul 1975	1	molting	" "
30.2	" "	" 7 Aug 1976	1	alternate plumage	" "
31.0	Pt. Pinos	17 Jul 1972	2		" "
31.1	" "	13 Aug 1983	2		" "
SAN LUIS OBISPO COUNTY					
32.0	Atascadero Beach	10 Aug 1981	1	found dead on beach	Stenzel et al. (1988)
33.0	Cambria	25 Aug 1966	1		Marantz (1986)
34.0	Cayucos Pier	26 Jul to 21 Aug 1981	6+		McCaskie (1982a); Marantz (1986)
35.0	Montano de Oro	15 Aug 1985	1		"
36.0	Morro Bay	4 Apr 1959	1	found dead on beach	"
SANTA BARBARA COUNTY					
37.0	Hollister Ranch Beach	17 Apr 1977	1	found dead on beach (mummified)	Lehman (1982)
38.0	Hope Ranch Beach	26 Apr 1986	2	found dead on beach, oiled	G. Johnson (pers. comm.)
39.0	Pt. Sal	15 Jul 1980	2		McCaskie (1980b); Lehman (1982)
39.1	" "	25 Aug 1980	9		McCaskie (1981); Lehman (1982)
39.2	" "	4 Aug to 24 Sep 1984	4-8		McCaskie (1982a; Lehman (1982)

Table 7. Continued.

39.3	Pt. Sal	8-21 Aug 1982	4		McCaskie (1983); Lehman (1982)
39.4	" "	11-21 Jul 1984	2		P. E. Lehman (pers. comm.)
40.0	Purisima Pt.	18 May 1982	1	found dead on beach	Stenzel et al. (1988)
41.0	Santa Barbara	30 Jul 1910	1	found dead on beach	Willett (1933)
41.1	" "	12 Apr 1922	1	molting	[UCMVZ 145346]
41.2	" "	21-24 Aug 1974	1		Lehman (1982)
41.3	" "	29Jul 1985	1		McCaskie (1985)
42.0	Santa Maria River	13 Aug 1983	1		McCaskie (1984)
VENTURA COUNTY					
43.0	Pt. Mugu	8 May 1982	1		McCaskie (1982b)

Table 8. At-sea records of Marbled Murrelets during the breeding season from cruises on the David Starr Jordan, 1985-1987 (D. G. Ainley, unpubl. data).

Rec. No.	Date	LOCATION Lat. (N)	Long. (W)	Name	No. Birds[1]	Time (PDT)	Depth (m)	Distance from shore (km)
1	22 Jun 1985	38°40.9'	123°29.7'	S. of Gualala River	1	0804	82	4.8
2	22 Jun 1985	38°49.5'	123°40.3'	N. of Gualala River	2	0912	64	3.0
3	12 Jun 1986	37°39.9'	122°59.5'	S. of Farallon Islands	1	2003	64	33.1 (3.5)[2]
4	16 Apr 1987	37°08.0'	122°24.2'	off Franklin Point	2	1456	44	4.1
5	16 Apr 1987	37°08.0'	122°23.8'	off Franklin Point	2	1458	44	3.4
6	16 Apr 1987	37°05.2'	122°22.0'	off Año Nuevo Point	2	1527	62	4.4
7	20 Apr 1987	37°02.7'	122°19.3'	off Waddell Creek	2	0711	66	5.7
8	20 Apr 1987	37°03.2'	122°19.6'	off Waddell Creek	2	0714	60	5.7
9	20 Apr 1987	37°03.4'	122°19.7'	off Waddell Creek	2	0715	60	5.7
10	20 Apr 1987	37°03.8'	122°20.4'	off Waddell Creek	3	0717	60	5.5
11	20 Apr 1987	37°04.3'	122°20.4'	off Waddell Creek[3]	2	0721	55	4.4
12	20 Apr 1987	37°05.6'	122°21.4'	off Año Nuevo Point	3	0758	48	3.1
13	20 Apr 1987	37°08.0'	122°23.0'	off Franklin Point[4]	2	0810	37	2.7
14	20 Apr 1987	37°12.5'	122°27.9'	off Pescadero Point	1	0843	59	5.0
15	20 Apr 1987	37°12.8'	122°28.7'	off Pescadero Point	3	0848	64	5.7
16	20 Apr 1987	37°10.9'	122°28.5'	off Pigeon Point[5]	2	2118	68	5.9
17	2 Jun 1987	37°09.2'	122°25.8'	off Pigeon Point	2	2131	62	4.2
18	12 Jun 1987	37°08.0'	122°27.2'	off Pigeon Point	2	1740	73	7.3
19	12 Jun 1987	37°08.0'	122°27.0'	off Pigeon Point	4	1817	73	7.1

[1] All birds were observed on the water except for record nos. 16 and 18 which were flying.
[2] This record was 3.5 km south of the Farallon Islands but 33.1 km from the nearest mainland point (Bolinas Point). This bird may have been misidentified and is excluded in Fig. 2.
[3] Associated with Velella lines.
[4] Associated with a 20-m long oil slick.
[5] Associated with a current line.

Table 9. At-sea records of Marbled Murrelets during the breeding season from aerial surveys of seabirds conducted by the University of California, Santa Cruz (D. B. Lewis, unpubl. data; see Briggs et al. 1987).[1]

Rec. No.	Location Lat.	Long.	Name	Date	No. birds	Depth zone (m)[2]
1	39°53'	123°55'	Jackass Gulch	5-7 May 1980	2 unid. small alcids	<25
2	40°05'	124°06'	Shelter Cove area	5-7 May 1980	2 unid. small alcids	<25
3	34°45-50'	120°40+'	Point Sal area	21-25 Jul 1980	1 unid. murrelet[3]	180-1800
4	41°15-20'	124°10+'	Redwood Creek area	21-25 Jul 1980	1 unid. small alcid	0-180
5	41°30'	124°05'	White Rock	19-21 May 1981	4 Marbled Murrelets	<25
6	37°06'	122°18'	Año Nuevo area	19-21 May 1981	2 Marbled Murrelets	<25
7	39°58'	123°59'	Pt. No Pass	30 Jun-2 Jul 1981	1 unid. small alcid	<25
8	41°03'	124°08'	Trinidad	30 Jun-2 Jul 1981	5 Marbled Murrelets	<25
9	37°05-10'	122°20+'	Año Nuevo	20-24 Jul 1981	2 Marbled Murrelets	0-180
10	35°28'	120°51'	Morro Bay area	3-5,19 May 1982	2 Marbled Murrelets[3]	<25
11	37°59'	122°49'	Point Reyes area	3-5,19 May 1982	1 Marbled Murrelet	<25
12	36°50-55'	122°01+'	Monterey Bay area	24-28 May 1982	1 unid. murrelet[3]	>1800
13	41°01-05'	122°10+'	Trinidad area	21-25 Jun 1982	1 unid. small alcid	0-180

[1] Data for Coastal Surveys 303 (1-3 July 1980) and 311 (3-11 July 1982) were not available though trip notes indicated that murrelets were seen.
[2] Observations on Coastal Surveys were within 1 km of shore and were assigned depths of <25m.
[3] These birds may have been Xantus Murrelets (*Synthliboramphus hypoleucus*) based on their southerly distribution and/or depth zone (Briggs et al. 1987). They are excluded in Fig. 2.

