Inventory of the Queen Charlotte Islands Ermine

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ABSTRACT

A subspecies of ermine (*Mustela erminea haidarum*) is one of the few endemic terrestrial mammals on the Queen Charlotte Islands (QCI). This subspecies is on the British Columbia Red List, and is classified as Vulnerable by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Its status reflects its rareness on QCI historically, the paucity of mammalian prey species available, and lack of knowledge of its habitat use and population limitations. Competition from an increasing endemic marten (*Martes americana*) population may be threatening ermine population viability. From 1992 to 1998 we used a variety of inventory techniques, over a range of habitats, to determine QCI ermine distribution and habitat use as follows: live-trapping with Sherman traps (1992 summer; 1993 fall; 1995 spring; 1997 spring); interviews with QCI trappers and residents (1997 and 1998); snow-tracking and track stations (1997 and 1998). Between 275 and 325 interviews produced 162 new records (mainly sightings) to add to 32 previous records. Live-trapping was less successful (1992: 0 in 50 trap nights; 1993: 2 in 2,301 trap nights; 1995: 0 in approx 3,000 trap nights; 1997: 0 in 1,414 trap nights). Snow-tracking (22 km on foot; 900 km by road) and track stations (2,692 nights) produced no definite ermine sign. The great majority of new records were from the Coastal Western Hemlock submontane wet hypermaritime biogeoclimatic variant (CWHwh1), with ermine most often found within 100 m of a water body, including the ocean. Ermine were live-trapped in second-growth forest. Results demonstrate a widespread distribution on the archipelago (including some smaller islands), and a continuing rarity. They suggest no particular reliance on old-growth forest, but heavier use of riparian and marine foreshore habitats.

Key words: ermine, interspecific competition, introduced species, inventory, marten, *Martes americana*, *Mustela erminea*, Queen Charlotte Islands, short-tailed weasel, stoat.

The Queen Charlottes Island ermine or short-tailed weasel (*Mustela erminea haidarum*) is limited in distribution to the Queen Charlotte Island (QCI) archipelago off the central British Columbia coast. This subspecies exhibits less sexual dimorphism than other subspecies, and unique cranial morphology (Foster 1965). It appears to have persisted, separate from mainland ermine populations, in a coastal refugium isolated by ice during at least the most recent Pleistocene glaciations, and subsequently to have been isolated by the sea (Foster 1965, Cowan 1989).

Prior to European settlement, only 8 species of non-marine mammals persisted on QCI, and this fauna was dominated by carnivores including the ermine, a subspecies of pine marten (*Martes americana nesophila*), and a subspecies of black bear (*Ursus americanus carlottae*; Foster 1965, Nagorsen 1990). The dominance of carnivores likely resulted in intense competition for the few endemic mammalian prey: dusky shrew (*Sorex monitcolus elassodon*); deer mouse (*Peromyscus maniculatus keenii*); and Sitka mouse (*Peromyscus maniculatus prevostensis*; Nagorsen 1990). This may explain the relative rarity of the carnivores and their tendency to forage in the intertidal (Foster 1965). Since the early 1900s, the introduction of black-tailed deer (*Odocoileus hemionus columbianus*), red squirrel (*Tamiasciurus hudsonicus lanuginosus*), raccoon (*Procyon lotor vancouverensis*), muskrat (*Ondatra zibethicus* *osoyoosensis*), roof rat (*Rattus rattus*), domestic cat (*Felis domesticus*), and beaver (*Castor canadensis leucodontus*; Nagorsen 1990) has altered the patterns of energy flow through the food web in ways that are not altogether clear (Cowan 1989). The non-marine mammalian fauna on QCI remains depauperate (11 species) compared to the mainland coast at the same latitude (31species), and is still dominated by carnivores (Cowan 1989). It is conceivable that some carnivores, such as the marten and raccoon, have benefited from the more diverse, introduced prey base. However, the smaller ermine, often not adapted to feed on these introduced species, may face more intense competition from proliferating populations of competitors.

The QCI ermine is a Red-listed ("endangered/threatened") species in British Columbia. It is classified as Vulnerable nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). These rankings reflect its apparent rarity, the lack of knowledge of its habitat use and population limitations, and its likely vulnerability. This vulnerability may have increased because of major changes in the pattern of habitat distribution on QCI following European settlement activities such as timber harvesting, trapping, and agriculture, and because of changes in the species composition and energy flow through the food web following mammalian introductions.

Given this general knowledge, we initiated an inventory in 1992 with the goal of better assessing the current status of the QCI ermine. Our specific objectives have been to: 1) more accurately determine its present distribution on QCI; 2) obtain some estimate of abundance and historical trend in abundance; and 3) determine its habitat associations. The inventory work has been coordinated by A. Derocher, D. Reid, and L. Waterhouse over the years. Much of the field work has been accomplished by P. Buck, R. Bettner, and C. French, working as contracted biologists, and other staff as acknowledged below. This paper summarizes the inventory work to date, and suggests some routes for further investigation.

STUDY AREA

The Queen Charlotte Island archipelago is separated from the mainland coast by a minimum of 80 km (Cowan 1989), and has 2 main islands, Graham and Moresby, separated by narrows. Biological and geological evidence indicates that unglaciated refugia, largely tundra, persisted on the present land mass of QCI and on exposed portions of the continental shelf through the late Wisconsin glaciations (Heusser 1989). Whether these refugia were sufficient in extent and biotic composition to enable the persistence of ermine populations, isolated from mainland populations throughout the Pleistocene, remains unclear. However, isolation would have been absolute since the retreat of the latest Wisconsin glaciation, and subsequent inundation of the continental shelf in Hecate Strait (Foster 1965, Heusser 1989).

Today, the QCI archipelago has a maritime climate. Winter snowfalls are relatively uncommon, and the snow rarely persists below 300 m elevation for more than a few days. Terrestrial habitats are primarily forested. The Coastal Western Hemlock (CWH) zone ranges from sea level to 600–700 m. The Mountain Hemlock (MH) zone extends above the CWH up to 800 m (lower on windward slopes and higher on leeward slopes), and Alpine Tundra (AT) covers higher elevations than the MH (Meidinger and Pojar 1991). These zones are subdivided into CWHwh1 (submontane wet hypermaritime), CWHwh2 (montane wet hypermaritime), CWHvh2 (central very wet hypermaritime), MHwh1 (windward wet hypermaritime), and MHwh2 (leeward wet hypermaritime; Green and Klinka 1994). Extensive land clearing for agriculture and timber harvesting has dramatically increased the proportion of younger seral stage vegetation communities on the islands, especially in the past 50 years. In addition, there are numerous beach, bog, marsh, and fen habitats on the archipelago.

METHODS

Information on distribution, abundance, and habitat use was gathered, often at the same time, using the following techniques: review of previous records; interviews regarding new records; live trapping; track station surveys; snow tracking.

