The Roles of Introduced Rats and Commercial Fishing in the Decline of Ancient Murrelets on Langara Island, British Columbia

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Abstract: *I examined the decline of Ancient Murrelets (*Synthliboramphus antiquus*), a small, burrow-nesting seabird, at Langara Island. The island's seabird colony was historically one of the largest colonies of Ancient Murrelets in British Columbia—perhaps in the world—with an estimated 200,000 nesting pairs. I reviewed historical information and compared the results of surveys from 1981 and 1988 that employed the same census protocol. The extent of the colony, a potential index of population size, declined from 101 ha in 1981 to 48 ha in 1988. Burrow density increased during the same period, however, suggesting that the colony had consolidated. In 1988, the population estimate was 24,200 ± 4000 (S.E.) breeding pairs compared to 22,000 ± 3700 in 1981. In 1988, 29% of the burrows that were completely searched contained bones of Ancient Murrelets. Bones were most common in burrows located in abandoned areas of the colony and were least common where burrow occupancy was high. The discovery of adult Ancient Murrelets killed in their burrows by introduced rats, combined with the high proportion of burrows with bones, suggests that rats (*Rattus rattus *and* R. norvegicus*) have contributed significantly to the decline of the population. In addition, the presence and activities of a salmon-fishing fleet in the 1950s and 1960s may also be linked to the decline of the Langara Ancient Murrelet population during that period because these fisheries are known to have caused heavy mortality through fatal light attraction and drowning in gill nets. The combined effects of ongoing predation by introduced rats and—to a lesser extent—previous, episodic fishery-induced mortality are probable causes for the population decline.*

El papel de las ratas introducidas y la pesca comercial en la declinación *de Synthliboramphus antiquus* en la Isla Langara, en la Columbia Británica

Resumen: *En el presente trabajo examiné la declinación de* Synthliboramphus antiquus, *una pequeña ave marina que anida en cuevas, en la Isla Langara. La colonia de aves marinas de la isla fue históricamente una de las más grandes de la Columbia Británica y quizás la más grande en el mundo con unos 200,000 pares de anidadores. Revisé la información histórica y comparé los resultados de las evaluaciones realizadas en 1981 y 1988 que utilizaron el mismo protocolo de censo. La extensión de la colonia, un índice potencial del tamaño poblacional, declinó de 101 ha. en 1981 a 48 ha. en 1988. Sin embargo, la densidad de cuevas se incrementó durante el mismo período, lo que sugiere que la colonia se ha consolidado. En 1988, la estimación poblacional fue de 24,200 ± 4000 (S.E.) pares de reproductores en comparación con 22,000 ± 3700 en 1981. En 1988, un 29% de las cuevas que fueron revisadas completamente contenían huesos de* Synthliboramphus antiquus. *Los huesos fueron más comunes en cuevas localizadas en áreas abandonadas de la colonia y fueron menos comunes en areas dónde el grado de ocupación era alto. El descubrimiento de adultos muertos de* Synthliboramphus antiquus *en sus cuevas por ratas introducidas, combinado con la alta proporción de cuevas con huesos sugiere que las ratas (*Rattus rattus *y* R. norvegicus*) han contribuído significativamente a la declinación de la población. Adicionalmente, la presencia de actividades de la flota pesquera del*

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Paper submitted March 21, 1994; revised manuscript accepted September 29, 1994.

salmón en las décadas de 1950 y 1960 podría también estar ligada a la declinación de la población de Synthliboramphus antiquus *de Langara durante dicho período, puesto que se sabe que estas pesquerías han causado una alta mortalidad mediante la fatal atracción luminosa y sofocaminento en redes agalleras. Los efectos combinados de la de predación actual por ratas introducidas y en menor grado por la mortalidad episódica inducida por la pesca son las causas probables de la declinación poblacional.*

Introduction

Catastrophic population declines of numerous island-breeding seabird species have occurred worldwide, and seabird conservation is becoming an increasingly important issue as development extends to archipelagoes of all oceans (Atkinson 1985; Bailey & Kaiser 1993; Lowe 1993). Moreover, human-introduced mammalian predators, particularly rats, have been implicated in many of the documented declines. Langara Island in British Columbia, Canada, represents a classic case history of the progress of seabird population decline. A study of the seabird decline on Langara may therefore provide insight into a number of important general issues that relate to seabird conservation biology.

