STATUS OF THE MARBLED MURRELET IN BRITISH COLUMBIA

MICHAEL S. RODWAY[1]
Canadian Wildlife Service, P. O. Box 340
Delta, British Columbia V4K 3Y3

HARRY R. CARTER
U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center
6924 Tremont Road, Dixon, California 95620

SPENCER G. SEALY
Department of Zoology, University of Manitoba
Winnipeg, Manitoba R3T 2N2

R. WAYNE CAMPBELL
Vertebrate Zoology Division, Royal British Columbia Museum
Victoria, British Columbia V8V 1X4

Abstract. The Marbled Murrelet (*Brachyramphus marmoratus*) is widespread in nearshore habitats throughout coastal British Columbia. Populations have been censused reliably only in Barkley and Clayoquot sounds on the west coast of Vancouver Island. The provincial population may approach 45,000 breeding birds. Local studies and casual observations suggest a movement from exposed inshore waters into sheltered nearshore waters beginning late in the breeding period, and a post-breeding shift into the Strait of Georgia by a portion of the population. No nests have been found in British Columbia, but evidence indicates that nesting occurs in old-growth forests within 101 km of the ocean. Adult diet during the breeding season is mostly fish, primarily Pacific sandlance (*Ammodytes hexapterus*) and Pacific herring (*Clupea harengus*). Euphausiids are important in the spring at Langara Island in the Queen Charlotte Islands. Sandlance are the prey most frequently fed to nestlings. Data on winter diet are scant. The most serious threat to Marbled Murrelets in British Columbia is the rapid removal of old-growth forest nesting habitat. Only a small portion of this habitat is currently protected within established parks and government reserves. Information on the amount of suitable old-growth habitat remaining in British Columbia is urgently needed to identify critical areas and focus conservation efforts. Marbled Murrelets also suffer substantial mortality at sea in gill nets and from oil pollution.

Key words: Brachyramphus marmoratus; *British Columbia; distribution; Marbled Murrelet; old-growth forest; seasonal movements; threats.*

INTRODUCTION

Intensive searches for the nest of the Marbled Murrelet (*Brachyramphus marmoratus*) focused on coastal British Columbia intermittently during the first half of this century, yet nest sites still have not been found in the Province (Drent and Guiguet 1961, Sealy 1974, Sealy and Carter 1984). Nevertheless, anecdotal observations of early naturalists provided important glimpses into the natural history, distribution, habitat use, and breeding biology of the species, both at sea and at inland locations. Studies of the species' ecology began in 1970 at Langara Island in the northwestern Queen Charlotte Islands and extended through 1982 in Barkley Sound on the west coast of Vancouver Island. At-sea transects were used to describe and quantify the diurnal pattern of foraging, at-sea distribution, and population size (Carter 1984, Sealy and Carter 1984, Carter and Sealy 1990). Collections and observations of birds at sea provided information on diet, clutch size, and breeding phenology (Sealy 1974, 1975a, b; Carter 1984). Observations of murrelets dispersed widely in the literature and unpublished field notes were used to establish use of inland forested habitat and freshwater lakes in British Columbia and elsewhere in the species' range (Carter and Sealy 1986, 1987b). Those studies indicated murrelets' use of old-growth forests and pointed to the conservation problems of nesting

[1] Present address: Department of Biology, Memorial University of Newfoundland, St. John's, Newfoundland A1B 3X9, Canada.

habitat removal by logging (Sealy and Carter 1984) and mortality due to gill-net fishing (Carter and Sealy 1984). At-sea surveys conducted throughout much of British Columbia in the late 1970's and 1980's (e.g., Vermeer et al. 1983) increased our knowledge of the local distribution of this species during the breeding and non-breeding seasons. The 1988 *Nestucca* oil spill indicated that murrelets are threatened further by oil pollution (Rodway et al. 1989; Burger, in press).

Our objectives were to summarize all available published and unpublished information on Marbled Murrelets at sea and inland in British Columbia to the end of 1989, focusing on timing of breeding, distribution, movements, diet, population size, and conservation problems.

Methods

Data in this paper were collated by MSR from several sources. SGS and HRC have published extensively on their 1970–1982 at-sea studies of Marbled Murrelets in British Columbia, reviewing much of the biology of the species in British Columbia and throughout its range. They also summarized published and unpublished observations of downy young, fledglings, and adults at inland and lake sites. RWC, at times assisted by MSR and HRC, has led several ornithological expeditions in the 1970's and 1980's to describe bird distribution throughout coastal British Columbia, has produced bibliographies of published and unpublished works on birds in British Columbia (Campbell et al. 1979, 1988), and has compiled published and unpublished observations of birds in the Royal British Columbia Museum (RBCM) ornithological database (also drawn on earlier by HRC and SGS). MSR also compiled observations of Marbled Murrelets from Canadian Wildlife Service studies in the 1970's and 1980's and from Christmas Bird Counts. In addition, MSR analyzed at-sea records of murrelets in the RBCM database to define seasonal trends in different regions and habitats along the coast (Rodway 1990). Those records were not collected systematically, but the number of birds reported per record was considered indicative of the concentration of birds in the area observed. Comparing the frequency of records within various size classes during different seasons revealed changes in general levels of abundance or, at least, changes in dispersion patterns. Only records that identified specific locations were included in comparisons. Records were lumped by month and grouped by geographic region and habitat type (exposed inshore waters; protected nearshore waters, including the Strait of Georgia and other inside waters; and fiords). Chi-square tests were used for all comparisons.

Results And Discussion

Breeding phenology

Studies of reproductive phenology have been conducted at Langara Island (Sealy 1974, 1975a) and in Barkley Sound (Carter 1984). Timing was inferred from almost daily observations of adults and young at sea and from examination of follicular and brood patch development in collected specimens. The nesting season extends from mid-April to late September (Fig. 1). At Langara Island, egg laying occurred from about 15 May to late June or early July. Sealy (1974) determined that Marbled Murrelets lay one-egg clutches and that both parents incubate. From first sightings of birds carrying fish, made on 13 June 1970 and 16 June 1971, he estimated an incubation period of 30 days. The first young were observed at sea on 6 July 1970 and 7 July 1971. Dates were slightly earlier in Barkley Sound. The first bird carrying fish was seen on 4 June 1979, and the first fledglings were seen at sea on 4 July 1979 and 28 June 1980.

In the province as a whole, young at sea have been sighted between 28 May and 5 October (Appendix 1). Although the breeding cycle in British Columbia extends over at least 5 months, most chicks fledge by late July (Carter 1984).

At-sea distribution

Marbled Murrelets occur in summer and winter throughout coastal waters (Brooks and Swarth 1925; Munro and Cowan 1947; Campbell 1976; Campbell et al., in press). They are common in protected nearshore waters and exposed inshore waters (see definitions in Kessel [1979]) within 5 km, and most frequently, 1–2 km of land. Few are found farther offshore (Martin and Myres 1969, Campbell and Shepard 1971, Carter 1984, Sealy and Carter 1984). Birds are widely distributed in channels, inlets, fiords, and bays, as well as along outer coastlines of forested islands. They have been reported from 139 of 177 coastal map grids (Campbell et al., in press; RBCM ornithological data base).

Marbled Murrelets are rare around isolated, nonforested islands frequented by other nesting seabird species. During seven summers of ob-

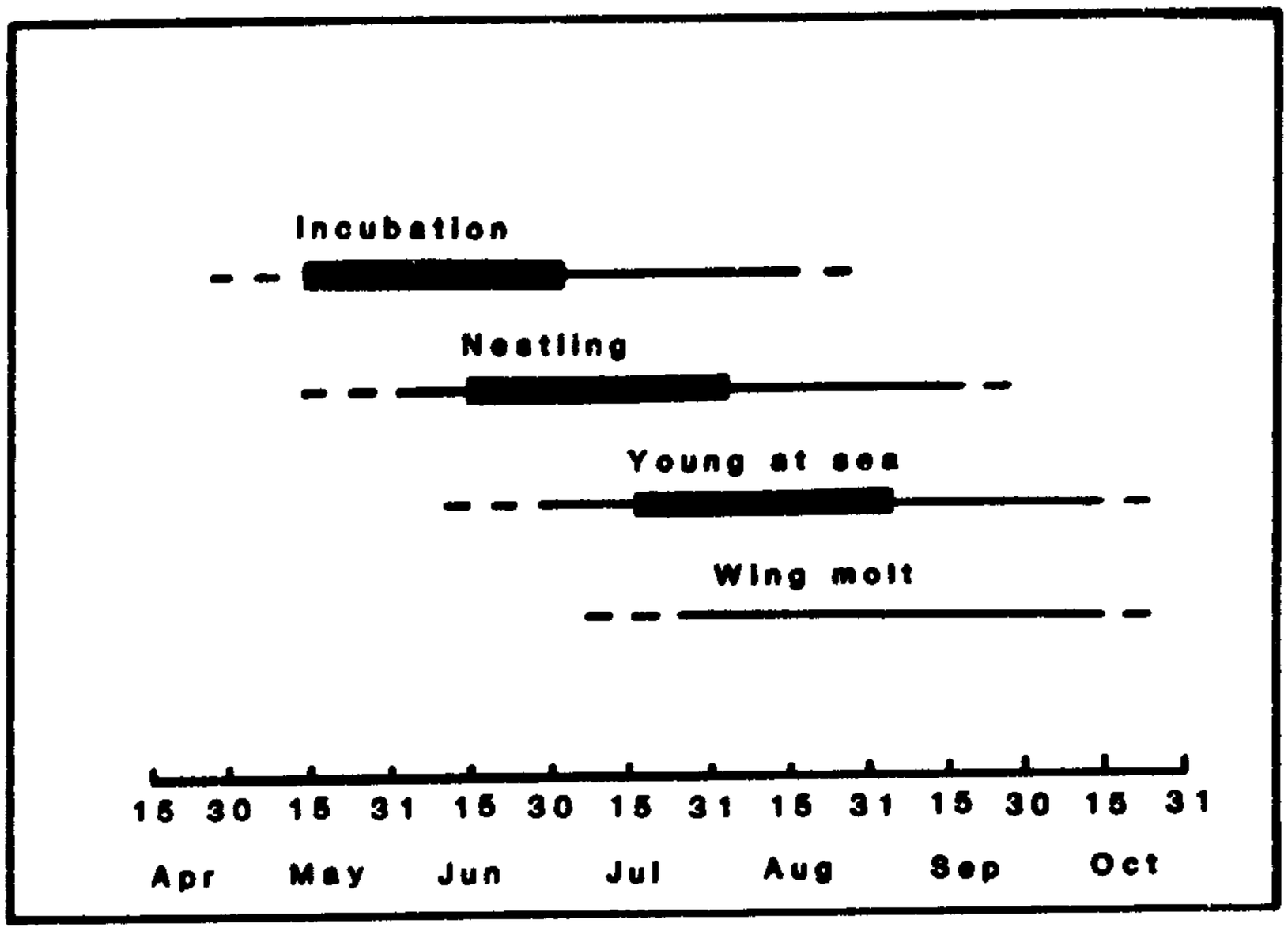


FIG. 1. Breeding phenology of Marbled Murrelets in British Columbia. Predominant periods, known ranges, and inferred ranges are indicated by thick bars, solid lines, and dotted lines, respectively.

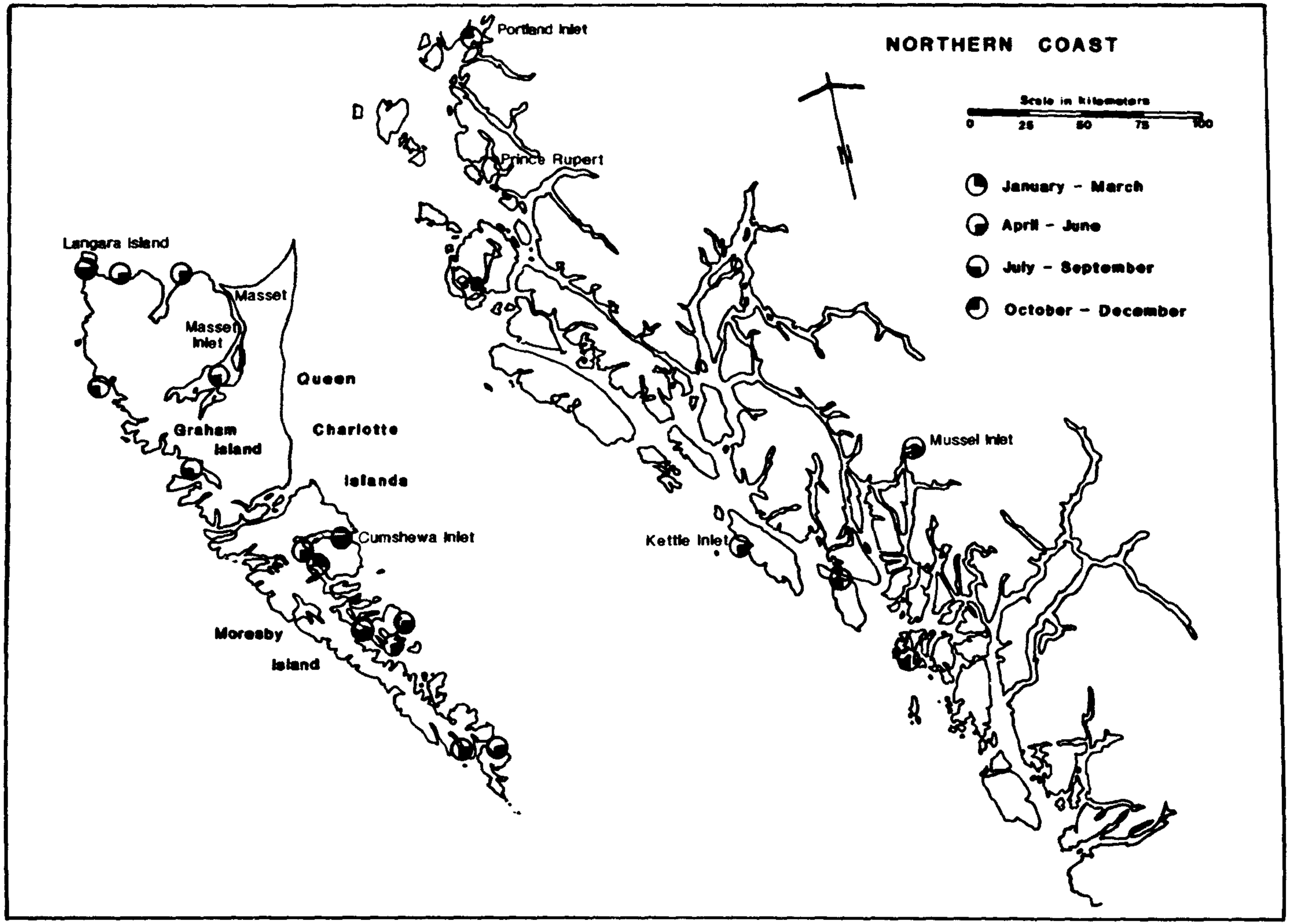
servations in the outer, treeless Scott Islands off of the northwest tip of Vancouver Island, there have been only three sightings of individuals in basic plumage (Carl et al. 1951; Vermeer et al. 1976a, b; Rodway et al. 1990). Birds in breeding plumage were sighted around the inner, forested islands in that group.

