Committee on the Status of Endangered Wildlife in Canada

Comité sur le statut des espèces menacées de disparition au Canada

Ottawa, Ont. K1A 0H3
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STATUS REPORT ON THE ANCIENT MURRELET *SYNTHLIBORAMPHUS ANTIQUUS* IN CANADA

BY

ANTHONY J. GASTON

STATUS ASSIGNED IN 1993
VULNERABLE

REASON: LARGE DECLINES WITH SOME BREEDING COLONIES THREATENED WITH ELIMINATION. HOWEVER, STILL A LARGE POPULATION WITH SOME COLONIES SECURE AT PRESENT.

OCCURRENCE: BRITISH COLUMBIA

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STATUS REPORT ON THE ANCIENT MURRELET *SYNTHLIBORAMPHUS ANTIQUUS* IN CANADA

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A. ABSTRACT

The Ancient Murrelet breeds on offshore islands across the northern Pacific from China to British Columbia. The total world population is in the order of half a million breeding pairs, of which about half breed in Canada, all in the Queen Charlotte Islands of British Columbia. The species is a major prey species for Falco peregrinus pealei, a vulnerable race in Canada. The previously very large colony of Ancient Murrelets at Langara Island has decreased by about 90% over the past several decades and numbers occupying colonies on Lyell Island and the Limestone islands have been considerably reduced. In all cases these declines seem to be related to the presence of introduced rats or raccoons. The two colonies affected by rats; Langara and Lyell islands, may be extirpated soon. Ancient Murrelets are all but gone from Murchison Island which is also occupied by rats. Although the rats do not appear to be spreading in the archipelago, the raccoons are, threatening many seabird colonies and putting more than half the current population of Ancient Murrelets at risk. In the absence of any evidence that rats can be eliminated, or that the spread of raccoons can be halted, I suggest that the species should be designated as vulnerable.

B. DISTRIBUTION

B.1 World

The Ancient Murrelet breeds in a thin arc, about 9000 km in length, around the northern rim of the Pacific Ocean (Figure 1). The species becomes progressively more abundant from China to British Columbia. However, it is easily overlooked because it visits land only at night, and it is hard to census, so numbers for many breeding areas are probably very unreliable. Canada is the only part of its breeding range where we can be fairly confident that population estimates are better than orders of magnitude.

In Asia, Ancient Murrelets are thinly distributed in small colonies separated by long distances. In the Aleutian chain the species is more common, but numbers there are poorly known. It becomes abundant once we reach the Sandman Reefs and other islands south of the Alaska Peninsula, but it is a dominant constituent of the marine bird community only in the Queen Charlotte Islands, B.C. and adjacent parts of southeastern Alaska (Gaston 1992). In Canada, it breeds only in the Queen Charlotte Islands where nesting occurs on at least 30 islands (Rodway 1991).

Ancient Murrelet occur mainly in subarctic waters, where mean annual surface water temperatures are between 5° and 15°C (Kitano 1981). Its distribution, defined by Udvardy (1963) as, "subboreal, pan-pacific", is similar to that exhibited by the Rhinoceros Auklet and the Tufted Puffin, although both of these species breed south to California on the east side of the Pacific, whereas the Ancient Murrelet is replaced in that area by the congeneric Xantus' Murrelet Synthliboramphus hypoleucos. In winter the species spreads south as far as California and Taiwan (Gaston 1992).

C. PROTECTION

Ancient Murrelets, being defined as migratory birds under the Migratory Birds Convention Act, and being considered non-game birds, are protected throughout the year. However, native peoples can take them legally for subsistence purposes at any time.

A little less than half of the Canadian-breeding population nests on islands in the Gwaii Haanas National Park Reserve. Their breeding habitat within the park is well protected from disturbance. The small colonies on Reef Island and the Limestone islands are protected as Provincial Wildlife Management Areas.

D. POPULATION SIZE AND TREND

D. 1 STATUS OUTSIDE CANADA

D 1.1 Asia

In China the Ancient Murrelet breeds on Chenlushan Island, in Jiangsu Province (200 pairs, Chen Zhao-qing 1988), Takung Tao, off the Shandong coast (Meyer de Schauensee 1984), and Qingdao in Shandong and islets offshore from Shanghai Municipality (Tso-Hsin 1987). In Korea, Ancient Murrelets seem to be somewhat more common, though still not numerous. Both Austin (1948) and Gore and Pyong-Oh (1971) mentioned that the species bred on a number of offshore islands, with several hundred on Nishi Island, in northwest Korea and Chibaldo Island, on the southwest coast (Kuroda, in Austin 1948). The species was said to be abundant in northeast Hamgyong Pukto, close to the USSR border (Mori, in Austin 1948), and probably nested also in Kangwon Do on the East coast. All of these observations are more than 30 years old, and the current status of the Ancient Murrelet in Korea may be rather different.

In Russia, Ancient Murrelets breed on several islands in Peter the Great Bay, off Vladivostok. Shibaev (1987) estimated 500 pairs on Verkhovskii Island and in the same area the species has been recorded breeding on Russkii, Karamzin (100 pairs in the 1960s) and Klykov islands. Litvinenko and Shibaev (1991) estimated the total population of Peter the Great Bay at 1200 pairs.

Elswhere on the coasts of the Sea of Japan the status of the Ancient Murrelet is unclear. Murata (1958) estimated 500 pairs nesting on Teuri Island, Hokkaido, Japan, but later authors considered them to be much less numerous there (Hasegawa 1984, Fujimaki 1986). They may also breed at a few other sites off the coast of Japan (Yamashina 1961, Fujimaki 1986, Hasegawa 1984) and Sakhalin (Litvinenko and Shibaev 1991).

In the Sea of Okhotsk, Ancient Murrelets occur during the breeding season around the Shantar Islands (Litvinenko and Shibaev 1991). Talan Island, not far from Magadan, on the north coast of the Sea of Okhotsk supports 5000 breeding pairs (Springer et al.

1992). There are several colonies known on the coasts of Penzhinskaya Gulf, the northeastern extension of the Sea of Okhotsk, but no figures are available for population sizes (Lobkov 1986, Vyatkin 1986). These colonies constitute the most northerly known breeding stations for the species. Kondratiev (1991) estimated 25 000 birds in the Sea of Okhotsk, spread among 18 sites. Recent estimates for the Kuril Islands suggest 3000 pairs according to Shuntov (1986), 3000 individuals according to Litvinenko and Shibaev (1991). The latter authors considered that the population of the Kurils has probably been affected by predation from introduced brown rats Rattus norvegicus. Evidence of rat predation on adult Ancient Murrelets was also found on Moneron Island, one of two small colonies off the east coast of Sakhalin (Nechaev 1986, Litvinenko and Shibaev 1991).