Langara, at the northeast tip of the Queen Charlotte Islands (Haida Gwaii), was historically one of the largest seabird colonies in British Columbia (Drent & Guiguet 1961). The Ancient Murrelet (*Synthliboramphus antiquus*) was believed to be the most numerous seabird species on Langara (Green 1916; Darcus 1930), numbering about 200,000 birds (Gaston 1992), perhaps the world's largest colony (Nelson 1990); "The whole island is a warren of Ancient Murrelets . . . " (Green 1916); "The numbers can only be described as astronomical" (Beebe 1960); and "Immense numbers nesting here" (Drent & Guiguet 1961). Peregrine Falcons (*Falco peregrinus pealei*), specializing on seabird prey (Green 1916; Beebe 1960; Blood 1968; Nelson & Myers 1976), were also found on the island in breeding densities unsurpassed in British Columbia (Blood 1968). At one time, Langara supported several other species of burrow-nesting seabirds: Tufted Puffin (*Fratercula cirrhata*), Rhinoceros Auklet (*Cerorhinca monocerata*), Cassin's Auklet (*Ptychoramphus aleutica*), and Fork-tailed Storm Petrels (*Oceanodroma furcata*; Drent & Guiguet 1961), but those species have virtually disappeared from the island (Campbell et al. 1990; Royal British Columbia Museum, unpublished data).

Despite the lack of rigorous estimates of the size of past Ancient Murrelet populations on Langara, insight into the historical population size can be obtained from three sources: accounts of the colony extent, actual counts of birds, and counts of the number of pairs of Peregrine Falcons. On June 6, 1947, Guiguet observed families of Ancient Murrelets making their way to the sea at Henslung Cove. He remarked "The big hatch is on, thousands of downies, escorted by parents, go down to sea every night" (Drent & Guiguet 1961). On May 29, 1952, Guiguet observed birds on the water in Parry Passage, and his "extremely conservative estimate" was 60,000 birds in an area about 300 by 300 meters (C. J. Guiguet Provincial Museum field notes, Royal British Columbia Museum, unpublished). Beebe (1960), who studied Peregrine Falcons on Langara from 1952 to 1958, stated that ". . . the entire fringe forest seems to be one continuous colony, extending to all parts of the island that I know, from Cloak Bay around to Langara Point." Signs that colony extent had diminished were evident in 1970, when Sealy noted (cited in Nelson & Myres 1976) that the colony near Dadens, which was "riddled with burrows" in 1966 (Campbell 1969), had been abandoned. In retrospect, Sealy estimated 80,000 to 90,000 pairs of Ancient Murrelets in 1971 (Vermeer et al. 1984).

Total counts of occupied Peregrine Falcons nests on Langara indicate that numbers declined from about 21–23 pairs in the early 1950s to 5–6 pairs during 1968–1973 (Nelson & Myres 1976). Their numbers have since remained roughly constant (Nelson 1990). On Langara, the dominant prey species in the diet of nesting Peregrine Falcons is the Ancient Murrelet (Green 1916; Beebe 1960; Nelson 1977, cited in Gaston 1992). Nelson and Myers (1976) and Nelson (1990) have argued that a decline in Ancient Murrelets during the 1950s and 1960s was the immediate cause of the falcon decline on Langara. Gaston (1992) has suggested, however, that this reduction may have been at least in part related to chlorinated hydrocarbon contamination.

In 1981, the Canadian Wildlife Service (CWS) conducted a census of the Ancient Murrelet population of Langara. They estimated 22,500 breeding pairs, located primarily on the northeastern corner of the island (Rodway et al. 1983). I report the results of a 1988 survey, compare the findings with those made in 1981, and discuss several possible factors that may have contributed to the long-term decline of seabirds on Langara.