Table 10. Summary of at-sea records of Marbled Murrelets from the Oregon border to Humboldt Bay during the 1979-1980 California seabird colony survey (data from Table 5).

Coastal segment	USFWS (unpubl. data) 1979	USFWS (unpubl. data) 1980	This study 1979	This study 1980	This study Combined[1]
Oregon border to Pt. St. George	7[2]	14[2]	7	14	14
Pt. St. George to Klamath River	58	211[3]	58	108[6]	108
Klamath River to Redwood Creek	3[2]	69[3]	3	69	69
Redwood Creek to Trinidad	28	35[3]	19[4]	35	35
Trinidad to Humboldt Bay mouth	49	9[2]	44[5]	9	44
Total	145	358[3]	130	235[7]	270

[1] Uses highest counts for coastal segments from 1979 or 1980.
[2] Areas with poorest coverage.
[3] Excludes 20 birds between False Klamath Rock and Green Rock on 21 Aug 1979 that are included in total.
[4] Highest count on 1 Aug 1979, but excludes 1 HY bird.
[5] Highest count on 5 Jun 1979.
[6] Includes 108 of 131 birds observed on 19 May 1980; excludes count of 80 birds off Whaler Island where 79 were counted on 19 May 1980 between Whaler Island and Castle Rock.
[7] Excludes 20 birds in footnote 3 above.

Table 11. Summary of at-sea records of Marbled Murrelets from northern and central California during the 1979-1980 California seabird colony survey (data from Tables 4, 5, and 10).

Coastal segment	USFWS (unpubl. data) 1979	USFWS (unpubl. data) 1980	This study 1979	This study 1980	This study Combined[1]
Oregon border to Humboldt Bay mouth	145 (76.3)[2]	358 (79.4)	130 (74.3)	235 (80.0)	270 (70.5)
Humboldt Bay mouth to Pillar Point	20 (10.5)	3 (0.7)	20 (11.4)	3 (0.9)	20 (5.2)
Pillar Point to Santa Cruz	25 (13.2)	90 (20.0)	25 (14.3)	90 (27.2)	90 (23.5)
Santa Cruz to Point Conception	0 (0.0)	5 (1.1)	0 (0.0)	3[3] (0.9)	3 (0.8)
Total	190	451	175	331	383

[1] Uses highest counts for coastal areas from 1979 or 1980.
[2] Numbers in parentheses refer to percent of annual total.
[3] Excludes 2 birds at Pt. Sal on 16 Jul 1980 that were seen on 15 Jul 1980 as well.

Table 12. Acres of old-growth redwood forests remaining on commercial lands and in parks in California in 1978 (data from Green 1985).[1]

	Commercial		Park		Total	
County	Acres	%	Acres	%	Acres	%
Del Norte	33420	18.3	11360	15.9	44780	17.6
Humboldt	74860	41.0	51628+	72.4	126488	49.8
Mendocino	43100	23.6	1724+	2.4	44824	17.7
Sonoma	8080	4.4	120	0.2	8200	3.2
Marin	4230	2.3	770	1.1	5000	2.0
San Francisco	0	0	0	0	0	0
San Mateo	4530	2.5	2915	4.1	7445	2.9
Santa Cruz	2470	1.4	2640	3.7	5110	2.0
Monterey	11860	6.5	130+	0.2	11990	4.7
Total	182550		71287+[2]		253837+	

[1] "Old growth" trees defined as 24" dbh and larger in net Scribner Log Rule.
[2] A separate total of 76,000 acres is also given; thus, percentages are considered approximate only.

Table 13. Records of mortality of Marbled Murrelets due to oil pollution in California.

Location	Date	No. oiled	Source
San Francisco	11 Mar 1937	12	Aldrich (1938); Moffitt & Orr (1938)
Bolinas Spit	21 Mar 1937	2	Aldrich (1938); Moffitt & Orr (1938)
Santa Cruz	pre 1947	many	Streator (1947)
Morro Bay	21 Dec 1953	1	Munro (1957)
Morro Bay	31 Jan 1954	1	Munro (1957)
Morro Bay	9 Jan 1957	1	Munro (1957)
Las Varas Ranch Beach	21 Sep 1976	1	Stenzel et al. (1988)
Bodega Bay	9-14 Nov 1984	1	PRBO (1985)
Half Moon Bay	1-8 Feb 1986	3	Page & Carter (1986)
Año Nuevo State Reserve	Feb 1986	3	G. J. Strachan (pers. comm.)
Hope Ranch Beach	26 Apr 1986	2	G. Johnson (pers. comm.)

Appendix 1. Summary of inland records and censuses of AHY Marbled Murrelets in California (1904-1987), excluding data in Table 1. Locations are indicated in Figure 5. Numbers of birds reported must be interpreted with extreme caution (see text). Times reported in parentheses refer to the actual period of detection and times have not been adjusted from those reported (i.e., times are in both PST and PDT). Sources include: bird record files maintained by R. A. Erickson (RAE), S. W. Harris (SWH), Santa Cruz Bird Club, and the northern California regional editors for American Birds; field notes housed at the Museum of Vertebrate Zoology (MVZ), University of California, Berkeley; and specimens housed at MVZ and the Humboldt State University Museum (HSUM).