Ancient Murrelets breed on the east coast of Kamchatka on at least five islands. Starichkov Island supports the largest population known on the Asiatic shore of the Pacific- about 6500 pairs (Vyatkin 1986). No numbers are available for the other colonies, but they are almost certainly smaller, and some may be extinct (Flint and Golovkin 1990). The population of the Commander Islands is also poorly known, although the species occurs on both Bering and Copper islands.

In summary, there are probably no more than a few hundred pairs of Ancient Murrelets breeding in China, a few thousand on the Korean Peninsula, and a similar population around the coasts of the Sea of Japan. The Sea of Okhotsk, Kamchatka and the Commander islands seem to be the species' main stronghold in Asia, with perhaps a few tens of thousands of pairs. The wide range of the Ancient Murrelet in Asia suggests that it may have been more common formerly. Human persecution and introduced predators, especially rats, could have drastically altered its populations before any naturalist had time to assess them. This damage probably continues.

D. 1.2 The Aleutian Islands and the Bering Sea

The status of the Ancient Murrelet in Alaska is imperfectly known. In 1989, the U.S. Fish and Wildlife Service seabird colony catalogue (Catalogue of Alaskan Seabird Colonies- Computer Archives) listed 66 known and 8 probable breeding sites, with an estimated total population of just under 110 000 breeding birds. However, recent surveys at sea and estimates taking into account the poor coverage of earlier surveys, suggested that numbers may be considerably higher (D. Forsell, V. Mendenhall pers. comm.). Much more remains to be done to elucidate the status of the Ancient Murrelet in Alaska.

Small numbers of Ancient Murrelets occur in the Bering Sea in summer (G. L. Hunt, pers. comm., Sealy et al. 1971). They breed on many of the Aleutians Islands, but they are probably most abundant at present in the Fox Islands, at the eastern end of the chain, where at least six islands each support a thousand or more breeding pairs. Elsewhere in the Aleutians, the largest colonies are on Buldir Island, in the Rat Islands, on Koniuji Island, in the Andreanof group, and on Chagulak Island, among the Islands of the Four Mountains group. None of these estimates are likely to be better than orders of magnitude, because no detailed censuses have been carried out (E. Bailey, pers. comm.). Numbers must have been much higher in the past (Lensink 1984), because foxes were introduced onto most of the Aleutians from 1750 onwards, and increasingly after the purchase of Alaska by the United States, to encourage fur trapping (Jones and Byrd 1979). Existing populations of Ancient Murrelets in the eastern Aleutians are all on fox-free islands (Nysewander et al. 1982). The large population of 4000-5000 pairs on Buldir Island may be representative of what was found previously throughout the Aleutians (Byrd and Day 1986).

D. 1.3 The Alaskan Peninsula and the Gulf of Alaska

Around the Alaskan Peninsula Ancient Murrelets occur only on the south coast, where they breed on all the major island groups; the Sandman Reefs, and the Pavlof, Shumagin and Semidi islands. In the Sandman Reefs the species is common on 6 of the 14 occupied islands. The largest colony in this area is on Castle Rock, in the Shumagins, where Moe and Day (1977) estimated 15,000 pairs. This is the largest colony reported from any treeless site, although Amagat Island may support more (E. Bailey pers. comm.). Two other colonies in this group are believed to support over 1000 pairs, and the species is "abundant" on five others. "Thousands" occur on Spitz Island, to the east of the Shumagins, and on two islands in the Semidi group. As in the Aleutians, numbers of murrelets breeding in these islands were greatly affected by introduced foxes. Where the foxes have died out, or been removed, Ancient Murrelet populations may recover (Bailey 1978, Bailey and Faust 1980).

To the east of the Semidi Islands, in the Cook Inlet/Kodiak Island area, Ancient Murrelets appear to be much less common than further west. Only ten sites are listed by the US Fish and Wildlife Service Catalogue between Shelikof Strait and South-East Alaska. The species is uncommon in the Barren Islands, which support good populations of other seabirds, and is absent altogether from the remote Middleton Island, in the centre of the gulf (a former fox farm, and currently supporting many rabbits).

The Ancient Murrelet population in southeastern Alaska is practically all concentrated on Forrester Island, at the most southerly tip of the Alaska panhandle, where a survey by DeGange et al. (1977) gave an estimate of 30,000 pairs, making it the largest colony outside of the Queen Charlotte Islands. The only other colony of any size is on St. Lazaria Island (1000, Nelson et al. 1987).

D. 2. CANADA

D. 2.1 The Queen Charlotte Islands

Ancient Murrelets in the Queen Charlotte Islands are concentrated in two areas: off the west coast of Graham Island, in the north, and off the east coast of Moresby Island, in the south (Figure 2). Both of these areas supports about 120,000 breeding pairs. The northern population is concentrated in three large colonies, on Langara (24,000 pairs), Frederick (68,000) and Hippa (40,000) islands. The southern group is spread over at least 17 islands. An additional 10 smaller colonies, comprising about 20,000 breeding pairs, occur off the west side of Moresby Island (Table 1), the largest being on Helgesen Island (7700 pairs; Rodway 1991).

The colonies off Graham Island have been known since the early 1900s, but no attempt was made to census them until 1981, although Spencer Sealy made a retrospective estimate of the size of the Langara Island colony for 1970-71. Prior to that, only general statements, such as "astronomical" (Beebe 1960), "immense numbers", or "thousands" (Drent and Guiget 1961), were available. We have an even shorter record of the South Moresby colonies, which were unknown to outsiders until the 1960s, although familiar to the local Haida. For most Ancient Murrelet colonies in the archipelago, even orders of magnitude were uncertain until the Canadian Wildlife Service surveys of 1983-86 (Rodway et al. 1988, 1990). Consequently, we have information on whether populations are increasing, stable or declining for only a few colonies.