Methods

Langara Island (54° 12′N, 133°1′ W at Iphigenia Point) is approximately 3270 ha in size and 9.5 km across at its broadest point. The island's flora and the nesting habitat of Ancient Murrelets have been described by Sealy (1976) and Vermeer et al. (1984). Gaston (1992) provides a comprehensive account of Ancient Murrelet biology. A team of six researchers visited Langara from May

6 to June 7, 1988. The results of that survey are reported in full by Bertram (1989).

In areas where birds were still nesting, transects that had been conducted in 1981 were resurveyed. The transects ran along the same bearing and commenced at locations specified by Rodway et al. (1983). Survey coverage within the colony was increased by running additional transects between the ones conducted in 1981. The new transects were perpendicular to the shore and were spaced 300–500 meters apart. At 40-meter intervals along each transect, the number of Ancient Murrelet burrows in 5-by-5 meter plots was counted.

Burrows were distinguished from holes in the ground by signs of Ancient Murrelet nesting activity: egg membranes, eggshell fragments, feathers, nest cups, faecal material, or worn, flattened earth that had been trampled underfoot. The proportion of burrows that contained an active nesting pair was estimated by inspecting the entire content of all burrows in every other plot along a transect. Later in the season, we attempted to make complete inspections of all burrows in every plot. Burrows subject to complete inspection were classified as occupied (if they contained an incubating adult, egg, chicks, or eggshell membrane and shell remains from freshly hatched eggs), unoccupied, or unknown (if the ends of all tunnels could not be reached). Between plots along each transect, evidence of murrelet activity such as burrowing, broken eggs, and feather piles left by avian predators, were noted to facilitate delineation of the colony boundaries. When no active burrows or other signs of activity could be found within a plot or in the area halfway toward adjacent plots along a transect, the area was not considered part of the colony. Areas classified as part of the colony in 1981 by Rodway et al. (1983) were not surveyed in 1988 if no signs of active burrowing could be found. Abandoned areas were explored on foot, however, to determine if small pockets of breeding Ancient Murrelets still remained. If such areas were discovered, the number of active burrows was conservatively estimated by counting.

The number of breeding pairs was estimated as follows. Following Rodway et al. (1983), the area covered by the colony was calculated by multiplying the length of the burrowing area (determined by following the 30-meter contour line on a 1:50,000-scale topographical map of the island) by its width (determined by averaging the extent of burrowing obtained from transects). The number of burrows in the colony ± S.E. was estimated by multiplying the colony area by the average burrow density ± S.E. Multiplying that figure by the proportion of occupied burrows provided an estimate of the number of occupied burrows, or pairs of birds that consituted the nesting population in the area transected. Estimates of the number of birds breeding in pocket that were not transected were added to obtain the estimate of the total breeding population. To facilitate comparisons of the 1981 and 1988 surveys, the raw data from 1981 (in Rodway et al. 1983) were used to recalculate the population estimate and error term in the manner outlined above.

Broken eggs, chewed spruce cones (assumed to have been left by introduced rats), and bones or dead birds in burrows were recorded along transects. Ancient Murrelet skulls found in burrows were identified as intact or as chewed if the cranial case appeared to have been opened in a way other than by deterioration. No other mammals that might be responsible for the chewed spruce cones or skulls are known from Langara (Cowan & Guiguet 1965).

In order to investigate the presence of rats within and around the colony, 10 snap and three live traps were placed at locations close to McPherson Point that appeared to be used by rats (evidence included worn paths under logs or worn areas where chewed spruce cones, rat dung, or both were found). Most traps were placed within 30 meters (range 10–80 m) of the edge of the vegetation and the rocky shoreline. Some traps were placed in the colony, mostly about 50 meters from shore and approximately 30 meters above sea level. Other traps were placed on the colony periphery where abandoned burrows and signs of rat activity were found.

Results

We found 160 burrows in 108 plots along 16 transects on the northeast side of Langara. We searched the entire contents of 56 burrows. The proportions of active burrows in plots along individual transects ranged from 0 in areas that had been abandoned to 67% in active areas of the colony. Within the active portions of the colony, burrow occupancy averaged 38%.