Rec. No.	Location	Date	No. Birds	Notes	Source
DEL NORTE COUNTY					
1.0	Crescent City (one mile south) [N. B. same location as record 2.0 - added in proof]	Jun 1984	1	flying to sea	P.W.C. Paton & D.M. Taylor (in litt.)
2.0	Crescent City (tank farm east of harbor)	1978 or 1979	-	flying inland at dusk	G.S. Lester (pers. comm.)
2.1	" "	14 Jun 1981	2	calling, flying at dusk	G.S. Lester (RAE files)
3.0	Crescent City (Pebble Beach Dr. at Pacific Ave.)	14 Jun 1981	5-6	calling, overhead (2100)	" "
4.0	Del Norte Coast Redwoods SP (Damnation Creek)	2 Nov 1985	1	calling (0619)	R.A. Erickson (unpubl. data)
4.1	" "	3 Nov 1985	0	none heard or seen from 0617 to 0628	" "
4.2	" "	7 Jul 1987	(1)	census conducted from 2015 to 2115; flying, calling (2053-2110)	H.R. Carter & T.G. Sander (unpubl. data)
4.3	" "	8 Jul 1987	(2)	census conducted from 2030 to 2137; flying, calling (2059-2113)	" "
5.0	Del Norte Coast Redwoods SP (Mill Creek Campground)	summer 1978 or 1979	-	heard once at dusk	G.J. Strachan (pers. comm.)
6.0	Elk Valley Road (at Parkway Drive)	16 Dec 1979	1	calling at dawn	G.S. Lester (Del Norte Co. Christmas Bird Count)
6.1	" "	20 Apr 1982	14	calling at dawn	G.S. Lester (RAE files)
6.2	" "	26 Apr 1982	30	calling at dawn	" "
6.3	" "	3 Dec 1984	-	calling at dawn	" "
7.0	Elk Valley Road (at quarry on Jordan Creek drainage)	18 Dec 1983	30	calling at dawn	W.E. Rodstrom (Del Norte Co. Christmas Bird Count)
7.1	" "	16 Dec 1984	10	calling at dawn	J.A. Rooney (Del Norte Co. Christmas Bird Count)

Appendix 1. Continued.

7.2	" "	22 Dec 1985	few	calling at dawn	A.D. Barron (Del Norte Co. Christmas Bird Count)
7.3	" "	21 Dec 1986	0	None seen or heard at dawn	" "
7.4	" "	20 Dec 1987	several	calling at dawn	" "
8.0	Elk Valley Cross Road (at Wonder Stump Road)	mid-Dec 1987	1	calling; flying inland at dusk	" "
9.0	Hutsinpillar Creek	1 May 1985	1+	calling at dawn	R.A. Erickson (unpubl. data)
9.1	" "	2 Jun 1985	1-2	calling (0525)	" "
9.2	" "	12 Oct 1985	0	census conducted from 0648 to 0705; none seen or heard	" "
9.3	" "	5 May 1986	-	calling at dawn	G.S. Lester (pers. comm.)
9.4	" "	1 Aug 1986	1	calling at dawn	R.A. Erickson (unpubl. data)
9.5	" "	2 Aug 1986	several	calling (0815-0830)	" "
10.0	Bytree Road	25 Apr 1986	6	calling at dawn, flying inland	A.D. Barron (pers. comm.)
10.1	Bytree Road	spring 1987	1	calling at dawn, flying inland	" "
11.0	Jedediah Smith Redwoods SP (Bigouchi/Stout Grove)	16-24 Jul 1977	10	flying inland at dusk, to sea at dawn	Winter & Morlan (1977); R. Schmuck (Amer. Birds files)
11.1	" "	fall 1978	50	calling at dawn	G.J. Strachan (RAE files & SWH files)
11.2	" "	27 Apr 1979	1	calling at dawn	G.J. Strachan (RAE files)
11.3	" "	18 Jun 1979	17	calling, flying	" "
11.4	" "	21 Jun 1979	10	present	" "
11.5	" "	18 Jul to 10 Aug 1979	up to 16-18	in pairs, flying inland and to sea	Laymon & Shuford (1979); G.J. Strachan (Amer. Birds files & SWH files)
11.6	" "	23 Jul 1979	11	present	G.J. Strachan (RAE files)
11.7	" "	6 Aug 1979	6	(0700)	" "
11.8	" "	24 Jul 1981	1-2	calling (0730)	R.A. Erickson (unpubl. data)
11.9	" "	6 Jan 1983	8+	calling at dawn	G.S. Lester (RAE files & SWH files)
11.10	" "	11 Jan 1983	0	none seen or heard at dawn	" "

Appendix 1. Continued.

11.11	"	"	18 Dec 1983	30	calling at dawn	G.J. Strachan (Del Norte Co. Christmas Bird Count)
11.12	"	"	30 Jun 1987	0	census conducted from 2000 to 2230; none seen or heard	R. W. Becking (unpubl. data)
11.13	"	"	1 Jul 1987	few	census conducted from 0430 to 0700; calling in distance	" "
12.0	Jedediah Smith Redwoods SP (Howland Summit)		13 Mar 1982	3	calling at dawn	G. S. Lester (RAE files)
12.1	"	"	24 Apr 1982	10	calling at dawn; (0500)	R.A. Erickson (unpubl. data)
12.2	"	"	19 Apr 1986	1	calling at dawn	A.D. Barron (pers. comm.)
12.3	"	"	19 Jun 1986	1	calling at dawn	" "
13.0	Jedediah Smith Redwoods SP (end of Walker Rd.)		1978 or 1979	-	heard on several occassions	G.J. Strachan & G.S. Lester (pers. comm.)
14.0	Klamath Post Office		16 Aug 1981	-	calling at dawn	G.J. Strachan (RAE files)
15.0	Klamath River mouth (Fortain Ranch on south side)		summer 1980	-	calling	G.S. Lester (RAE notes)
15.1	"	"	3 Feb 1981	5-6	calling (0650-0710)	" "
15.2	"	"	5 Feb 1981	5-6	calling (0700-0715)	" "
15.3	"	"	9 Jun 1981	2+	calling at dawn	" "
15.4	"	"	to 17 Aug 1981	up to 60+	"regular" at dawn	" "
15.5	"	"	11 Mar 1982	2	calling at dawn	" "
15.6	"	"	12 Mar 1982	1	calling at dawn	" "
15.7	"	"	late Jul 1982	many	calling at dawn	" "
15.8	"	"	15 Oct 1982	1	calling at dawn	" "
16.0	Klamath River mouth (Requa Hill, on north side)		6 Jan 1983	2+	calling at dawn	R.A. Erickson (unpubl. data & SWR files)
17.0	Lake Talawa		22 Jul 1986	1	adult flying to sea low over lake at midday	A.D. Barron (pers. comm.)
18.0	Terwer Valley		16 Jul 1981	3, (2) (2)	calling; (0650 & 0710) 0710)	R.A. Erickson (unpubl. data) (unpubl. data)
18.1	"	"	19 Jul 1981	25-35, (4)	calling, flying (0600-0715)	" "

Appendix 1. Continued.