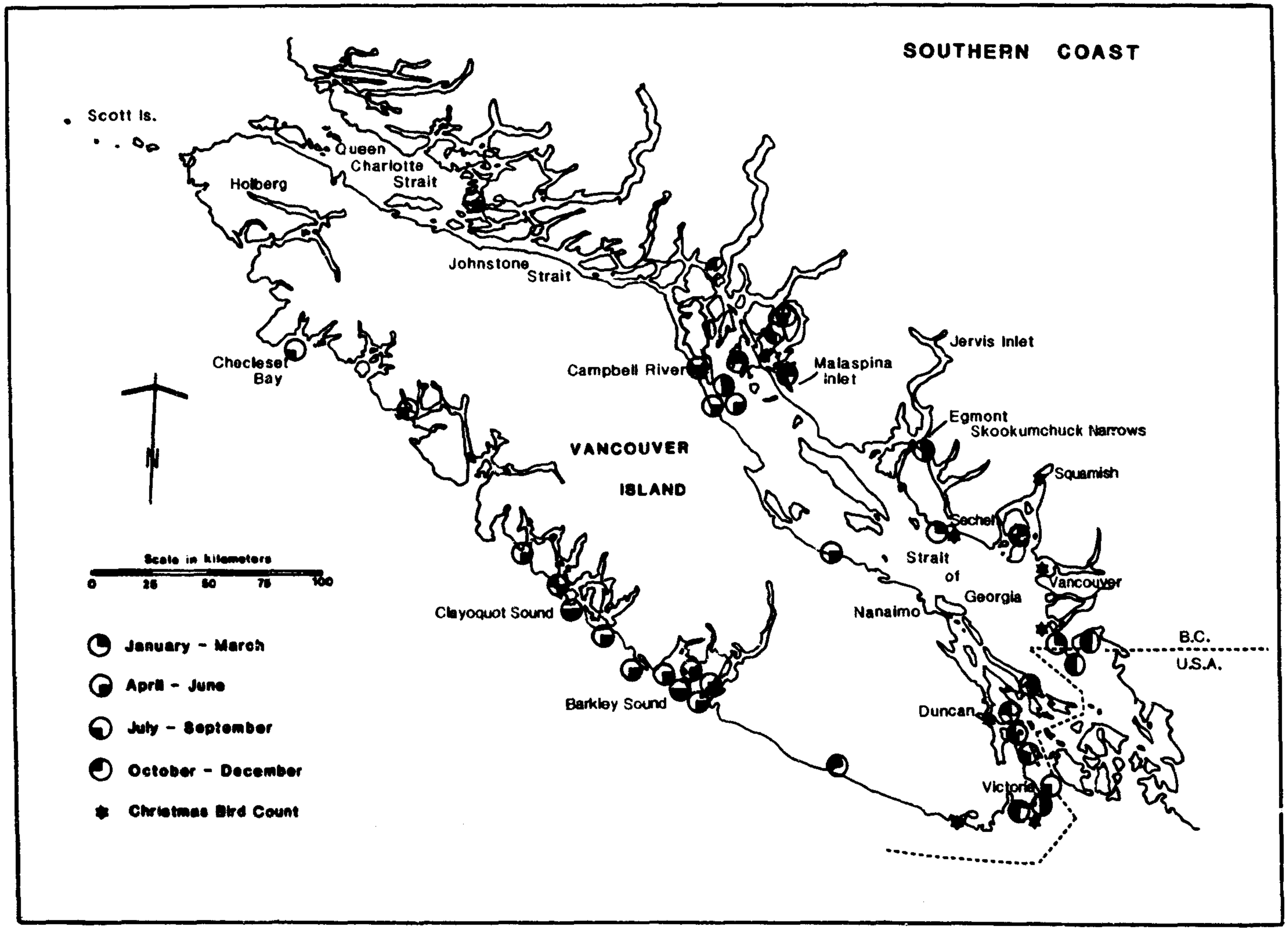
Abundance and distribution patterns are poorly known in most regions. One intensive survey (Sealy and Carter 1984) encompassed inshore and nearshore waters along the west coast of Vancouver Island from Cape Beale to Estevan Point, including Barkley and Clayoquot sounds. Censuses were conducted during the nestling period, between 1 and 25 June 1982. Murrelets occurred widely in this area but exhibited a clumped distribution pattern. Loose aggregations occurred in predictable locations, probably in response to dependable food resources. Flocks of one and two birds were most frequent (83% of flocks observed) and comprised 63% of all birds seen (Carter 1984). Most sightings involved less than 10 birds, but aggregations of more than 100, and as many as 3197 birds were recorded. Aggregations occurred in all inshore areas, but none were found in fiords. Data from less intensive surveys indicate similar summer distribution patterns in this area (Guiguet 1971, Robertson 1974, Hatler et al. 1978, Porter and Sealy 1981). Small, dispersed flocks have been most frequently recorded. Flocks of one or two birds comprised 70–96% of flocks recorded in Pacific Rim National Park (Hatler et al. 1978). Aggregations have been noted in the same locations from year to year.

Of almost 4,500 records of Marbled Murrelets in the RBCM data base, 41% were of one or two birds, and 77% were of less than 10 birds. There are 98 records (2%), from 60 different locations, of aggregations of 100 or more birds (Appendix 2; Fig. 2). The largest concentrations have been reported in spring (March–May) at Skookumchuck Narrows and Cortes Island, in summer (June–August) in Barkley and Clayoquot sounds, and in winter (December–February) in the Ladner area, near Sechelt, and at Cortes Island (Carter 1984; Campbell et al., in press). Relatively more records of greater than two birds in RBCM

→

FIG. 2. A. Locations of reported aggregations of 100 or more Marbled Murrelets along the north coast of British Columbia (see Appendices 2, 3). B. Locations of reported aggregations of 100 or more Marbled Murrelets along the south coast of British Columbia (see Appendices 2, 3).


NORTHERN COAST
Scale in Kilometers
0
25
50
75
100
January - March
April - June
July - September
October - December
Portland Inlet
Prince Rupert
Langara Island
Masset
Masset Inlet
Queen Charlotte Islands
Graham Island
Cumshewa Inlet
Moresby Island
Mussel Inlet
Kettle Inlet


SOUTHERN COAST
Scott Is.
Queen Charlotte Strait
Holberg
Johnstone Strait
Checleset Bay
Campbell River
Malaspina Inlet
Jervis Inlet
Egmont
Skookumchuck Narrows
Squamish
VANCOUVER ISLAND
Sechelt
Strait of Georgia
Vancouver
Nanaimo
Clayoquot Sound
Barkley Sound
Duncan
Victoria
B.C.
U.S.A.
N
Scale in kilometers
0 25 50 75 100
January - March
April - June
July - September
October - December
Christmas Bird Count

files than in Hatler et al. (1978) and Carter (1984) suggested that casual observers reported large flocks more readily than small flocks. Fledged young have been sighted in most coastal regions of British Columbia (Appendix 1; Fig. 3). As with other sightings, the distribution and frequency of records largely reflects observer efforts.

Population movements

Although considered resident over most of its range, local movements of murrelets do occur (Sealy 1974, 1975a). Seasonal changes in abundance and dispersion have been documented in specific localities in British Columbia, but overall patterns of population shifts are unknown. Carter (1984) recorded an increase in densities of Marbled Murrelets along transects in Barkley Sound from early May to the end of June, followed by a decline in numbers from mid-July through September 1979. The timing of increases corresponded to the progression of breeding from the incubation into the nestling phase, when both mates of nesting pairs would be expected to be foraging at sea. However, the increase in total numbers was five-fold, much greater than the doubling expected. Numbers in Trevor Channel increased 10 to 20 fold. Those increases represented both a shift of populations within the study area, and probably an influx of birds from other nearby areas. Subsequent decreases resulted primarily from birds leaving the area, but some birds shifted into shoreline habitats, where they occurred in moderate numbers through September (Porter 1981).

A similar decline in numbers from summer to fall has been reported at several localities on the west coast of Vancouver Island (Richardson 1971, Robertson 1974, Hatler et al. 1978) and low numbers have been reported in March and April (Rodway 1989). At Langara Island, Marbled Murrelets also were scarce in early spring, becoming regularly abundant near the end of April at the onset of the breeding season (Sealy 1974). Thus, a post-breeding shift appears to occur away from waters along the west coasts of Vancouver Island and the Queen Charlotte Islands.

The Strait of Georgia is an important wintering area for Marbled Murrelets. Christmas Bird Counts conducted between 1957 and 1988 revealed large aggregations using that area (Appendix 3). Considerable year-to-year variation in local distribution and abundance is evident when comparing annual counts. At several widely-spaced localities, Marbled Murrelets have been found to be more numerous in winter than summer (Tatum 1971, 1973; Butler and Campbell 1987; Morgan 1989; Vermeer 1989). However, other studies indicate that numbers in summer can be higher than in winter, at least in some years (Tatum 1972, Dawe 1980, Vermeer et al. 1983).

Records in the RBCM database were analyzed to more closely examine population movements in British Columbia (Rodway 1990). In nearshore waters of the Strait of Georgia, the number of birds/record was significantly lower in winter-spring (December to May; $n = 1154$) than in summer-fall (June to November; $n = 1745$; $P < 0.001$). Spring records reported smaller numbers than in all other seasons ($P < 0.001$ for all comparisons). There was no significant difference ($P = 0.81$) between breeding season (April to September; $n = 1948$) and nonbreeding season (October to March; $n = 951$) in the number of birds/record (Fig. 4).

Numbers of birds/record in nearshore habitats outside the Strait of Georgia were greater in summer ($n = 823$) than winter ($n = 94$; $P < 0.005$). Most significant differences were found when comparing March to August ($n = 833$) with September to February ($n = 84$; $P < 0.001$) or February to July ($n = 725$) with August to January ($n = 182$; $P < 0.001$). The relative frequency of larger records was highest between May and August ($n = 758$; $P < 0.001$).

Using all records in fiord habitat, larger records were more frequent in winter ($n = 152$) than summer ($n = 221$; $P < 0.01$). Differences between summer and winter were not significant if only fiords entering the Strait of Georgia were considered ($P = 0.11$). Greater use of fiord habitat in winter has not been previously recognized (but see Morgan [1989], Vermeer [1989]).

In exposed inshore waters, the number of birds/record were larger from February to July ($n = 264$) than from August to January ($n = 48$; $P < 0.05$). Differences were most significant between the peak of the breeding season (May to July; $n = 248$) and the fall molt and movement period (August to October; $n = 40$; $P < 0.01$). There were few ($n = 24$) records from other months. Carter (1984) also found low numbers in this habitat after July.

Food habits

Marbled Murrelets feed in shallow, nearshore waters (Sealy 1975b, Carter 1984), often opportunistically on locally abundant prey, mainly fish

(Carter 1984). They usually forage solitarily or in pairs (Carter and Sealy 1990), but occasionally join mixed-species feeding flocks (Sealy 1973, Hoffman et al. 1981, Porter and Sealy 1981) and sometimes initiate them (Chilton and Sealy 1987).

Around Langara Island, Marbled Murrelets foraged within 500 m of shore in waters less than 30 m deep (Sealy 1975b). They fed mainly on Euphausiids (*Thysanoessa spinifera*) during the first month after returning in April. Later, Pacific sandlance (*Ammodytes hexapterus*) predominated, along with smaller numbers of seaperch (*Cymatogaster aggregata*). In addition, rockfish (*Scorpaenidae*) were taken by subadults. Sandlance and seaperch predominated in the diet of fledglings.

In Barkley Sound, murrelets were widely distributed in inshore and nearshore habitats early in the breeding season, but aggregated in south Trevor Channel during nestling and fledging periods (Carter and Sealy 1990). Changes in the distribution of murrelets paralleled changes in the distribution of the principal prey, Pacific herring (*Clupea harengus*) and sandlance (Carter 1984). Euphausiids were not found in collected specimens although most birds were collected after the period when euphausiids were abundant in the diet at Langara Island. Adults carried single fish, primarily sandlance, to nestlings, and less frequently herring and anchovy (*Engraulis mordax*) (Carter 1984, Carter and Sealy 1987a). Prey selected for nestlings were larger than ingested prey, even though they were less abundant. Larger herring, available later in the season, predominated in the stomachs of molting and hatching-year birds.

Less information is available on winter diets of Marbled Murrelets in British Columbia. Five birds collected in Barkley Sound in December contained scorpaenid rockfish and squid (*Loligo opalescens*) as well as large juvenile herring and sandlance (Carter 1984). Munro and Clemens (1931) found mysids and fish, primarily *Cymatogaster* in four specimens collected in Departure Bay on the east coast of Vancouver Island in March. Marbled Murrelets probably feed year-round on juvenile salmon (*Onchorhynchus* sp.) in coastal lakes of British Columbia (Carter and Sealy 1986).

