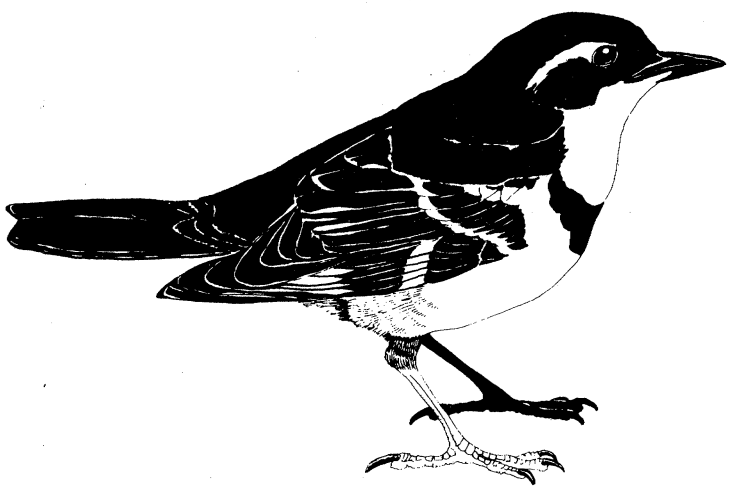
BRITISH COLUMBIA SEABIRD COLONY INVENTORY: REPORT #5 - WEST COAST VANCOUVER ISLAND

Michael S. Rodway
Moira J.F. Lemon



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ABSTRACT

As part of the Canadian Wildlife Service Seabird Colony Inventory Program we surveyed all colonies between Gillam Islands and McQuarrie Islets, and Cleland Island from 6 to 17 July 1988. Seabird Rocks was surveyed on 26 and 30 July 1988. Colonies south of McQuarrie Islets which were known to support only surface-nesting species were not surveyed.

Solander Island was resurveyed on 28 to 30 May 1989 to assess possible impacts to local seabird breeding populations following the Nestucca oil spill, which impacted the west coast of Vancouver Island in January and February of 1989. Results were compared to those obtained in 1988.

The West Coast Vancouver Island region supports almost half a million breeding seabirds. Storm-petrels (*Oceanodroma furcata* and *O. leucorhoa*), predominantly Leach's Storm-Petrels, comprise 80% of the total population, 90% of which nests on only two colonies, Gillam Islands and Solander Island. Solander Island supports most of the Cassin's Auklet (*Ptychoramphus aleuticus*) and Tufted Puffin (*Fratercula cirrhata*) populations breeding in the region. Breeding distribution and populations of Marbled Murrelets (*Brachyramphus marmoratus*), which are assumed to nest in this region, are unknown.

Known threats to nesting seabirds in this region include oil pollution, gill-net fisheries, human disturbance and predation. Mortality during the Nestucca oil spill had no apparent impact on breeding populations on Solander Island.

RÉSUMÉ

Dans le cadre du programme d'inventaires des colonies d'oiseaux marins du Service canadien de la faune, nous avons inventorié toutes les colonies entre les îles Gillam et les ilôts McQuarrie, et l'île Cleland entre les 6 et 17 juillet 1988. Les rochers des oiseaux (seabird rocks) furent recensés les 26 et 30 juillet 1988. Les colonies au sud des ilôts McQuarrie ne supportaient apparamment que des oiseaux nichant sur le sol et n'ont pas été inventoriées.

L'île de Solander fut revisitée les 28 et 30 mai 1989 afin de déterminer les impacts possibles de déversement d'huile Nestucca de janvier 1989, sur les populations nidificatrices d'oiseaux marins. Les résultats sont comparés à ceux obtenus en 1988.

La côte ouest de l'île de Vancouver supporte près d'un million d'oiseaux marins nicheurs. Les pétrels tempetes (*Oceanodrama leucorhoa* and *furcata*), surtout le pétrel cul blanc compte pour 80% de ces oiseaux et 90% des pétrels nichent dans seulement deux colonies: les îles Gillam et l'île de Solander.

L'île de Solander contient la majorité des alques de Cassin (*Ptychoramphus aleutica*) et des macareux huppés nichant dans la région. La distribution de l'alque marbré de même que la dimension de la population nidificatrice sont inconnus pour cette region.

Les menaces pesant sur les oiseaux marins nichant dans cette région incluent la pollution par l'huile, la pèche au filet, le dérangement humain et la prédation. La mortalité due au déversement d'huile Nestucca n'a apparamment en aucun effet sur la population nidificatrice de l'île de Solander.

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Many thanks to Brian Carter and Mike Force who assisted with surveys north of Tofino, and Alan Burger and Don Garnier who conducted the surveys on Cleland Island and Seabird Rocks. Their help was greatly appreciated.

We are grateful to K. Vermeer for sharing not yet published results of 1989 surveys of Pelagic Cormorants and Glaucous-winged Gulls.

Permission to work on Ecological Reserves, was provided by L. Goulet.

INTRODUCTION

Almost half a million seabirds are currently estimated to breed at 72 sites along the west coast of Vancouver Island (Rodway *in press* - Fig. WV-1; Table WV-1). There are 93 historic nesting sites in this region, but a number of small colonies of Pelagic Cormorants (*Phalacrocorax pelagicus*), Black Oystercatchers (*Haematopus bachmani*) and Glaucous-winged Gulls (*Larus glaucescens*) were not occupied on recent surveys (Rodway *et al.* in prep.; Vermeer *et al.* in prep.; this study). Storm-petrels (*Oceanodroma furcata* and *O. leucorhoa*), predominantly Leach's Storm-Petrels, comprise 80% of the total nesting seabird population, 90% of which nests on only two colonies, Gillam Islands and Solander Island. Solander Island supports most of the Cassin's Auklet (*Ptychoramphus aleuticus*) and Tufted Puffin (*Fratercula cirrhata*) populations breeding in the region.

The entire region was surveyed in 1975, and most colonies were located at that time (Campbell 1976). Previous and subsequent surveys of local areas provided comparative counts for surface-nesting species in specific areas (Campbell and Stirling 1968; Guiguet 1971; Hatler *et al.* 1978; Carter *et al.* 1984). Prior to 1988, population estimates for burrow-nesting species were based on explorations and incomplete sampling methods, and were difficult to compare between years.

The primary goal of the 1988 survey was to obtain baseline estimates for burrowing species that could be used to monitor future population trends and identify current and potential threats to those populations. All species were censused at all colonies between Gillam Islands and McQuarrie Islets, and on Cleland Island from 6 to 17 July (Fig. WV-1). Seabird Rocks was surveyed on 26 and 30 July. Colonies south of McQuarrie Islets which were known to support only surface-nesting species were not surveyed in 1988. Vermeer *et al.* (in prep.) censused Pelagic Cormorants and Glaucous-winged Gulls at all colonies along the west coast of Vancouver Island in 1989. Results from that survey are briefly summarized here (see Summary and Conclusions).

Breeding distribution and populations of Marbled Murrelets (*Brachyramphus marmoratus*), which are assumed to nest in this region, are unknown. Sealy and Carter (1984) derived at-sea population estimates of Marbled Murrelets in Barkley and Clayoquot sounds in 1982. Current population levels have not been investigated. Special survey methodology will be required to address the unique conservation problems presented by this species (Sealy and Carter 1984; Rodway 1990).

As part of follow-up studies to the Nestucca oil spill, which impacted the west coast of Vancouver Island in January and February of 1989 (Rodway *et al.* 1989), the senior author returned to Solander Island on 28 to 30 May 1989. The colony was resurveyed and results were compared to those obtained in 1988. Detailed data from both those surveys are presented in this report.

Known threats to nesting seabirds in this region include oil pollution, gill-net fisheries, human disturbance and predation. Checleset Bay and Barkley Sound attract many recreational boaters, and some colonies of cormorants may have declined or been abandoned as a result (Hatler et al. 1978). Carter and Sealy (1984) documented gill-net mortality of Marbled Murrelets, Common Murres (*Uria aalge*) and Rhinoceros Auklets (*Cerorhinca monocerata*) in Barkley Sound. Mink (*Mustela vison*) have been sighted on Cleland Island and were suspected on Thomas Island. They were likely responsible for much of the predation observed. The presence and impact of mink on those colonies should be monitored.

Many of the colonies in and north of Barkley Sound are included in the proposed Pacific Rim National Park, and Solander Island, Cleland Island, the islands in Checleset Bay, and Race Rocks have protective status as Provincial Ecological Reserves.