18.2	"	"	21	Jul	1981	47+, (3)	census conducted from 0553 to 0810; calling, flying (0557-0745)	"	"
18.3	"	"	23	Jul	1981	5+	calling at dawn	"	"
18.4	"	"	24	Jul	1981	5+	calling at dawn	"	"
18.5	"	"	26	Oct	1981	4+, (2+)	calling (0620 & 0625)	"	"
18.6	"	"	27	Oct	1981	0	none seen or heard from 0605 to 0630	"	"
18.7	"	"	2	Nov	1981	1	calling (0629)	"	"
18.8	"	"	23	Nov	1981	5, (2)	census conducted from 0620 to 0715; calling (0652-0702)	"	"
18.9	"	"	24	Nov	1981	8-12, (2)	census conducted from 0635 to 0715; calling (0641-0700)	"	"
18.10	"	"	25	Nov	1981	3-4, (2)	census conducted from 0650 to 0700; calling (0652-0655)	"	"
18.11	"	"	30	Nov	1981	0	census conducted from 0650 to0710; none seen or heard	"	"
18.12	"	"	3	Dec	1981	0	census conducted from 0625-0725; none seen or heard	"	"
18.13	"	"	4	Dec	1981	0	census conducted from 0652 to 0712; none seen or heard	"	"
18.14	"	"	7	Dec	1981	0	census conducted from 0647 to 0710; none seen or heard	"	"
18.15	"	"	14	Dec	1981	3-5, (2)	census conducted from 0648 to 0715; calling (0704-0713)	"	"
18.16	"	"	15	Dec	1981	1	calling (0617)	"	"
18.17	"	"	17	Dec	1981	2-3, (1)	census conducted from 0648 to 0720; calling (0702-0709)	"	"
18.18	"	"	8	Jan	1982	6, (1)	census conducted from 0655 to 0715; calling (0701-0712)	"	"
18.19	"	"	4	Feb	1982	1-2	census conducted from 0640 to 0715; calling (0713 only)	"	"
18.20	"	"	4	Mar	1982	0	census conducted from 0606 to 0636; none seen or heard	"	"
18.21	"	"	10	Jul	1987	4-5, (2)	census conducted from 0500 to 0615; flying, calling (0528-0600)	H.R. Carter & T.G. Sander (unpubl. data)	

Appendix 1. Continued.

19.0	Yurok Redwood Experimental Forest	10 Mar 1985	0	census conducted; none seen or heard at dawn	Paton et al. (in review); R.A. Erickson (unpubl. data)
19.1	" "	Apr 1985	up to 12	calling, flying, on 3 of 4 dawn census days	" "
19.2	" "	May 1985	up to 20+	calling, flying, on 5 dawn census days	" "
19.3	" "	Jun 1985	up to 20	calling, flying on 6 dawn census days	" "
19.4	" "	18 Jul 1985	many	census conducted; calling at dawn	" "
19.5	" "	Aug 1985	0	none seen or heard on 4 dawn census days	" "
19.6	" "	Sep 1985	0	none seen or heard on 3 dawn census days	" "
19.7	" "	Oct 1985	up to 16-24	calling, flying on 2 of 3 dawn census days days	" "
19.8	" "	Nov 1985	some	calling, flying, on 3 of 5 dawn census days	" "
19.9	" "	Dec 1985	0	none seen or heard on 2 dawn census days	" "
19.10	" "	Jan 1986	0	none seen or heard on 2 dawn census days	" "
19.11	" "	Feb 1986	0	none seen or heard on 2 dawn census days	" "
19.12	" "	Mar 1986	0	none seen or heard on 4 dawn census days	" "
19.13	" "	Apr 1986	0	none seen or heard on 2 dawn census days	" "
19.14	" "	May 1986	2-35	calling, flying, on 2 dawn census days	" "
HUMBOLDT COUNTY					
20.1	Big Lagoon (Maple Creek)	9 Aug 1949	some	calling, overhead, at dawn	H.L. Cogswell (in litt., MVZ field notes)
20.2	" "	11 Aug 1949	some	calling, flying to sea (0525)	" "
20.3	" "	12 Aug 1949	3	calling, flying (until 0620)	A.H. Miller (MVZ field notes)

Appendix 1. Continued.

20.4	"	"	13 Aug 1949	-	calling (0545)	" "
20.5	"	"	15 Aug 1949	3	calling at dawn	H.L. Cogswell (in litt., MVZ field notes)
20.6	"	"	16 Aug 1949	some	calling (0445)	" "
20.7	"	"	17 Aug 1949	some	calling (0505+)	" "
20.8	"	"	18 Aug 1949	3+	calling, circling, flying inland and to sea (0515 & 0545)	A.H. Miller & H.L Cogswell (MVZ field notes)
20.9	"	"	19 Aug 1949	2	calling, circling, flying inland and to sea (until 0615)	" "
21.0	Carlotta		1 Jul 1916	2	flying to sea at dawn	Dawson (1923)
21.1	"	"	May to Jul	some	calling, flying	Grinnell & Miller (1944)
21.2	"	"	23 Jul 1923	(4)	calling, flying, in pairs (until 0535)	J. Grinnell (MVZ field notes)
21.3	"	"	26 Jul 1923	(2)	calling, flying (until 0535)	" "
21.4	"	"	30 Jul 1923	-	calling (until 0700)	" "
21.5	"	"	1 Aug 1923	-	calling (0500)	" "
21.6	"	"	15 Jul 1929	-	calling in distance (0530)	" "
21.7	"	"	16 Jul 1929	-	calling in distance (0525 & 0540)	" "
21.8	"	"	17 Jul 1929	-	calling in distance (0620)	" "
21.9	"	"	18 Jul 1929	-	calling until 0705	" "
21.10	"	"	8 Jul 1930	-	calling (0540)	" "
21.11	"	"	3 Jul 1932	2	calling (0420 & 0537)	" "
21.12	"	"	26 Jul 1932	-	calling (0430)	" "
21.13	"	"	27 Jul 1932	-	calling (0445-0615)	" "
22.0	Cheatham Grove [N.B. Part of Grizzly Creek Redwoods SP but location correct on Fig. 5 - added in proof]		27 Jun 1987	4	census conducted from 0530 to 0715; in pairs, flying, circling, calling	R. W. Becking (unpubl. data)
23.0	Dry Lagoon SP		27 Jun 1954	2	flying to sea	R. Mall (Amer. Birds files & SWH files)
24.0	Eureka		16 Jul 1916	1	adult, on ground	Grinnell & Miller (1944); H. S. Swarth (MVZ field notes) [MVZ 27096]
25.0	Eureka (Sequoia Park)		May 1987	0	census conducted from 0430 to 0700; none seen or heard	R.W. Becking (unpubl. data)

Appendix 1. Continued.