The population estimates for the 1981 and 1988 surveys were similar: 22,000 ± 3700 and 24,200 ± 4000, respectively (Table 1). Burrow density was significantly higher in 1988 ($t = -2.62$, df = 51.4, $p = 0.049$). Estimates of burrow occupancy were 26% in 1981 and 38% in 1988, but they were statistically indistinguishable (Table 1).

The area of the Ancient Murrelet colony declined from 100.8 ha in 1981 to 46.3 ha in 1988 (Fig. 1). In 1988, the colony was confined primarily to the north end of the island in a 3-km zone extending west from McPherson Point. A small pocket of nesting birds was also located on Cohoe Point. No signs of active nesting were found on Iphigenia Point. The area west of Fury Bay was not inspected in 1988. A dead chick was discovered in that area, however, suggesting breeding activity in the vicinity (R. W. Nelson, personal communication).

In 1988, all regions of the colony, as well as the area previously occupied by Ancient Murrelets in 1981, showed signs of rat activity. Chewed spruce cones were

Table 1. Survey results for Ancient Murrelets on Langara Island in 1981 (Rodway et al. 1983) and 1988 (this study).

Year	*Colony Area (ha)*	*Burrow Density $(m^2)^{-1}$*			*Burrow Estimate*			*Population Estimate*[a]	
		Mean	*S.E.*	n^b	*Total Number*	*S.E.*	*Occ (%)*[c]	*Pairs*	*S.E.*
1981	100.8	0.082[d]	0.014	39	82,650	14,100	26[e]	22,000	3700
1988	46.3	0.136[d]	0.023	31	63,000	10,500	38[e]	24,200	4000

[a] *Estimate includes pairs from areas that were not transected.*
[b] *n = number of plots within the colony.*
[c] *Occ = occupancy.*
[d] $t = -2.62$; $df = 51.4$; $p = 0.049$.
[e] *No significant difference based on a chi-square test of the number of occupied and unoccupied burrows in each year.*

found on 11 of the 16 transects, suggesting that rats were present throughout the northeast coast of the islands. Survey of the area south of Dibrell Bay to Cohoe Point and the abandoned colony at Iphigenia Point occasionally turned up chewed spruce cones and abandoned burrows containing murrelet bones (one burrow had rat dung at the entrance and chewed spruce cones inside). An active rat den was also found at the former site.

Ancient Murrelet bones were found in 17% of the 160 burrows discovered. This figure is likely to be an underestimate, however, because many of those burrows (65%) were not completely searched. Among the 56 burrows that were searched completely, 29% contained bones. Skeletal remains were most frequently discovered in abandoned areas of the colony and were least common in areas where burrow occupancy was high. Sixteen skulls were found in total, but seven of these were badly deteriorated. Three of the nine recent skulls had holes in the cranium that appeared to have been inflicted by chewing.

Several dead adult Ancient Murrelets were found in the colony. On one occasion a recently killed pair was found in a burrow, within 15 cm of each other. Both birds had gaping wounds to the nape region. Neither had brood patches. Bones were also discovered in the same burrow. A fresh, dead Ancient Murrelet was found in the mouth of another burrow; it had an open wound from the nape to the pectoral girdle. Another kill, with a similar wound was located 2 meters away. One of the latter two birds had brood patches. Two more kills appeared to have been dead for longer; in one the skull had been chewed open and the upper abdomen eaten.

Eleven broken eggs were found in the 108 plots surveyed; rats were likely responsible for some of those losses. Two eggs were notable in that they were found in the open within 1 meter of a burrow entrance and were largely intact except for 3-by-2 cm holes that appeared to have resulted from chewing. Neither egg showed signs of incubation, and both still contained half of their contents.

Rat dens were found near the shore among old piles of driftwood that had become part of the vegetation edge. Rat trails were common in the forest near the shore around our camp at McPherson Point. Rats were rarely seen, but one live rat was observed in the late evening by flashlight as it moved up a forested slope toward the Ancient Murrelet colony. Two adult female Norway rats (*Rattus norvegicus*; 299 and 352 g) and three young-of-the-year were trapped (90, 115, 122 g).