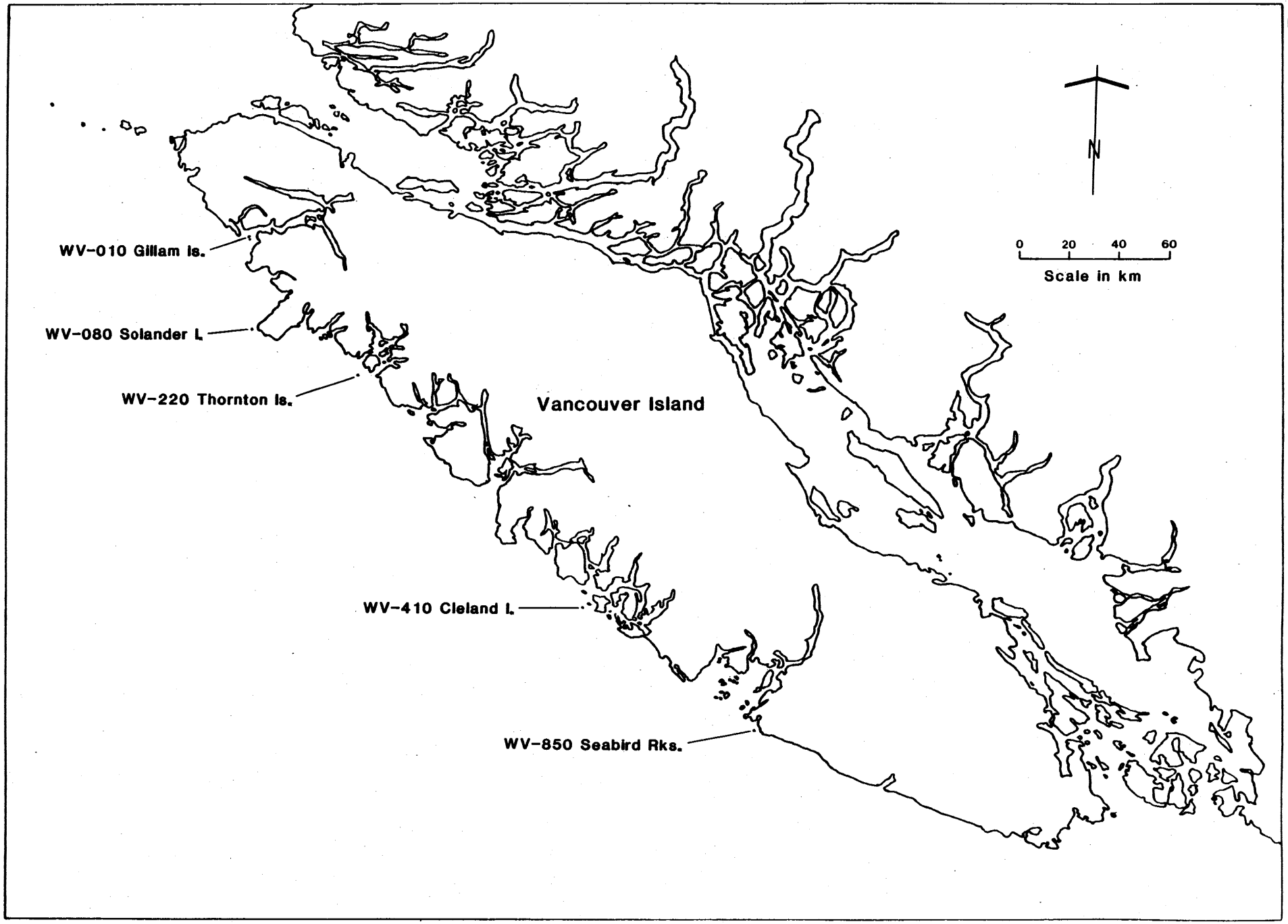

Figure WV-1. Seabird colonies on the west coast of Vancouver Island surveyed in 1988. See detail of northern survey area on following page.

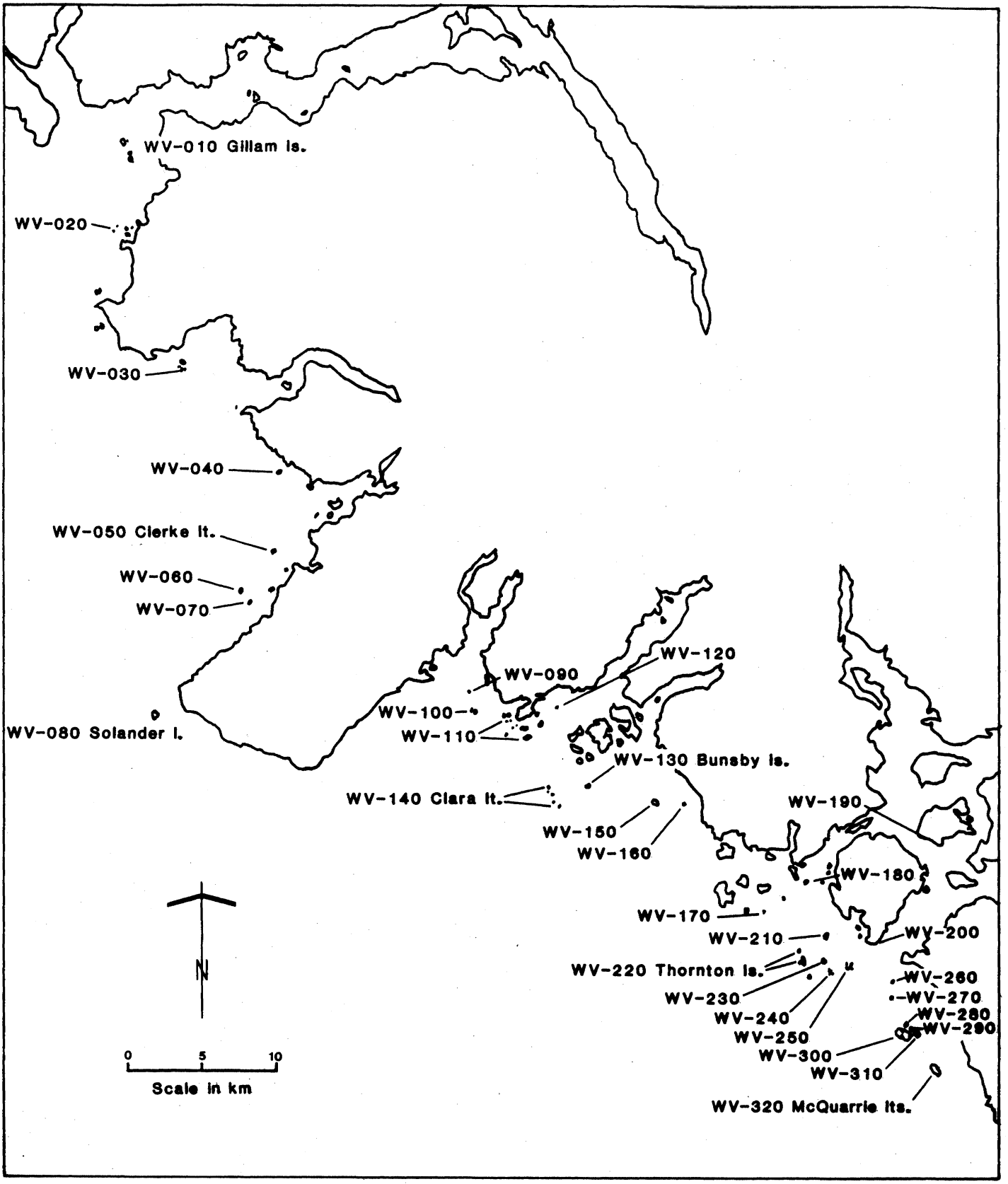

Figure WV-1. (continued) Detail of northern survey area.

METHODS

Census methods were selected according to the area, habitat, and species of birds nesting on an island (Nettleship 1976). Because all colonies along the west coast of Vancouver Island are on small islands, it was possible to explore the entire area of those islands to determine colony extent and appropriate census techniques.

1. Total Count. Total nest counts were made for Pelagic Cormorants, Black Oystercatchers and Glaucous-winged Gulls unless nests were inaccessible. Population estimates equal the number of nests counted. In inaccessible areas, numbers of gull nests were estimated to be half the number of adults present on territories. Within the text, lists of nests counted use these abbreviations: Sta - Start; Emp - empty; E - egg; Y - young.

Total numbers of Pigeon Guillemots (*Cepphus columba*) seen around colonies were counted, but no standardized observation techniques were employed (see Nettleship 1976), and no attempt was made to estimate actual nesting populations.

2. Partial count. On Seabird Rocks, colony area of burrowing species was too small to be effectively sampled with line transects, but too extensive to perform a total burrow count in the time available. To obtain estimates of burrow numbers a partial count was conducted. All burrows were counted in about half the colony area. Numbers of burrows in the rest of the colony were estimated by counting burrows in representative portions of different habitat areas, and then extrapolating burrow density to the remainder of each habitat area sampled.

3. Line Transects With Quadrats. Line transects were used to estimate breeding populations of burrowing species on all colonies except Seabird Rocks (see Partial Count).

3.1. **Transect location.** Transects were run throughout accessible colony areas. On all transected colonies except Solander Island, evenly spaced transects were run on parallel bearings across colony islands. Transects were spaced 50-75 m apart. On Solander Island, placement was modified due to steep terrain. We attempted to sample 1% of the area of a colony. That value was the maximum sampling effort we found possible within the time allotted.

3.2. **Quadrats:** Quadrats were set at predetermined intervals along transect lines. Along shore, the first quadrat occurred at the edge of the vegetation, unless that was inaccessible. Plots ranged in size from 1x1 m to 3x3 m, and spacing varied from 5 to 15 m. The size was selected so that an average of at least one burrow occurred in each quadrat. The density of burrowing encountered in most areas was best sampled with smaller, more frequent plots (Savard and Smith 1985).