Previous Records

We compiled records existing previous to this study. These included records in the Conservation Data Centre of the British Columbia Ministry of Environment, Lands and Parks and records in the Royal British Columbia Museum. The latter included this museum's specimens, and records of specimens held in the American Museum of Natural History, the Cowan Vertebrate Museum at the University of British Columbia, the Smithsonian Institution, and the Museum of Vertebrate Zoology at the University of California, Berkeley and Los Angeles.

Interviews

We conducted detailed interviews with holders of registered commercial traplines on QCI, and interviews with other QCI residents and visitors known to have seen, or have been likely to see, ermine or ermine sign. Key interviewees were identified by long-time trappers and QCI residents George and Terry Husband. Many of the interviews were solicited through newspaper articles and advertisements in July and August 1997 respectively, and an information booth and display at the Tlell Fall Fair in August 1997.

All interviews were conducted using a formal Occurrence Report Interview form, recording the following information: 1) observer name and contact; 2) date of observation; 3) location with UTM (universal transverse mercator) coordinates where possible; 4) elevation; 5) type of observation (visual, trapped live, trapped dead, snow track, other track, other sign); 6) broad habitat type (coniferous forest, deciduous forest, mixed forest, shrub, fen, bog, pasture, road, clearcut, beach); 7) forest harvest history (clearcut <10 yr, clearcut >10 yr, selective cut <10 yr, uncut or selectively cut >10 yr, unknown); 8) nearest water type (marine, estuary, lake, river >3 m wide, creek <3 m wide, marsh, unknown); 9) distance to nearest open water; 10) observation details confirming an ermine (size, pelage, tracks, etc.). We asked observers to describe the animal in detail, and we were looking for a description including at least 1 of the following characteristics: elongate body with long tail, short legs, and small head; rusty brown above with white belly in summer, and white in winter; black tip on the tail; bounding, smooth, and slinking gait. We asked trappers a number of more detailed questions regarding their history of trapping, their choice of bait, and their impression of the status of ermine.

Live Trapping

We attempted to capture ermine alive in July 1992, September 1993, March and April 1995, and February and March 1997. We used double-door Tomahawk cage traps (#206; Tomahawk Live Trap Co., Tomahawk, WI) in 1992, and folding aluminum Sherman traps (model XLF15; H.B. Sherman Inc., Tallahassee, FL) with dimensions 10 X 12 X 38 cm, in subsequent years. The following baits and lures were used: 1992, raw deer and bacon; 1993, raw bacon and Hawbaker weasel lure (S. Hawbaker and Sons, Fort Loudon, PA); 1995, raw bacon, and beaver meat and castors; 1997, sardines and fish fertilizer.

In 1992, traps were set primarily in riparian habitats, spaced every 500–1,000 m, and checked once a day for periods of 4 days. In subsequent years, traps were set in lines 500–2,000 m long, at sites chosen on the basis of past sightings, and with a view to sampling a range of habitat types. In these years, traps were approximately 50 m apart, and were placed at the base of trees, and under logs and tree roots. They were checked twice daily for a period of 4 days. Because of high capture rates of non-target species, principally the 2 species of *Peromyscus* (hereafter called deer mice), the 1997 effort included placement of either 2 or 4 traps at each station. Habitats were defined as follows: mature forest (>80 yr); second growth (10–80 yr); clearcut (<10 yr); marine shorefront (any within 100 m of high tide); riparian (any within 50 m of freshwater); bog (treed with moss and standing water); marsh/fen (standing water with emergent vegetation, often graminoids, but no canopy).

In 1992, traplines were located on Moresby Island near Alliford Bay and on Graham Island at Survey Creek. In 1993, traplines were located in numerous locations on Graham Island including Yakoun Lake, Rennell Sound, Honna River, Delkatla marsh, Tow Hill Ecological Reserve, White Creek, Pure Lake, Mamin River, lower Yakoun River, Tlell River; and at numerous sites on Moresby including Sachs Creek, Alliford Bay, Gray Bay, Copper Creek, Skidegate Lake, and South Main road at miles 1 and 4. In 1995, traplines on Graham Island were located at Kumdis Creek, Yakoun River, Gold Creek, Woodpile Creek, Lawnhill, and Honna River; and on Moresby Island at Sachs Creek, Moresby Camp, and Mosquito Lake. In 1997, traplines on Graham Island were set at Tarundl Creek and Kagan Bay, and on Moresby Island at Sachs Creek and South Bay Main road.

Track Stations

We attempted to document ermine distribution and habitat use by attracting ermine to baited and scented track stations from October 1997 through February 1998. Each station consisted of a Sherman aluminum live trap, previously boiled in a solution of boughs of local trees, and placed, generally under substantial cover of logs, tree roots, or boughs, as a cubby with 1 door locked open. The tracking plate was an aluminum sheet cut to fit on the floor of the trap cubby, with chevron cuts to hold white tracking paper close to the mouth of the cubby, and carbon soot placed on the plate in the interior of the cubby, following procedures outlined by Zielinski (1995). Each cubby was baited with a spreadable mixture of fish oil, butter, and Hawbaker weasel lure (S. S. Hawbaker and Sons, Fort Loudon, PA), and also, in 1998, commercial ermine anal scent gland semiochemical (1:1 mixture of 2-proplythietane and 3-propyl-1,2-dithiolane; Phero Tech Inc., Delta, BC). In addition we sprayed a solution of fish oils and weasel lure in alcohol on local vegetation in attempts to disperse the odours more widely.

Track stations, about 50 m apart, were set in lines traversing a variety of habitats, with special emphasis on riparian and marine foreshore habitats in areas where ermine had previously been reported. To change the sooted carbon plate and tracking paper, stations were initially visited every day and were kept in place for only 4 days. In November 1997 this period was increased to 7 days, with visits every second day.

Snow Tracking

We attempted to document ermine distribution and habitat use in winter 1998–99 by travelling on foot or by vehicle through forested habitats or along roads approximately 2 days after a snowfall.

RESULTS

Distribution

Thirty records of QCI ermine previous to this study indicated an extensive distribution on Graham Island, and a less extensive distribution on Moresby Island, but no confirmed evidence from other smaller islands (Appendix A). Only 1 record, from Skidegate Channel, indicated a distribution including portions of the west coast of the archipelago. Ninety percent of previous records were of ermine trapped dead by registered trappers, or other collectors.

We collected 162 new records of QCI ermine from interviews (Fig. 1, Appendix B). Each record represents an individual ermine, or evidence of 1 ermine. Of these, 121 (75%) were visual observations. Nearly all observers were able to identify at least 1 of the key characteristics of an ermine, and 69 of the visual observations (57%) were of ermine with the distinctive white pelage of winter. Twenty-five records (15%) were of ermine trapped dead by registered trappers, and not previously reported to the Conservation Data Centre. Seven (4%) were of snow tracks, with 5 reported by experienced QCI trappers. Six reports (4%) were based on other sign: 3 of dead chickens killed by ermine based on skin punctures; 2 of secondhand reports of cabin pets; 1 of an ermine den identified by odour. Three (2%) were of ermine killed by domestic cats. We consider these records complete to the end of 1997.