Discussion

The progressive decline in colony extent for Ancient Murrelet on Langara is among the best-documented declines of a seabird population threatened by introduced predators. It is striking that the Ancient Murrelet colony, once reported to be "one continuous colony" around the perimeter of most of Langara (Beebe 1960) extended for only 3 km on the north coast in 1988. Furthermore, systematic surveys indicated that the colony extent in 1988 had been reduced to less than half that reported in 1981. Despite the significant change in colony area, the population estimates from 1981 and 1988 were similar. But small sample sizes and large S.E. estimates contribute to inaccuracy in those population estimates (see also Bertram 1989). The decline in colony extent may therefore be the most instructive gauge of population size. I evaluated three factors that could have contributed to the decline of the Ancient Murrelet population and other seabirds on Langara.

Predation by Introduced Rats

Rats (*Rattus* spp.) have reached 82% of the worlds major oceanic islands and major island groups (Atkinson 1985). Moreover, there are many accounts of *Rattus* spp. preying on seabird eggs, chicks, and adults (Fisher & Baldwin 1946; Austin 1948; Kepler 1967; Harris 1970; Imber 1975, 1978, 1984; Taylor 1979; Pye & Bonner 1980; Moller 1983; Woodby 1988). The effect of introduced rats on seabird populations varies from little long-term effect on productivity (Norman 1970; Fall et al. 1971) to significant declines in breeding populations