Burrows were counted within each quadrat and their entrance characteristics recorded: location (ie, under grass tussocks, tree roots, shrubbery, ferns etc.), accessibility (whether it was obscured, or obstructed), and signs of activity (droppings, feathers, etc.), both at the entrance and in the tunnel. Each burrow entrance was explored to elbow length. If within this distance, entrances connected into the same tunnel, only one burrow was recorded and the number of entrances was noted. Habitat parameters were measured: distance from shore, altitude, slope, percent and species composition of ground cover, shrub cover, and forest canopy. To place the quadrat in the context of the overall habitat, tree species, percent composition, and average size (for forested islands), and general terrain features were documented for the area surrounding each quadrat within a radius equal to half the distance between quadrats. Evidence of predation (eggshells, carcasses, feather piles) within each

quadrat was recorded. Detailed analyses of habitat data are not included in this report but will be presented in subsequent documents.

3.3. **Colony area**: Colony area was defined to include all portions of an island where burrows with recent signs of activity (droppings, feathers, regurgitated food, fragments of eggshell or egg membrane, worn entrances or tunnels, excavation, or fresh nesting material) were located. If burrows were located, but no signs of recent activity were observed in an area, the colony was considered abandoned. If there were no burrows within a quadrat, the surrounding area was searched for colony evidence to determine if the plot fell within the colony and should be used in density calculations.

Distance, elevation, and slope measurements taken along the transects, as well as during the exploration, were used to draw colony areas on detailed topographic maps or air photos. The horizontal surface area of the colony was measured on that map with a compensating polar planimeter. Adjusting for slope, the area of the colony was given by:

$$C_s = A_m T^2 \ (\cos \Theta)^{-1}$$

where C_s is the colony surface area, A_m is the area on the map, T is the scale of the map, and Θ is the mean slope along the transects. The colony area calculations take into account the average uphill slope, but not the undulations between quadrats or between transects. Therefore our calculations give a conservative estimate of the total surface area available to birds for nesting.

3.4. **Burrow density**: Counts from all plots within colony areas were used to calculate average burrow densities. Densities are quoted plus or minus one standard error. On figures, burrows/ha is abbreviated to b/ha.

3.5. **Burrow occupancy:** The percentage of burrows that actually contained nesting birds was determined by complete examination of a sample of burrows. If an adult, egg, chick, or freshly hatched egg membrane was found, the burrow was considered occupied. Burrows were considered empty if all tunnel branches were explored and none of the above were found. Signs such as a well worn entrance or droppings were not used to distinguish between occupied and empty burrows. Exploring burrows longer than an arm's reach required digging one or more access holes until the end was reached. Excavated holes were immediately patched with sticks and soil. To minimize disturbance, adults were not pulled from burrows except to confirm species identification.

To obtain a representative sample of the entire colony, we attempted to determine the occupancy of every burrow within surveyed quadrats. Where that was not feasible, we selected plots from different areas of the colony and explored every burrow in each plot selected. For Cassin's Auklets on Solander Island in 1989 we selected plots randomly and fixed the sample size at five burrows per plot. On other colonies plot selection was arbitrary and number of burrows in each sample varied. Occupancy tables within colony accounts indicate the distribution of quadrats where occupancy data was obtained.

Occupancy was not determined on small Cassin's or Rhinoceros auklet colonies. In those cases the median British Columbia occupancy rate for each species was used to estimate nesting population (see Rodway *et al.* 1988).

Occupancy rate was calculated according to the formula:

$$R = \frac{\bar{x}}{\bar{y}}$$

where x_i is the number of occupied burrows in the i^{th} quadrat, and y_i is the total number of occupied plus empty burrows in the i^{th} quadrat and $\bar{x}$ and $\bar{y}$ are, respectively, the mean of the x_i and y_i over all quadrats.

The variance of R is calculated from:

$$Var(R) = \frac{\bar{x}^2}{\bar{y}^2}\left[\frac{s_x^2}{\bar{x}^2} + \frac{s_y^2}{\bar{y}^2} - \frac{2s_{xy}^2}{\bar{x}\bar{y}}\right]$$

where s_x is the standard error of $\bar{x}$, s_y is the standard error of $\bar{y}$, and s_{xy}^2 is the covariance of $\bar{x}$ and $\bar{y}$ (Kendall and Stuart 1963).

The standard error of R is the square root of Var(R).

3.6. **Total burrows and nesting population estimates:** The total number of burrows (**B**) is the product of the overall average density of burrows, as determined in the quadrats, and the total area of the colony. **B** multiplied by the occupancy rate, (**R**) gives an estimate of nesting pairs (**P**). Calculations are quoted plus or minus one standard error.

$$P = BR$$

The variance of P is calculated from

$$Var(P) = B^2\,Var(R) + R^2\,Var(B) - Var(B)\,Var(R)$$

The standard error of P is the square root of Var(P).

4. Distinguishing species:

The burrows of different species are often mixed. This presents problems for surveyors when burrow contents cannot be determined. Identification of burrows must then be based on indicative signs found in the burrow or at the burrow entrance. We developed a set of criteria for distinguishing burrows of storm-petrels, Cassin's Auklets, Rhinoceros Auklets and Tufted Puffins: size of entrance; wear at the entrance; droppings in and around the burrow entrance; regurgitated food (for Cassin's Auklet); feathers found in the burrow; eggshell fragments found in the burrow; and odour.

Storm-petrels (*Oceanodroma furcata* and *O. leucorhoa*) were found nesting in conjunction with Cassin's Auklets, Rhinoceros Auklets and Tufted Puffins. Little difficulty was encountered differentiating storm-petrel burrows according to size (5-7cm wide). The musty odour of petrels was also helpful.

Cassin's Auklets were found nesting in the same areas as Rhinoceros Auklets and Tufted Puffins. The size of burrows of those species are generally distinct: Cassin's Auklet burrows are 10-12 cm wide, Rhinoceros Auklet burrows are 12-15 cm wide, and Tufted Puffin burrows are 15-18 cm wide. Droppings, regurgitated food, eggshell fragments, and feathers provided more conclusive evidence.

Rhinoceros Auklets and Tufted Puffins have relatively clean burrow entrances compared to Cassin's Auklets, which often leave white fecal streaking along the approach and into the entrances of their burrows. This distinction is less useful in grassy areas, and during rainy weather, since droppings do not accumulate under those conditions. The droppings of Rhinoceros Auklets are large, generally globular, pale yellow with black, viscous blobs, and are often deposited to one side of the burrow entrance. Tufted Puffin droppings are whitish or yellowish, and are often released during flight or take-off, though they are sometimes deposited near the burrow entrance. Cassin's Auklet droppings have a more arresting odour than either Rhinoceros Auklet's or Tufted Puffin's, as does their regurgitated food, some of which they invariably lose at the entrance to their burrows when delivering it. The entrance and vicinity of Rhinoceros Auklet and Tufted Puffin burrows are more extensively trampled and worn than those of Cassin's Auklets.

Abdominal feathers (which are often lost in burrows) of each species can be distinguished by their colour pattern (size is not reliable). The overall colour of Cassin's Auklet and Rhinoceros Auklet feathers are similar, but the colour pattern of the feather plumules are distinct. Cassin's Auklet plumules are mostly dark with a tip of white, while the colour of Rhinoceros Auklet plumules is uniform greyish white and is similar to that of the base of the main feather. Abdominal feathers of Tufted Puffins have dark rather than white ends. Eggshell fragments of all three species are white and are difficult to distinguish unless a substantial portion of the shell is present and can be identified by size.

5. Predation:

During exploration, notes were kept of all signs of predation or mortality encountered. Areas around Bald Eagle (*Haliaeetus leucocephalus*), Peregrine Falcon (*Falco peregrinus*), and Common Raven (*Corvus corax*) nests, and around river otter (*Lutra canadensis*) runs and dens were examined in detail. This gave an indication of the degree and the kind of species being preyed upon. To quantify the level of predation, we calculated the density of prey remains recorded in quadrats, using the minimum possible number of birds represented by the evidence found. We assumed that one feather pile represented one bird. Estimates only allow coarse comparisons between colonies because surveys occurred at various times in the nesting season. It underestimates total predation because plots only sample remains left within the colony before the end of the season.

6. Staging:

Near dusk, during part of the breeding season, Rhinoceros Auklets aggregate on the water adjacent to colony areas, and then circle in large wheels around nesting slopes, in typical puffin fashion (Harris 1984; see Rodway *et al.* 1990). This behavior occurs on Cleland Island (Rodway pers. obs.), but it was not monitored in 1988. Thus no specific information on staging was available for this report.

7. Time:

Times quoted are Daylight Savings Time. Subtract one hour from Daylight Savings Time to calculate Pacific Standard Time.

COLONY ACCOUNTS

WV-010 GILLAM ISLANDS 92 L/5

Location: Entrance to Quatsino Sound, east of Kains Island. 50°26'30"N 127°57'50"W

Land status: Crown land.

Date of visit: 6,7 July 1988.

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Line transects: 21 quadrats, 1x1 m, surveyed every 15 m along 4 parallel transects run across the islands at a bearing of 270° (Fig. WV010-1). Transects were spaced 75 m apart, and their total lengths, in numerical order, were 35 m, 81 m, 62 m and 100 m. All storm-petrel burrows within plots were examined to determine occupancy. Total counts were made of surface-nesting species.

Description: This small chain of islands have rocky shores, steep in areas, with small crevices and gorges segmenting perimeter sections. They have a total area of 6.0 ha, 2.9 of which are vegetated, and rise to a maximum elevation of 46 m. The larger, northern island is forested with Sitka Spruce (*Picea sitchensis*), but only isolated, dwarfed spruce occur on other islets. Thick salmonberry (*Rubus spectabalis*) and currant (*Ribes* sp.) form most of the understory on the treed island, and cover much of the southern islets. Salal (*Gaultheria shallon*), elderberry (*Sambucus racemosa*) and crabapple (*Malus diversifolia*) also form dense pockets on the north island. Luxuriant grass and forbs crown the middle island, and surround shrubby interiors on north and south islands. Lower rocks are bare.