Inland Distribution

Nest sites

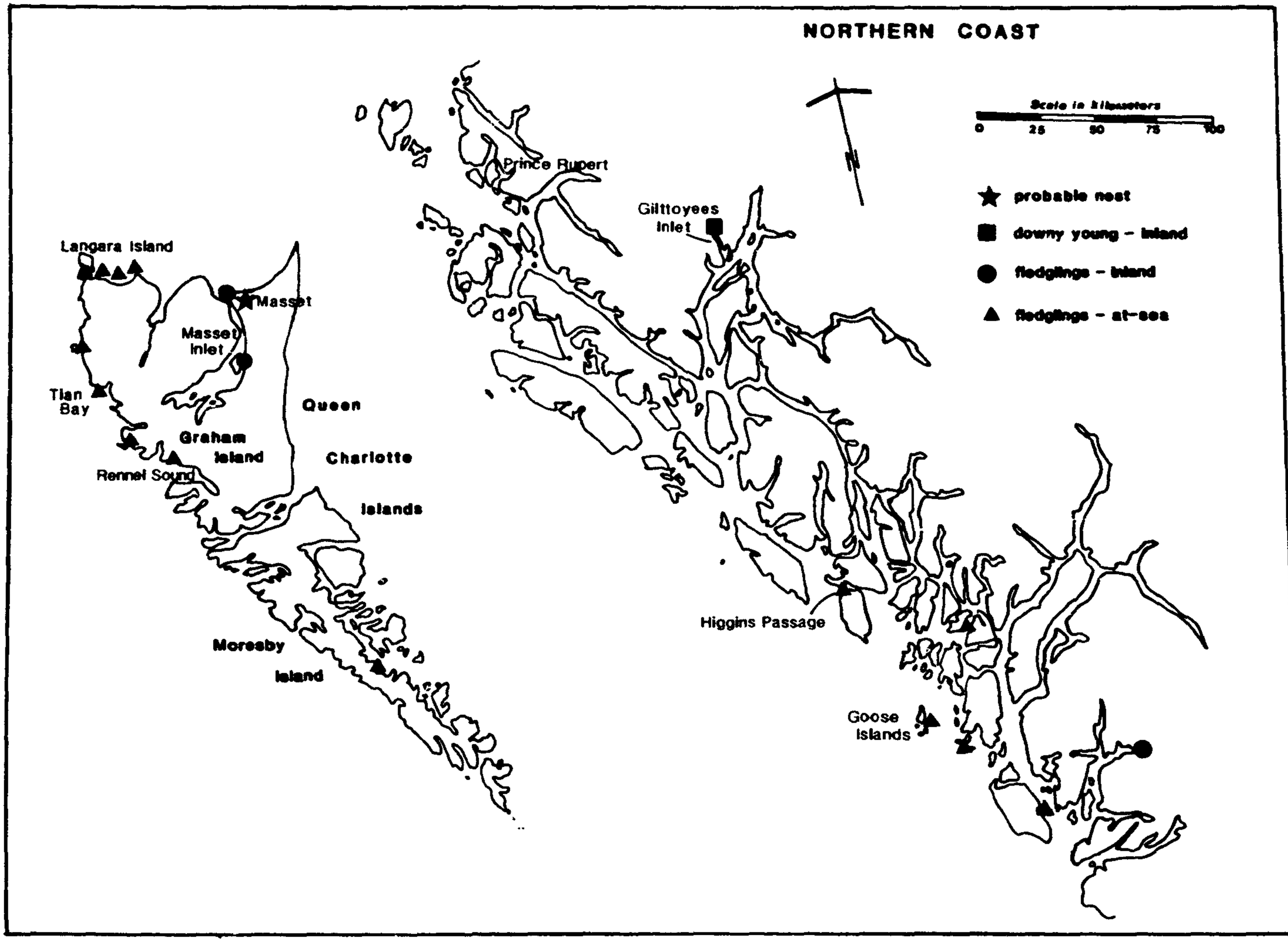
No confirmed nests have been found in British Columbia. Two probable nests have been reported. On 4 June 1953, a stunned adult and eggshell fragments were recovered from a felled tree located 0.8 km from the ocean at Masset in the Queen Charlotte Islands (Drent and Guiguet 1961). On 28 June 1967, two chicks fell from a tree being cut outside Holberg, on Vancouver Island, 6 km from the ocean (Harris 1971). A suspected nest platform was located 18 m up the tree. Breeding distribution and habitat use are largely inferred from observations of flightless young, fledglings at sea, follicular development of collected females, and breeding behavior of adults. All available evidence has suggested that Marbled Murrelets nest only in old-growth forests in British Columbia (Sealy and Carter 1984), although murrelets are known to nest on the ground in the northern Gulf of Alaska (Mendenhall, this volume). At Coates Lake in the Queen Charlotte Islands, murrelets were active in old-growth forest surrounding the lake, but were absent from adjacent subalpine and alpine areas (Eisenhawer and Reimchen, in press).

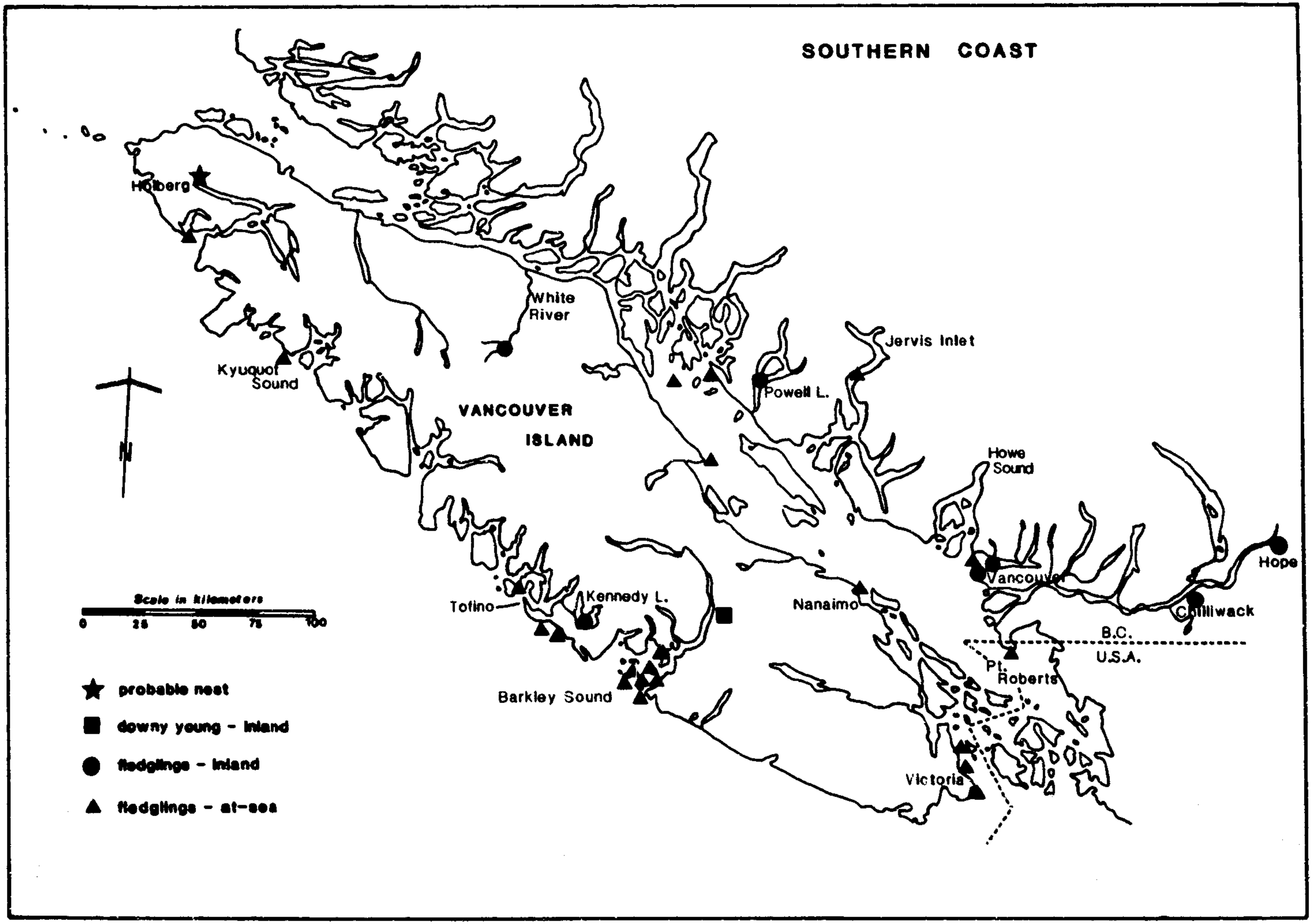
Hatching-year birds

Carter and Sealy (1987b) summarized nine inland records of hatching-year birds from British Columbia (including the Holberg record above). Four additional records have been obtained (Appendix 4; Fig. 3). On 15 July 1986, a fledgling with an intact egg-tooth was found on a logging road 35 km from the sea near the head of the White River in the Sayward area about 100 m from old-growth forest (J. Braun, pers. comm.). Campbell et al. (in press) reported a flightless young, with egg-tooth and weighing 140 g, found in downtown Chilliwack on 7 July 1987. The bird was banded and released at Stanley Park in Vancouver on 8 July. T. L. Thacker (field notes) described a fledgling with egg-tooth that was picked up in the village of Hope on 12 July 1947 and later released on the Fraser River. The Hope record, at 101 km from the nearest salt water, is the farthest inland location known to be used by Marbled Murrelets in North America. H. M.

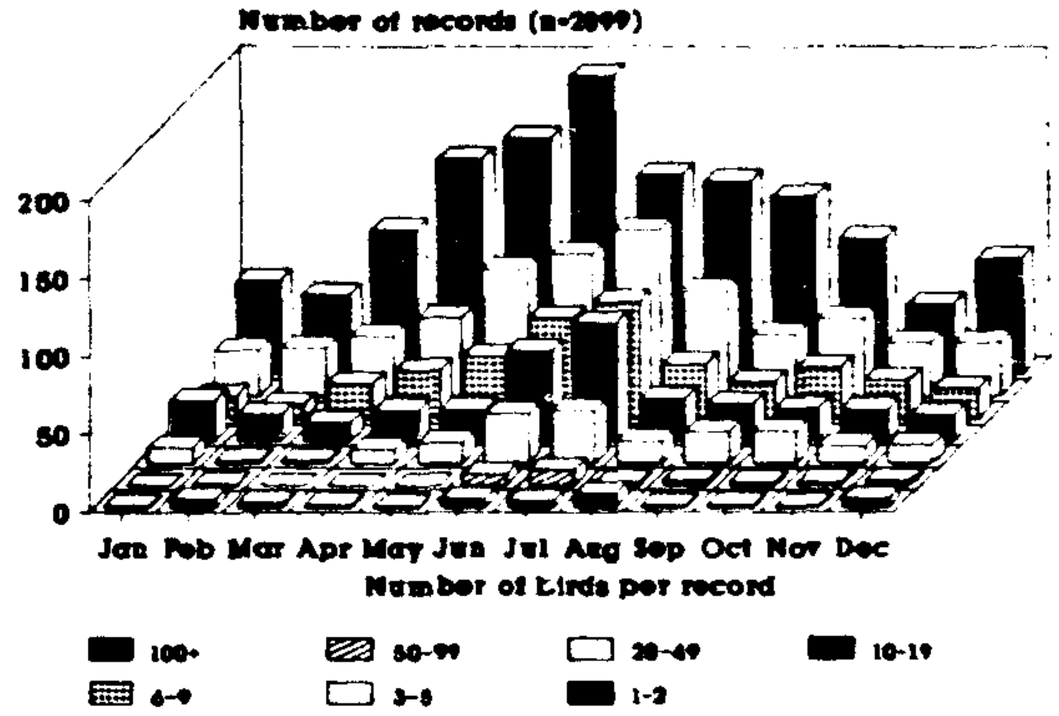
→

FIG. 3. A. Locations of probable nests and inland and at-sea sightings of hatching year Marbled Murrelets in northern British Columbia (see Appendices 1, 4). B. Locations of probable nests and inland and at-sea sightings of hatching year Marbled Murrelets in southern British Columbia (see Appendices 1, 4).

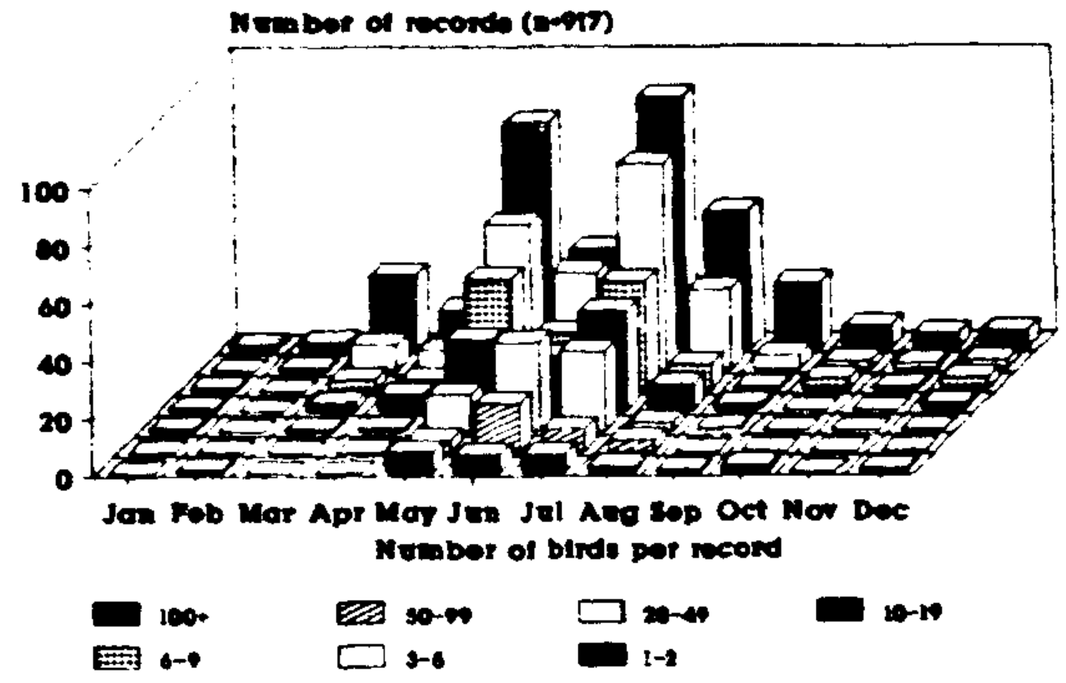

NORTHERN COAST
Scale in kilometers
0
25
50
75
100
probable nest
downy young – inland
fledglings – inland
fledglings – at-sea
Prince Rupert
Gilttoyees Inlet
Langara Island
Masset
Masset Inlet
Tlan Bay
Queen Charlotte Islands
Graham Island
Rennel Sound
Moresby Island
Higgins Passage
Goose Islands