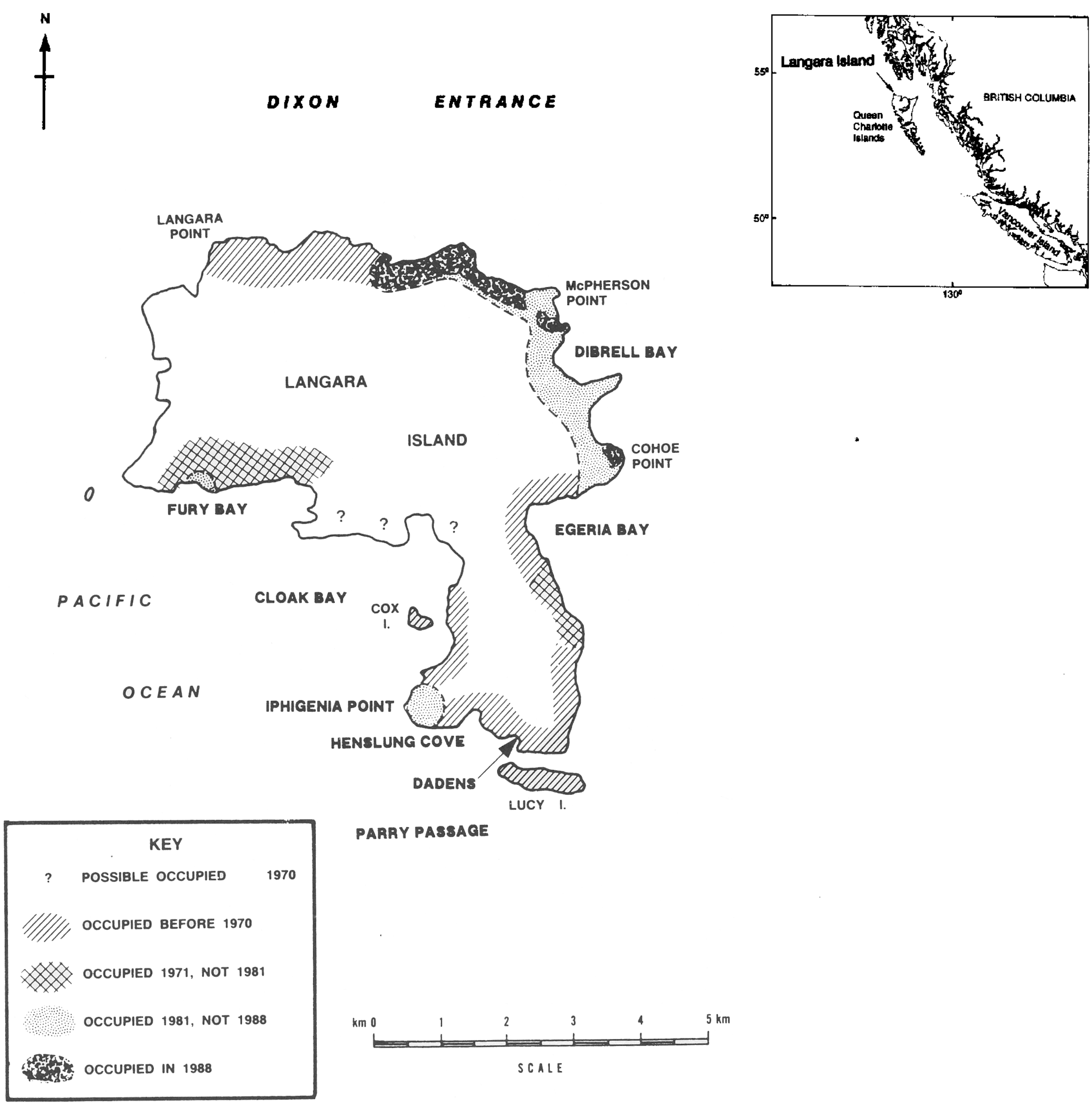

Figure 1. A reconstruction of the extent of the historical colony of Ancient Murrelets on Langara Island since the 1950s (adapted from Gaston 1992).

(Grant et al. 1981; Tomkins 1985). Factors that influence the servility of predation by introduced rats include physical features of the habitat, availability of alternate foods for the predator, and the relative size and behavior of the predator and prey species (Moors & Atkinson 1984). Imber (1975) concluded that petrels would be endangered by a species of rat whose maximum weight approaches or exceeds that of the seabird.

The evidence from this study (particularly dead adults found underground with rat-inflicted wounds), coupled with other historical information, indicates that mortality caused by introduced rats is likely to be the primary cause of the decline of Ancient Murrelets on Langara. It is noteworthy that other studies (Austin 1948; Twigg 1975; Moller 1983) have reported that rats commonly kill seabirds by attacking the neck region. Descriptions of adult Ancient Murrelets, found dead in burrows with similar wounds, have also been reported by previous visitors to Langara (Sealy 1976; Vermeer et al. 1984; Royal British Columbia Museum 1977, unpublished data). Furthermore, the adult rats trapped on Langara in 1988 were roughly 1.5 times heavier than adult Ancient Murrelets. This size difference between predator and prey suggests that rats on Langara can easily kill adult Ancient Murrelets.

The high proportion of burrows containing bones, particularly in the abandoned part of the colony, supports the inference that rats are causing a decline of Ancient Murrelets on Langara. Despite surveys of 31 Ancient Murrelet colonies throughout the Queen Charlotte Islands (Gaston 1992), reports of bones in burrows are unknown (G. W. Kaiser, personal communication) except from one other colony, Lyell Island, where rats (*R. rattus*) have also been observed (Rodway et al. 1988; A. J. Gaston, personal communication). A 1992 survey of Lyell Island indicated that the number of breeding pairs of Ancient Murrelets and their colony extent have both declined since 1982 (Lemon 1993). Bones were found in 15% of the burrows that were completely searched. Moreover, 20 to 40 occupied burrows showed signs of rat predation—five dead adults and 15 broken eggs. The dead adults had been chewed about the neck, shoulder, and breast.

Black rats (*R. rattus*) were first collected on Langara in 1946 (Royal British Columbia Museum specimens, Bertram & Nagorsen, unpublished manuscript). They were later implicated as predators on Ancient Murrelet eggs (Campbell 1968; Sealy 1976; Rodway et al. 1983), adults (Beebe 1960; Sealy 1976; Royal British Columbia Museum 1977, unpublished data; Rodway et al. 1983; Vermeer et al. 1984), and chicks (Sealy 1976) but were never considered a threat to the population. It is striking that two of the areas where rats were previously reported to prey on murrelets were later abandoned (Egeria Bay in 1981; Iphigenia Point in 1988). During a visit to Langara in June 1993, no evidence of black rats (droppings or tree nests) was found, but Norway rats were again captured at McPherson Point and also on nearby Lucy Island (Fig. 1; C. W. S., unpublished data). Norway rats, first reported in the Queen Charlotte Islands in 1981, may have replaced black rats on Langara (Bertram & Nagorsen, unpublished manuscript). If true, rat predation intensity on Ancient Murrelets may have increased because *R. norvegicus* is larger than *R. rattus*, and it is therefore likely to represent a greater threat to seabirds.