Tent caterpillars have infested shrubbery over extensive areas, especially on the south end of the north island. Much of the salal in that area had dead tops in 1988.

Nesting species:

Storm-petrel: Both Fork-tailed and Leach's storm-petrels were nesting throughout vegetated areas with enough soil to support burrows (Fig. WV010-1). Only a small portion of the grassy area on islet G had deep enough soil for burrowing, and we did not include that area in calculations of colony area. We estimated 100 burrows there. Burrow density was highest on the largest island (Table WV010-1). Density tended to be higher in herbaceous or mossy vegetation, but was also high under thick shrubbery in some areas, especially along transect 3.

Leach's Storm-Petrels outnumbered Fork-tailed Storm-Petrels almost two-to-one in identified burrows, but we suspect the proportion of Leach' Storm-Petrels were underestimated because of the number of eggs found that could not be definitely associated with a particular species (Table WV010-2). All Fork-tailed Storm-Petrel burrows identified contained chicks, and all known Leach's Storm-Petrel burrows contained eggs. Thus, unidentified eggs most likely belonged to Leach's Storm-Petrels, though some Fork-tailed Storm-Petrel were recently hatched, and cold eggs may have belonged to either species.

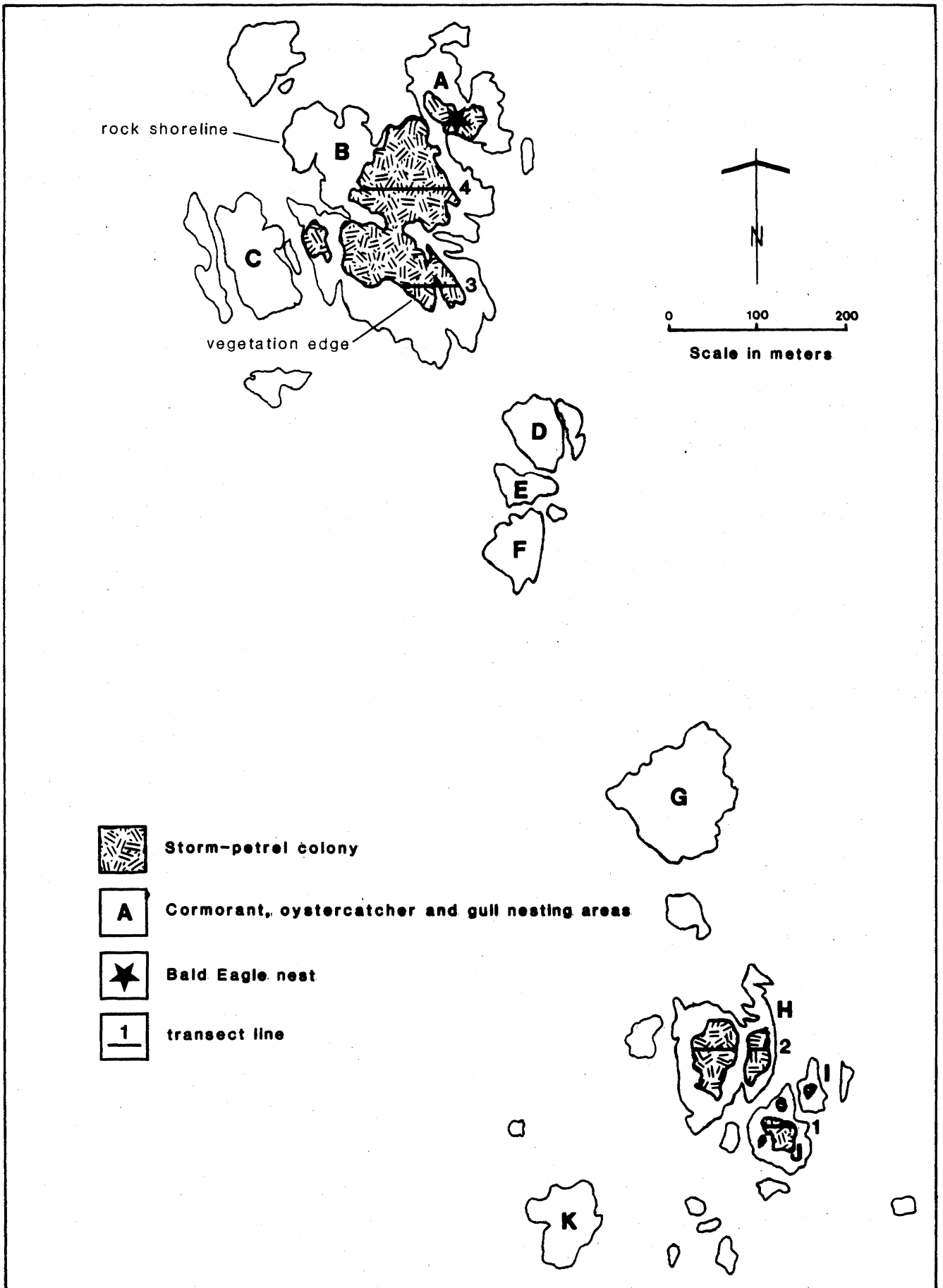

Figure WV010-1. Seabird colony areas on Gillam Islands in 1988.

1988 Population estimate:

Number of sample plots:	21 (21 m^2 - 0.07% of colony)
Average density:	40,476 ± 6917 burrows/ha
Colony area:	2.9 ha
Total burrows:	117,480 ± 20,059
1988 Occupancy rate:	97.7 ± 2.4% (43 of 44 known)
Species ratio:	37% Fork-tailed to 63% Leach's storm-petrels
1988 Nesting population:	
Fork-tailed Storm-Petrel:	42,468 ± 7323 pairs
Leach's Storm-Petrel:	72,310 ± 12,470 pairs

Table WV010-1. Number of storm-petrel burrows in 1x1 m plots along transects on Gillam Islands in 1988.

	Plot						
Transect	1	2	3	4	5	6	7
1	5	2	2				
2	1	0	0	1	1	1	
3	9	6	7	8	7		
4	8	8	8	2	4	4	1

Table WV010-2. Occupancy of storm-petrel burrows on Gillam Islands in 1989.

Location Transect	Plot	Fork-tailed: Empty	Fork-tailed: chick	Leach's: Adult	Leach's: Adult +egg	Leach's: Cold egg	Leach's: Warm egg	Leach's: Unid. adult	Total Occup.	Total known
Islet G					1				1	1
1	1		3						3	3
1	2	1							0	1
1	3				1	1			2	2
2	1			1					1	1
2	4			1					1	1
3	near 1		1	1					2	2
3	1		3	2	1				6	6
3	2		1	1	1		1		4	4
3	3				1		1		2	2
3	5		1	1	2	1			5	5
4	1			1			1		2	2
4	2		3		1				4	4
4	3		1	2	1	1		1	6	6
4	5			1	2				3	3
4	6						1		1	1
Total		1	13	11	11	3	4	1	43	44

Pelagic Cormorant: There were eight empty, unattended nests on islet E, with 17 adults in breeding plumage plus 14 non-breeding birds roosting nearby. Nest building appeared to be in progress, though nests were mostly complete.

Black Oystercatcher: We located 13 oystercatcher nests on the various islets (Fig. WV010-1). Most nests contained eggs, and few young had hatched (Table WV010-3). Nests were primarily composed of shells and rock chips; one contained bits of moss. We found two broken eggs.

Table WV010-3. Black Oystercatcher nests on Gillam Islands in 1988.

	Contents					
Area	Empty	1 egg	2 eggs	3 eggs	1 young	Total
A			1			1
B		1	1			2
C	1*	1				2
D		1			1	2
F	1					1
G		1		1		2
H	1					1
J	1*					1
K		1				1
Total	4	5	2	1	1	13

* young suspected

Glaucous-winged Gull: Gulls were nesting on most bare and grassy areas (Fig. WV010-1). A total of 646 nests were counted (Table WV010-4). Nest materials were predominantly grass, plus some fern and forbs in a few nests. Young were just beginning to hatch at the time of our census. We found a total of 25 broken or depredated eggs.

Table WV010-4. Glaucous-winged Gull nests on Gillam Islands in 1988.

			Contents							
Area	Start	Empty	1E	2E	3E	4E	1E2Y	3Y	1Y	Total
A		1		2	15		2		1	21
B				1	3	2				6
C		10	22	35	59			1		127
D		3	5	13	22		1			44
E		4	6	1	2					13
F	1	20	11	21	26		1			80
G	3	36	30	45	89					203
H		23	9	4	20					56
I		5	2	7	8			1		23
J		11	10	11	23	1				56
K		4	2	3	8					17
Total	4	117	97	143	275	3	4	2	1	646

Pigeon Guillemot: We counted a maximum of 45 birds around the islands at 1200 h on 7 July. Eleven nests were confirmed on areas D, G, H and J (Fig. WV010-1): 2 with 1 egg; 3 with 2 eggs; 1 with 2 young; 1 with 1 young; and 4 with adults.