New records indicated a distribution encompassing 2 additional islands of substantial size in the archipelago: Louise (records from 1983, 1986, and 1993); Burnaby (record from 1985; Fig. 1, Appendix B). One record was of an ermine on a floating log boom (Sep 1980, Skaat Harbour, Moresby Island; Appendix B). Occupation of relatively isolated habitats on the west coast was confirmed for Tian Head, Rennell Sound, and Government Creek.

New records were predominantly from portions of the archipelago with the highest human populations (near the settlements of Masset, Port Clements, Tlell, Skidegate, Queen Charlotte City, Alliford Bay, and Moresby Camp), or from along the roadways linking these settlements. However, distribution was not even along these roadways. Records were clumped in the following locations on Graham Island: Delkatla and Canadian Forces Base Masset; middle Masset Sound near mouth of Watun River; Kumdis Creek; tributaries to southern Mayer Lake; Mayer River; lower Yakoun River; confluence of Gold Creek and Yakoun River; lower Phantom Creek and Yakoun River; Lawn Creek and Lawnhill coast; Tarundl Creek and lower Honna River. On Moresby Island these include: lower Sachs Creek and Alliford Bay; the stream draining into Skidegate Inlet along the South Main road; Mosquito Lake and Creek; Copper Creek and Copper Bay. These records indicate an association with water bodies, both freshwater and marine.

Intensive live trapping produced few results (Table 1). We caught only 2 ermine. Both were caught in mid-September 1993 on Moresby Island, 1 on lower Sachs Creek, and the other near mile 1 on the South Main road. Both of these were sites identified by interviews as likely locations for ermine. We caught numerous deer mice in the Sherman live traps (Table 1).

Track stations, run for a total of 2,692 station nights, produced no confirmed evidence of ermine. Track station lines were run in the following areas: lower Tarundl Creek and Honna River (Oct: 196 station nights); Sleeping Beauty (Nov: 171 station nights); Sandspit to Grey Bay (Nov: 215 station nights); Rennell Sound (Nov: 277 station nights); Delkatla to Rose Spit (Nov: 347 station nights); Tlell River to Mayer Lake (Jan: 370 station nights); Lawnhill (Feb: 140 station nights); Yakoun River (Feb: 472 station nights); Deena River (Feb: 240 station nights); Government Creek (Feb: 264 station nights).

Searches for snow tracks covered approximately 22 km on foot and 900 km by vehicle on roads, but produced no evidence of ermine.

Abundance

Our interviews revealed records of ermine from 1920 to 1997. Where age could be attributed accurately to decade (n = 161), there was a moderate frequency in the first 3 decades (1920s: 15; 1930s: 9; 1940s: 11), few in the 1950s (1) and 1960s (6), and an increasing frequency in recent decades (1970s: 24; 1980s: 37; 1990s: 58). Over the past decade there were 1–13 records per year. The decline in frequency of observations in the 1950s and 1960s is intriguing. The proportion of records of ermine trapped dead prior to 1950 (n = 12, 34%) was substantially higher than the proportion since 1950 (n = 13, 10%). Conversely, the proportion of visual observations increased from 51% (n = 18) before 1950 to 81% (n = 102) after 1950.

On 5 occasions, 2 ermine were seen together. In 1 case, both were believed to be juveniles, judging by their small size.

Habitat Associations

New Records

To investigate the ermine's habitat associations based on data from interviews, we removed records in the following circumstances: the ermine had been trapped without clear recollection by the trapper of habitat (n = 7); a second ermine was seen at the same time, so only 1 of the 2 records was used (n = 5); a cat killed the ermine (n = 3); the ermine was in a building including a chicken house (n = 17; Appendix B). This left 130 new records for the analyses.

Nearly all records (n = 121, 93%) were from the CWHwh1, the biogeoclimatic variant covering most of the eastern side of the archipelago below approximately 350 m. There were 6 records from the CWHvh2, the very wet variant at lower elevations on the west side of the Windward Mountains; 2 records from the CWHwh2, the variant above 350 m elevation on the east side of the Windward Islands; and 1 record from the MHwh2, near tree line. There were no records from the MHwh1 or from the Alpine Tundra.

The great majority of the 130 records (87%) were associated with forested habitats, including coniferous (69%), mixed (9%), deciduous (1%), shrub (1%), and bog (7%) types.