Commercial Fishing Operations

Commercial fishing operations in the colony vicinity during the 1950s and 1960s were a possible contributor to the decline of the Ancient Murrelet population on Langara. Mortality resulted from light attraction and drowning in gill nets. Like many other nocturnal seabird species, Ancient Murrelets are attracted to light at night and often die when they collide with anchored or moving vessels. These potentially large sources of mortality have received little attention with respect to Langara seabirds. Vermeer et al. (1984) wrote, ". . . local fishermen reported to Sealy in 1970 and 1971 that an unquantified number of Ancient Murrelets and Rhinoceros Auklets drowned in gill nets on the east side of Langara Island." The report of Ancient Murrelet deaths is supported by a detailed letter to the commissioner of a Peregrine Falcon Inquiry in British Columbia (Shelford 1988) from Charles Bellis (Masset, B. C., V0T 1M0), who fished commercially for salmon around Langara Island during the 1950s and 1960s:

> . . . in Cloak Bay in the 50s and 60s we used to shovel over fifty Murrelets overboard in the mornings after they had struck guywires of our fishing boat. We were not the only boat anchored in the bay, and if one multiplies the number of boats anchored per night over a breeding season, say ten per night for twenty nights, killing fifty birds per night we would lose ten thousand birds per season. I believe this is a conservative estimate, and points to the seriousness of the problem.

and

> . . . numbers of Murrelets . . . were caught in gillnets during the fishing season off Langara Island. . . . I, myself, have not had more than fifty birds at a time, however, one of my companions told me he had "a bird in every mesh" one morning at Langara. This would have been over five hundred murrelets. . . . during the seabird breeding season . . . no night fishery [should be] allowed.

Fishing activity around Langara increased significantly during the 1950s and remained intense until the mid 1960s (Fig. 2). At the peak in 1963 there were 452 trolling and gill-netting vessels around Langara. This large fishing fleet had the potential to cause mass mortality of seabirds and may have contributed significantly to the decline of Ancient Murrelets on Langara prior to the 1970s.

Reduced Zooplankton Production

Nelson and Myres (1976) hypothesized that the decline of Ancient Murrelets on Langara may have resulted from reductions in the zooplankton upon which the birds feed. They reasoned that "Either biocides have affected plankton (probably via the Davidson Current flowing north from California), or an anomalous intrusion of warm water near the British Columbia coast for most of 1957–71 has reduced the supply of plankton" (Nelson & Myres 1976; see also Nelson 1976). Gaston (1992) argued that it is unlikely that pesticides or oceanographic changes caused a consistent decline in zooplankton production in the region. Gaston's (1992) view is further supported by zooplankton samples collected from the weathership at Ocean Station P (50°N, 145°W) during

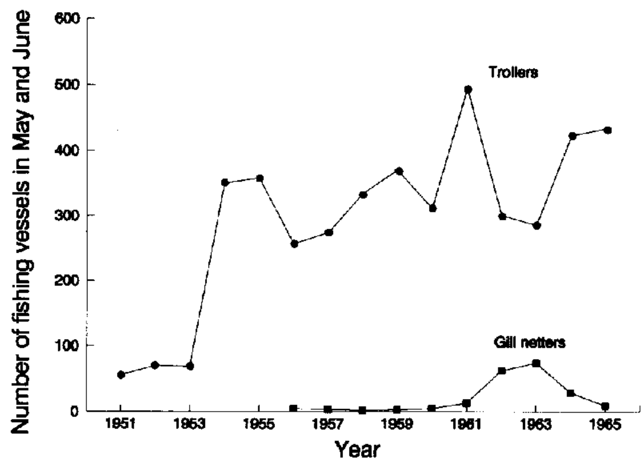

Figure 2. The mean number of fishing vessels in May and June reported for the Langara Island region (Area 1 of the British Columbia fisheries regions) from 1951 to 1965. Data were compiled from annual area history reports by the Department of Fisheries and Oceans Canada (unpublished).