At Langara Island, Sealy estimated 80,000-90,000 breeding pairs of Ancient Murrelets in 1971 (Vermeer et al. 1984), but by then, many formerly occupied areas were deserted (Nelson and Myres 1976; Sealy pers. comm.). By 1981 the estimated population had fallen to 25,700 pairs (Rodway et al. 1983). Another census in 1988 provided a similar (statistically indistinguishable) estimate, of 24,100 pairs, although the occupied area had contracted further (Bertram 1989). Early accounts suggested that the occupied area was much more extensive than was found in the 1980s (Figure 3), and everything points to a dramatic reduction in the population of what

was probably, at one time, the largest colony in the Queen Charlotte Islands, perhaps in the world (Nelson 1990).

One feature of the declining murrelet population on Langara Island is that it appears to be concentrating more and more. When Rodway et al. (1983) surveyed it in 1981 they found a relatively high density of 840 burrows/ha, averaged over the whole occupied area (101 ha). Bertram, in 1988, found an average of 1358 burrows/ha; higher than any other colony in the Queen Charlotte Islands. Estimates of average density are obviously affected by the choice of colony boundary. If some unoccupied areas are included the density will be lower, but compensated for in the population estimate by the increased area of the colony. In this case a difference in the interpretation of where the colony boundary was cannot explain the differences in density, because the mean density found by Bertram was greater than the maximum density found by Rodway et al. We have to conclude that, despite the contraction taking place in the colony area, and despite a very low rate of burrow occupancy (26% in 1981), the Ancient Murrelets continued to dig burrows.

We can make an educated guess at the size of the original Ancient Murrelet population of Langara Island. The extent of coastline suitable for Ancient Murrelets is about four times that occupied in 1981. If we assume that the density of burrows in 1981 was representative of earlier times, and that the proportion of burrows occupied would have been similar to the average for Queen Charlotte Island colonies (63%), we obtain an estimate of more than 200 000 pairs. This is more than three times the size of the largest Ancient Murrelet colony at present (Frederick Island), and sufficient to have prompted the kind of hyperbole used to describe it by Beebe, Drent and Guiget, and others.

Several small colonies in the southeast Moresby area disappeared during the last two decades. Murrelets were present on Low Island and the Skedans Islands in 1970, but were gone by 1983 (Summers 1974, Rodway et al. 1988). It is unlikely that either of these sites would have supported large populations because the islands

involved are very small. It may be significant that the Peregrine Falcon nest sites on these two islands, active in earlier decades, were never occupied during the 1980s (K. Moore pers. comm.).

On Boulder and Sea-Pigeon Islands, in the inner part of Skincuttle Inlet, Bristol Foster found eggshells and the remains of dead adults in 1960 (Drent and Guiget 1961), but Summers (1974) found no sign of breeding in 1971. Introduced raccoons Procyon lotor, sometimes present on Boulder and Sea-Pigeon islands (D. Masselink and M. Van den Brink pers. comm.), may have been responsible for their abandonment by Ancient Murrelets.

Summers (1974), on his survey in 1971, found abundant burrowing on Arichika Island and the Bischof Islands, estimating 500 pairs on each. By 1985 Rodway et al. (1988) could find no trace of these colonies. The abruptness of their disappearance may be misleading; many burrows could already have been deserted when Summers visited the islands. Although these colonies have certainly disappeared recently, the cause of their desertion is unknown.

The only other colonies for which a population changes have been demonstrated are the East and West Limestone Islands and Lyell Island, all in the South Moresby area. Summers (1974), found burrows covering both the Limestone Islands, except for a small area on the east island. He estimated the total population at over 5000 pairs. In 1983 the CWS survey team estimated about 1500 pairs on the two islands (Rodway et al. 1988), and in 1989 a similar estimate was obtained (Gaston et al. 1989), with only a handful remaining on the west island, occupying a small portion of the northeast corner. At Dodge Point, Lyell Island in 1982 a CWS survey estimated 10,700 breeding pairs. A repeat survey in 1992 found a reduction of about 25% and a contraction of about 30% in the colony area (M. Lemon pers. comm.).

In 1985 and 1986 CWS field crews set up permanent monitoring plots on several Ancient Murrelet colonies in the Queen Charlotte Islands. The plots were mapped and clearly marked on the ground and the numbers of burrows counted. On George Island in 1985, 258 burrows were present in eight monitoring plots. A return visit in

1991 found 327 burrows in the same plots; an increase of 27%. In 1992 a similar visit to plots set up on Ramsay Island in 1985 showed that the population of monitoring plots there had also increased. It is hard to evaluate such small samples monitored over a short period of time, but it is possible that, in the Gwaii Haanas area, at least, numbers of Ancient Murrelets are increasing.

D. 2.2 OTHER PARTS OF CANADA AND U.S.

Outside the Queen Charlotte Islands, there are only two definite records of Ancient Murrelets breeding in North America south of Alaska. A nest with eggs was found by Hoffman (1924) on Carroll Island, Washington State, and another was reported from the Moore Group, B.C., off the mainland coast of Hecate Strait, in 1970 (Campbell et al. 1990). There have been no subsequent records from Washington, but small numbers are seen offshore during summer and a fledgling was recorded in 1978. A very small breeding population may exist there still (Speich and Wahl 1989). Small numbers are also seen off the northern part of the West coast of Vancouver Island in summer, and breeding is possible there, but no evidence for it exists. Family parties, including small chicks, are sometimes seen in the southern part of Queen Charlotte Sound, but these may well have originated from the Queen Charlotte Islands, because dispersal away from the breeding sites is very rapid (Duncan and Gaston 1990). There is no definite evidence that, south of Alaska, Ancient Murrelets breed regularly anywhere other than in the Queen Charlotte Islands.

D. 3 CAUSES OF OBSERVED TRENDS

Nelson and Myres (1976) suggested that the Ancient Murrelet population declined on Langara Island because there was a reduction in the availability of food, either because of pesticide pollution, or because of changes in the marine current systems controlling local productivity. Levels of organochloride pesticide residues (DDE 0.4-2.0, dieldrin 0.004-0.014 ppm wet weight) in a small sample of Ancient Murrelet eggs taken at Langara Island in 1968 were actually lower than those observed in 1970 and 1971 in the eggs of a variety of other seabirds, including storm petrels, which have diets similar to that of the Ancient Murrelet (Elliot et al. 1989). There is no suggestion that any of the other species declined and the levels obtained were below those thought to have measurable effects on reproduction or survival. This makes it unlikely that pesticides were involved. The levels found were similar to those seen in a small sample of eggs from Buldir Island, in the western Aleutians (Ohlendorf et al. 1982). More recent analyses of deserted eggs taken from Reef Island in 1986 showed that levels of DDE had fallen only slightly, to 0.3-1.5 ppm, and dieldrin to 0.003-0.006 ppm.