SOUTHERN COAST
Holberg
White River
Kyuquot Sound
VANCOUVER ISLAND
Jervis Inlet
Powell L.
Howe Sound
Hope
Vancouver
Chilliwack
Tofino
Kennedy L.
Nanaimo
B.C.
U.S.A.
Pt. Roberts
Barkley Sound
Victoria
N
Scale in kilometers
0 25 50 75 100
probable nest
downy young - inland
fledglings - inland
fledglings - at-sea

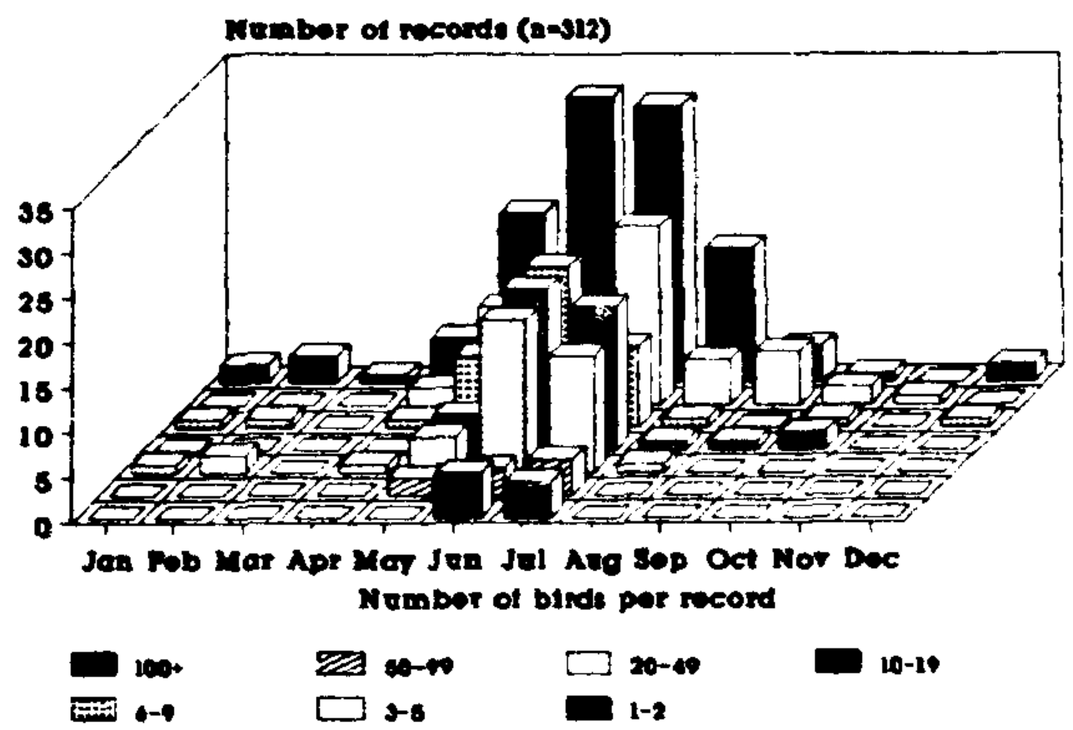
Strait of Georgia - nearshore habitat



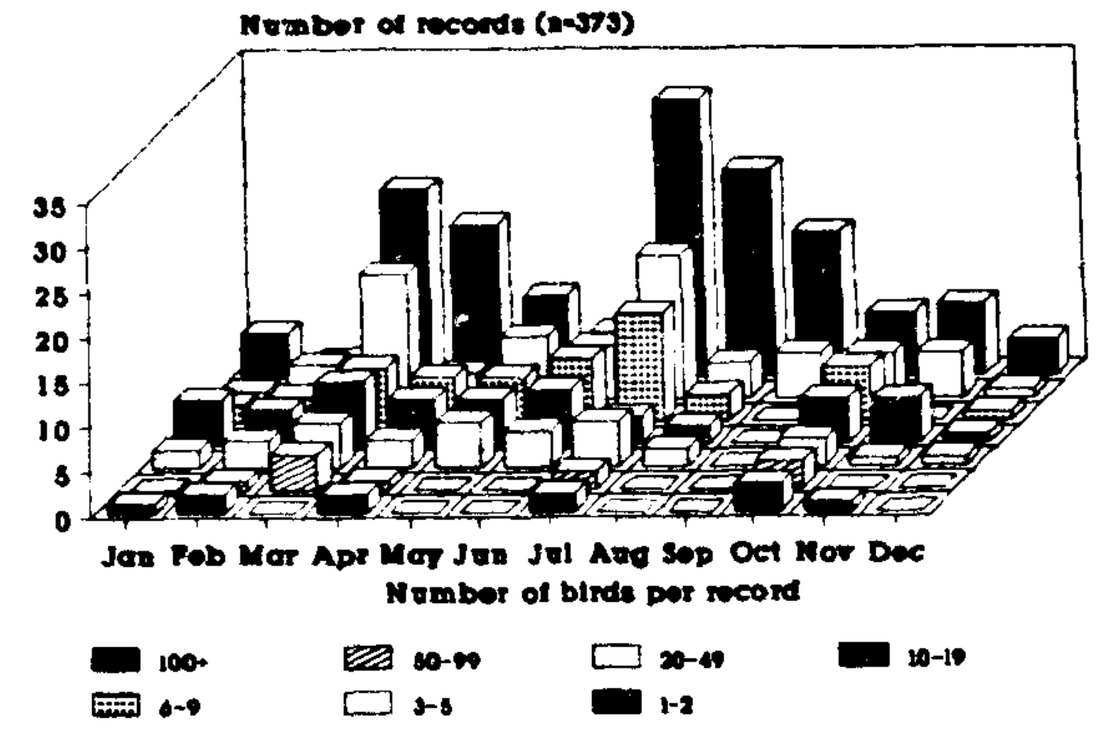
All records in nearshore habitat outside the Strait of Georgia



All records in exposed inshore habitat



All records in fiord habitat



Laing (field notes) noted a fledgling on Owikeno Lake at the head of Rivers Inlet on 15 July 1937.

Freshwater lakes

Adult Marbled Murrelets are known to use coastal lakes year-round (Carter and Sealy 1986). Of 67 North American records compiled, 78.6% were from British Columbia, primarily from Vancouver Island and the adjacent mainland (Appendix 5; Fig. 5). Most observations were made during the breeding season and 19% were from the nonbreeding season. Four lakes had records from summer and winter. Brooks (1928) and Munro (1924) had earlier reported regular use of Harrison and Cowichan lakes in winter. Most lakes where Marbled Murrelets have been sighted are less than 20 km from salt water. Cultus and Harrison lakes in southern British Columbia are 50 to 75 km from the ocean, respectively.

Other inland records

There is a paucity of other inland records of Marbled Murrelets calling at or flying over forested areas (see Appendix 5; Fig. 5) because there is limited access to most coastal, forested areas and only a few observers familiar with murrelet vocalizations and activity. Most of these records were obtained right along the coast from boats or shore. Specific surveys to determine murrelet distribution have been initiated by the Canadian Wildlife Service (see later), but these efforts must be greatly expanded before a complete picture will be available.

Population Size and Trends

A reliable estimate of the numbers of Marbled Murrelets in British Columbia is not available. Densities and populations have been estimated in specific locations along the west coast of Vancouver Island, in the Queen Charlotte Islands, and in the Strait of Georgia. There are no estimates from Johnstone Strait, Queen Charlotte Strait, or the northern mainland coast.

Sealy and Carter (1984) counted 9955 birds in Clayoquot and Barkley sounds in June 1982 using a boat census technique specifically designed for determining numbers and distribution of murrelets at sea. All exposed inshore, protected nearshore, and fiord waters were surveyed. Fifteen percent of birds counted were assumed to be nonbreeding birds (Sealy 1975a), and breeding population was estimated at 8460 birds.

In July 1972, Robertson (1974) conducted limited boat surveys in the protected nearshore waters of Sydney Inlet in Clayoquot Sound, Trevor Channel in Barkley Sound, and between Cartwright and Tasu sounds on the west coast of the Queen Charlotte Islands. Extrapolating from observations made in surveyed areas, about 22,000 Marbled Murrelets were estimated along the west coast of Vancouver Island in summer (18,000 in protected nearshore waters and 3900 in exposed inshore waters), and 3000–4000 birds were estimated along the west coast of the Queen Charlotte Islands. Estimates were likely biased upwards since surveys include fledged young in July, and it is unclear how extrapolations were made. By adjusting only for nonbreeding birds (after Sealy and Carter 1984), breeding population estimates of 18,700 and 2550–3400 birds were derived for the west coasts of Vancouver Island and the Queen Charlotte Islands, respectively.

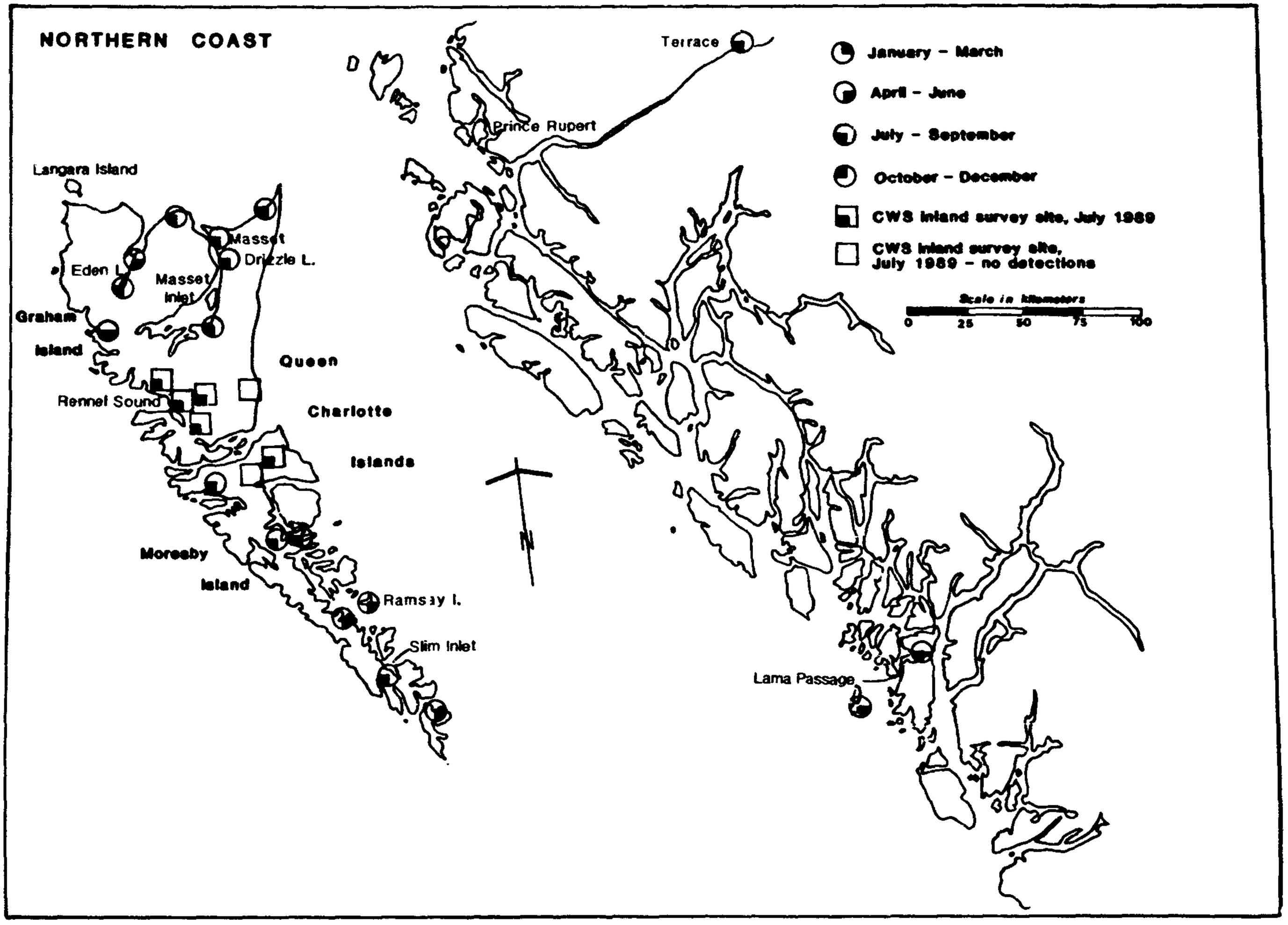
Vermeer et al. (1983) summarized densities of birds observed during boat surveys in the Queen Charlotte Islands and in the northern Strait of Georgia in 1977. Based on distances surveyed and densities listed, about 3025 Marbled Murrelets were counted in May and June in the Queen Charlotte Islands. Most birds would be incubating at this time (Sealy 1974). By adjusting for nonbreeders and birds at nests, about 5150 breeding birds were estimated. In the northern