Tufted Puffin: Two or three pairs of puffins were suspected nesting on islet J. One was seen there on 6 July, and three were present on 7 July. Nests were not located.

Predation: During exploration we found 52 wings of Leach's Storm-Petrels and 1 Fork-tailed Storm-Petrel wing. Most wings were singles; a few were still connected. Few prey remains were encountered in surveyed quadrats: 1 Leach's Storm-Petrel wing and feather pile in plot 2 on transect 1; and 4 single Leach's Storm-Petrel wings in plot 4 on transect 2. Extrapolating from that evidence yields an imprecise estimate of 4144 $\pm$ 3025 birds killed on the colony at the time of our survey.

Associated species:

Bald Eagle - One nest in the middle of the northeast island, 10 m high in a 15 m spruce, was attended by two adults.

Glaucous-winged/Western Gull hybrid *L. glaucescens/occidentalis* - One adult hybrid appeared to be paired with a Glaucous-winged Gull.

Common Murre - 3 in breeding plumage.

Marbled Murrelet - 14 in summer plumage off the east side.

Ancient Murrelet *Synthliboramphus antiquus* - An adult was feeding a 3/4 grown chick along the west side of the main island, and two fully grown juveniles were sighted off the east side on 7 July.

Rhinoceros Auklet - 1 off the east side.

Northwestern Crow *Corvus caurinus* - One injured fledgling, suspected to have been hit by a Bald Eagle, was found in a tidal crevice on islet G.

River Otter - Scats of fish were seen on the south end of islet H.

Other birds and mammals sighted:

Harlequin Duck *Histionicus histrionicus* - 2 males and 5 in female plumage

Least Sandpiper *Calidris minutilla* - 1

Mew Gull *Larus canus* - 3 adults roosting on islet H.

California Gull *L. californicus* - We counted 230, 20 of which were adults and the rest second and third year birds, roosting on islet H.

Herring Gull *L. argentatus* - 1 adult.

Fox Sparrow *Melospiza iliaca* - One nest with two eggs was located in a tussock of Tufted Hairgrass on islet G. Nest was a woven grass and fern cup lined with white gull feathers.

Song Sparrow *M. melodia*

Harbour Seal *Phoca vitulina* - 2

WV-020 ROWLEY REEFS 92 L/5

Location: North of Restless Bight, south of the entrance to Quatsino Sound.
50°23'57"N 127°58'30"W

Land status: Crown land.

Date of visit: 7 July 1988 (1900-1910 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: Rowley Reefs are 11 m high, bare rocks with scant tufts of grass in higher crevices.

Nesting species:

Pelagic Cormorant: One dilapidated nest, with fresh nesting material scattered about, was located on the outer south rock. No birds were near the nest. Five birds in breeding plumage and 30 nonbreeding birds were roosting on the west rock.

Black Oystercatcher: Two nests with one and two eggs each were found on the west and south rocks. Nests were made of rock chips and mussel shells. Six adults were present.

Associated species:

Glaucous-winged Gull - 1 adult.

Marbled Murrelets - 12 in summer plumage to northeast.

WV-030 RUGGED ISLANDS 92 L/5

Location: East of Lawn Point off entrance to Klaskino Inlet. 50°18'50"N 127°55'W

Land status: Crown land.

Date of visit: 7 July 1988 (1950-2035 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: The larger islands are treed, but nesting has only been recorded on the southern rocks. These are steep, jagged rocks, rising to 15 m elevation, with patches of grass on higher sections. Their total area is 1.2 ha.

Nesting species:

Black Oystercatcher: There was one nest with three eggs on the west of the south rocks. It was made of rock chips on grass. Four adults were present.

Glaucous-winged Gull: We found two nests with two and three eggs each on the west of the south rocks. Nests were made of grass. Four adults were present.

Pigeon Guillemot: Two birds were sighted around the rocks.

Associated species:

Pelagic Cormorant - 97 nonbreeding birds were roosting on the south rock.

Marbled Murrelet - 35 in summer plumage between Rugged Islands and Gould Rock.

Other birds and mammals sighted:

Harlequin Duck - 27 molting males; some mostly eclipse.

Black Turnstone *Arenaria melanocephala* - 1

California Gull - 250, mostly immatures, roosting.

Harbour Seal - 2

WV-040 GOULD ROCK 92 L/4

Location: Between the mouths of Klaskino and Klaskish Inlets. 50°15'08"N 127°49'38"W

Land status: Crown land.

Date of visit: 7 July 1988 (2102-2112 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: Gould is a 10 m high rock.

Nesting species:

Black Oystercatcher: We found one nest with two cold eggs, plus three empty scrapes. There was a broken or hatched eggshell beside one empty nest. Nests were made of rock chips and mussel and barnacle shells. Five adults were present.

Glaucous-winged Gull: No gulls were present and no nests were observed.

Associated species:

Pelagic Cormorant - Three birds in breeding and seven in nonbreeding plumage were roosting.

Other birds and mammals sighted:

Harlequin Duck - 5

WV-050 CLERKE ISLET 92 L/4

Location: Southwest of Klaskish Inlet. 50°12'26"N 127°49'54"W

Land status: Crown land.

Date of visit: 9 July 1988 (1512-1555 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: This 12 m high, 80x100 m, granitic rock is generally rounded but is dissected by many cracks and crevices. Tufts of herbaceous vegetation grow in higher fissures.

Nesting species:

Black Oystercatcher: One nest with one egg and two empty scrapes were found. Nests were made of gooseneck barnacle, limpet and mussel shells.

Glaucous-winged Gull: A total of 29 gull nests were counted: 2 starts, 10 empty, 2 with 1 egg, 5 with 2 eggs, 9 with 3 eggs, and 1 with 2 eggs and 1 hatched eggshell. Most nests were made of grass, some with forbs, and a few lower nests were built exclusively of seaweeds.

Pigeon Guillemot: Eight birds were seen and two nests confirmed: one with one egg, and one with adult flying out.

Associated species:

Pelagic Cormorant - 9 in breeding and 38 in nonbreeding plumage roosting.

Common Murre - 5

Ancient Murrelet - 1 adult and 1 full grown juvenile off north end.

Rhinoceros Auklet - 33 off north side.

Other birds and mammals sighted:

Pacific Loon *Gavia arctica* - 400 in winter plumage to north.

Harlequin Duck - 5

Surfbird *Aphriza virgata* - 2

Western Sandpiper *Calidris mauri* - 9

Short-billed Dowitcher *Limnodromus griseus* - 2 in summer plumage.

California Gull - 400 second and third year birds.

WV-060 HACKETT ISLAND 92 L/4

Location: North side of the Brooks Peninsula. 50°11'N 127°51'38"W

Land status: Crown land.

Date of visit: 9 July 1988 (1625-1630 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Boat around island.

Description: Hackett is a 4.4 ha forested island, rising to 56 m elevation, with dense shrub understory and steep rocky shores.

Nesting species: No seabirds were seen from the water.

Associated species:

Marbled Murrelet - 2 to north.

Rhinoceros Auklet - 1 to north.

Tufted Puffin - 1 to north.

Other birds and mammals sighted:

Pacific Loon - 70 in winter plumage to north.

WV-070 GUILLIAMS ISLAND 92 L/4

Location: North side of the Brooks Peninsula. 50°10'40"N 127°51'06"W

Land status: Crown land.

Date of visit: 9 July 1988 (1635-1650 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Boat around island.

Description: Dense salal under spruce covers most of the island above the rocky shoreline. The island rises to 26 m elevation and has an area of 4.0 ha.

Nesting species:

Black Oystercatcher: Four birds were foraging in tidal areas on the south side of the island. There was no indication of nesting, though we did not land.

Associated species:

Pelagic Cormorant - 1 in breeding and 1 in nonbreeding plumage roosting.

Bald Eagle - 1 adult.

Marbled Murrelet - 49 from Guilliams Island to Cape Cook.

Tufted Puffin - 1 to west.

Other birds and mammals sighted:

Pacific Loon - 200 birds in winter plumage to west.

Harbour Seal - 4 with 1 pup.

WV-080 SOLANDER ISLAND 92 L/4

Location: Off the western tip of the Brooks Peninsula. 50°06'45"N 127°56'15"W

Land status: Provincial Ecological Reserve.

Date of visit: 8,9 July 1988; 28-30 May 1989.

Colony access: Drop-off from boat.

Base camp: Excellent camping on beaches on the north side of the Brooks Peninsula.

Observers: 1988: M. Lemon, M. Rodway, B. Carter, M. Force; 1989: M. Rodway, B. Carter, D. Grinnell.

Census method: 1988: Line transects: 42 quadrats, 1x1 m, surveyed at 5 m intervals along transect 1, and 19 quadrats, 1x1 m, surveyed at 15 m intervals along transect 2 (Fig. WV080-1; Table WV080-1). Plot spacing was increased along transect 2 because of time constraints and deteriorating weather conditions. All storm-petrel burrows within plots, plus a few just outside plots, were examined to determine storm-petrel occupancy. Extremely fragile burrows were not disturbed. Occupancy rate for other species was not determined.