The possibility that oceanographic changes are involved in the decline of Ancient Murrelet populations is hard to discount, because there is very little information. However, long-term studies in California (Ainley and Boekelheide 1990) and Alaska (Hatch et al. in press) do not suggest directional changes in oceanographic events affecting those areas, which bracket the Queen Charlotte Islands.

Studies by Bertram (1989), showed that ship rats Rattus rattus, introduced on Langara Island some time before the end of the second world war, had killed many adult Ancient Murrelets in their burrows. Evidence of rat predation on Langara had been noted earlier by Campbell (1968), Sealy (1976) and Rodway et al. (1983). Bertram found murrelet bones in 29% of all burrows searched, and they were most common in parts of the colony that had been abandoned. Bones are rarely found in burrows in colonies where rats

are absent (Rodway et al. 1988, Bertram 1989, pers. obs.). There is a strong suggestion that rats were responsible for the decline in Ancient Murrelets at Langara Island, at least in recent years, although we do not know when the rats arrived on the island.

Rats are known to be present on at least three other islands supporting Ancient Murrelets. At Murchison Island there are only a handful of breeding Ancient Murrelets, although the nearby and very similar House Island supports more than 2000 pairs. There is a possibility that the population on Murchison has been greatly reduced by the rats.

At Dodge Point, Lyell Island, evidence of rat predation was found during a census in 1982. In 1992 50% of occupied burrows showed evidence of rat predation in the form of dead adult murrelets, or depredated eggs (M. Lemon pers. comm.). No census has been conducted at the third colony, on Kunghit Island, so we cannot tell whether rats are affecting the colony. However, rats are very numerous around the small settlement at Rose Harbour on the same island.

The cause of the decline observed at the Limestone Islands is almost certainly raccoon predation. In the 1990 and 1991 breeding seasons, raccoons were definitely active on the east island, digging up burrows, killing adults and eating eggs. In 1991 three adult raccoons on East Limestone island are estimated to have killed at least 11% of breeding adult Ancient Murrelets and to have reduced the number of chicks leaving the colony by 35% (Gaston 1991, Gaston et al. 1992). They also appear to have extirpated a small pocket of perhaps 10-15 pairs of Cassin's Auklets Ptychoramphus aleuticus. Raccoons were removed from the island during the winter of 1991-92 and in 1992 numbers of Ancient Murrelet chicks produced rebounded by 20%, while adult mortality was reduced by nearly 80% (Laskeek Bay Conservation Society unpubl.).

Raccoons are also present on Helgesen Island, off the west coast of Moresby Island, where 7 were counted in 1991 during a single spotlight survey at night. This island supported 7700 pairs of

Ancient Murrelets in 1986, as well as thousands of Rhinoceros Auklets Cerorhinca monocerata, Cassin's Auklets and Storm-Petrels. There is very little inter-tidal foraging habitat available to raccoons on this island. Consequently, it seems unlikely that raccoons could survive there in large numbers during the winter and it is possible that they cross from the nearby mainland of Moresby Island during the breeding season.

Apart from the disappearance of murrelets from Boulder and Sea Pigeon islands, referred to above, colonies of burrow nesting Rhinoceros Auklets and Cassin's Auklets on Saunders Island, on the west coast of the Charlottes have been deserted (Rodway et al. 1990). In all cases the deserted islands showed evidence of raccoon activity (Rodway 1991). Leaving aside the probably small and marginal colonies on Low and Skedans islands, four out of six colony abandonments that we know of involve islands where raccoons are, or have been, present. Raccoons are known to coexist with burrow nesting seabirds at present only on the Limestone islands (until removed in 1991), on Helgesen Island and possibly on Kunghit Island, where the presence of raccoons has not been confirmed, and Skincuttle and George islands where they are believed to have just arrived. Surveys of most islands in the southern half of the archipelago in 1991 and 1992 suggested that raccoons may be continuing to spread to the more remote islands (M. Van den Brink pers. comm.).

D. 4 EFFECTS ON PEREGRINE FALCON POPULATIONS

The decline in the number of murrelets on Langara Island has been accompanied by a dramatic decline in the numbers of Peregrine Falcons Falco peregrinus pealei breeding there, which fell from about 20 pairs in the 1950s to 5 or 6 pairs during 1968-73, remaining stable since then (Nelson and Myres 1976, Nelson 1988, 1990). The Ancient Murrelet is the main prey of the peregrine at Langara Island (Beebe 1960, Nelson 1977), and it is very tempting to link the two population declines. However, the timing does not fit very well. There is a possibility that peregrines declined

first, due to pesticide contamination but that the reduction in the Ancient Murrelet population has prevented any recovery since the banning of chlorinated hydrocarbon pesticides.

Notwithstanding the doubts about the causes of the initial decline of peregrines at Langara Island, it appears that the resident peregrines in the Queen Charlotte Islands depend heavily on the small burrow nesting seabirds for food, especially the Ancient Murrelet (Nelson 1977, Gaston 1992). That being the case, the current declines in populations of burrow nesting seabirds, including Ancient Murrelets, must cause concern for the peregrine population, currently 50-70 pairs (BC Dept of Environment). The Queen Charlotte Islands are the main breeding area in Canada for the race pealei.

E. HABITAT

E. 1 BREEDING HABITAT

Most islands on which Ancient Murrelets breed are between 20-2000 ha in area. Breeding sites are situated up to 300 m, exceptionally 400 m, from the sea. They do not coexist naturally with any mammalian terrestrial predators except river otters (Gaston 1992). In the Queen Charlotte Islands, in South-East Alaska, in some places in Peter the Great Bay, and probably also in the Kuril Islands, Ancient Murrelets nest under forest. However, from Kamchatka through the Commander and Aleutian islands, and as far east as the Gulf of Alaska, most of the islands on which they breed are treeless (Gaston 1992). Where forest is available, it appears to be the species' preferred breeding habitat (Vermeer et al. 1984). Where it is absent, Ancient Murrelets usually pick the most densely vegetated area available, provided that it is not waterlogged. On Buldir Island, they occupy the lowland tall-plant complex, which grows about 1 m high (Byrd and Day 1986). In the eastern Aleutians they are found in Elymus/Calamagrostis grassland and mixed Elymus and umbelliferae. Their burrows are also found in the foundations of abandoned native houses (Nysewander et al. 1982). Tussock grasslands is probably their main breeding habitat throughout much of their Alaskan range (Bendire 1895, Nysewander et al. 1982), but they also breed on some small islands practically devoid of vegetation, and there they must make do with cracks in the rocks; they are common in such habitat on islands off the Alaska Peninsula (E. Bailey pers. comm.).