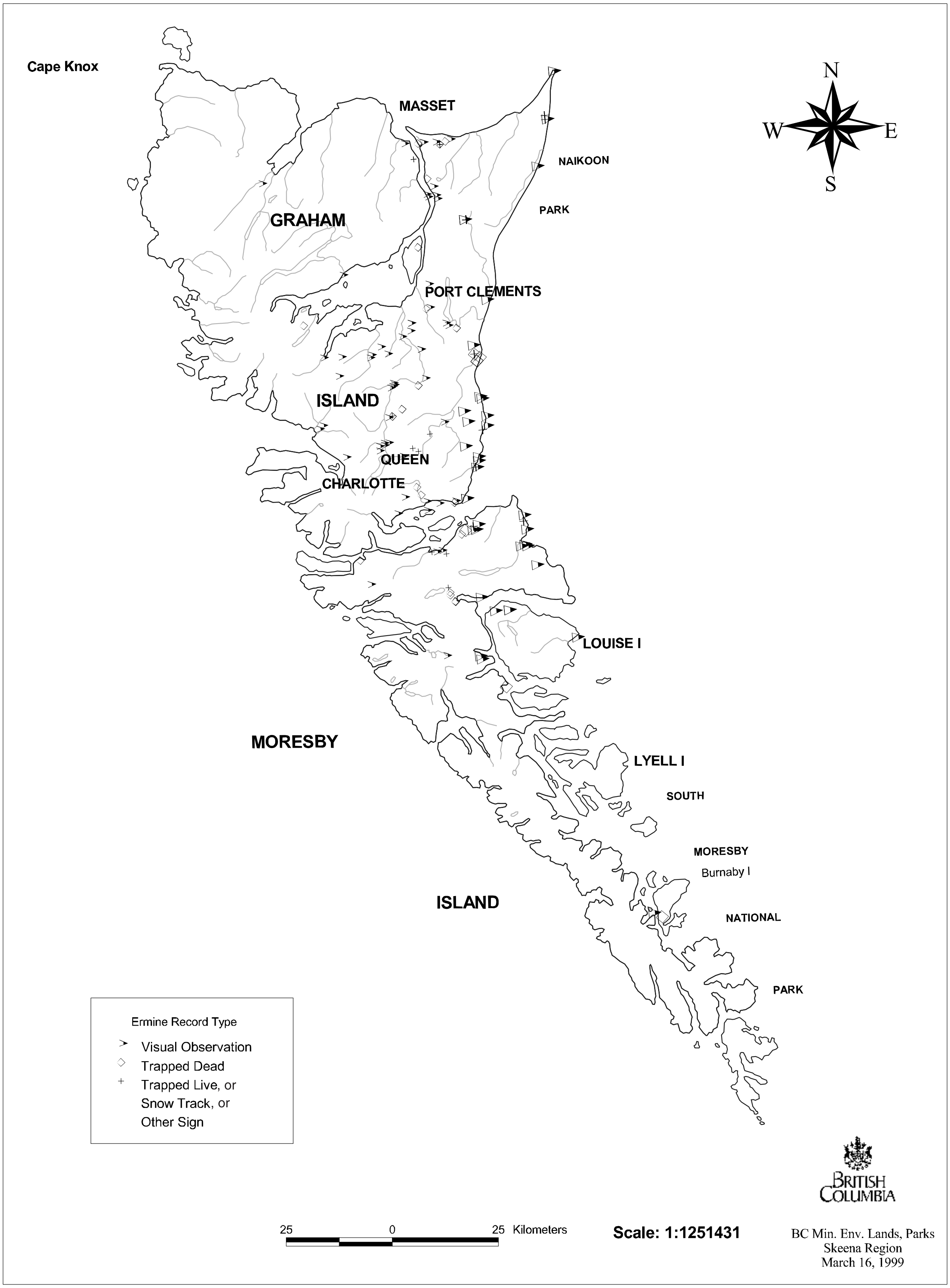

Figure 1. Locations of new records of Queen Charlotte Islands ermine by record type.

Table 1. Live-trapping dates, habitats, effort, and capture rates for Queen Charlotte Islands ermine and deer mice.

Date	Habitat type[a]	Trap-station nights[b]	Trap nights	Ermine captures	Deer mice/100 trap nights
1992 (8–28 Jul)	Riparian	100	100	0	not applicable
1993 (9–22 Sep)	Mature forest	220	220	0	13
	Second growth	445	445	1	9
	Clearcut	287	287	0	18
	Marine shorefront	456	456	0	23
	Riparian	552	552	1	9
	Bog	102	102	0	4
	Marsh/Fen	239	239	0	23
1995 (Mar)	Various	1,050	1,050	0	not available
1997 (24 Feb–6 Mar)	Riparian	490	1,414	0	25

[a] As defined in the text.
[b] Trap-station nights = total no. of stations X no. of nights.
[c] Trap nights = total no. of traps, including multiple traps per station, X no. of nights.

Five percent were associated with beaches, and pasture and fen habitats included 4% each.

Of the 113 observations associated with forested habitats, 54 (48%) were in uncut forest, 42 (37%) in clearcuts >10 years old, and 16 (14%) in clearcuts <10 years old.

One hundred and seventeen of the records included data on distance from nearest water body. Water body types nearest to an observed ermine included all the principal types on the archipelago, with ocean, creeks, and rivers dominating (Fig. 2). Ninety of 117 records (77%) were within 100 m of water (Fig. 2). There was a tendency for ermine to be closer to water when the water was the ocean, an estuary, a river, or a creek, than when it was a lake or marsh (Fig. 2).

Reasonably accurate estimates of elevation were available for 73 of the 130 observations. A substantial majority (n = 47, 64%) were within 10 m of sea level (high tide). These naturally included all sightings in beach habitats, as well as all sightings in pasture. They also included 33 of 56 (60%) records from forested habitats. A smaller proportion (n = 17, 23%) of records were from 11–50 m elevation, and fewer still (n = 9, 12%) were above 50 m elevation. The highest elevation recorded was 800 m on Slatechuck Mountain, still in forested habitat.

On 13 occasions the observer provided some information on ermine foods. There were 3 records of ermine killing domestic chickens and 3 additional cases where ermine were hunting chickens. Ermine were observed chasing rats or deer mice, and having killed swallows (*Hirundo* sp.) on 1 occasion each. Two ermine were observed together eating a muskrat. Scavenging included stealing a lunch bag from a vehicle, food from a cook house, and bait from a trap set.

Live Captures

Two ermine were captured alive, 1 in riparian forest and 1 in upland second-growth forest (Table 1). The capture site in riparian forest (lower Sachs Creek) was 700 m from the ocean and 47 m from the creek. This was a second-growth forest dominated by Sitka spruce, (10–109 cm DBH [diameter at breast height]) with substantial hemlock (31–52 cm DBH) and alder (15–41 cm DBH) in the canopy. Canopy closure was 75–80%, and there was little understory or forest floor vegetation, but substantial coarse woody debris (25% cover of pieces >5 cm diameter). Black bears were actively feeding on spawning chum salmon (*Oncorhynchus keta*) in the vicinity.

The capture site in upland second-growth forest (near mile 1 on the South Main road) was about 25 m from a swampy depression. The 30- to 40-year-old forest was dominated by Sitka spruce (17–51 cm DBH), with substantial composition of hemlock (13–36 cm DBH), redcedar (14–48 cm DBH), and alder (15 cm DBH). Canopy closure was 70–80%, and there was a moderate cover of various shrubs and ferns. Black bear sign was evident.

Deer mice were frequently caught in Sherman traps (Table 1). In 1993, deer mice were apparently more abundant in marine foreshore and marsh/fen habitats, perhaps reflecting good food sources from graminoids in these sites. The 1997 data are not directly comparable because the number of traps at each station was increased.

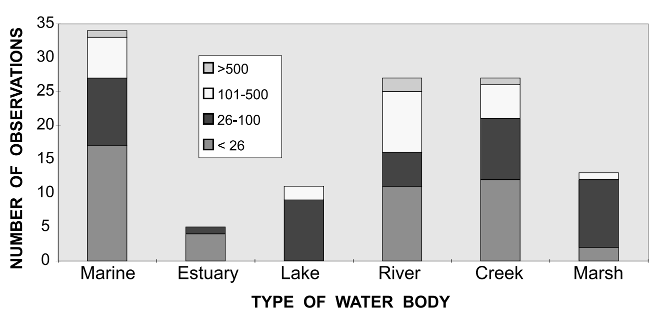

Figure 2. Frequencies of distances (m) of ermine observations from water for each of 6 water types.

DISCUSSION

Distribution

This study confirms the continued existence in the 1990s of ermine populations on both Graham and Moresby islands, and possibly on Louise Island. Ermine have colonized at least 1 other middle-sized island, Burnaby. However, they probably have little ability to cross open water except on floating logs or debris, and sufficient numbers to establish a breeding population would rarely colonize islands concurrently. Consequently, their distribution on other islands is possible but not highly probable.

The records suggest a distribution primarily in the lower elevation CWHwh1, close to the ocean or along valley bottoms. This pattern is explained in part by the distribution of humans in time and space: most settlements are at low elevation in the CWHwh1, and most major roads follow ocean front or valley bottoms. The relative scarcity of observations at low elevations on the west side of the archipelago (CWHvh1) probably results from relatively low human visitation. However, there is also evidence that this observed distribution is a fairly accurate reflection of ermine distribution: even along major roads, sightings tend to be clumped at certain water courses or river mouths, and there were very few records from upland sites in the CWHwh1 and CWHwh2 despite an extensive network of logging roads.

Population Limitation

The QCI ermine remains a very rare animal as previously indicated by Foster (1965) and Cowan (1989). The very low frequency of records in the past decade confirms this, and is noteworthy because the ermine is not a particularly secretive or inconspicuous animal (Fagerstone 1987). Evidently there are strong and persistent limitations to its potential population growth on QCI.