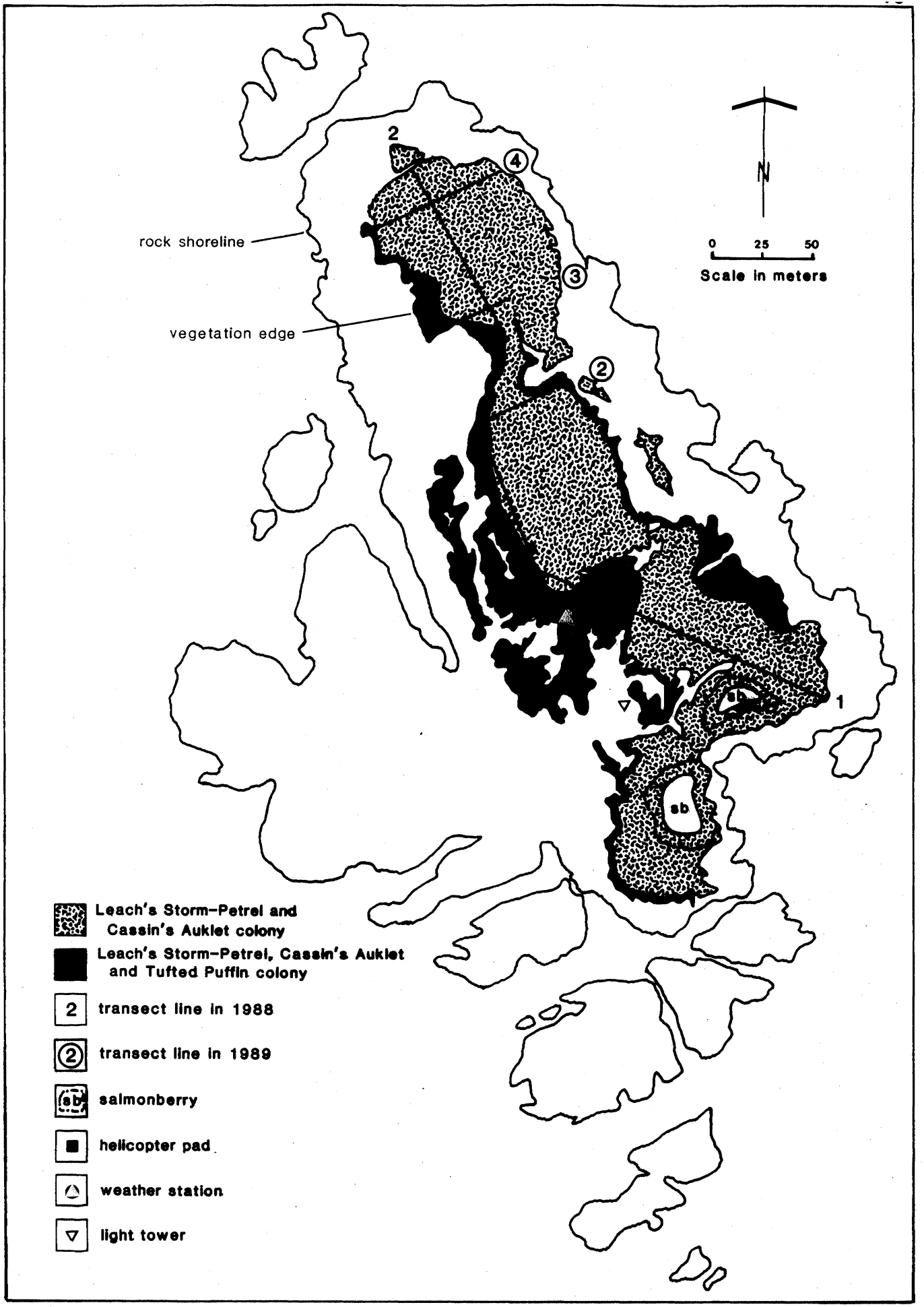

Figure WV080-1. Seabird colony areas on Solander Island in 1988 and 1989.

All cormorant nests were counted; numbers of gull nests were estimated from counts of adults on territories.

1989: Line transects: 67 quadrats, 2x2 m, surveyed at 5 m intervals along four transects (Fig. WV080-1; Table WV080-1). For Cassin's Auklet occupancy, the contents of five burrows were determined in each of 10 randomly chosen plots. Every Tufted Puffin burrow encountered within plots was explored for occupancy. The contents of 26 arbitrarily chosen storm-petrel burrows were determined.

Table WV080-1. Transect parameters on Solander Island in 1988 and 1989.

Transect	Bearing (°)	Total length (m)	Elevation (m) Beg.	End	Max.	Average slope (°)	Range of slope (°)
1988:							
1	295	206	12	80	85	29	7-36
2	150[a]	283	20	84	86	16	0-37
1989:							
1	295	204	12	80	85	29	17-41
2	246	45	40	57	60	33	26-40
3	246	23	20	30	30	25	0-45
4	246	57	35	30	40	33	28-42

[a] bearing jogged to follow ridge line (see Fig. WV080-1).

Description: Solander Island is a monumental island, with precipitous rocky faces and steep grassy slopes culminating in a conical rocky peak at 94 m elevation. It has a total area of 7.7 ha, 3.4 ha of which are vegetated. Deeply creviced pinnacles of rock are attached to the south and west sides, and an isolated rock lies off the northwest corner. Grass covers most of the more moderate northern, eastern and southern slopes, extending over the rounded ridge-line north of the rocky crest and down small portions of the western face where soil has collected. Grass is primarily *Calamagrostis nutkaensis*, with *Deschampsia caepitosa* on edges above cliffs or rock outcroppings. *Montia* grows over worn areas amongst the grass, and scattered pockets of *Angelica* occur on upper slopes. There is a large patch of salmonberry on the south slope, and few, sporadic, short salmonberry mix with the grass in other areas.

There is a navigation beacon on the peak of the island, and an automated weather station, established in 1984, on the ridge just north of it. Solander Island was established as a Provincial Ecological Reserve in 1971.

Nesting species:

All burrowing species were nesting in similar areas in 1988 and 1989. Burrow densities between years were not significantly different for any species (Kruskal-Wallis results: $p > 0.1$), though densities were lower for all species. Sampling intensity was higher in 1989 than 1988, and we suspect burrow density estimates from 1989 were more accurate than from 1988. Transects were more uniformly spaced through colony areas in 1989, and probably provided a more representative sample of the colony than those in 1988.

Fork-tailed Storm-Petrel: No evidence of nesting by Fork-tailed Storm-Petrels was found in 1988 or 1989.

Leach's Storm-Petrel: Leach's Storm-Petrels were nesting in all grassy areas and as far as 10 m into the solid patch of salmonberry on the south end of the island (Fig. WV080-1). Burrows were most abundant on the east slope of the main section of the island (Tables WV080-2, WV080-4). Length of explored burrows averaged 37 ± 1 cm in 1988 (range = 15-70 cm; n = 72).

Most birds were incubating at the time of our visit in 1988; only one chick had hatched (Table WV080-3). In 1989, about half the birds investigated had not yet laid eggs (Table WV080-5). More burrows were examined to determine occupancy rate in 1988 than in 1989, and we prefer to use the 1988 rate for the 1989 population estimate rather than the rate of 100% determined in 1989.

1988 Population estimate:

Number of sample plots:	60 (60 m^2 - 0.2% of colony)
Average density:	22,500 ± 2360 burrows/ha
Colony area:	3.4 ha
Total burrows:	76,500 ± 8024
1988 Occupancy rate:	97.4 ± 1.8% (74 of 76 known)
1988 Nesting population:	74,511 ± 7938 pairs

1989 Population estimate:

Number of sample plots:	67 (268 m^2 - 0.8% of colony)
Average density:	20,970 ± 1718 burrows/ha
Colony area:	3.4 ha
Total burrows:	71,629 ± 5868
1989 Occupancy rate:	100% (26 of 26 known)
Use 1988 occupancy rate of:	97.4 ± 1.8% (74 of 76 known)
1989 nesting population:	69,767 ± 5858 pairs

Table WV080-2. Number of storm-petrel burrows in 1x1 m plots along transects on Solander Island in 1988. Plots considered outside the colony are indicated by a dash.

Transect 1				Transect 2	
Plot	Burrows	Plot	Burrows	Plot	Burrows
1	5	22	3	1	2
2	3	23	4	2	2
3	2	24	3	3	2
4	6	25	3	4	2
5	5	26	2	5	1
6	4	27	2	6	0
7	2	28	0	7	4
8	6	29	4	8	1
9	3	30	0	9	0
10	1	31	0	10	1
11	4	32	1	11	4
12	6	33	2	12	1
13	2	34	2	13	2
14	7	35	0	14	1
15	1	36	3	15	3
16	5	37	1	16	-
17	2	38	0	17	3
18	2	39	0	18	1
19	1	40	3	19	0
20	0	41	0		
21	5	42	0		

Table WV080-3. Occupancy of storm-petrel burrows along transects on Solander Island in 1988. Locations marked with an asterisk were in the vicinity of the listed plots.

Location			Leach's Storm-Petrel								
Tran	Plot	Empty	Two adults	One adult	Adult + egg	Adult+ chick	Warm egg	Cold egg	Unid. adult	Total occup.	Total known
1	1			1					1	2	2
1	2			1						1	1
1	3*				1					1	1
1	4				5					5	5
1	5				2		1			3	3
1	5*				3			1		4	4
1	6				4					4	4
1	7				2					2	2
1	8	1			3					3	4
1	9				3					3	3
1	11						1			1	1
1	12				2	1			1	4	4
1	13		1		1					2	2
1	14				3		1			4	4
1	16		1							1	1
1	17				1					1	1
1	18				1					1	1
1	19				1					1	1
1	21				1		1			2	2
1	22				2					2	2
1	23				1					1	1
1	24				1					1	1
1	25			1	1					2	2
1	27				1					1	1
1	29				1			1		2	2
1	32				1					1	1
1	33			1	1					2	2
1	34				1					1	1
1	36				1				1	2	2
2	1			1	1					2	2
2	2				2					2	2
2	4				1					1	1
2	7	1								0	1
2	10				1					1	1
2	11			1	2					3	3
2	12				1					1	1
2	13								1[a]	1	1
2	15				1		1			2	2
2	17								1[a]	1	1
Total		2	2	6	53	1	5	2	5	74	76

[a] incubating.