Burrows dug by the birds themselves seem to be the most typical nest sites where there is a sufficient depth of soil. In forest habitat, in the Queen Charlotte Islands, burrows are tunnelled under the base of trees, stumps, or fallen logs, and may penetrate fissures in the underlying rocks (Drent and Guiget 1961). Outside forest they make use of rock crevices, or burrows made among the roots of grass tussocks (Bendire 1895).

E. 2 BREEDING HABITAT PROTECTION

Two large colonies off the west coast of Graham Island, Langara and Hippa islands, are provincial ecological reserves. Off the east coast of Moresby Island 14 colony islands are included within the Gwaii Haanas National Park Reserve and another three are protected as Provincial Wildlife Management areas. The only colony of more than 10 000 pairs that has no protected area status is Frederick Island, currently the largest colony at 68 000 pairs.

E. 3. BREEDING HABITAT QUALITY AND QUANTITY

The breeding habitat of the Ancient Murrelet in the Queen Charlotte allows them to take advantage of all but the largest islands of the archipelago, as all but a few very small and exposed islets support coastal rainforest. Some colony islands are densely burrowed throughout (e.g. Rankine Island, most of coastal Frederick Island, Rodway et al. 1988, pers. obs.), whereas others have large areas of apparently suitable habitat which is either unused, or supports only a low density of burrows (e.g. Ramsay and Reef islands). The density of burrowing decreases from south to north among the islands of south-east Moresby. There is no evidence that the population is limited by the availability of breeding habitat, except possibly on a few very densely burrowed islands. Competition for burrowing space with Cassin's Auklets is likely in a few places where their respective breeding habitats overlap (Vermeer et al. 1984).

F. GENERAL BIOLOGY

F. 1. Reproduction and survival

Ancient Murrelets almost invariably lay 2 eggs. There is only one clutch per year and no replacements are laid. Where there are no introduced predators, breeding pairs rear an average of 1.5 young per year to the stage of colony departure, which takes place 2-3 days after hatching (Vermeer and Lemon 1986, Gaston 1992). Most family parties seen at sea soon after departure from their colonies consist of two adults and two chicks, so despite the precocial departure, survival of young during the first few days appears to be high (Gaston 1992).

The only information available on other aspects of population dynamics comes from studies by Gaston (1990) at Reef Island in the Queen Charlottes. Birds begin to prospect for breeding sites occasionally in their first summer, but more typically in the second summer. Some, perhaps many, birds begin to breed at three and probably most do so by four. The annual survival of breeding adults is about 77%, which is relatively low for an auk. The annual survival of pre-breeders may be a little higher.

F. 2. Movements

Ancient Murrelets breed in the Queen Charlotte Islands from April-June. They leave the vicinity of their breeding colonies soon after the end of breeding. Family parties originating from colonies in Hecate Strait remain in the strait for several weeks (Duncan and Gaston 1990) and some appear off the Goose Islands, in Queen Charlotte Sound at the same period (Guiget 1953). By August, Ancient Murrelets are uncommon in Hecate Strait and in September they virtually disappear from B.C. waters (Gaston 1992). Their whereabouts at this season is unknown.

Large numbers of Ancient Murrelets appear in inshore waters off Vancouver island by late October, where they remain until mid-February (Wahl et al. 1981, Campbell et al. 1990). Smaller numbers occur at the same season in waters out to the edge of the

continental shelf off Washington, Oregon and California (Ainley 1976, Balz and Morejohn 1977, Briggs et al. 1987). By March they appear in large numbers in Hecate Strait and begin visiting their colonies prior to laying which begins in early April.

Only one banding recovery of a Canadian Ancient Murrelet has been reported away from the Queen Charlotte Islands; a pre-breeder found dead on a beach in Washington State. We do not know for sure that the birds that occur in winter off southern British Columbia originate from the Queen Charlotte Islands, but as the numbers involved are large and the Queen Charlottes are the main breeding area in the eastern Pacific, it seems a likely assumption.

F. 3. Behaviour/Adaptability

Natural changes in breeding habitat created by windthrow and by subsequent regeneration of trees seem to have little effect on Ancient Murrelets, as birds can be found breeding in all types of forest. At Limestone Island a large area cleared by a wildfire more than 20 years ago is not being used by murrelets although Alder has regenerated strongly. This suggests that recolonisation following forest destruction may take a long time.

The contraction in the area occupied by the declining Ancient Murrelet colonies at Langara and Lyell islands seems to be a response to the heavy predation pressure being exerted by rats. This may indicate that birds recruiting to the colony require some critical density of active burrowing to attract them. Whether the consequent concentration of burrows acts to reduce or enhance the chance of predation is not known.

Pre-breeding birds have been trapped on islands other than the one where they were reared, leading Gaston (1990) to suggest that many birds disperse from their natal colony to breed. This suggestion is unproven as yet, although the rate of return of chicks banded in 1990 at East Limestone Island (only 3% of pre-breeders in 1992, although about 50% of departing chicks were banded) further supports the idea. If many recruits at Ancient Murrelet colonies were hatched elsewhere then colonies may continue

to receive recruits despite experiencing low reproduction due to predation. This might explain the remarkable resilience of the Limestone islands population and the apparent stabilization of the population at Langara Island. As long as colonies subject to predation make up only a small proportion of the total regional population they may be maintained by recruitment from elsewhere. However, if predators spread to more colonies, we should expect that a point will be reached when production at unaffected colonies can no longer compensate for losses at affected colonies. At that point we can expect the population to suffer a very steep decline, not only at affected colonies, but throughout the entire archipelago.