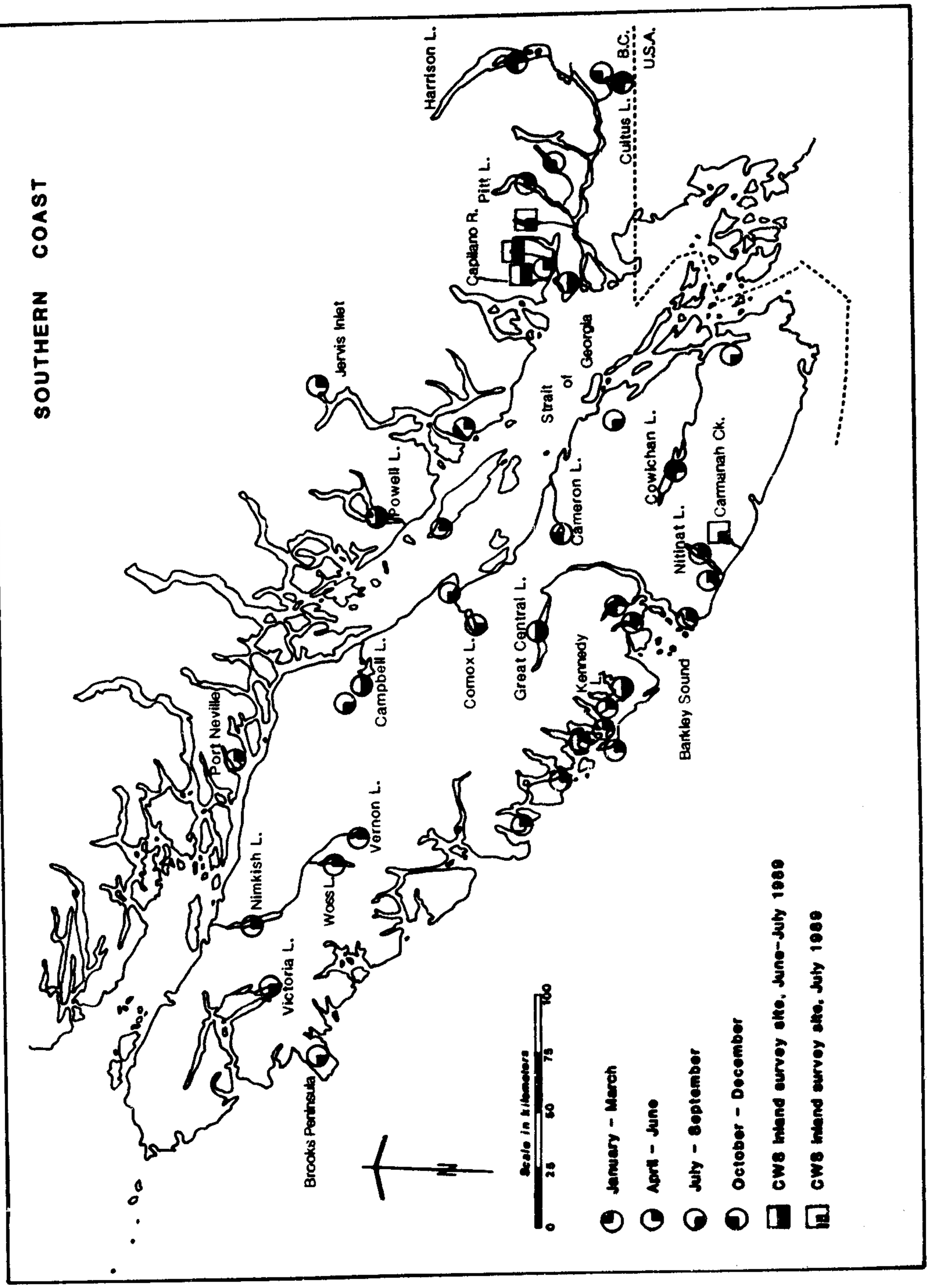
←

FIG. 4. Frequency distribution of the number of Marbled Murrelets reported per sight record in inshore, nearshore, and fiord habitats in British Columbia. Data from the ornithological database housed at the Royal British Columbia Museum.

→

FIG. 5. A. Locations of inland sightings of adult Marbled Murrelets on the north coast of British Columbia (see Appendix 5). B. Locations of inland sightings of adult Marbled Murrelets on the south coast of British Columbia (see Appendix 5).


NORTHERN COAST
Terrace
Prince Rupert
Langara Island
Masset
Driezzle L.
Eden L.
Masset Inlet
Graham Island
Queen Charlotte Islands
Rennel Sound
Moresby Island
Ramsay I.
Slim Inlet
Lama Passage
January - March
April - June
July - September
October - December
CWS inland survey site, July 1989
CWS inland survey site, July 1989 - no detections
Scale in kilometers
0 25 50 75 100
N


SOUTHERN COAST
Harrison L.
B.C.
U.S.A.
Cultus L.
Pitt L.
Capilano R.
Jervis Inlet
Powell L.
Strait of Georgia
Cameron L.
Cowichan L.
Nitinat L.
Carmanah Ck.
Campbell L.
Comox L.
Great Central L.
Kennedy L.
Barkley Sound
Port Neville
Nimkish L.
Woss L.
Vernon L.
Victoria L.
Brooks Peninsula
Scale in kilometers
0
25
50
75
100
January – March
April – June
July – September
October – December
CWS inland survey site, June–July 1988
CWS inland survey site, July 1988

Strait of Georgia, 3380 birds were counted in March and April, primarily during the pre-breeding period. Assuming that birds from other populations were not present and adjusting for nonbreeders, about 3025 breeding birds were estimated.

As many as about 27,000 breeding birds were estimated in surveyed areas. Assuming similar densities along the northeast coast of Vancouver Island and the northern mainland coast, an approximate total population estimate for British Columbia would be about 45,000–50,000 breeding birds. This is a crude estimate based on limited surveys conducted 7–17 years ago. Extensive surveys are required to obtain reliable estimates which can act as a baseline to measure future changes (Sealy and Carter 1984).

Population trends cannot be defined with available data. Past authors have suggested population declines in the Strait of Georgia. Brooks (1926) was struck by the scarcity of Marbled Murrelets along the east coast of Vancouver Island during the winter of 1925-26 compared to numbers observed in 1920 and earlier. He suspected crude oil or disease may have been responsible for decreases. Pearse (1946) reported a decline in Marbled Murrelets in the Comox area between 1917 and 1944. He related changes in avian populations to the removal of coniferous forests. There are no quantitative data available from those periods. Christmas Bird Counts since 1957 reveal no clear trends (Appendix 3).

Conservation Problems

Nesting habitat

Rapid removal of old-growth forest nesting habitat has been considered the most serious threat to Marbled Murrelets in British Columbia (Sealy and Carter 1984). Available evidence from southeast Alaska to California suggests dependence on large conifers within tracts of undisturbed old-growth forest for nesting habitat (Marshall 1988; Eisenhawer and Reimchen, in press; see other papers in this volume). In British Columbia, large trees are most common in low elevation forests on valley bottoms and sidehills. These forests are commercially attractive, have already been extensively eliminated, and continue to be harvested. Extensive studies are required to determine the specific locations and types of habitat being used by Marbled Murrelets in British Columbia and to fully evaluate the seriousness of this threat.

During road transects and fixed station counts (see protocols in Paton et al. [1988]) conducted in 1989 in the watershed north of Vancouver, murrelets were detected primarily in old-growth forest; murrelets were detected in second-growth forest (60–80 years old) only in proximity to old-growth stands (J-P. Savard and M. Lemon, unpubl. data). In 1989, murrelet activity levels (i.e., number of detections/census) were higher in undisturbed old-growth habitat in the Carmanah Valley on the west coast of Vancouver Island than at any station on the north shore above Vancouver, where sampled old-growth areas alternated with patches of recent clear-cuts. In the Queen Charlotte Islands, highest activity levels along the 12 road transects surveyed occurred in, or close to, old-growth forest stands (J-P. Savard and M. Lemon, unpubl. data).

Estimates of the total amount of old-growth forest remaining in coastal British Columbia are not available. Two studies present estimates in local areas. About 75% of forested land in the Barkley and Clayoquot sound area was old-growth (>140 years old) in 1980–82 (Sealy and Carter 1984). At that time, harvest schedules forecast the loss of 95% of original old-growth within 50 years. In 1985, late mature or old-growth forest comprised only 5% of crown forest land on coastal islands along the east coast of Vancouver Island (Morgan et al. 1985). Considering current harvest rates, old-growth forest containing the size of trees known to be used by Marbled Murrelets will be rare outside parks and reserves in the near future.

Fisheries

In Barkley Sound, intensive, salmon gill-net fisheries overlapped areas where Marbled Murrelets aggregated during their breeding season (Carter and Sealy 1984). In 1979 and 1980, Marbled Murrelets were the most frequently entangled waterbird. An estimated 380 murrelets, representing 7.8% of the potential fall population, were killed annually. Ninety-three percent of the birds killed were breeding adults. Off Cape Mudge, where murrelets and sports fishermen aggregated, murrelets were frequently caught on small, brilliantly colored fishing lures at depths up to 20 m (Campbell 1967).

Mariculture developments have proliferated in recent years throughout nearshore feeding areas for murrelets in southern British Columbia (Booth and Rueggeberg 1988). Entanglement of alcids was reported at one of 68 salmon farms

surveyed (Rueggeberg and Booth 1989), and displacement from traditional foraging areas, contamination of food supplies by antifoulants and antibiotics, and alteration of local food supplies from decomposition of fish food and fish excretion are potential problems for Marbled Murrelets (Vermeer and Morgan 1989).

Marine pollutants

Mortality from oil contamination is poorly documented in British Columbia. Following a fuel oil spill near Vancouver, British Columbia in spring 1929, Racey (1930) found two Marbled Murrelets in a total of 15 oiled, dead birds encountered along a quarter mile stretch of Crescent Beach. He suspected total mortality in the area was "enormous." During the *Nestucca* spill off Grays Harbor, Washington in December 1988, 12 Marbled Murrelets were identified in a sample of 856 oiled carcasses collected from beaches along the west coast of Vancouver Island (Rodway et al. 1989). Extrapolating from that proportion (1.4%), indicated that 50 of the total 3568 dead birds counted in British Columbia, and 120–150 of the total estimated (Burger, in press) were Marbled Murrelets. Expected mortality would be much greater from a spill occurring in summer when Marbled Murrelet densities along the west coast are higher.

Marbled Murrelets collected at Langara Island in 1969 had low levels of organochlorines relative to other alcids (Noble and Elliot 1986). In contrast, Marbled Murrelets collected at Horseshoe Bay in 1968–69 had the highest concentrations of mercury recorded in any seabird species from the west coast of Canada (Fimreite et al. 1971). Effects of those contaminants on murrelet populations are unknown.

Conclusion

It is widely accepted that Marbled Murrelets depend on old-growth forest for nesting habitat throughout the southern portion of their range, including British Columbia (Sealy and Carter 1984, Carter and Sealy 1987b, Marshall 1988). Well within the next century, appropriate old-growth forest, of a stature known to be used for nesting, will be rare outside of parks and reserves, which at present may provide protection for only a small fraction of Marbled Murrelet nesting habitat. Larger reserves and/or substantial changes in logging practices will be required to insure the continued existence of viable Marbled Murrelet populations in British Columbia. If logging of old-growth proceeds at its present rate, it could be only a matter of decades before the situation in British Columbia becomes similar to California, where continued population decline and possible extinction has been expected in the near future (Carter and Erickson 1988). Breeding populations in Oregon and Washington also may be reaching a critical status because of low numbers and limited nesting habitat (Marshall 1988; see other papers in this volume). Extensive research efforts are urgently needed to provide data on abundance, distribution, and habitat requirements of Marbled Murrelets in all coastal areas of the province on which to base management actions.

Acknowledgments

M. S. Rodway received support from MacMillan Bloedel Ltd. to summarize data on Marbled Murrelets. Many thanks to the many contributors to the RBCM ornithological data base who are responsible for much of our current knowledge of Marbled Murrelet distribution in British Columbia. We are grateful to Canadian Wildlife Service personnel Jean-Pierre L. Savard and Moira J. F. Lemon for making the results of their inland surveys available; Gary W. Kaiser for sharing data collected during at-sea surveys, as well as compilations of other Marbled Murrelet records; Anthony J. Gaston for providing records from the Queen Charlotte Islands; and G. E. John Smith for consultation on feasible ways to statistically analyze data from RBCM files. Special thanks to Moira J. F. Lemon, who on her own time assisted with compilation and mapping of RBCM records.

Literature Cited

Anonymous. 1927. Marbled Murrelet taken at Harrison Lake, British Columbia. Murrelet 8:16.

Bishop, L. B. 1930. The Ancient Murrelet in the Inside Passage. Murrelet 11:19.

Boggs, B., and E. Boggs. 1964. Northern Pacific coast region. American Birds 18:530–532.

Booth, J. A., and H. I. Rueggeberg. 1988. Marine birds and aquaculture in British Columbia: assessment and management of interactions. Phase I report: description of interactions and a method for assessing habitat overlap. Unpublished report. Canadian Wildlife Service, Delta, British Columbia.

Brooks, A. 1926. The mystery of the Marbled Murrelet. Murrelet 7:1–2.

Brooks, A. 1928. Does the Marbled Murrelet nest inland? Murrelet 9:68.

Brooks, A., and H. S. Swarth. 1925. A distributional list of the birds of British Columbia. Pacific Coast Avifauna No. 17.

Buffam, F. 1966. Wickaninnish Provincial Park summer report 1966. Unpublished report, British Columbia Parks Branch, Victoria, British Columbia. 14 pp.

Burger, A. E. In press. Effects of the Nestucca oil spill on seabirds along the southwest coast of Vancouver Island in 1989. Technical Report Series. Canadian

Wildlife Service, Pacific and Yukon Region, Delta, British Columbia.

Butler, R. W. 1973. Mitlenatch Island Nature Park–1973 summer report. Unpublished report, British Columbia Parks Branch, Victoria, British Columbia.

Butler, R. W., and R. W. Campbell. 1987. The birds of the Fraser River delta: populations, ecology and international significance. Canadian Wildlife Service Occasional Paper No. 65.

Campbell, R. W. 1967. Fishing lures, a hazard to sea birds. Blue Jay 25:71–72.

Campbell, R. W. 1970. Recent information on nesting colonies of Mew Gulls on Kennedy Lake, Vancouver Island, British Columbia. Syesis 3:5–14.

Campbell, R. W. 1976. Sea-birds breeding on the Canadian west coast. Pages 39–65 *in* Mountains and Seas. Canadian Nature Federation Special Publication No. 5.

Campbell, R. W., and M. Shepard. 1971. Summary of spring and fall pelagic birding trips from Tofino, British Columbia. Vancouver Natural History Society Discovery 150:13–16.

Campbell, R. W., and D. Stirling. 1968. Notes on the natural history of Cleland Island, British Columbia with emphasis on the breeding bird fauna. Provincial Museum of Natural History and Anthropology Report for the year 1967, Victoria, British Columbia.

Campbell, R. W., T. D. Hooper, and N. K. Dawe. 1988. A bibliography of British Columbia ornithology. Volume II. British Columbia Provincial Museum Heritage Record No. 19. Victoria, British Columbia.

Campbell, R. W., M. G. Shepard, and R. H. Drent. 1972. Status of birds in the Vancouver area in 1970. Syesis 5:137–167.