The ermine has a wide distribution in boreal, montane, and coastal forested habitats, and tundra environments of North America and Eurasia (Fagerstone 1987). Two principal factors act proximally to limit population growth in continental systems: access to arvicoline rodent prey, and ability to avoid predation by raptors and larger mammalian carnivores. The ermine is considered a specialist predator on arvicoline rodents, in particular those of the genera *Microtus*, *Lemmus*, *Dicrostonyx*, and *Clethrionomys*. This is based on its morphological adaptations and on the significantly enhanced survival, reproduction, and population density of ermine when these prey species are most abundant, such as during cyclic highs (Fitzgerald 1977, Simms 1979*a*, Erlinge 1981, Fagerstone 1987). However, populations can persist when arvicoline rodents are scarce, because some individuals survive on alternate prey such as other cricetid rodents, small lagomorphs, and small birds and their eggs, and by scavenging (King 1985, Fagerstone 1987). Female ermine reproduction can be significantly reduced when the system includes a variety of avian and mammalian competitors for the arvicoline prey base (Erlinge 1983). Many microtine rodents tend to prefer earlier successional plant communities, such as grassland, marsh, tundra, and shrub communities, and this likely explains the ermine's frequent preference for these habitats compared to more mature forest (Simms 1979*a*, Fagerstone 1987, Samson and Raymond 1998).

Ermine can fall prey to a variety of nocturnal and diurnal raptors, such as the snowy owl (*Nyctaea scandiaca*), rough-legged hawk (*Buteo lagopus*), and goshawk (*Accipiter gentilis*), and mammalian carnivores such as the domestic cat, red fox (*Vulpes vulpes*), and marten (Errington 1967, Weckwerth and Hawley 1962, Powell 1973, Fagerstone 1987). The recovery of red fox populations in sand dune habitats of coastal Netherlands, with a limited prey base not including arvicoline rodents, may even have caused the extinction of the local ermine population as a result of fox predation on ermine (Mulder 1990). Ermine apparently have adapted to reduce the predation risk. Their white winter pelage in northern latitudes generally makes them more cryptic, and the black-tipped tail may displace predator strikes from other parts of the body (Powell 1973, 1982). Their more intensive use of habitats with relatively heavy ground cover of coarse woody debris, herbaceous vegetation, and shrub cover (Doyle 1990, Samson and Raymond 1998) may also reflect their need to minimize predation risk.

The ermine has not been intensively studied in coastal and montane ecosystems. One study in the Cascade range of Oregon (Doyle 1990) can be considered most comparable to the situation on the QCI. The ermine, and various small rodents comprising potential ermine prey (i.e., the deer mouse and the creeping vole [*Microtus oregoni*]), were more abundant in riparian habitats than in upland habitats. This difference in abundance was correlated with significantly higher cover of deciduous and evergreen herbs and shrubs in the riparian sites compared to upland sites (Doyle 1990).

These patterns in continental ermine ecology explain a great deal of the rarity of QCI ermine, which evidently are strongly food-limited and subject to substantial predation risk. Regarding food limitation, ecosystems on QCI lack many of the ermine's preferred food species, and the ermine's access to other potential foods is subject to substantial competition. The endemic small mammal prey base on QCI is limited to the 2 species of *Peromyscus* and 1 shrew (Foster 1965, Cowan 1989), and includes none of the arvicoline rodents to which ermine are superbly adapted as predators. Consequently ermine are forced to find alternative prey. Introduced black rats are potential ermine prey (Fagerstone 1987), and are apparently hunted by ermine on QCI judging by 1 of our records. However, Cowan (1989) raises the possibility that rats may have reduced or eradicated *Peromyscus* populations, at least on Langara Island. If this is true, even locally, on Graham or Moresby islands, the net effect of rats on ermine food availability may be negative. The introduced muskrat is unlikely to be available to ermine most of the time, because of its size and aquatic habits, and the reported case of ermine eating muskrat may have been a case of scavenging. In the relative absence of their preferred small mammal prey base, QCI ermine would be forced to broaden their prey base and include scavenged food. Foods likely include eggs, nestlings, and perhaps adults of some birds, intertidal organisms, insects, and scavenged foods including any items, such as salmon, left by larger carnivores. Some of our new records substantiate these possibilities, with a number of cases of scavenging and predation on domesticated birds.

It is unlikely that these alternative foods can compensate for the lack of arvicoline prey. This is because ermine are not well adapted to hunting many of the alternatives (e.g., most birds), because the alternatives are only locally or seasonally available (e.g. spawning salmon, rats), and the alternatives can be common in the diet of generalist ermine competitors, such as marten, red squirrels, and raccoons. Raccoons are likely exploitative competitors in that they frequently predate bird nests and feed on invertebrates in the intertidal and freshwater systems (Sanderson 1987). Red squirrels are also potential exploitative competitors, feeding seasonally on eggs and nestlings. Marten on QCI have a diverse winter diet, including many of the ermine's likely foods, in the following frequencies of occurrence: deer (35.1%); small mammals (14.4%); birds (54.6%); fish (26.8%); invertebrates (26.8%; Nagorsen et al. 1991). Nagorsen et al. (1991) found that a substantial portion of the invertebrates were marine, and believed that much of the deer and fish was scavenged. Marten are likely exploitative and interference competitors with ermine. There was general agreement among the interviewed trappers that marten populations had increased on QCI by a factor of 5–10 since the 1940s. Some attributed this increase to the introduction of the red squirrel in 1947, and others to the increase in younger seral stage forests with good habitat for deer mice. Given the frequency of deer in the marten's winter diet (Nagorsen et al. 1991), the proliferation of deer following their introduction in the early 1900s (Cowan 1989) may also have facilitated marten population growth. The declining frequency of ermine records from the 1930s and 1940s to the 1950s and 1960s may reflect a declining ermine population resulting from reduced abundance of and access to food in the face of marten competition, and perhaps marten predation. An alternate explanation is that trapper effort declined markedly after the 1940s. In any case, the increase in marten is very likely detrimental to ermine population persistence.

One selective advantage of sexual dimorphism in small mustelids may be the ability of conspecifics to exploit a wider prey base, thereby reducing intraspecific competition for food (Moors 1980). QCI ermine exhibit less sexual dimorphism than mainland subspecies (Foster 1965). Perhaps the lack of a diverse small mammal prey base means that selection to reduce intraspecific competition cannot be realized in terms of diet partitioning. Nevertheless, the competition likely still exists, and ermine may attempt to reduce it by other means, such as spacing mechanisms.

Regarding risk of predation, the following are possible ermine predators on QCI: goshawk, bald eagle (*Haliaeetus leucocephalus*), harrier (*Circus cyaneus*), sharp-shinned hawk (*Accipiter striatus*), red-tailed hawk (*Buteo jamaicensis*), black bear, marten, and domestic cat. This study uncovered 3 records of ermine killed by cats. Although ermine were not discovered in any of the marten stomach samples analyzed by Nagorsen et al. (1991), ermine are sometimes killed by marten (Weckwerth and Hawley 1962). Ironically the ermine's white winter pelage, an adaptation to reduce winter predation risk, may be a liability in the largely snow-free QCI winters. In order to reduce risk, ermine may be forced to forage more extensively at night, especially when far from cover, such as in the intertidal.