G. LIMITING FACTORS

G. 1. INTRODUCED PREDATORS

Evidence from many parts of the Ancient Murrelets breeding range suggests that the main factor limiting populations in the past century has been the introduction of exotic mammals to colony islands; rats in Asia, foxes in Alaska and rats and raccoons in British Columbia (see above, section D).

Before the arrival of europeans in the 18th century, the Queen Charlotte Islands supported several mammals liable to take seabirds: the deer mice Peromyscus sitkensis and P. maniculatus, which are allopatric within the archipelago and which take eggs on occasions, the marten Martes americana, the weasel Mustela erminea and the river otter Lutra canadensis, all of which might be capable of taking adult birds. At present, only the deer mice and the river otter occur on islands occupied by seabirds. Mammals introduced since the arrival of europeans and which occur on at least some seabird islands include the black tailed deer Odocoileus hemionus, the ship or roof rat, the raccoon and the red squirrel Tamiasciurus hudsonicus (Cowan 1989). Of these, only the rat and the raccoon have been proven to have an adverse impact on seabirds.

In the Queen Charlotte Islands numbers at Langara Island, probably the largest colony prior to this century, have fallen by approximately 90%, probably mainly due to rats. Several smaller colonies have been extirpated, probably by raccoons, which have also severely affected the Limestone Islands. The colony at Dodge Point is dwindling in the face of rat predation. If we accept the conservative figure of 200,000 pairs for the original population of Langara Island, the present Ancient Murrelet population of British Columbia has probably fallen by about 50% over the past 50 years.

Rats do not appear to have spread to new islands in the Queen Charlottes during the past decade. Their absence from many seabird islands known to have been inhabited by non-native people for varying lengths of time in the past (e.g. Burnaby, East Copper) suggests that special circumstances may be necessary for rats to

persist. However, the possibility of further introductions remains and may be exaccerbated by the increased boat traffic occurring within the area of the Park Reserve.

Masselink and Van den Brink (1992) have shown that most islands in the Queen Charlottes within 600 m of a source area now support raccoons. However, raccoons have also been observed on Ramsay, Skincuttle and Kunghit islands, all more than 1 km from potential source areas (Table 1). All but the furthest colonies (Langara, Marble, Reef) must be considered to be vulnerable to invasion by raccoons within the next decade. Evidence obtained so far suggests that Ancient Murrelets cannot coexist indefinitely with raccoons and that once they are established on colony islands the murrelets will eventually be extirpated.

G. 2. OTHER POSSIBLE FACTORS AFFECTING POPULATIONS

Compared to the impact of introduced mammalian predators, other possible causes of Ancient Murrelet declines seem fairly trivial. Disturbance by tourists at breeding colonies may cause some reproductive failures in a species which is extremely sensitive to disturbance (Gaston et al. 1988a). Some disruption of family departures may be caused by artificial lights around camps, or on fishing boats or fishing lodges, because the chicks are very strogly attracted to light when leaving the colony (Gaston et al. 1988b).

Ancient Murrelets, like all auks, are very vulnerable to oiling at sea. The Ancient Murrelet was one of the commonest birds killed in oil spills in the Sea of Japan (Kazama 1971). However, it has not occurred in great numbers in any spill on the west coast of North America. Ancient Murrelets comprised only 2.4% of birds washed up on the west coast of Vancouver Island as a result of the Nestucca spill in early 1989 (Rodway et al. 1989). Currently, oil appears to pose little threat to Ancient Murrelets. However, the possibility of oil exploration and development in Hecate Strait remains. If this took place it could create significant additional mortality of Ancient Murrelets. In addition, Hecate Strait and

Dixon Entrance are important shipping lanes and the possibility of a major spill near important colonies, although remote, cannot be discounted.

The possible logging of the Ancient Murrelet colony area on Lyell Island in the 1980s was a major point of contention in the aggitation over the protection of South Moresby. None of the other colonies were threatened by logging at that time and there is still no interest in any of the colony islands. Most are too small, or too exposed, to attract the attention of logging companies.

Although it is possible that levels of chlorinated hydrocarbons in Ancient Murrelets were high enough in the 1960s to have had an impact on the reproduction of peregrines that fed on them, no levels have been identified that suggest the murrelets themselves might be affected (Elliot et al. 1989). To summarise, it appears unlikely that causes other than the impact of introduced mammals can have caused the recent and continuing decline of the Ancient Murrelet population in the Queen Charlotte Islands.

H. SPECIAL SIGNIFICANCE OF THE SPECIES

The Ancient Murrelet is the most numerous member of its genus. The other three congeners all have very small ranges (Craveri's Murrelet Synthliboramphus craveri, Baja California; Xantus' Murrelet, California; Japanese Murrelet S. wumizusume, Japan). The Ancient Murrelet's closest relative, the Japanese Murrelet, is severely endangered (Collar and Andrews 1988, J. Piatt pers. comm.). The genus is unique, among seabirds, in having chicks that are fully precocial and which go to sea at 2-3 days old, never having been fed in the nest. Many interesting physiological adaptations are associated with this precocial strategy (Gaston 1992).

Rodway (1991) considered that 74% of the world population bred in the Queen Charlotte Islands. However, this was based on the undoubtedly minimal estimate for Alaska given by Sowls et al. (1978). Assuming that Alaska supports at least 200,000 pairs at present, and that there are a further 25,000 pairs in Asia (Gaston 1992) it appears that the population of the Queen Charlotte Islands constitutes about half the world total. If V.Mendenhall's guess (pers. comm.) that the Alaska population could be as high as 800,000 birds (400,000 pairs) is correct the proportion in British Columbia falls to a little over 30%. For the moment, pending better information from Alaska, it is probably best to consider that Canada supports half the world population.

Ancient Murrelets were harvested in the past by the Haida of the Queen Charlotte Islands, a practice that persisted at least into the 1960s (W. Campbell, pers. comm.). Many of the older Haida remember eating them. Hence the birds have some cultural significance for them. The Masset band council has expressed concern (to G. Kaiser, CWS-P&YR) about the declining population at Langara Island.

The Ancient Murrelet has become the "flagship" of conservation efforts in the Queen Charlotte Islands, especially by the Laskeek Bay Conservation Society, which is trying to encourage the

eradication or control of introduced animals in the archipelago. Locally, and in the Canadian Park Service, there is a lot of concern about the more cryptic impacts of raccoons, especially on the inter-tidal fauna. Protecting Ancient Murrelets can help to focus attention on the whole issue of the ecosystem effects of introduced animals.