Campbell, R. W., M. G. Shepard, and W. C. Weber. 1973. Vancouver birds in 1971. Unpublished report, Vancouver Natural History Society, Vancouver, British Columbia.

Campbell, R. W., H. R. Carter, C. D. Shepard, and C. J. Guiguet. 1979. A bibliography of British Columbia ornithology, Volume I. British Columbia Provincial Museum Heritage Record No. 7. Victoria, British Columbia.

Campbell, R. W., M. G. Shepard, B. A. MacDonald, and W. C. Weber. 1974. Vancouver birds in 1972. Unpublished report, Vancouver Natural History Society, Vancouver, British Columbia.

Campbell, R. W., N. K. Dawe, I. McT. Cowan, J. Cooper, G. W. Kaiser, and M. C. E. McNall. In press. Birds of British Columbia. Volume II. Nonpasserines–Diurnal birds of prey through woodpeckers. Royal British Columbia Museum, Victoria, British Columbia.

Carl, G. C., C. J. Guiguet, and G. A. Hardy. 1951. Biology of the Scott Island Group, British Columbia. Pages 21–63 *in* Provincial Museum of Natural History and Anthropology Report for the year 1967, Victoria, British Columbia.

Carter, H. R. 1984. At-sea biology of the Marbled Murrelet (*Brachyramphus marmoratus*) in Barkley Sound, British Columbia. Master of Science Thesis, University of Manitoba, Winnipeg, Manitoba.

Carter, H. R., and R. A. Erickson. 1988. Population status and conservation problems of the Marbled Murrelet in California, 1892–1987. Unpublished report, California Department of Fish and Game, Sacramento, California.

Carter, H. R., and S. G. Sealy. 1984. Marbled Murrelet mortality due to gill-net fishing in Barkley Sound, British Columbia. Pages 212–220 *in* D. N. Nettleship, G. A. Sanger, and P. F. Springer (editors). Marine birds: their feeding ecology and commercial fisheries relationships. Special Publication, Canadian Wildlife Service, Ottawa.

Carter, H. R., and S. G. Sealy. 1986. Year-round use of coastal lakes by Marbled Murrelets. Condor 88: 473–477.

Carter, H. R., and S. G. Sealy. 1987a. Fish-holding behavior of Marbled Murrelets. Wilson Bulletin 99: 289–291.

Carter, H. R., and S. G. Sealy. 1987b. Inland records of downy young and fledgling Marbled Murrelets in North America. Murrelet 68:58–63.

Carter, H. R., and S. G. Sealy. 1990. Daily foraging behavior of Marbled Murrelets. Studies in Avian Biology 14:93–102.

Chilton, G., and Sealy, S. G. 1987. Species roles in mixed-species feeding flocks of seabirds. Journal of Field Ornithology 58:456–463.

Darcus, S. J. 1927. Discovery of the nest of the Marbled Murrelet (*Brachyramphus marmoratus*) in the Queen Charlotte Islands, British Columbia. Canadian Field-Naturalist 41:197–199.

Dawe, N. K. 1980. Flora and fauna of the Marshall-Stevenson Unit, Qualicum National Wildlife Area (update to June 1979). Unpublished report, Canadian Wildlife Service, Delta, British Columbia.

Dickinson, J. C., Jr. 1953. Report on the McCabe collection of British Columbia birds. Bulletin of the Museum of Comparative Zoology (Harvard) 109: 123–209.

Drent, R. H., and C. J. Guiguet. 1961. A catalogue of British Columbia sea-bird colonies. British Columbia Provincial Museum Occasional Paper No. 12.

Eisenhawer, A. E., and T. E. Reimchen. In press. Inland flight patterns of Marbled Murrelets on the Queen Charlotte Islands, British Columbia. Canadian Field-Naturalist.

Fimreite, N., W. N. Holsworth, J. A. Keith, P. A. Pearce, and I. M. Gruchy. 1971. Mercury in fish and fish-eating birds near sites of industrial contamination in Canada. Canadian Field-Naturalist 85:211–220.

Flahaut, M. R., and Z. M. Schultz. 1954. The fall migration–north Pacific coast region. Audubon Field Notes 8:36–38.

Foottit, R. 1969. Summer report for 1969–Mitlenatch Island Nature Park. Unpublished report, British Columbia Parks Branch, Victoria, British Columbia.

Guiguet, C. J. 1953. An ecological study of Goose Island, British Columbia with special reference to mammals and birds. British Columbia Provincial Museum Occasional Paper No. 10.

Guiguet, C. J. 1956. Enigma of the Pacific. Audubon Magazine 58:164–167, 174.

Guiguet, C. J. 1971. A list of seabird nesting sites in Barkley Sound, British Columbia. Syesis 4:253–259.

Harris, R. D. 1971. Further evidence of tree nesting in the Marbled Murrelet. Canadian Field-Naturalist 85:67–68.

Hatler, D. F., R. W. Campbell, and A. Dorst. 1978.

Birds of Pacific Rim National Park. British Columbia Provincial Museum Occasional Paper No. 20.
Hobson, M. 1976. Naturalist's summer report–Miracle Beach Park, 1976. Unpublished report, British Columbia Parks Branch, Victoria, British Columbia.
Hoffman, W., D. Heinemann, and J. A. Wiens. 1981. The ecology of seabird feeding flocks in Alaska. Auk 98:437–456.
Kessel, B. 1979. Avian habitat classification for Alaska. Murrelet 60:86–94.
Manuwal, D. A., T. R. Wahl, and S. M. Speich. 1979. The seasonal distribution and abundance of marine bird populations in the Strait of Juan De Fuca and northern Puget Sound in 1978. NOAA Technical Memorandum ERL MESA-44.
Marshall, D. B. 1988. Status of the Marbled Murrelet in North America: with special emphasis on California, Oregon, and Washington. U.S. Fish and Wildlife Service Biological Report 88.
Martin, P. W., and M. T. Myres. 1969. Observations on the distribution and migration of some seabirds off the outer coasts of British Columbia and Washington State, 1946–1949. Syesis 2:241–256.
Mills, E. L. 1960. Birds observations in the Queen Charlotte Islands, British Columbia. Canadian Field-Naturalist 74:156–158.
Morgan, K. H. 1989. Marine birds of Saanich Inlet, a Vancouver Island fjord entering the Strait of Georgia. Pages 158–165 *in* K. Vermeer and R. W. Butler (editors). The ecology and status of marine and shoreline birds in the Strait of Georgia, British Columbia. Special Publication, Canadian Wildlife Service, Ottawa, Ontario.
Morgan, K., A. Hetherington, and S. Wetmore. 1985. The effects of forest management on bird communities of the coastal islands of southern British Columbia: problem analysis. Unpublished report, Research Branch, British Columbia Ministry of Forests, WHR-19. Victoria, British Columbia.
Munro, J. A. 1921. British Columbia bird notes. Murrelet 2:15–17.
Munro, J. A. 1924. Miscellaneous bird notes from southern Vancouver Island, 1923. Canadian Field-Naturalist 38:147–150.
Munro, J. A., and W. A. Clemens. 1931. Waterfowl in relation to the spawning of Herring in British Columbia. Biological Board of Canada, Bulletin No. 17.
Munro, J. A., and I. McT. Cowan. 1947. A review of the bird fauna of British Columbia. British Columbia Provincial Museum Special Publication No. 2.
Noble, D. G., and J. E. Elliot. 1986. Environmental contaminants in Canadian seabirds, 1968–1984: trends and effects. Technical Report Series No. 13. Canadian Wildlife Service, Ottawa.
Paton, P. W. C., C. J. Ralph, and H. R. Carter. 1988. The Pacific Seabird Group's Marbled Murrelet survey and intensive inventory handbook. Unpublished report, United States Forest Service, Redwood Sciences Laboratory, Arcata, California.
Pearse, T. 1946. Notes on changes in bird populations in the vicinity of Comox, British Columbia–1917 to 1944. Murrelet 27:4–9.
Porter, J. M. 1981. The dynamics of seabird multispecies flocks in Barkley Sound, British Columbia. Master of Science Thesis, University of Manitoba, Winnipeg, Manitoba.
Porter, J. M., and S. G. Sealy. 1981. Dynamics of seabird multispecies feeding flocks: chronology of flocking in Barkley Sound, British Columbia, in 1979. Colonial Waterbirds 4:104–113.
Poynter, G. A. 1960. A report on the birds of the lower Vancouver Island region for the year 1959. Mimeograph, Victoria Natural History Society, Victoria, British Columbia.
Racey, K. 1930. Effect of fuel oil on sea birds. Murrelet 11:22.
Reimchen, T. E., and S. Douglas. 1984. Seasonal and diurnal abundance of aquatic birds on the Drizzle Lake Reserve, Queen Charlotte Islands, British Columbia. Canadian Field-Naturalist 98:22–28.
Richardson, F. 1971. Birds of Grant Bay and Browning Inlet, northwest Vancouver Island, British Columbia; A year's phenology. Murrelet 52:29–40.
Ricker, W. E. 1937. Christmas bird census, 1936–Vedder Crossing, British Columbia. Canadian Field-Naturalist 51:27.
Robertson, I. 1974. An inventory of seabirds occurring along the west coast of Canada. Part II: The shoreline and inlet zone. Unpublished report, Canadian Wildlife Service, Delta, British Columbia.
Rodway, M. S. 1989. Distribution and abundance of waterbirds in Barkley Sound and the Long Beach/Tofino/Grice Bay area in spring 1989 following the Nestucca oil spill. Technical Report Series No. 76. Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.
Rodway, M. S. 1990. Status report on the Marbled Murrelet *Brachyramphus marmoratus*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, Ontario.
Rodway, M. S., M. J. F. Lemon, and G. W. Kaiser. 1988. British Columbia Seabird Colony Inventory: Report #1–East Coast Moresby Island. Technical Report Series No. 50. Canadian Wildlife Service, Pacific and Yukon Region, Delta, British Columbia.
Rodway, M. S., M. J. F. Lemon, and K. S. Summers. 1990. British Columbia Seabird Colony Inventory: Report #4–Scott Islands. Census results and impact of the Nestucca oil spill on breeding populations in 1989. Technical Report Series No. 86. Canadian Wildlife Service, Pacific and Yukon Region, Delta, British Columbia.
Rodway, M. S., M. J. F. Lemon, J-P. L. Savard, and R. McKelvey. 1989. Nestucca oil spill: impact assessment on avian populations and habitat. Technical Report Series No. 68. Canadian Wildlife Service, Pacific and Yukon Region, Delta, British Columbia.
Rueggeberg, H., and J. Booth. 1989. Interactions between wildlife and salmon farms in British Columbia: results of a survey. Technical Report Series No. 67. Canadian Wildlife Service, Pacific and Yukon Region, Delta, British Columbia.
Savile, D. B. O. 1972. Evidence of tree nesting by the Marbled Murrelet in the Queen Charlotte Islands. Canadian Field-Naturalist 86:389–390.
Schultz, Z. M. 1958. The nesting season–northern Pacific coast region. Audubon Field Notes 12:435.
Sealy, S. G. 1973. Interspecific feeding assemblages

of marine birds off British Columbia. Auk 90:796–802.
Sealy, S. G. 1974. Breeding phenology and clutch size in the Marbled Murrelet. Auk 91:10–23.
Sealy, S. G. 1975a. Aspects of the breeding biology of the Marbled Murrelet in British Columbia. Bird-banding 46:141–154.
Sealy, S. G. 1975b. Feeding ecology of the Ancient and Marbled Murrelets near Langara Island, British Columbia. Canadian Journal of Zoology 53:418–433.
Sealy, S. G., and H. R. Carter. 1984. At-sea distribution and nesting habitat of the Marbled Murrelet in British Columbia: problems in the conservation of a solitarily nesting seabird. Pages 737–756 *in* J. P. Croxall, P. G. H. Evans, and R. W. Schreiber (editors). Status and conservation of the world's seabirds. International Council for Bird Preservation Technical Publication No. 2.
Shepard, M. G. 1974. British Columbia birds–winter season, 1973–1974. Vancouver Natural History Society Discovery (New Series) 3:11.
Shepard, M. G. (editor). 1976. British Columbia birds–October to December, 1975. Vancouver Natural History Society Discovery (New Series) 5:10–13.
Simpson, G. B. 1925. (Christmas bird censuses, 1924) Lake Cowichan, V.I., British Columbia, December 24, 1924. Canadian Field-Naturalist 39:21.
Simpson, G. B. 1926. Christmas bird census from Lake Cowichan, British Columbia. Canadian Field-Naturalist 40:10.
Simpson, G. B. 1927. Christmas bird census at Lake Cowichan, British Columbia. Canadian Field-Naturalist 41:10.
Speich, S. M., and T. R. Wahl. 1989. Catalog of Washington seabird colonies. U.S. Fish and Wildlife Service Biological Report 88.
Sprot, G. D. 1928. Notes from southern Vancouver Island. Murrelet 9:20–21.
Summers, K. R. 1974. Seabirds breeding along the east coast of Moresby Island, Queen Charlotte Islands, British Columbia. Syesis 7:1–12.
Tatum. J. B. (editor). 1971. Bird report for southern Vancouver Island (1970). Unpublished report, Victoria Natural History Society, Victoria, British Columbia.
Tatum, J. B. (editor). 1972. Annual bird report (1971) for southern Vancouver Island. Unpublished report, Victoria Natural History Society, Victoria, British Columbia.
Tatum, J. B. (editor). 1973. Annual bird report (1972) for southern Vancouver Island. Unpublished report, Victoria Natural History Society, Victoria, British Columbia.
Vermeer, K. 1989. Marine birds of Jervis Inlet, a mainland fjord entering the Strait of Georgia. Pages 148–157 *in* K. Vermeer and R. W. Butler (editors). The ecology and status of marine and shoreline birds in the Strait of Georgia, British Columbia. Special Publication, Canadian Wildlife Service, Ottawa, Ontario.
Vermeer, K., and K. H. Morgan. 1989. Mariculture and bird interactions in the Strait of Georgia. Pages 174–176 *in* K. Vermeer and R. W. Butler (editors). The ecology and status of marine and shoreline birds in the Strait of Georgia, British Columbia. Special Publication, Canadian Wildlife Service, Ottawa, Ontario.
Vermeer, K., D. A. Manuwal, and D. S. Bingham. 1976a. Seabirds and pinnipeds of Sartine Island, Scott Group, British Columbia. Murrelet 57:14–16.
Vermeer, K., K. R. Summers, and D. S. Bingham. 1976b. Birds observed at Triangle Island, British Columbia, 1974 and 1975. Murrelet 57:35–42.
Vermeer, K., I. Robertson, R. W. Campbell, G. Kaiser, and M. Lemon. 1983. Distribution and densities of marine birds on the Canadian west coast. Unpublished report, Canadian Wildlife Service, Delta, British Columbia.
Wahl, T. R., S. M. Speich, D. Manuwal, K. V. Hirsch, and C. Miller. 1981. Marine bird populations of the Strait of Juan de Fuca, Strait of Georgia, and adjacent waters in 1978 and 1979. EPA-600/F-81-156, U.S. Environmental Protection Agency.
Young, C. J. 1927. A visit to the Queen Charlotte Islands. Auk 44:38–43.
Young, C. J. 1930. A study of the Rhinoceros Auklet and other birds in British Columbia, 1929. Pages 16–19 *in* Provincial Museum of Natural History Report for the year 1929, Victoria, British Columbia.