The patterns of ermine habitat use drawn from records in this study are best explained by the likely patterns of ermine prey abundance, and predation risk. Ermine were not often observed in habitats with little cover (e.g., beach, pasture, or fen). However they were frequently in forest or other cover within and near habitats (i.e., the marine foreshore and freshwater riparian), which would provide relatively good prey densities (i.e., deer mice, invertebrates, and birds). Their tendency to be further from lakes and marshes than from other water bodies might reflect a need to keep in cover. There is no indication that they are dependent on old-growth forests, though they likely benefit from coarse woody debris in any forest stand.

Inventory Techniques

Of the various inventory techniques we employed, only the process of soliciting reports, and following these up with interviews, proved very successful. This approach has the benefit of producing an historic as well as current distribution, and obtaining data for habitat and abundance estimates. We are confident that the great majority of new records are definitely of ermine, judging by the ability of the interviewee to identify key features of an ermine, the high frequency of ermine seen in white winter pelage, and the long experience of most trappers interviewed. A few records may be invalid, with red squirrels being the most likely species for confusion.

Live trapping and track stations were relatively unsuccessful in documenting ermine presence, and the question is whether the techniques were adequate or the lack of success actually reflects absence. King and Edgar (1977) suggest using a wooden trap of dimensions 60 X 17 X 11 cm. The Sherman traps we used were somewhat smaller, especially in length (38

X 12 X 10 cm), but the entrance was not substantially smaller. The captured ermine still had room to move around in the traps. The Sherman traps were metal, which is not as desirable as wood because of condensation and conductance of extreme temperatures (King and Edgar 1977). The metal may have deterred ermine under some circumstances. We would seriously consider making larger, wooden traps and track tunnels for future work, to eliminate all concerns.

We experimented with a variety of baits, but only raw bacon was successful. This may or may not indicate a preference for this bait. Dilks et al. (1996) found that eggs, broken and hard boiled, were the most effective bait in an ecosystem where ermine were likely feeding extensively on birds' eggs. Given the likely wide diet breadth of QCI ermine, we suspect that most baits offered would have been suitable to lure ermine into traps and track stations.

Resident North American ermine occupy home ranges in the order of 1 to at least 35 ha, and food-stressed individuals, which might well describe those on QCI, tend to have larger ranges (Fitzgerald 1977, Simms 1979*b*, Samson and Raymond 1998). We set live traps and track stations 50 m apart, so that 1–30 stations would have been placed in a hypothetical animal's range, and trap lines could have intersected the home ranges of 1–5 animals. This was done in order to increase the chances of detecting an ermine should it be present. A wider spacing of stations would not have allowed us to cover many more home ranges because most of the time is spent in walking between traps, or in travelling between trapping areas.

King and Edgar (1977) recommend tracking tunnels (50 X 8 cm) open at both ends, with a central ink pad, and tracking papers (17 X 7 cm) at each end. Our track stations were open at only 1 end, and had a similar sized tracking paper (16.5 X 9 cm). Dilks et al. (1996) found no significant difference in the number of ermine entering single-entrance baited tunnels compared to double-entrance tunnels.

Overall, we are confident that we would have caught or detected ermine if they were present at the locations sampled, and that our lack of results actually reflects absence during the sampling periods.

Management Implications

There are relatively few opportunities to improve the population viability for a species that is so intrinsically rare. The highest priority is to reduce predation by alien species, in particular domestic and feral cats and raccoons, by removing these species from wild and suburban habitats wherever possible. Secondly, we should manage likely ermine habitats to reduce predation risk. This could include maintaining or enhancing coarse woody debris in riparian and marine foreshore areas, and maintaining wave-washed logs above storm tide lines. Thirdly, management actions should attempt to enhance prey abundance and availability where possible. Opportunities are limited, and their benefits in terms of ermine population viability less clear. However, they could include attempts to enhance breeding bird and deer mouse populations in riparian areas, and attempts to control introduced rats, as they are competitors with deer mice. In general terms the former would include enhancing heterogeneity of canopy, understory, and ground cover species composition and structure. Prescriptions would vary with the target bird species involved, and the kinds of seed sources potentially available to deer mice.

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Appendix A. Details of previous records of Queen Charlotte Islands ermine.

Year	Month	Data source[a]	Record type[b]	Island	Location
1898	Mar	CDC	TRD	Graham	Masset
1900	Jun	RBM	TRD	Moresby	Cumshewa Inlet
1900	Jun	RBM	TRD	Moresby	Cumshewa Inlet
1900	Jun	RBM	TRD	Moresby	Cumshewa Inlet
1900	Jul	RBM	TRD	Graham	Skidegate
1910	Aug	RBM	TRD	?	?
1910	Aug	RBM	TRD	?	?
1914	Mar	RBM	TRD	Graham	McClinton Bay
1914	Mar	RBM	TRD	Graham	?
1916	May	RBM	TRD	Graham	Masset
1916	May	RBM	TRD	Graham	Masset
1916	May	RBM	TRD	Graham	Masset
1916	May	RBM	TRD	Graham	Masset
1916	Aug	RBM	TRD	Graham	Masset
1940	Dec	RBM	TRD	Graham	Skidegate
1945	Jan	CDC	TRD	Moresby	Skidegate Channel
1959	Nov	RBM	TRD	Graham	Tlell
1963	Dec	CDC	TRD	Graham	Tlell
1965	Aug	RBM	VO	Moresby	Takakia Lake
1973	Nov	RBM	TRD	Graham	Tlell
1974	Feb	CDC	TRD	Graham	Yakoun River
1974	Feb	CDC	TRD	Graham	Yakoun River
1974	Jan	RBM	TRD	Graham	Tlell
1975	Nov	RBM	TRD	Graham	Kumdis Creek
1975	Dec	RBM	TRD	Graham	Kumdis Creek
1986	Jan	RBM	TRD	Moresby	Selwyn Point
1986	Feb	RBM	VO	Graham	Juskatla Inlet
1987	Sep	RBM	VO	Moresby	Sachs Creek
1987	Jan	RBM	TRD	Moresby	?
1987	Jan	RBM	TRD	Moresby	?

[a] CDC = British Columbia Conservation Data Centre; RBM = Royal British Columbia Museum.
[b] TRD = Trapped Dead; VO = Visual Observation.

Appendix B. Details of new records of Queen Charlotte Islands ermine collected during this study.