26.0	Freshwater	Jul 1983	1	adult fell out of tree being felled by loggers	S.W. Harris (in litt. & files); P.W.C. Paton (pers. comm.) [HSUM 5484]
27.0	Grizzly Creek Redwoods SP (campground)	28 Apr 1973	2	calling before sunrise	Remsen & Gaines (1973a); S.W. Harris & R. LeValley (SWH files)
27.1	" "	29 Apr 1973	1-2	calling at dusk	R.A. Erickson (unpubl. data & SWH files)
27.2	" "	8 May 1976	4	in pairs, circling, calling	J. & M. Proke (Amer. Birds files) & SWH files)
27.3	" "	4 Nov 1984	2	calling, flying downstream at 0630	S. D. Fitton (in litt.)
27.4	" "	14 Aug 1987	1	census conducted from 0530 to 0715; flying, calling	R.W. Becking (unpubl. data)
28.0	Highway 101 (at Davison Road)	1930 to 1946	-	calling every year	Davison (J. Davis, MVZ field notes)
28.1	" "	1975 to 1984	-	calling several times	G.J. Strachan (pers. comm.)
29.0	Highway 101 (just north of Little River)	Apr 1987	1	adult found dead on road	A.D. Barron (pers. comm.)
30.0	Orick	15 Jul 1981	2-3	calling at dawn	G.S. Lester (RAE files & Redwood NP records)
30.1	"	15 Dec 1981	(2+)	census conducted from 0642 to 0715; calling (0703 only)	R.A. Erickson (unpubl. data)
30.0	Patrick's Point SP	1975 to 1984	-	calling once or twice	G.J. Strachan (pers. comm.)
31.0	Prairie Creek Redwoods SP (Big Tree)	18 Feb to 1 Mar 1987	some	calling on 8 dawn census days	H.R. Carter & T.G. Sander (unpubl. data)
32.1	" "	18-31 May 1987	many	calling, flying on 7 dawn census days; on 10 dusk census days	" "
32.2	" "	29 Jun to 5 Jul 1987	many	calling, flying on 4 dawn census days; on 6 of 7 dusk census days	" "
33.0	Prairie Creek Redwoods SP (Boyes Creek, two miles east of Elk Prairie)	19 Jun 1987	(2)	census conducted; calling, flying, at dusk	" "
33.1	" "	20 Jun 1987	(6)	census conducted from 0500 to 0615; calling, flying (0518-0601)	" "
34.0	Prairie Creek Redwoods SP (Cal Barrel Road)	1975 to 1984	-	heard over	G.J. Strachan (pers. comm.)

Appendix 1. Continued.

35.0	Prairie Creek Redwoods SP (East ridge)	22 Jul 1972	some	overhead at dusk	M. Keith (Park records)
36.0	Prairie Creek Redwoods SP (Elk Prairie)	mid-Oct to Nov 1965	some	regular daybreak flight over	Chase & Paxton (1966); E.A. Pugh (Amer. Birds files)
36.1	" "	winter 1965-1966	several	calling, flying over at dawn	E.A. Pugh (Amer. Birds files)
36.2	" "	24 Jun 1970	-	calling at dusk	M. Keith (RAE files)
36.3	" "	8 Jul to 2 Aug 1970	many	calling, at dusk	Baldridge et al. (1970); M. Keith (Amer. Birds files)
36.4	" "	22 Jul 1970	-	calling (1900)	" "
36.5	" "	23 Jul 1970	15	calling, circling, flying to sea at dusk	M. Keith (Park records)
36.6	" "	24 Jun to 6 Aug 1971	many	calling, every evening	DeSante & LeValley (1971); M. Keith (Park records)
36.7	" "	24 Jul 1971	10-15	calling, flying, circling (2045)	M. Keith (Park records)
36.8	" "	1 Aug 1971	many	calling, flying, circling at dusk	" "
36.9	" "	6 Aug 1971	-	calling at dusk	" "
36.10	" "	28 May 1972	-	calling (1830); first time at dusk this spring	M. Keith (Amer. Birds files)
36.11	" "	6 Jun 1972	-	calling at dusk	" "
36.12	" "	7 Jun 1972	few	calling at dusk	" "
36.13	" "	10 Jul 1972	-	calling (0600 & 2100)	" "
36.14	" "	15 Jul 1972	many	calling at dusk (2100)	" "
36.15	" "	22 Jul 1972	many	calling at dusk	" "
36.16	" "	5 Aug 1972	-	"last date heard"	" "
36.17	" "	3 Jul 1974	2	flying low (2100)	D.E. Schmoldt (Park records)
36.18	" "	8 Jul 1974	several	calling, flying (2230)	" "
36.19	" "	11 Jul 1974	several	calling, flying (2100-2130)	" "
36.20	" "	18 Jul 1974	6	flying	" "
36.21	" "	22 Jul 1974	3	flying	" "
36.22	" "	20 Jun 1975	many	(2000)	G.J. Strachan (Park records)
36.23	" "	28 Jun 1975	few	calling	" "
36.24	" "	23-24 Aug 1975	2+	calling, flying	O.J. Nolkman (Amer. Birds files)

Appendix 1. Continued.

36.25	"	"	Jul 1976	100	"most ever", flying (1800-2100)	G. J. Strachan (Park records)
36.26	"	"	3 Aug 1976	4	flying low (2030)	" "
36.27	"	"	13 Aug 1976	30	flying, calling (2000)	" "
36.28	"	"	23-26 Jan 1978	30	calling (~0700)	G.J. Strachan (SWH files)
36.29	"	"	14 Dec 1980	30+	calling at dawn	" "
36.30	"	"	Jan 1981	many	calling at dawn on 13 days	A. & B. Wilkinson (unpubl. data)
36.31	"	"	8 Jan 1981	30-31, (4)	census conducted from 0713 to 0740; calling, flying (0713-0734)	R.A. Erickson (unpubl. data)
36.32	"	"	15 Jan 1981	31, (4)	census conducted from 0653 to 0730; flying, calling (0659-0720)	" "
36.33	"	"	20 Jan 1981	few	calling, flying,	G.S. Lester (RAE files)
36.34	"	"	Feb 1981	many	calling at dawn on 4 days	A. & B. Wilkinson (unpubl. data)
36.35	"	"	Oct 1981	many	calling at dawn on 18 days	" "
36.36	"	"	5 Oct 1981	2, (1)	census conducted from 0700 to 0715; calling, flying (0704-0705)	R.A. Erickson (unpubl. data)
36.37	"	"	13 Oct 1981	6+, (2)	census conducted from 0708 to 0725; calling, flying (0708-0712)	" "
36.38	"	"	15 Oct 1981	(2+)	census conducted from 0712 to 0720; calling, flying (0712-0713)	" "
36.39	"	"	16 Oct 1981	30, (2+)	census conducted from 0650 to 0730; calling, flying (0651-0711)	" "
36.40	"	"	19 Oct 1981	0	census conducted from 1810 to 1830; none heard or seen	" "
36.41	"	"	20 Oct 1981	82+, (6)	census conducted from 0700 to 0745; calling, flying (0700-0738)	" "
36.42	"	"	22 Oct 1981	49+, (2)	census conducted from 0649 to 0749; calling, flying (0657-0743)	" "
36.43	"	"	26 Oct 1981	0	census conducted from 1745 to 1830; none seen or heard	" "

Appendix 1. Continued.