APPENDIX 1. Hatching-year Marbled Murrelets sighted at sea in British Columbia. Records are ordered geographically from south to north.

Location	Date	Number	Notes	Source
Strait of Georgia to Queen Charlotte Strait				
Southern Van. I.	1st week Jul 1959			Poynter 1960
Southern Van. I.	8 Aug 1972		First noted	Tatum 1973
Victoria	14 Jun 1958	1	First seen	Schultz 1958
Victoria	Early Jul 1961	Many		RBCM data base
Victoria	6 Jul 1961	1	First seen	RBCM data base
Victoria	19 Jun 1988	1	First seen this year	RBCM data base
Cordova Bay	5 Jul 1952	2	First seen this year	C. J. Guiguet notes
Oak Bay	21 Jul 1958	6		C. J. Guiguet notes
Oak Bay	24 Jun 1961	1	First seen this year	C. J. Guiguet notes
James Island	5 Jul 1952	2	First seen this year	C. J. Guiguet notes
Sidney–Victoria	15 Jul 1935	Many	Half grown with adults	Drent and Guiguet 1961
Departure Bay	15 Jul 1935	1	Half grown with adult	Munro and Cowan 1947
Point Roberts	10 Jun 1970	2–3		Campbell et al. 1973
English Bay	8 Jul 1971	Some		Campbell et al. 1972
Cape Lazo	17 Aug 1929	Many		Bishop 1930
Jervis Inlet	Aug 1987	2		Vermeer 1989
Mitlenatch I.	16 Jul 1927	1	Half grown with adult	Munro and Cowan 1947
Mitlenatch I.	6 Jul 1965	1		RBCM data base
Mitlenatch I.	17 Jul 1973	1		Butler 1973
Mitlenatch I.	18 Jul 1977	2	First seen	RBCM data base
Copeland I.	24 Aug 1934	2	Male, female; egg-teeth	Dickinson 1953
West coast Vancouver Island				
Cape Beale	4 Aug 1969	13		Guiguet 1971
Barkley Sound				
	4 Jul 1979		First seen	Carter 1984
	28 Jun 1980		First seen	Carter 1984
	5 Oct 1980	1	Intact egg-tooth	Carter 1984
Trevor Channel				
Folger I.–Cape Beale	24 Aug 1970	Many		Guiguet 1971
Whittlestone Pt.	2 Aug 1968	3		Guiguet 1971
Whittlestone Pt.	31 Aug 1970	10		Guiguet 1971
Aquilar Pt.	9 Aug 1964	Many		Guiguet 1971
Deer Group				
Edward King I.	10 Aug 1968	Many		Guiguet 1971
Diana I.	7 Aug 1968	1		Guiguet 1971
Sandford I.	10 Aug 1967	Many		Guiguet 1971
Sandford I.	30 Jul 1970	12		Guiguet 1971
Fleming I.	8–9 Aug 1967	Some		Guiguet 1971
Fleming I.	14 Aug 1968	>6		Guiguet 1971
Tzartus I.	7 Aug 1969	2		Guiguet 1971
Tzartus I.	20 Aug 1969	1		Guiguet 1971
Broken Group				
Effingham I.	22 Aug 1976	Some		RBCM data base
Cree I.	4 Aug 1970	Many		Guiguet 1971
Cree I.–Miller Reef	20 Aug 1970	>100		Guiguet 1971
Sea-lion Rks.	18 Jul 1968		First seen	Hatler et al. 1978
Wickaninnish Park	3 Jul 1966	Many		Buffam 1966
Long Beach	2 Jul		Earliest record	Hatler et al. 1978
Long Beach	17 Jul 1960		First seen	Hatler et al. 1978
Father Charles Ch.	17 Jul 1970	1	First seen	C. J. Guiguet notes
Brown Channel	14 Jul 1957	1	Female; egg-tooth	Drent and Guiguet 1961
Quatsino	10 Jul 1949	1	First seen	Martin and Myres 1969
Northern mainland coast				
Safety Cove	1 Aug 1937	1		Laing (RBCM field notes)
Spider I.	4 Jul 1939	1	Egg-tooth; some down	Munro and Cowan 1947
Goose I.	25 Jun 1948	1	First seen	Guiguet 1953

APPENDIX 1. Continued.

Location	Date	Number	Notes	Source
Troup Passage	21 Jul 1968	1	With 36 adults	RBCM data base
Higgins Passage	2 Jul 1948	5		Guiguet 1953
Queen Charlotte Islands				
Skidegaten Lagoon	28 May 1980	Some	Much calling	RBCM data base
Tartu Inlet	13 Jul 1947	1		Drent and Guiguet 1961
Nesto Inlet	9 Jul 1947	1	With two adults	Drent and Guiguet 1961
Tian Bay	7 Jul 1947	3	Just out of nest	Drent and Guiguet 1961
Peril Bay	27 Jun 1947	1	First of season	Drent and Guiguet 1961
Peril Bay	28 Jun 1947	2	Females; egg-teeth	Drent and Guiguet 1961
N coast Graham I.	7 Jul–10 Aug 1971	164	Scattered; probably some repeat sightings	Sealy 1974
Langara I.	22 Jul 1920	1	Sheaths remaining	Brooks 1926
	21 Jun 1926	Several	Still some down	Darcus 1927
	6 Jul 1970	1	First seen	Sealy 1974
	7 Jul 1971	1	First seen	Sealy 1974

APPENDIX 2. Seasonal aggregations of 100 or more Marbled Murrelets recorded in British Columbia during breeding and nonbreeding seasons. See Appendix III for aggregations reported from Christmas Bird Counts. Records from field notes of C. J. Guiguet are taken from Carter (1984). Records are ordered by day and month.

Date	Location	Number	Source
Spring—April to June			
Strait of Georgia to Queen Charlotte Strait			
1 Apr 1977	Egmont	400	RBCM data base
1 Apr 1977	Skookumchuck Narrows	1,800	Vermeer 1989
5 Apr 1976	Qualicum	214	Dawe 1980
28 Apr 1980	Cape Mudge	300	RBCM data base
30 May 1963	Chatham I. to Discovery I.	200–300	Guiguet (RBCM field notes)
9 Jun 1976	Miracle Beach to Discovery Passage	130	RBCM data base
19 Jun 1974	Stories Beach	>100	RBCM data base
21 Jun 1968	Campbell River	100	RBCM data base
21 Jun 1968	Quathiaski Cove	100	RBCM data base
21 Jun 1968	Discovery Passage	265	Hobson 1976
21 Jun 1969	Mitlenatch I. to Miracle Beach	150	Foottit 1969
26 Jun 1982	Spring Passage	215	Campbell et al., in press
West coast Vancouver Island			
20 May 1972	Loudoun Channel	268	Hatler et al. 1978
12 Jun 1970	Cree I. to Seabird Rks.	>200	Guiguet 1971
20 Jun 1975	Wickaninnish Bay	320	Campbell et al., in press
Jun 1982	S of Hotspring Cove	106	Sealy and Carter 1984
Jun 1982	SE of Flores I.	3,197	Sealy and Carter 1984
Jun 1982	S of Vargas I.	417	Sealy and Carter 1984
Jun 1982	N end Wickaninnish Bay	408	Sealy and Carter 1984
Jun 1982	W of Ucluelet	115	Sealy and Carter 1984
Jun 1982	SW Broken Group	622	Sealy and Carter 1984
Jun 1982	E side Broken Group	422	Sealy and Carter 1984
Jun 1982	Satellite Passage	154	Sealy and Carter 1984
Jun 1982	SW end Trevor Channel	515	Sealy and Carter 1984
Queen Charlotte Islands and north coast			
13 May 1983	Topping I.	245	Campbell et al., in press
18 May 1982	Gogit Passage	292	Rodway et al. 1988
23 May 1977	W end Faraday and Murchison I.	>100	RBCM data base
29 May 1977	Louscoone Inlet	165	Campbell et al., in press
3 Jun 1959	Mathers Creek	200–400	Guiguet (RBCM field notes)
5 Jun 1959	Beattie Anchorage	400	RBCM data base
6 Jun 1982	Gogit Passage	222	Rodway et al. 1988
11 Jun 1988	Kettle Inlet	110	Rodway, unpubl. data
12 Jun 1989	Mussel Inlet	200	R. Burns, pers. comm.

APPENDIX 2. Continued.

Date	Location	Number	Source
17 Jun 1986	High I.	110	RBCM data base
29 Jun 1986	Wiah Ft. to Cape Edenshaw	180	RBCM data base
29 Jun 1986	Klashwun Pt. to Coneehaw Rk.	180	RBCM data base
29 Jun 1986	Cloak Bay	120	RBCM data base
Summer—July to September			
Strait of Georgia to Queen Charlotte Strait			
Summer 78/79	Boundary Bay	340	Speich and Wahl 1989
Summer 78/79	Point Roberts	170	Speich and Wahl 1989
Summer 1978	Sidney approach	177	Manuwal et al. 1979
2 Jul 1949	Haro Strait	130	RBCM data base
8 Jul 1936	Haro Strait	291	Munro and Cowan 1947
9 Jul 1987	Clover Point	214	RBCM data base
10 Jul 1987	Clover Point	125	RBCM data base
16 Jul 1989	Theodosia Inlet	124	Kaiser, unpubl. data
16 Jul 1989	Pendrell Sound	119	Kaiser, unpubl. data
16 Jul 1989	Waddington Channel	202	Kaiser, unpubl. data
27 Jul 1967	Duncan Bay	125	RBCM data base
2 Aug 1935	Haro Strait	150	Munro and Cowan 1947
13 Aug 1973	Pt. Roberts	150	RBCM data base
17 Aug 1957	Sidney	120	RBCM data base
21 Aug 1982	Sidney Channel	163	RBCM data base
24 Aug 1986	Bowen I.	100	RBCM data base
24 Aug 1986	Tsehum Harbour	146	RBCM data base
25 Aug 1952	Sidney	150–200	Campbell et al., in press
25 Aug 1962	Sidney	140	Campbell et al., in press
27 Aug 1987	Sidney Channel	120	RBCM data base
15 Sep 1985	Coal I.	>120	RBCM data base
17 Sep 1984	Colbourne Passage	>100	RBCM data base
West coast Vancouver Island			
2 Jul 1970	Barkley Sound	>125	RBCM data base
22 Jul 1978	Checleset Bay	150	Campbell et al., in press
24 Jul 1971	Cleland I.	105	Campbell and Stirling 1968
8 Aug 1988	Barkley Sound	>200	RBCM data base
20 Aug 1970	Cree I. to Miller Reef	>100	Guiguet 1971
5 Sep 1953	Eliza I.	250	Flahaut and Schultz 1954
Queen Charlotte Islands and north coast			
Summer 1946	Masset Inlet	200	Guiguet 1956
Summer 1948	Bardswell I.	>100	Guiguet 1956
2 Jul 1948	Higgins Passage	300	Guiguet 1953
7 Jul 1947	Tian Bay	120–200	Guiguet (RBCM field notes)
10 Jul 1977	Shuttle Passage	132	RBCM data base
12 Jul 1977	Cumshewa Inlet	268	Campbell et al., in press
20 Jul 1977	Gospel I.	123	Campbell et al., in press
21 Jul 1971	Cloak Bay and Parry Passage	400	Sealy 1975b
24 Jul 1947	Mathers Creek	>400	Guiguet (RBCM field notes)
26 Jul 1947	Masset Inlet	200	Guiguet (RBCM field notes)
Fall—October to December			
Strait of Georgia to Queen Charlotte Strait			
1 Oct 1953	Saltspring I.	100's	Guiguet (RBCM field notes)
18 Oct 1989	Malaspina Inlet	106	Kaiser, unpubl. data
19 Oct 1986	Ogden Point	100	RBCM data base
30 Oct 1982	Lancelot Inlet	114	Kaiser, unpubl. data
30 Oct 1982	Malaspina Inlet	105	Kaiser, unpubl. data
4 Nov 1976	Arran Pt.–Arran Rapids	2,300	Summers, unpubl. data
12 Nov 1981	Myrmidon Pt.	300	RBCM data base
21 Nov 1975	Cortes I.	450	Campbell et al., in press
9 Dec 1977	Cortes I.	230	Dorst, unpubl. data
10 Dec 1972	Point Roberts	450	Campbell et al. 1974
15 Dec 1975	Cortes I.	1,300	Shepard 1976
23 Dec 1977	Cortes I.	650	Dorst, unpubl. data
25 Dec 1972	Point Roberts	237	Campbell et al. 1974
Winter 78/79	Point Roberts	100–500	Wahl et al. 1981
Winter 78/79	Boundary Bay	100–500	Wahl et al. 1981

APPENDIX 2. Continued.