Table WV080-4. Number of storm-petrel, Cassin's Auklet and Tufted Puffin burrows in 2x2 m plots along transects on Solander Island in 1989. Plots considered outside colony are indicated by a dash.

	Storm-petrel				Cassin's Auklet				Tufted Puffin			
Plot	Transect				Transect				Transect			
	1	2	3	4	1	2	3	4	1	2	3	4
1	1	6	11	0	11	1	0	0	-	1	-	-
2	16	12	0	0	4	2	0	0	-	-	-	-
3	11	16	4	0	9	0	0	0	-	-	-	-
4	7	15	5	8	3	4	6	0	-	-	-	-
5	7	20	3	9	5	4	6	0	-	-	-	-
6	13	19		8	5	4		3	-	-		-
7	15	10		2	4	5		1	-	-		-
8	18	10		1	4	4		0	-	-		-
9	17	13		0	3	3		0	-	2		-
10	14			4	5			3	-			0
11	22			7	7			0	-			0
12	19			3	7			1	-			2
13	10				4				-			
14	12				3				-			
15	10				11				-			
16	8				11				-			
17	8				13				-			
18	5				16				-			
19	3				11				-			
20	7				10				-			
21	10				10				-			
22	12				11				-			
23	15				14				-			
24	7				8				-			
25	0				5				-			
26	3				9				2			
27	2				10				1			
28	9				5				1			
29	6				6				1			
30	4				4				3			
31	4				0				2			
32	3				2				2			
33	8				5				0			
34	9				4				0			
35	10				3				0			
36	13				6				1			
37	4				5				-			
38	8				6				0			
39	7				4				3			
40	15				1				3			
41	4				4				4			

Table WV080-5. Occupancy of storm-petrel burrows along transects on Solander Island in 1989.

Location			Leach's Storm-Petrel					
Transect	Plot	Empty	Two adults	One adult	Adult + egg	Cold egg	Total occup.	Total known
1	2		1	1	1		3	3
1	3		1				1	1
1	5				1		1	1
1	7					1	1	1
1	8				2		2	2
1	9				3		3	3
1	37			1			1	1
1	38			1			1	1
1	40			3		1	4	4
2	1			1	1	1	3	3
2	5					1	1	1
3	4			1 (dead)			1	1
4	4			1	1		2	2
4	10		1				1	1
4	12			1			1	1
Total		0	3	10	9	4	26	26

Pelagic Cormorant: We counted 464 nests with adults sitting on them in 1988. Eggs were visible in some nests. Nests were distributed on rocks and cliffs along the west, south and north sides of the island. Some nests (126) were on east faces of west rocks and were visible only from the top of the island. Counts conducted from the water would not detect nests in those areas.

Nest building was in progress when we visited the island in 1989. Breeding birds were attending and constructing nests in most areas where they had been located in 1988, as well as on the southeast corner of the island, near the beginning of transect 1, where they had not been in 1988.

We observed three incidents of disturbance to cormorants while we were conducting surveys in 1989: two airforce jets and one Coast Guard helicopter passing Cape Cook put all cormorants on the east side of the island into the air. They reacted similarly to the approach of our boat.

Black Oystercatcher: There were two adults flying around the island in 1988. We found one nest with three eggs on the southwest rock in 1989. The nest was made mostly of rock chips with few shells. A maximum of three adults were flying around the island.

Glaucous-winged Gull: Gulls were nesting in all rocky areas around and on top of the island. We counted 693 adults on territories in 1988 and estimated a nesting population of 347 pairs. Fifty-three accessible nests on the top of the island were inspected: empty - 16; 1 egg - 7; 2 eggs - 8; 3 eggs - 20; 1 egg 2 young - 1; 2 eggs 1 young - 1.

In 1989, nests were under construction at the time of our visit, though we did find two nests with one egg each and one nest with three eggs. No population estimate was made.

Pigeon Guillemot: Maximum numbers counted around the island were 60 in 1988 and 107 in 1989. One adult was seen in a crevice near the top of the north face of the main section of the island in 1988.

Cassin's Auklet: Cassin's Auklets were burrowing in all grassy areas and as far as 10 m into the thick patch of salmonberry on the south side of the island (Fig. WV080-1). Distribution and burrow density were similar in 1988 and 1989 (see above). As with storm-petrels, burrows were most frequent on the east slope of the main section of the island (Tables WV080-6, WV080-4). Mean length of burrows examined in 1989 was 71 ± 3 cm (range = 30-130 cm; n = 48).

Chicks had fledged from 26 of 30 burrows examined in 1988; four burrows still held large chicks. We did not attempt to determine an occupancy rate in 1988. In 1989, chicks had hatched in most burrows explored. Chicks were small - about a third were still accompanied by an adult (Table WV080-7).

1988 Population estimate:

Number of sample plots:	60 (60 m^2 - 0.2% of colony)
Average density:	17,333 ± 2043 burrows/ha
Colony area:	3.4 ha
Total burrows:	58,932 ± 6946
1988 Occupancy rate:	not determined

1989 Population estimate:

Number of sample plots:	67 (268 m^2 - 0.8% of colony)
Average density:	11,754 ± 1198 burrows/ha
Colony area:	3.4 ha
Total burrows:	40,149 ± 4092
1989 Occupancy rate:	84.4 ± 6.5% (38 of 45 known)
1989 nesting population:	33,886 ± 4321 pairs

Table WV080-6. Number of Cassin's Auklet burrows in 1x1 m plots along transects on Solander Island in 1988.

Transect 1				Transect 2	
Plot	Burrows	Plot	Burrows	Plot	Burrows
1	1	22	3	1	0
2	1	23	4	2	0
3	1	24	3	3	1
4	0	25	4	4	1
5	0	26	2	5	1
6	2	27	2	6	0
7	0	28	5	7	0
8	1	29	1	8	1
9	0	30	1	9	4
10	3	31	1	10	0
11	3	32	0	11	1
12	1	33	1	12	0
13	4	34	1	13	3
14	1	35	0	14	2
15	5	36	1	15	2
16	4	37	2	16	-[a]
17	3	38	0	17	3
18	2	39	2	18	2
19	5	40	2	19	0
20	6	41	4		
21	1	42	0		

[a] plot on helicopter pad

Table WV080-7. Occupancy of Cassin's Auklet burrows along transects on Solander Island in 1989. Only samples with five burrows each were used to calculate an occupancy rate. Contents of other burrows listed were determined incidentally.

Transect	Plot	Empty	Cold egg	Adult	Adult + egg	Adult + chick	Chick	Total occup.	Total known
1	2	1			1		3	4	5
1	11		1	1			3	5	5
1	13	1			1	2	1	4	5
1	32	3				2		2	5
1	37				2		3	5	5
1	40					2	3	5	5
2	7	1		1		2	1	4	5
3	4	1					4	4	5
4	6				1	1	3	5	5
4	7						1		
4	10				1				
Total		7	1	2	6	9	22	38	45
Incidental burrows:									
1	3		1				1		
1	5					1			
1	20		1						
2	2		1						
Overall total		7	4	2	6	10	23		

Tufted Puffin: Puffins were nesting in perimeter grassy areas around the rim of western cliffs, along the break in steep grassy slopes on the mid-east side, and on the east slope of the main section of the island above 70 m elevation (Fig. WV080-1; Tables WV080-8, WV080-4). Distribution and densities were similar in 1988 and 1989 (see above). Length of burrows examined in 1989 averaged 71 ± 9 cm (range = 30-200 cm; n = 19).

At the time of our visit in 1988, we encountered freshly hatched eggshells, suggesting that chicks were just beginning to hatch. In the few burrows explored, adults were incubating eggs, one of which was pipping. No occupancy rate was determined. In 1989, most burrows held incubating birds (Table WV080-9). A maximum of 700 puffins were counted flying around nesting slopes in both years.

1988 Population estimate:

Number of sample plots: 17 (17 m^2 - 0.2% of colony)

Average density: 5882 ± 1500 burrows/ha

Colony area: 1.0 ha

Total burrows: 5860 ± 1494

1988 Occupancy rate: not determined

1989 Population estimate:

Number of sample plots: 20 (80 m^2 - 0.8% of colony)

Average density: 3500 ± 376 burrows/ha

Colony area: 1.0 ha

Total burrows: 3487 ± 375

1989 Occupancy rate: 90.0 ± 6.6% (18 of 20 known)

1989 nesting population: 3138 ± 408 pairs

Table WV080-8. Number of Tufted Puffin burrows in 1x1 m plots along transects on Solander Island in 1988. Plots considered outside the colony are indicated by a dash.