36.44	"	"		Nov 1981	many	calling at dawn on 11 days (0650-0700)	A. & B. Wilkinson (unpubl. data)
36.45	"	"		Dec 1981	20	calling at dawn on 4 days (0655)	" "
36.46	"	"	8	Dec 1981	23-44, (4+)	census conducted from 0638 to 0713; calling, flying (0645-0706)	R.A. Erickson (unpubl. data)
36.47	"	"	9	Dec 1981	20-25	calling, flying (0645-0720)	" "
36.48	"	"	16	Dec 1981	30-35	census conducted from 0642 to 0720; calling, flying (0642-0714)	" "
36.49	"	"		Jan 1982	3-25	calling at dawn on 11 days (0700-0715)	A. & B. Wilkinson (unpubl. data)
36.50	"	"		Feb 1982	3-15	calling at dawn on 8 days	" "
36.51	"	"	9	Feb 1982	40	census conducted from 0650 to 0720; calling, flying (0650-0715)	R.A. Erickson (unpubl. data)
36.52	"	"		Mar 1982	5-20	calling at dawn on 5 days (0615-0630)	A. & B. Wilkinson (unpubl. data)
36.53	"	"		Apr 1982	10-20	calling at dawn on 3 days (0500-0600)	" "
36.54	"	"		May 1982	many	calling at dawn on 17 days (0545), at dusk on 3 days (2040)	" "
36.55	"	"		Jun 1982	many	calling at dawn on 9 days, at dusk on 5 days	" "
36.56	"	"		Jul 1982	many	calling at dawn on 11 days, at dusk on 8 days	" "
36.57	"	"		Oct 1982	2-20	calling at dawn on 17 days (0700-0715)	" "
36.58	"	"		Nov 1982	some	calling at dawn on 3 days	" "
36.59	"	"		Dec 1982	many	calling at dawn on 9 days	" "
36.60	"	"		Jan 1983	some	calling at dawn on 12 days	" "
36.61	"	"		Apr 1983	some	calling at dawn on 12 days (0530)	" "
36.62	"	"		fall 1983	-	"numbers down"	A. Wilkinson (RAE files)
36.63	"	"	23	Jun 1985	60 (6)	calling (0545-0615)	G.J. Strachan (RAE files)

Appendix 1. Continued.

36.64	"	"	Oct 1985	6-20	calling at dawn on 6 days (0615-0715)	A. & B. Wilkinson (unpubl. data)
36.65	"	"	13 Oct 1985	5-10	census conducted from 0610 to 0730; calling, flying (0640-0705)	H.R. Carter (unpubl. data)
36.66	"	"	Nov 1985	5-20	calling at dawn on 8 days (0615-0705); at dusk on 1 day (1715)	A. & B. Wilkinson (unpubl. data)
36.67	"	"	Dec 1985	1-10	calling at dawn on 11 days (0650-0715)	" "
36.68	"	"	Jan 1986	1-6	calling at dawn on 7 days (0650-0715)	" "
36.69	"	"	Feb 1986	3-10	calling at dawn on 10 days (0620-0700)	" "
36.70	"	"	Mar 1986	0	none heard at dawn or dusk	" "
36.71	"	"	Apr 1986	-	calling at dawn on 1 day (0500); at dusk on 1 day	" "
36.72	"	"	May 1986	many	calling every dawn (0545-0615); most dusks (2030-2100)	" "
36.73	"	"	Jun to early Aug 1986	10-20	calling every dawn (0600-0800), most dusks (1800-2000)	" "
36.74	"	"	late Aug 1986	5-10	calling every dawn and most dusks	" "
36.75	"	"	Oct 1986	4-10	calling at dawn on 9 days (0615-0715)	" "
36.76	"	"	Nov 1986	4-6	calling at dawn on 8 days (0640-0700)	" "
36.77	"	"	Dec 1986	1	calling at dawn on 3 days (0700-0715)	" "
36.78	"	"	15 Jan to 11 Mar 1987	some	calling at dawn on 35 of 53 dawn census days; not heard or seen on 22 dusk census days	H.R. Carter & T.G. Sander (unpubl. data)
36.79	"	"	14-26 May 1987	many	calling, flying on 11 dawn census days; on 6 dusk census days	" "
36.80	"	"	25 Jun to 7 Jul 1987	many	calling, flying on 10 dawn census days; on 10 dusk census days	" "
36.81	"	"	23 Sep 1987	many	calling, flying at dawn	" "
37.0	Prairie Creek Redwoods SP (two miles west of Elk Prairie)		11 Jun 1946	-	present	A.H. Miller (MVZ field notes)

Appendix 1. Continued.