Year	Month	Record type[a]	Location (Island/Drainage)	Elev. (m)	Habitat type[b]	Forest harvest history[c]	Water type[d]	Distance to water (m)
1900	?	VO	Graham/Hancock	0	Beach	UC	MR/ES	5
1920	Fall	VO	Graham/Sewall	1	Bldg	RC	MR	55
1921	Spring	OSI	Graham/Sewall	1	Bldg	RC	MR	55
1922	April	OSI	Graham/Chinukundl	3	Bldg	OC	MR	35
1922	Summ.	VO	Graham/Sewall	1	Bldg	RC	MR	55
1922	Spring	VO	Graham/Sewall	1	Bldg	RC	MR	55
1924	Fall	VO	Graham/Sewall	1	Bldg	?	MR	55
1926	Summ.	VO	Graham/Sewall	1	Bldg	?	MR	55
1928	Dec	VO	Graham/Watun	0	PA	OC	MR	30
1928	Dec	TRD	Graham/Cape Ball	?	?	?	?	?
1928	Dec	TRD	Graham/Cape Ball	?	?	?	?	?
1928	Dec	TRD	Graham/Cape Ball	?	?	?	?	?
1928	Dec	TRD	Graham/Cape Ball	?	?	?	?	?
1928	Dec	TRD	Graham/Cape Ball	?	?	?	?	?
1928	Dec	TRD	Graham/Cape Ball	?	?	?	?	?

continued…

Appendix B. Continued.

Year	Month	Record type[a]	Location (Island/Drainage)	Elev. (m)	Habitat type[b]	Forest harvest history[c]	Water type[d]	Distance to water (m)
1928	Jul	VO	Graham/Masset	0	FE	UC	MR	50
1930	Jan	TRD	Graham/Yakoun	?	CF	UC	RI	25
1930	Jan	TRD	Graham/Yakoun	?	CF	UC	RI	25
1935	Jan	VO	Graham/Skidegate	2	PA	OC	CR	5
1936	Mar	VO	Graham/Cape Ball	60	FE	UC	RI	150
1936	Mar	VO	Repeat					
1936	Feb	TRD	Graham/Yakoun	?	CF	UC	CR	15
1936	Feb	TRD	Graham/Yakoun	?	CF	UC	CR	15
1936	Feb	OSI	Graham/Yakoun	?	CF	UC	CR	15
1939	Jun	VO	Moresby/Cumshewa	0	CF	OC	MR	?
1940	Nov	VO	Graham/Ain	0	CF	UC	MR/ES	50
1940	Sep	VO	Graham/Tlell	?	Bldg	UC	RI	8
1943	Jan	TRD	Graham/Kumdis	0	CF	UC	MR	50
1944	Jan	TRD	Graham/Kumdis	0	CF	UC	MR	50
1945	Jul	VO	Graham/Fife Pt	5	Bldg	UC	MR	150
1945	Feb	VO	Graham/Tlell	?	Bldg	UC	MA	25
1946	Dec	VO	Graham/Danube	30	Bldg	UC	LA	300
1946	Nov	OSI	Graham/Fife Pt	?	Bldg	UC	ES	?
1947	Jan	VO	Moresby/Skidegate	10	PA	OC	CR	20
1947	Jan	VO	Repeat					
1947	Jul	OSI	Graham/Fife Pt	5	Bldg	UC	MR	150
1952	Jul	VO	Moresby/Copper	5	CF	OC	MR	6
1963	Sep	VO	Graham/Cape Ball	3	PA	UC	ES / RI	10
1964	Mar	CAT	Graham/Tlell	?	?	?	?	?
1965	Fall	VO	Graham/Mayer	?	MF	UC	CR	500
1967	Feb	TRD	Graham/Masset	0	CF	UC	MR	3
1967	Feb	TRD	Graham/Masset	0	CF	UC	MR	3
1968	Fall	VO	Graham/Mayer	15	CF	UC	CR	?
1972	Aug	VO	Graham/Tarundl	0	Beach	OC	MR	3
1972	Jul	VO	Graham / Honna	0	FE	OC	MR	3
1972	Wint.	VO	Graham/Mayer	?	BO	UC	MA	30
1972	Wint.	VO	Graham/Mayer	?	BO	UC	MA	30
1972	Wint.	VO	Graham/Mayer	?	BO	UC	MA	30
1972	Wint.	VO	Graham/Mayer	?	BO	UC	MA	30
1973	Wint.	VO	Graham/Marie	?	CF	UC	LA	40
1973	Wint.	VO	Graham/Marie	?	CF	UC	LA	40
1973	Wint.	VO	Graham/Marie	?	CF	UC	LA	40
1973	Wint.	VO	Graham/Marie	?	CF	UC	LA	40
1973	Wint.	VO	Graham/Marie	?	CF	UC	LA	40
1973	Wint.	VO	Graham/Marie	?	CF	UC	LA	40
1973	Wint.	VO	Graham/Marie	?	CF	UC	LA	40
1974	Apr	VO	Moresby/Lagoon	10	CF	RC	MR	20
1974	Apr	VO	Moresby/Lagoon	0	Beach	UC	MR	5
1975	Nov	VO	Graham/Yakoun	20	CF	OC	RI	100
1975	Jan	VO	Graham/Blackwater	?	CF	OC	CR	60
1975	Jan	STR	Graham/Coho	?	CF	UC	CR	10
1975	Wint.	TRD	Graham/Mayer	15	FE	UC	RI	10
1975	Wint.	TRD	Graham/Mayer	15	FE	UC	RI	10
1978	Dec	VO	Graham/Yakoun	?	CF	OC	RI	800
1978	Aug	VO	Graham/Tlell	20	BO	UC	CR	50
1978	Spring	VO	Graham/Mayer	15	CF	UC	CR	?
1979	May	VO	Graham/Yakoun	10	CF	UC	RI	130
1980	Nov	VO	Graham/Slatechuck	0	ME	OC	MR	10

continued…

Appendix B. Continued.