I. EVALUATION AND PROPOSED STATUS

Although there are currently upwards of 200,000 pairs of Ancient Murrelets breeding in Canada, many people are concerned about the status of the species in the long term (Summers and Rodway 1988, Rodway 1991, Bailey and Kaiser in press). The declines at the rat-affected colonies on Langara and Lyell islands seem likely to persist and result in extirpation fairly soon. Rats are known to have extirpated the very similar Japanese Murrelet from at least one colony in the past decade (Takeishi 1987). They are a worldwide scourge of insular avifaunas (Atkinson 1985). Raccoons threaten most of the other colonies, of which Helgesen Island (7,700 pairs), Alder Island (14,400 pairs) and the Copper islands (aggregate of nearly 30,000 pairs) seem to be the most immediately at risk. The two largest colonies, Frederick and Hippa islands, are separated from the mainland of Graham Island by less than 1 km and must be vulnerable to invasion by raccoons. Both are large islands with substantial intertidal areas and hence could support large raccoon populations through the non-breeding season.

Given the difficulty inherent in trying to eradicate rats from large, wooded islands, and the fact that raccoons seem likely to spread to other Ancient Murrelet colonies soon, the long term outlook for the species is not good. With several colonies on islands that are far offshore (Rankine, Ramsay, Reef with approximately 50,000 pairs between them), the total extirpation of the species seems unlikely in the near term. However, if all colonies within 1 km of possible raccoon source areas were to be extirpated (a real possibility) and the populations on Langara and Lyell were wiped out by rats (very likely), the remaining population would be less than 80,000 pairs. Moreover, a raccoon has been sighted on Ramsay Island, more than 6 km from a source area, so there is no guarantee that even the remotest islands will not be colonized eventually. If Lyell Island is colonized, which seems probable considering its size, and the fact that the waters of Darwin Sound, which separate it from Moresby Island, are relatively

sheltered, House, Hotspring and Ramsay Islands will be vulnerable via the "stepping stones" of Faraday and Murchison islands. Considering the level of threat posed by these introduced predators, I suggest that a designation of vulnerable should be applied to the Ancient Murrelet. This could be rescinded if and when real progress is made in controlling rats and raccoons in the smaller islands of the Queen Charlotte archipelago.

J. CHANGING STATUS

The Canadian Wildlife Service plans to attempt the eradication of rats on Murchison and Langara islands in 1994 or 1995. If the attempt is successful on Langara, that will be an important step forward in protecting Ancient Murrelets. At the same time, Canadian Parks Service, Canadian Wildlife service and the B.C. Ministry of Environment are discussing how to develop a raccoon monitoring and control programme, involving the annual monitoring of key seabird colonies to detect the arrival of raccoons and their immediate removal. If this programme is developed and proves successful at containing raccoons and if, as a result, populations of Ancient Murrelets on affected islands are found to be increasing, we will be able to declare a win and remove the COSEWIC designation.

One other positive step that could help to safeguard Canada'a Ancient Murrelet population would be the creation of a protected area on Frederick Island, where about 30% of the murrelets currently breed. This island has no protected status at present. Designation as a Migratory Bird Sanctuary, or a Provincial Wildlife Management Area would help to ensure that this most important colony remains strictly protected.

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Table 1. Breeding populations of Ancient Murrelets in the Queen Charlotte Islands (from Rodway 1991).

Locality	Population (pairs)		Year	Distance to raccoonsource area (km)
WEST COAST OF GRAHAM ISLAND				
Langara I.	24 000	(R)	1988	1.0
Frederick I.	68 000		1980	0.7
Hippa I.	40 000		1983	0.7
Marble I.	1000		1977	3.5
WEST COAST OF MORESBY ISLAND				
Saunders I.	50		1986	P
Helgesen I.	7700		1986	P
Willie I.	10		1986	0.3
Carswell I.	1700		1986	0.7
Instructor I.	760		1986	0.2
Lihou I.	6500		1986	1.2
Luxmoore I.	1000		1986	0.5
Rogers I.	1700		1986	0.5
Cape Kuper, Moresby I.	10		1986	P
Anthony I.	200		1985	1.5
EAST COAST OF MORESBY ISLAND				
Kunghit I.	8800	(R)	1986	?P
Rankine I	26 000		1984	1.7
Bolkus I.	9900		1985	1.0
Skincuttle I.	2200		1985	P
George I.	11 600		1985	P
Jeffrey I.	1000		1985	1.0
East Copper I.	4400		1985	1.5
Howay I.	300		1985	1.2
Alder I.	14 400		1985	0.4
Ramsay I.	18 200		1984	5.5
Hotspring I.	6		1984	5.0*
House I.	2600		1984	5.0*
Murchison I.	20	(R)	1984	1.2*
Agglomerate I.	2200		1985	1.2*
Dodge Point, Lyell I.	10 700	(R)	1982	1.5
Reef I.	5000		1985	5.6
Limestone Is.	1500		1983	0.4

(R) = rats present
P = present
* = distance to nearest potential source area if Lyell Island is colonized