37.1	"	"	12 Jun 1946	-	calling at dawn	" "
37.2	"	"	12 Jun 1946	12	calling, wingbeats heard, flying inland and to sea (2000-2030)	A.H. Miller & J. Davis (MVZ field notes)
37.3	"	"	13 Jun 1946	some	calling, wingbeats heard (0415)	A.H. Miller (MVZ field notes)
37.4	"	"	13 Jun 1946	few	calling (2015)	A.H. Miller & J. Davis (MVZ field notes)
37.5	"	"	14 Jun 1946	few	calling (0500)	A.H. Miller (MVZ field notes)
37.6	"	"	14 Jun 1946	few	calling (1945)	A.H. Miller & J. Davis (MVZ field notes)
37.7	"	"	15 Jun 1946	3+	calling, wingbeats heard, flying inland (0430-0445)	A.H. Miller (MVZ field notes)
38.0	Prairie Creek Redwoods SP (Gold Bluffs Beach) at Butler Creek)		1930's	-	flying to sea out of forest	Davison (J. Davis, MVZ field notes)
38.1	"	"	29 Jul 1972	many	calling	M. Keith (Park records)
39.0	Prairie Creek Redwoods SP (Gold Bluffs Beach at Espa Lagoon)		1975 to 1984	-	flying over many times at dawn and dusk	G.J. Strachan (pers. comm.)
39.1	"	"	15 Feb 1981	-	calling at dawn	G.J. Strachan (RAE files)
39.2	"	"	fall 1983	-	"numbers down"	" "
40.0	Prairie Creek Redwoods SP (Gold Bluffs Beach - Espa Lagoon to Fern Canyon)		1975 to 1984	-	calling or flying flying inland at numerous sites at dusk	G.J. Strachan (pers. comm.)
41.0	Prairie Creek Redwoods SP (Gold Bluffs Beach at Fern Canyon)		25 May 1987	(2)	census conducted from 2037 to 2114; calling, flying inland and to sea (2037-2103), flying high at 500-900 feet	H.R. Carter & T.G. Sander (unpubl. data)
42.0	Prairie Creek Redwoods SP (Gold Bluffs Beach at Ossagon Creek)		15 May 1982	1	flying to sea (1035)	G.S. Strachan (RAE files)
43.0	Prairie Creek Redwoods SP (Highway 101 at Ah Pah Road)		10 Dec 1981	0	census conducted from 0653 to 0710; none seen or heard	R.A. Erickson (unpubl. data)
44.0	Prairie Creek Redwoods SP (Lincoln Prairie)		29 Jun 1975	3	flying low	G.J. Strachan (Park records)
44.1	"	"	21 Jun 1987	(2)	census conducted from 2020 to 2130; calling (2107-2111)	H.R. Carter & T.G. Sander (unpubl. data)
45.0	Redwood NP (Bridge Creek mouth)		summer 1976	-	calling	G.S. Lester (pers. comm.)

Appendix 1. Continued.

46.0	Redwood NP (Lost Man Creek)	1975 to 1984	-	heard calling several times at dusk	G.J. Strachan (pers. comm.)
46.1	" "	26 Feb 1987	(2)	census conducted; flying, calling (0615-0639)	N.R. Carter & T.G. Sander (unpubl. data)
46.2	" "	24 Jun 1987	(6)	census conducted from 0500 to 0720; flying, calling (0510-0700)	" "
46.3	" "	24 Jun 1987	(2)	census conducted from 2015 to 2130; flying, calling (2101-2117)	" "
46.4	" "	28 Jun 1987	16	census conducted from 0430 to 0700; in pairs, flying, calling	R.W. Becking (unpubl. data)
46.5	" "	6 Jul 1987	16	census conducted from 0430 to 0700; in pairs, flying, calling	" "
46.6	" "	8 Jul 1987	many	calling, flying (0522-0641)	N.R. Carter & T.G. Sander (unpubl. data)
46.7	" "	9 Jul 1987	many	calling, flying (0517-0614)	" "
46.8	" "	9 Jul 1987	(2)	census conducted from 2030 to 2130; calling, flying (2059-2104)	" "
46.9	" "	10 Jul 1987	many	flying, calling (0515-0645)	" "
47.0	Redwood NP (Redwood Creek mouth)	19 Jun 1987	1	heard calling (0637)	" "
48.0	Redwood NP [N.B. Tall Trees Grove, just north of record 45; location incorrect on Fig. 5 - added in proof]	4 Aug 1975	many	flying to sea (0615-0700); 2 flew from trees	D.J. Forsell (in litt. & Park records)
48.1	Redwood NP [N.B. Redwood Creek trailhead; location is slightly north of location 48 on Fig. 5 - added in proof]	1975 to 1984	-	heard over several times	G.J. Strachan (pers. comm.)
49.0	Stone Lagoon	17 Dec 1986	0	not heard at dawn	A. Wilkinson (pers. comm.)
50.0	Trinidad (half mile inland)	20-23 Jul 1916	many	flying inland (1950); to sea (0415), calling	Dawson (1923)
51.0	Westhaven (Sixth Ave.)	31 May 1986	3-4	calling (0645)	G.S. Lester (pers. comm.)
MENDOCINO COUNTY					
52.0	Russian Gulch SP	9 May 1976	2	flying inland at dawn	R.A. Erickson (Amer. Birds files)

Appendix 1. Continued.

SONOMA COUNTY					
53.0	Armstrong Redwoods SR	27 Jul 1987	0	census conducted from 0514 to 0608; none heard or seen	H.R. Carter & T.G. Sander (unpubl. data)
MARIN COUNTY					
54.0	Muir Woods National Monument	26 Dec 1981	0	none seen or heard at dawn	R.A. Erickson (unpubl. data)
54.1	" "	12 Jul 1987	0	census conducted from 0444 to 0615; none heard or seen	H.R. Carter & T.G. Sander (unpubl. data)
SAN MATEO COUNTY					
55.0	Año Nuevo SR	winter 1986-87	-	flying over on several occasions, calling	G.J. Strachan (Amer. Birds files)
55.1	" "	spring 1987	-	flying over consistently at dawn, calling	" "
56.0	Año Nuevo SR (Año Nuevo Creek)	Mar 1984 to Mar 1986	some	calling high overhead	G.J. Strachan (Santa Cruz Bird Club files)
57.0	Año Nuevo SR (Cascade Creek)	Mar 1984 to Mar 1986	some	calling	" "
58.0	Año Nuevo SR (Whitehouse Creek)	Mar 1984 to Mar 1986	some	calling high overhead	" "
59.0	Apanolio Canyon	30 Jul 1987	0	census conducted from 0500 to 0630; none heard or seen	H.R. Carter & T.G. Sander (unpubl. data)
60.0	Butano SP	29 Oct 1975	1	flew up from road	J. Schmus (Park records)
60.1	" "	14 Jul 1987	(5)	census conducted from 0455 to 0720; calling, flying (0524-0700)	H.R. Carter & T.G. Sander (unpubl. data)
60.2	" "	14 Jul 1987	(1)	census conducted from 2000 to 2115; wingbeats heard at 2028 only	" "
61.0	Canyon Road (at Butano Creek)	31 Jul 1977	some	flying to sea over treetops after sunrise	P.J. Metropulos (Amer. Birds files); Winter & Morian (1977)
61.1	" "	29 Mar 1987	2	flying, calling	R. Franz (Amer. Birds files)
61.2	" "	Jul 1987	-	calling, throughout month	" "
62.0	Memorial Park	15 Jul 1987	(3)	census conducted from 0450 to 0705; flying, calling (0529-0654)	H.R. Carter & T.G. Sander (unpubl. data)
63.0	Pescadero Creek	24 Aug 1904	some	calling, flying	Grinnell & Miller (1944); J. Grinnell (MVZ field notes)

Appendix 1. Continued.