Year	Month	Record type[a]	Location (Island/Drainage)	Elev. (m)	Habitat type[b]	Forest harvest history[c]	Water type[d]	Distance to water (m)
1980	Sep	VO	Moresby/Skaat	0	Beach	UC	MR	0
1980	Apr	OSI	Graham/Lawnhill	15	Bldg	OC	CR	80
1980	Jan	VO	Graham/Masset	30	CF	UC	MR	400
1981	Jan	TRD	Moresby/Alliford Bay	500	CF	OC	MR	350
1981	Jan	VO	Graham/Chinukundl	3	CF	OC	MR	30
1981	Nov	VO	Graham/Blackwater	?	CF	RC	CR	10
1982	Dec	TRD	Graham/Chown	0	CF	UC	RI	10
1982	Jan	TRD	Graham/Deep	0	MF	UC	CR	10
1982	Jan	TRD	Moresby/Alliford Bay	?	CF	OC	CR	?
1983	Dec	VO	Louise/Beatty Anch.	10	Bldg	OC	MR	50
1983	Oct	VO	Graham/Yakoun	?	CF	OC	RI	35
1983	Wint.	VO	Graham/Port Clements	1	Bldg	OC	CR	11
1984	Nov	VO	Graham/Yakoun	?	CF	OC	RI	7
1984	Nov	VO	Graham/Mayer	?	BO	UC	MA	35
1985	?	VO	Moresby/South Bay Rd	?	CF	OC	MR	500
1985	Nov	VO	Graham/Datlamen	20	CF	RC	RI	300
1985	Jan	TRD	Burnaby/Dolomite	?	CF	UC	MR	500
1986	?	VO	Graham/Yakoun	?	CF	UC	CR	?
1986	Jul	Vo	Moresby/South Bay Rd	75	CF	RC	MA	350
1986	Jul	VO	Louise/Mathers	1500	CF	RC	MR	1600
1986	Jul	VO	Repeat					
1986	Jan	VO	Graham/Miller	5	MF	?	MR	30
1986	Jan	TRD	Moresby/Mosquito	?	CF	OC	LA	300
1986	Feb	VO	Graham/Mayer	?	BO	UC	MA	30
1986	Feb	VO	Graham/Mayer	?	BO	UC	MA	30
1987	Dec	VO	Graham/Yakoun	?	CF	OC	RI	5
1987	Nov	VO	Graham/Yakoun	10	CF	UC	RI	75
1987	Sep	VO	Graham/Brent	250	CF	OC	CR	1
1987	Jun	VO	Graham/Brent	0	Bldg	UC	MR	15
1987	Feb	VO	Graham/Phantom	?	CF	UC	CR	75
1988	Jul	VO	Graham/Rose Spit	0	Beach	UC	MR	70
1988	Jul	VO	Repeat					
1989	Dec	VO	Graham/Florence	?	CF	RC	?	1000
1989	Sep	VO	Graham/Tlell	?	CF	UC	MA	20
1989	Jul	VO	Graham/Gold	?	CF	RC	RI	4
1989	Feb	VO	Graham/Kumdis	15	CF	OC	CR	100
1991	?	VO	Graham/Kagan	800	CF	UC	LA	50
1991	Nov	VO	Moresby/Sandspit	1	Beach	OC	MR	30
1991	Jul	VO	Graham/Mayer	?	CF	UC	?	?
1991	Jul	CAT	Graham/Tlell	?	?	?	?	?
1991	Jun	VO	Graham/Watun	0	CF	UC	ES / RI	5
1991	Feb	STR	Moresby/Mosquito	10	CF	OC	LA	80
1991	Jan	TRD	Moresby/Mosquito	?	CF	OC	MR /CR	?
1991	Sep	VO	Graham/Tian Head	0	CF	UC	MR	5
1992	Dec	VO	Graham/Yakoun	?	CF	OC	RI	200
1992	Dec	STR	Moresby/Chroustcheff	5	PA	OC	MR	?
1992	Jul	VO	Graham/Phantom	?	CF	RC	RI	1000
1992	Jul	VO	Graham/Yakoun	?	CF	RC	?	?
1992	Mar	VO	Moresby/Copper	?	MF	OC	MR	21
1992	Feb	VO	Graham/Miller	50	MF	UC	CR	60
1992	Jan	STR	Graham/Sue	?	CF	RC /OC	CR	?
1993	Dec	VO	Graham/Yakoun	?	SH	RC	RI	50
1993	Oct	VO	Graham/Mamin	?	CF	RC	CR	200

continued…

Appendix B. Continued.

Year	Month	Record type[a]	Location (Island/Drainage)	Elev. (m)	Habitat type[b]	Forest harvest history[c]	Water type[d]	Distance to water (m)
1993	Sep	VO	Louise/Skedans	1	CF	OC	MR	5
1993	Jul	VO	Moresby/Copper	1	Beach	OC	MR	10
1993	Jun	VO	Graham/Tlell	3	DF	OC	MR	25
1993	Apr	VO	Graham/Lawn Pt	1	MF	OC	MR	40
1993	Feb	VO	Graham/Yakoun	?	CF	OC	RI	200
1993	Jan	VO	Graham/Gregory	5	CF	OC	RI	200
1993	Nov	VO	Graham/Mayer	?	CF	UC	MA	30
1994	Dec	VO	Moresby/Sachs	15	CF	OC	MR /CR	200
1994	Jul	VO	Graham/Riley	?	CF	UC	?	?
1994	Mar	VO	Graham/QC City	8	CF	OC	MR	500
1994	Feb	STR	Graham/Survey	?	CF	RC	CR	100
1994	Jan	VO	Graham/Yakoun	?	CF	UC	CR	100
1995	Oct	VO	Graham/Towhill	10	MF	OC	RI	200
1995	Sep	VO	Graham/Yakoun	?	CF	UC	RI	20
1995	Jul	VO	Graham/Rennell	5	CF	OC	MR	25
1995	Mar	VO	Graham/Mamin	400	CF	UC /RC	CR	50
1995	Jan	STR	Graham/Survey	?	CF	OC	CR	80
1996	Dec	STR	Moresby/Deena	1	CF	OC	MR	10
1996	Dec	VO	Graham/Kumdis	50	MF	UC	CR	300
1996	Oct	VO	Graham/Davidson	?	CF	RC	CR	12
1996	Sep	VO	Graham/Delkatla	0	CF	OC	ES	10
1996	Sep	VO	Repeat					
1996	Jul	VO	Graham/Yakoun	250	CF	OC	RI	50
1996	Mar	VO	Graham/Yakoun	?	CF	OC	CR /RI	20
1996	Feb	TRD	Graham/Honna	?	?	?	?	?
1996	Feb	VO	Graham/Yakoun	?	CF	OC	CR	10
1996	Feb	VO	Graham/Yakoun	?	CF	OC	CR	10
1996	Jan	VO	Graham/Mayer	50	BO	UC	MA	15
1997	Aug	VO	Graham/Masset	10	MF	OC	CR	250
1997	Aug	VO	Moresby/Sachs	1	CF	OC	MR /CR	0
1997	Aug	VO	Graham/Kumdis	50	CF	UC /RC	MA	100
1997	Aug	VO	Moresby/Blaine	10	CF	OC	MR	240
1997	Aug	VO	Moresby/Heather	20	CF	RC	CR	?
1997	Jul	VO	Graham/Lawnhill	3	MF	UC	MR	30
1997	Jun	VO	Moresby/Government	?	CF	UC	RI	0
1997	May	VO	Graham/Towhill Rd	0	MF	OC	MA	60
1997	Feb	TRD	Graham/Honna	200	CF	OC	LA	500
1997	Aug	CAT	Graham/QC City	?	?	?	?	600
1997	July	VO	Graham/Lawnhill	10	CF	UC	CR	?
1997	Nov	VO	Graham/Mamin	30	CF	RC	RI	200
1997	Nov	VO	Graham/Mamin	20	CF	OC	RI	500

[a] VO = Visual observation; TRD = Trapped dead; STR = Snow track; CAT = Killed by cat; OSI = Other sign.
[b] CF = Coniferous forest; MF = Mixed forest; DF = Deciduous forest; SH = Shrub; FE = Fen; PA = Pasture; BO = Bog; Bldg = Building.
[c] UC = Uncut; OC = Old clearcut (>10 yr); RC = Recent clearcut (<10 yr).
[d] MR = Marine; ES = Estuary; RI = River; CR = Creek; LA = Lake; MA = Marsh.