Figure 1. Global distribution of the Ancient Murrelet

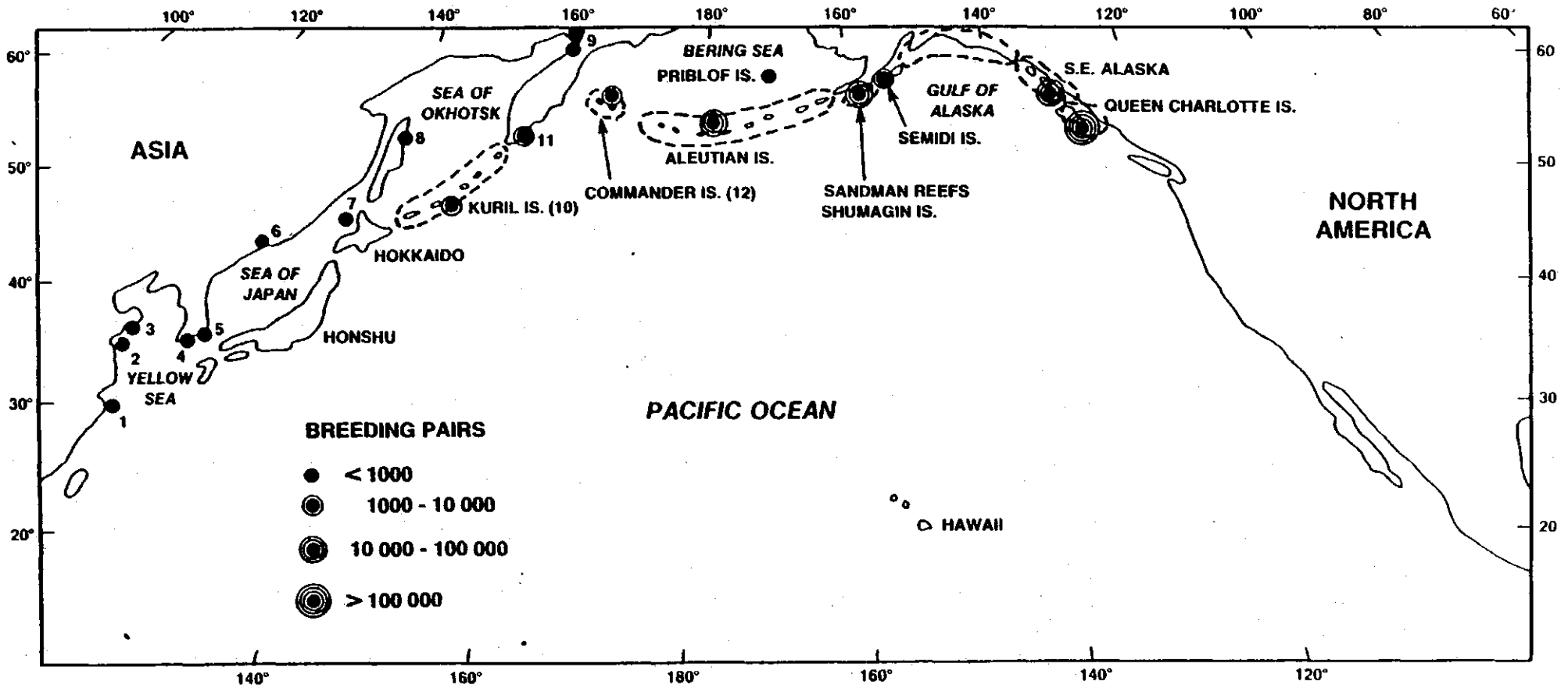

Figure 2. Ancient Murrelet colonies in the Queen Charlotte Islands (after Rodway 1991)

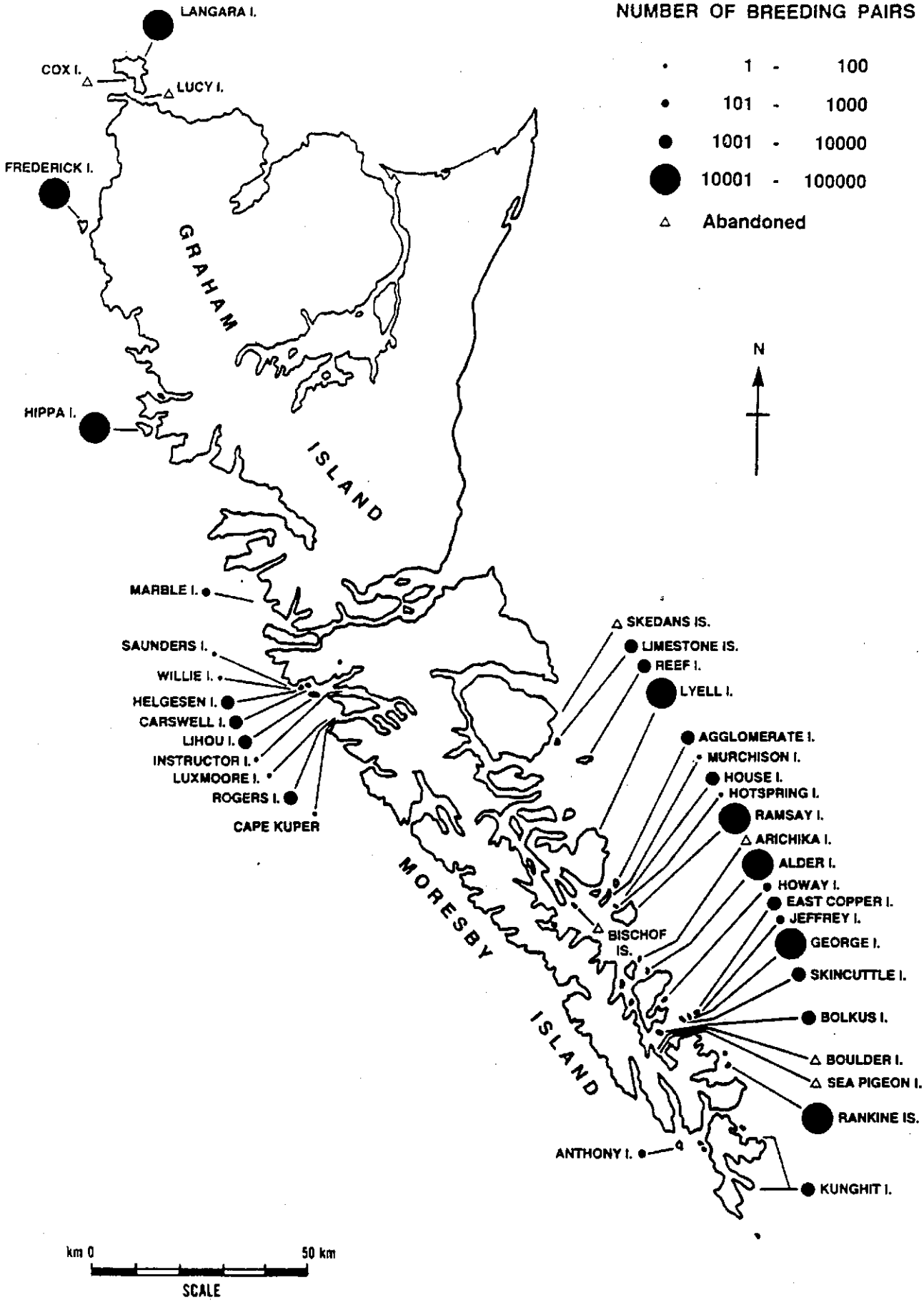

Figure 3. Changes in the distribution of breeding Ancient Murrelets at Langara Island