64.0	Portola SP	early Jul 1956	some	flying, circling over trees, at dawn	E.A. Pugh (Amer. Birds files)
64.1	" "	8 Feb 1957	several	flying, circling over trees, at dawn	" "
64.2	" "	early Jul 1973	some	landing in trees at dusk and leave at dawn	Remsen & Gaines (1973b); B.G. Elliott (Amer. Birds files)
64.3	" "	16 Jul 1987	(4)	census conducted from 0500 to 0735; flying, calling (0521-0722)	H.R. Carter & T.G. Sander (unpubl. data)
65.0	Sam MacDonald Park	22 Jul 1987	(4)	census conducted from 0500 to 0635; flying, calling (0535-0615)	" "
65.1	" "	23 Jul 1987	(2)	census conducted from 0504 to 0645; flying, calling (0555-0615)	" "
SANTA CRUZ COUNTY					
66.0	Big Basin Redwoods SP	19 Apr 1969	1	flying, calling (0600)	Cutler & Pugh (1959); E. A. Pugh (Amer. Bird files)
66.1	" "	Jul 1959	1	flying, calling	Singer & Verardo (1975)
66.2	" "	29 Jul 1960	1	calling	Park records
66.3	" "	1 Feb 1973	1	adult, on ground, injured	Singer & Verardo (1975)
66.4	" "	17 Jun 1973	1	adult, on ground, injured	" "
66.5	" "	12 Jun 1976	1	flying	Park records
66.6	" "	20 Jun 1976	20	census conducted from 0600 to 0645; flying, calling, circling	S.W. Singer (Amer. Birds files)
66.7	" "	26 Jun 1976	52	census conducted from 0525 to 0615; flying, calling	" "
66.8	" "	10 Jul 1976	100	census conducted from 0515 to 0645; calling, flying, circling	S.W. Singer & Santa Cruz Bird Club (unpubl. data)
66.9	" "	10 Jul 1976	50	flying through trees at dusk	Winter & Erickson (1976); A.H. Bledsoe & R.A. Morgan (Amer. Birds files)
66.10	" "	18 Jul 1976	many	census conducted from 0500 to 0700; calling, flying at dawn	S.W. Singer (unpubl. data)
66.11	" "	6 Aug 1976	3	census conducted from 1930 to 2100; calling, flying	" "

Appendix 1. Continued.

66.12	"	"	8 Aug 1976	62	census conducted from 0505 to 0700; calling, flying	"	"
66.13	"	"	21 Aug 1976	0	census conducted from 0515 to 0645; none seen or heard	"	"
66.14	"	"	24 Apr 1977	62	census conducted from 0515 to 0635; calling, flying	"	"
66.15	"	"	to end of Nov 1978	several	seen daily	M. Zumsteg (Santa Cruz Bird Club files)	
66.16	"	"	Dec 1978	some	calling	Park records	
66.17	"	"	Jan 1979 (3 dates)	10	flying	Winter & Laymon (1979); D. Parker (Amer. Birds files)	
66.18	"	"	late Aug 1983	0	none seen or heard at dusk	H.R. Carter (unpubl. data)	
66.19	"	"	18 May 1984	1	on ground, alive, injured, took off from ground	Park records	
66.20	"	"	2 Aug 1984	1	on ground, alive	"	"
66.21	"	"	17 Mar 1987	few	calling at dawn	H.R. Carter & T.G. Sander (unpubl. data)	
66.22	"	"	18 Mar 1987	(4)	calling (0545-0616)	"	"
66.23	"	"	23 Apr 1987	many	calling, flying at dawn	"	"
66.24	"	"	24 Apr 1987	many	calling, flying at dawn	"	"
66.25	"	"	28 Apr 1987	many	calling, flying at dawn	"	"
66.26	"	"	5 May 1987	many	calling, flying at dawn	"	"
66.27	"	"	29 May 1987	10	census conducted from 0500 to 0700; flying, circling, calling	R.W. Becking (unpubl. data)	
66.28	"	"	19-20 Jun 1987	10	census conducted from 0500 to 0700; flying, circling; calling	"	"
66.29	"	"	20 Jun 1987	20	calling, flying (0645-0710)	D.L. Suddjian & R. A. Morgan (Amer. Birds files)	
66.30	"	"	17 Jul 1987	(3)	census conducted from 0508 to 0715; calling, flying (0521-0706)	H.R. Carter & T.G. Sander (unpubl. data)	
66.31	"	"	18 Jul 1987	many	calling, flying at dawn	"	"

Appendix 1. Continued.

66.32	"	"	20 Jul 1987	many	calling, flying at dawn	" "
66.33	"	"	8 Aug 1987	8	census conducted from 0500 to 0635; calling, flying	S.W. Singer (unpubl. data)
66.34	"	"	14 Aug 1987	some	calling, flying, at dawn	H.R. Carter & T.G. Sander (unpubl. data)
66.35	"	"	25 Sep 1987	0	census conducted from 0615 to 0730; none seen or heard	" "
67.0	Kings Creek (Redwood Camp)		Jul 1957	2	flying up creek at dawn	C.J. Ralph (pers. comm.)
68.0	Majors Creek		18 May 1914	5+	flying to sea, at dawn, calling	Dawson (1923)
68.1	"	"	19 May 1914	6+	flying to sea at dawn, calling	" "
68.2	Majors Creek (Smith Grade Rd.)		25 Jul 1987	0	census conducted from 0439 to 0615; none seen or heard	H.R. Carter & T.G. Sander (unpubl. data)
69.0	Pelican Rock		10-13 Jul 1987	-	flying to sea	D.L. Suddjian (Amer. Birds files)
70.0	Univ. of Calif. Santa Cruz campus		Jun 1976	1	flying inland at dusk	T. Newberry (Santa Cruz Bird Club files)
70.1	"	"	late May to early Jun 1977	1	flying inland at dusk	Winter & Morlan (1977); A.S. Biedsoe (Amer. Birds files)
71.0	Waddell Creek		6 Apr 1972	1	flying, calling, above trees	T. Rogers (Amer. Birds files)
71.1	"	"	Mar 1984 through Dec 1987	-	calling several times at dawn and dusk	G.J. Strachan (pers. comm.)
71.2	"	"	10-13 Jul 1987	-	flying to sea	D.L. Suddjian (Amer. Birds files)