1956–1980, the longest continuous data series of plankton density for the North Pacific (Fulton 1983). Peterman (1987) used this data to develop an index of the total annual zooplankton biomass for the Gulf of Alaska. Peterman's indexes show no consistent decline in plankton production between 1957 and 1971, or at any time since ($F = 0.036$, df = 1,9; $p = 0.854$; Fig. 3). Moreover, a recent reanalysis of the zooplankton biomass data from Ocean Station P (using collections taken from June 15 to July 31 only) shows a significant long-term increase from 1957 to 1980 (Brodeur and Ware 1992).

My study implicates introduced rats as the primary contributor to the decline of Ancient Murrelets on Langara. In the 1980s the colony area contracted significantly, leaving the remaining birds consolidated in an area of high density. A 1993 survey of the Langara Ancient Murrelet population indicated that colony area has decreased by 50% and the breeding population has declined by 40% since 1988 (Harfenist 1994). The Canadian Wildlife Service is presently planning a campaign to eradicate rats and restore the seabird populations on Langara island. The outcome of such a campaign will be of considerable interest to Conservation Biologists because Langara will be the largest island for which rat eradication had been attempted (G. W. Kaiser, personal communication).

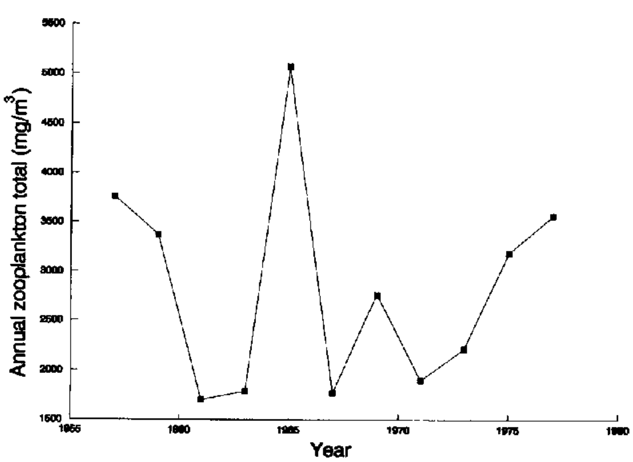

Figure 3. Historical annual zooplankton biomass (12-month sum beginning August 1) at Ocean Station P in the North Pacific Ocean (data from Peterman 1987).

Historical commercial fishing operations likely caused significant mortality of Langara Ancient Murrelets prior to the 1970s, but their contribution to the long-term population decline are unknown. Future management plans should evaluate the impact of the timing and location of commercial and sport fishing activities in the vicinity of the island. Managers should also identify anchorage sites used by all vessels in the Langara region to evaluate the potential for fatal light attraction and ways to mitigate its effects on present and future populations of seabirds.

Acknowledgments

This project was part of the Canadian Wildlife Service Migratory Bird Conservation program. I thank K. Henderson, G. W. Kaiser, M. McKay, and especially H. Hay and N. Holmes for assistance in the field. A. Harfenist led the Canadian Wildlife Service survey to Langara in 1993 and kindly discussed the results. The Canadian Coast Guard provided helicopter transportation to and from Langara. The light keepers at Langara, K. Brunn and L. Faurette, provided support and warm hospitality. I thank the Old Massett Village Council for permission to work in Duu Guusd Tribal Park, which includes Kiis Gwaii (Langara, Lucy, and Cox islands). K. Moore provided valuable logistical support on short notice. I am indebted to M. Lemon and M. Rodway for providing training in seabird survey techniques. B. Spilsted, of the Department of Fisheries and Oceans, Canada, provided information on the historical salmon fishery around Langara. S. Sealy and R. W. Nelson shared their personal observations on Langara. I thank A. J. Gaston, G. W. Kaiser, C. J. Ralph, and an anonymous reviewer for constructive comments on the manuscript.

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