Date	Location	Number	Source
West coast Vancouver Island			
5 Oct 1974	Port Renfrew	100	RBCM data base
11–13 Dec 1972	Clayoquot Sound	336	Robertson 1974
Queen Charlotte Islands and north coast			
5 Oct 1985	Portland Inlet	100	RBCM data base
Winter—January to March			
Strait of Georgia to Queen Charlotte Strait			
27 Jan 1975	Tsawwassen Jetty	240	Campbell et al., in press
Jan 1987	Skookumchuck Narrows	180	Vermeer 1989
3 Feb 1973	Active Pass	>300	Campbell et al., in press
6 Feb 1921	Bowen and Gambier I.	300	Munro 1921
6 Feb 1987	Sechelt to Trail I.	>1,700	RBCM data base
7 Feb 1977	Cortes I.	240	Dorst, unpubl. data
8 Feb 1986	Cattle Point	100	RBCM data base
21 Feb 1974	Egmont	300	Shepard 1974
22 Feb 1987	Sechelt	1,700	Campbell et al., in press
1–31 Mar 1976	Cortes I.	1,700	Campbell et al., in press
16 Mar 1982	Malaspina, Okeover and Theodosia Inlets	103	RBCM data base
27 Mar 1977	Cape Mudge	250	RBCM data base
Queen Charlotte Islands and north coast			
Jan 1978	Kitkatla Inlet	100's	P. W. Martin, pers. comm.
25 Feb 1979	Carmichael Passage	100	Campbell et al., in press

APPENDIX 3. Numbers of Marbled Murrelets recorded on Christmas Bird Counts in British Columbia from 1957 to 1988 (data from Audubon Field Notes/American Birds). Localities are ordered geographically from south to north inside and outside the Strait of Georgia.

Location	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Strait of Georgia																
Victoria		23	4	64	129	294	197	137	234	65	27	30	41	17	18	20
Sooke																
Duncan														9	8	6
North Saanich				10												
Pender Island								6	20	18	2	0	0	40	6	10
White Rock																5
Ladner	90	22	11	26	21	11	3	5	0	0	0	6	14	1	23	2
Nanaimo							15	14	12	4	72	38	0	0	0	6
Vancouver	91	77	5	9	24	58	78	10	46	166	342	32	268	79	59	274
Squamish																
Sunshine Coast																
Comox					8	4	10	9	0	2	11	1	13	3	5	16
Campbell River																3
Mean	91	41	7	27	46	92	61	30	52	43	76	18	56	21	17	38
S.D.	1	31	4	26	56	137	82	52	91	65	133	17	105	29	20	89
Min.	90	22	4	9	8	4	3	5	0	0	0	0	0	0	0	2
Max.	91	77	11	64	129	294	197	137	234	166	342	38	268	79	59	274
Outside the Strait of Georgia																
Bamfield																
Sayward																
Bella Bella																
Kitimat																
Prince Rupert																
Deep Bay																
Hecate Strait																
Skidegate Inlet																
Masset																
Mean																
S.D.																
Min.																
Max.																

APPENDIX 4. Hatching-year Marbled Murrelets found at inland sites in British Columbia.

Location	Date	Notes	Source
Hope	12 Jul 1947	On ground; fledgling	Thacker (field notes)
Chilliwack	7 Jul 1987	On ground; flightless	Campbell et al., in press
Vancouver (Pt. Grey)	23 Jul 1941	On ground; fledgling	Munro and Cowan 1947
Vancouver (Stanley Park)	18 Jul 1970	On ground by lagoon; flightless	Campbell et al. 1972
Powell Lake	7 Aug 1979	On water; fledgling	Carter and Sealy 1987b
Franklin River	13 Aug 1970	On ground; downy	Carter and Sealy 1987b
Kennedy Lake	19 Jun 1969	On water; half-grown fledgling	Campbell 1970
White River	15 Jul 1986	On ground; fledgling	J. Braun, pers. comm.
Owikeno Lake	15 Jul 1937	On water; fledgling	Laing (RBCM field notes)
Gilttoyees Inlet	26 Aug 1919	On ground by marsh; downy	Brooks 1926
Kumdis Slough	26 Jul 1947	On water; fledgling	Carter and Sealy 1987b
Masset	15 Jul 1947	On ground; flightless	Drent and Guiguet 1961

APPENDIX 3. Continued.

1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Mean	S.D.	Min.	Max.
19	21	16	25	14	16	12	51	32	17	29	232	84	72	53	68	66	76	4	294
										26	30	143	37	38	22	49	46	22	143
11	31	2	33	26	16	29	117	16	26	72	31	12	32	226	145	45	58	2	226
																10			
12	59	104	41	27	11	40	41	39	26	18	23	12	38	22	76	28	25	0	104
3	45	0	3	9	0	1	2	2	1	1	0	0	2	2	0	4	11	0	45
30	0	2,125	14	7	78	47	92	9	43	46	3	1	6	2	52	87	373	0	2,125
6	27	15	5	34	16	29	14	12	27	20	0	6	5	12	21	16	16	0	72
69	21	71	160	154	17	321	48	335	38	163	138	20	44	35	80	104	101	5	342
							199	44	76	46	23	11	26	9	10	49	60	9	199
						61	81	92	12	35	17		192	303	1.849	294	591	12	1.849
4	4	7	28	0	0	5	2	14	0	21	3	1	0	0	0	6	7	0	28
13	0	0	3	0	8	39	8	2	1	1	0		1	0		5	10	0	39
19	23	260	35	30	18	58	60	54	24	40	42	29	38	59	211				
21	20	700	49	48	23	94	60	97	23	44	71	47	53	99	545				
3	0	0	3	0	0	1	2	2	0	1	0	0	0	0	0				
69	59	2,125	160	154	78	321	199	335	76	163	232	143	192	303	1849				
													12	5	9	9	4	5	12
3	0	10	0	0	1	0	15	1	8	11	0					4	5	0	15
			24													24			
	2	0	0	0	1	0	0	17	0	0	0	0	0	0	0	1	4	0	17
							2	0	0	4	7	0	0	0	0	1	3	0	7
		9	15	2	5	3	3	4	7	2	6	1	7	2	0	5	4	0	15
							6									6			
									2	7	2	1	0	4	3	3	2	0	7
										2	0	0	2	0	4	1	2	0	4
3	1	6	10	1	2	1	5	6	3	4	3	0	4	2	3				
	1	6	12	1	2	2	6	8	4	4	3	1	5	2	4				
3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0				
3	2	10	24	2	5	3	15	17	8	11	7	1	12	5	9				

APPENDIX 5. Inland records of adult Marbled Murrelets in British Columbia. Records are ordered geographically from south to north.

Location	Date	Number	Notes	Source
Southern mainland				
Cultus Lake	Winter 1932–33	Many	On water	Carter and Sealy 1986
Cultus Lake	4 May 1933	1	On water	Carter and Sealy 1986
Cultus Lake	28 Dec 1936	6	At lake	Ricker 1937
Cultus Lake	11 Apr 1959	6	At lake	Carter and Sealy 1986
Cultus Lake	13 Jun 1964	1	At lake	Boggs and Boggs 1964
Cultus Lake	4 Apr 1965	2	At lake	RBCM data base
Cultus Lake	14 Jul 1971	>3		Campbell et al., in press
Alouette Lake	30 Nov 1981	1	At lake	Carter and Sealy 1986
Harrison Lake	3 Dec 1926	6	On water	Anon. 1927
Harrison Lake	28 Apr 1928	14–16	On water	Brooks 1928
Harrison Lake	13 Dec 1980	1	At lake	Carter and Sealy 1986
Harrison Lake	3 Jan 1981	2	At lake	Carter and Sealy 1986
Pitt Lake	11 May 1963	2	On water	Carter and Sealy 1986
Pitt Lake	11 Jun 1973	2	On water	Carter and Sealy 1986
Pitt Lake	4 May 1975	1	At lake	Carter and Sealy 1986
Vancouver	Summer 1926	1	Struck wire	Young 1930
North Vancouver	12 Jun 1933	Some	Flying inland	McT. Cowan (MVZ field notes)
Ruby Lake	11 Jun 1981	1	At lake	Carter and Sealy 1986
Powell Lake	13 Jun 1981	3	On lake	Carter and Sealy 1986
Princess Louisa Inlet	10 May 1985	2	Flying inland	RBCM data base
Port Neville	4 Jun 1978	1	Flying from *forest*	J. Rodway (field notes)
Vancouver Island and adjacent islands				
Malahat Ridge	4 Aug 1927	1	Road kill	Sprot 1928
Nitinat Lake	21 Jun 1984	46	On water	Carter and Sealy 1986
Tsusiat Lake	14 Jun 1982	Some	Heard calling	Carter and Sealy 1986
Mills Peninsula	28 Jun 1980	1	Flying to sea	Sealy and Carter 1984
Cowichan Lake	28 Nov 1923	In pairs	On water	Munro 1924
Cowichan Lake	7 Jan 1924	12	On water	Munro and Cowan 1947
Cowichan Lake	24 Dec 1924	8	At lake	Simpson 1925
Cowichan Lake	27 Dec 1925	24	At lake	Simpson 1926
Cowichan Lake	27 Dec 1926	30	At lake	Simpson 1927
Cowichan Lake	May–Jun	Some	Flying	Munro 1924
Effingham Inlet	24 Jun 1982	1	Flying to sea	Sealy and Carter 1984
Henderson Lake	10 Nov 1922	Several	On water	Munro 1924
Henderson Lake	25 Jun 1982	2	On water	Sealy and Carter 1984
Nanaimo Lakes	21 Aug 1963	12	At lakes	RBCM data base
Kennedy Lake	28 Jun 1925	Some	Flying inland	Darcus 1927
Kennedy Lake	29 Jun 1925	Some	On water	Darcus 1927; Young 1927
Kennedy Lake	19 Jun 1969	7 adults with 1 young	On water	Campbell 1970
Kennedy Lake	2 Jun 1978	1	At lake	Carter and Sealy 1986
Kennedy Lake	7 Jun 1984	2	On water	Carter and Sealy 1986
Kennedy Lake	19 Jun 1984	4	On water	Carter and Sealy 1986
Kennedy Lake	20 Jun 1984	7	On water	Carter and Sealy 1986
Kennedy Lake	26 Jun 1984	2	On water	Carter and Sealy 1986
Kennedy Lake	3 Jul 1984	7	On water	Carter and Sealy 1986
Kennedy River	28 Jun 1925	Some	Flying inland	Darcus 1927
Cox Bay	4 Jun 1982	1	Flying inland	Sealy and Carter 1984
E of Tofino	8 Jun 1982	2	Flying inland	Sealy and Carter 1984
Laddie I. mudflats	8 Jun 1982	10	Flying to sea	Sealy and Carter 1984
W of Grice Bay	8 Jun 1982	1	Flying inland	Sealy and Carter 1984
Meares Island	8 Jun 1982	1	Flying inland	Sealy and Carter 1984
Cameron Lake	1 Oct 1981	1	At lake	Carter and Sealy 1986
E of Bawden Bay	11 Jun 1982	1	Flying inland	Sealy and Carter 1984
Great Central Lake	4 May 1941	3	On water	Carter and Sealy 1986
Great Central Lake	22 Jul–23 Sept 1970	>5	On water	Carter and Sealy 1986; RBCM data base
Great Central Lake	13 Jul 1971	1	Flying	Carter and Sealy 1986
Great Central Lake	1 Aug 1978	Some	On water	Carter and Sealy 1986

APPENDIX 5. Continued.

Location	Date	Number	Notes	Source
Great Central Lake	6 Jun 1984	9	On water	Carter and Sealy 1986
Kanim Lake	16 Jun 1982	1	Flying	Sealy and Carter 1984
Comox Lake	summer	Some	Heard calling	Carter and Sealy 1986
Courtenay	28 Sep 1924	Some	Flying to sea	Pearse (RBCM field notes)
Courtenay	10 Aug 1934	1	Flying over	Pearse (RBCM field notes)
Courtenay	21 Jul 1938	Some	Flying inland	Pearse (RBCM field notes)
Bobs Lake	24 Jun 1981	1	At lake	Carter and Sealy 1986
Campbell Lake	1 Jul 1922		Heard calling	Carter and Sealy 1986
Campbell Lake	9 May 1975	1	At lake	Carter and Sealy 1986
Campbell Lake	summer	Some	Heard calling	Carter and Sealy 1986
Gray to Garrett lakes	1 Aug 1975	>8	Flying	Carter and Sealy 1986
Vernon Lake	15 Jun 1984	5	On water	Carter and Sealy 1986
Woss Lake	15 Jun 1984	9	On water	Carter and Sealy 1986
Brooks Peninsula	23 Jul 1978		Heard calling	RBCM data base
Victoria Lake	15 Aug 1981	5	At lake	Carter and Sealy 1986
Nimpkish Lake	May 1975	2	At lake	Carter and Sealy 1986
Nimpkish Lake	14 Jun 1984	5	On water	Carter and Sealy 1986
Northern mainland coast				
Goose Island	30 Jun 1948	1	Flying inland	Guiguet (RBCM field notes)
Hunter Island	5 Jul 1976	1	Flying inland	RBCM data base
Terrace	9 Aug 1976	1	On river	RBCM data base
Swan Lake	Jun 1979	1	At lake	Carter and Sealy 1986
Queen Charlotte Islands				
Heater Harbour	5 Jun 1986	8	Flying inland	Rodway, unpubl. data
Slim Inlet	3–14 Jul 1971	2–13	Flying in and out above and below treetop level	Summers 1974, unpubl. data
Hutton Inlet	17 Jun 1971	1	Heard calling	Summers, unpubl. data
Ramsay Island	20 May 1977	5	Flying inland	RBCM data base
Thurston Harbour	11 Jul 1977	6	Heard calling	RBCM data base
Pacofi Bay	20–23 Jul 1947		Flying to high country	Guiguet (RBCM field notes)
Security Cove	31 Jul 1957	Some	Flying to and from forest	Mills 1960
Coates Lake	Jun 1982	Some	Flying	Eisenhawer and Reimchen, in press
	1 Jun–3 Aug 1986	~70	Flying to and from forest	Eisenhawer and Reimchen, in press
Masset Inlet	28 Jul 1947	2	On road	Guiguet (RBCM field notes)
Eden Lake	summer	Some	On water	Guiguet 1956
Naden Harbour	20 Jun 1947	Some	Flying inland	Guiguet (RBCM field notes)
Drizzle Lake	Jul	2	On water	Reimchen and Douglas 1984
Masset	4 Aug 1947	2	Flying high from forest	Guiguet 1956 (RBCM field notes)
	25 Jul 1971	Several	Flying over	Summers, unpubl. data
Tow Hill	18 Aug 1974	1	Flying out of trees	RBCM data base
North coast Graham Island	17 Jul 1957	2	Flying inland	Savile 1972