Transect 1		Transect 2	
Plot	Burrows	Plot	Burrows
1-26	-	1-7	-
27	1	8	1
28	0	9	0
29	1	10	0
30	1	11	-
31	0	12	1
32	1	13	-
33	0	14	-
34	0	15	-
35	-	16	-
36	-	17	-
37	-	18	1
38	-	19	0
39	-		
40	1		
41	0		
42	2		

Table WV080-9. Occupancy of Tufted Puffin burrows along transects on Solander Island in 1989.

Transect	Plot	Empty	Adult	Adult + egg	Total occup.	Total known
1	26	1			0	1
1	27		1		1	1
1	28			1	1	1
1	29		1		1	1
1	30			2	2	2
1	31			2	2	2
1	32			2	2	2
1	36			1	1	1
1	39	1	1	1	2	3
1	40		1	2	3	3
1	41		1	1	2	2
2	9		1		1	1
Total		2	6	12	18	20

Horned Puffin: We did not confirm nesting by Horned Puffins, but birds were present both years. We saw six birds in 1988: one pair was sitting on a ledge on the southwest corner of the south bay; one bird was on a ledge on the east side of the west rock; and others were flying around the island. Three birds were on the water along the west side of the island in 1989.

Predation: We saw little evidence of predation in either year.

Associated species:

Bald Eagle - One adult, two subadults, and two immatures were perched on the island on 28 May 1989. No eagles were seen in 1988.

Peregrine Falcon - 1 flying off east and south sides in 1988; 1 pair flying off south cliffs in 1989.

Common Murre - 4 flying by in 1988; 40 in Brooks Bay in 1989.

Ancient Murrelet - 1 full-grown juvenile diving off east side, and 2 adults with 2, two-thirds grown young off Banks Reef, south of Solander in 1988.

Rhinoceros Auklet - 4 flying through south bay in 1988; 200 in Brooks Bay 1989.

Northwestern Crow - 3 dive-bombing gulls on territory in 1988, and 3 present each day in 1989.

Common Raven - 5 flying and calling over island in 1988, and 1 in 1989.

Other birds and mammals sighted:

Pacific Loon - 150 north of Clerke Point in 1988

Common Loon - 1 in winter plumage along north side of Brooks Peninsula in 1989.

Sooty Shearwater - 350 flying southwest out of Brooks Bay at 1900 h on 29 May 1989.

Surf Scoter *Melanitta perspicillata* - 60 flying north in 1989.

White-winged Scoter *M. fusca* - 1 in female plumage in 1988.

Spotted Sandpiper *Actitis macularia* - 1 in 1989.

Whimbrel - 3 along north side of Brooks Peninsula in 1989.

Red-necked Phalarope - 1 along north side of Brooks Peninsula in 1989.

California Gull - 60 flying by in 1988, and two immatures roosting in 1989.

Caspian Tern *Sterna caspia* - 1 flying north in 1988, and 3 flying north together in 1989.

Winter Wren *Troglodytes troglodytes*

Fox Sparrow

Song Sparrow

Pine Siskin *Carduelis pinus*

Northern Sea-lion *Eumetopias jubatus* - 55 on north rocks in 1988, and 41 in 1989.

Sea Otter - 1 in bay on the west tip of Brooks Peninsula south of Solander Island in 1989.

Killer Whale *Orcinus orca* - Family group of 6 swimming north on 29 May 1989.

WV-090 YULE ROCK 92 L/4

Location: West of Acous Peninsula, north of O'Leary Islets. 50°06'39"N 127°38'48"W

Land status: Part of Checleset Bay Ecological Reserve.

Date of visit: 9 July 1988 (1915-1920 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: Yule is a 6 m high rock.

Nesting species: Two Black Oystercatchers were present, but not defensive. No gulls or guillemots were seen.

WV-100 O'LEARY ISLETS 92 L/4

Location: West of Acous Peninsula, south of Nasparti Inlet. 50°06'07"N 127°38'26"W

Land status: Part of Checleset Bay Ecological Reserve.

Date of visit: 9 July 1988 (1925-2000 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: O'Leary Islets are steep, 23 m high, dissected rocks with scant pockets of herbaceous vegetation in higher crevices. Total area is 0.4 ha.

Nesting species:

Pelagic Cormorant: We counted a total of 41 nests, 34 on the west rock and 7 on the east rock. Of the 7 nests on the east rock, 3 were empty, and the rest contained 1, 2, 3, and 4 eggs respectively. The contents of 7 nests were determined on the west rock: 3 with 3 eggs, and 4 with 4 eggs. Ninety-eight cormorants were present, some of which were nonbreeding birds.

Black Oystercatcher: There was one nest with two eggs on the east rock. Two adults were present.

Glaucous-winged Gull: A total of 117 nests were counted (Table WV100-1). Nests were made of grass with some moss, seaweed and salal leaves. We found three broken eggs. All nests with young were on the highest section of the east rock.

Table WV100-1. Glaucous-winged Gull nests on O'Leary Islets in 1988.

	Emp	1E	2E	3E	2E1Y	1E2Y	3Y	2Y	Total
East rock	10	13	21	44	3	1	1	2	95
West rock		5	9	8					22
Total	10	18	30	52	3	1	1	2	117

Pigeon Guillemot: Five birds were around the east rock. We located one nest with two eggs, and one nest with one egg and one young. Two adults flew from crevices in other locations.

Associated species:

Tufted Puffin - 1 flying by.

Other birds and mammals sighted:

Northern Sea-lion - Two large bulls and six females on central tidal rocks.

Sea otter *Enhydris lutris* - 1 amongst central tidal rocks.

WV-110 CUTTLE ISLETS 92 L/4

Including unnamed islets to north.

Location: South and southwest of Acous Peninsula. 50°05'52"N 127°36'W (southern Cuttle Islet) and 50°06'27"N 127°36'55"W (unnamed islet).

Land status: Part of Checleset Bay Ecological Reserve.

Date of visit: 9 July 1988 (2050-2100 h)

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Boat around all islets in area.

Description: The main Cuttle Islets are wooded and have dense understories of salal and other shrubs above rocky shores. The unnamed islet to the northwest is mostly bare rock with grass and forbs on top. The area of all islands is about 7 ha.

Nesting species: No seabirds were seen.

Associated species:

Bald Eagle - One adult perched on outer island.

WV-120 SKIRMISH ISLETS 92 L/4

Location: South of Battle Bay at entrance to Ououkinsh Inlet. 50°06'47"N 127°34'16"W

Land status: Part of Checleset Bay Ecological Reserve.

Date of visit: 9 July 1988 (2100-2120 h)

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: Most islets are forested, but nesting has been recorded only on the small, bare, southern rock.

Nesting species:

Black Oystercatcher: We found one empty scrape of clam, gooseneck barnacle, and mussel shells. There was a depredated egg just below the nest. A flock of seven oystercatchers were roosting.

Associated species:

Bald Eagle - 1 adult.

WV-130 BUNSBY ISLANDS 92 L/4

Location: West of Malksope Inlet. The nesting rock is south of Cautious Point at the southwest corner of the group. 50°04'15"N 127°33'15"W

Land status: Part of Checleset Bay Ecological Reserve.

Date of visit: 9,10 July 1988. The gull rock was surveyed at 1500-1610 h on 10 July. We camped on the southwest forested island of the group.

Colony access: Boat landings on many beaches within the group, as well as on shell beaches on the gull rock.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count on gull rock; boat around all other islands.

Description: Most islands are wooded. The southern rock is a series of extensive, low (5 m high), flat reefs connected by a broad, central shell beach. Pockets of *Elymus* and *Angelica* grow in interior areas. Driftwood is scattered about.

Nesting species: Nesting occurred only on the gull rock off the southwest corner of the Bunsby Islands.

Black Oystercatcher: We estimated 7 pairs of oystercatchers nesting around the shell beach. We found 2 nests with 3 eggs, one nest with 1 egg, and 11 empty scrapes that appeared to represent four territories. Twelve adults were counted.

Glaucous-winged Gull: A total of 124 nests were counted on the southwest rock (Table WV130-1). Nests were composed primarily of grass with some forbs. Gulls nesting on lower sections of the rock were building nests of seaweed. Most birds were incubating full clutches, but many chicks had hatched and numerous eggs were pipping. We found five depredated eggs. We counted 257 immatures roosting.

Table WV130-1. Glaucous-winged Gull nests on the southwest rock of the Bunsby Islands in 1988.

Emp	1E	2E	3E	4E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	Total
21	8	13	51	1	3	7	1	7	6	6	124

Associated species:

Leach's Storm-Petrel - Two or three birds were heard calling around camp at 2400 h. No evidence of nesting was found.

Glaucous-winged/Western Gull hybrid - 3 third-year birds roosting on gull rock.

Marbled Murrelet - 30 along south side of Bunsby Islands.

River otter - Trails and scats of fish on the gull rock.

Other birds and mammals sighted:

Great Blue Heron *Ardea herodius* - 1 in channel in middle of group.

Brant *Branta bernicla* - 12 flying by.

Harlequin Duck - 2 in female plumage around gull rock.

Western Sandpiper - 7 on gull rock.

California Gull - 35 immatures roosting on gull rock.

Black Swift *Cypseloides niger* - 1 flying over.

Belted Kingfisher *Ceryle alcyon* - 1 in middle of group.

Chestnut-backed Chickadee *Parus rufescens*

Brown Creeper *Certhia americana*

Winter Wren

Swainson's Thrush *Catharus ustulatus*

Townsend's Warbler *Dendroica townsendi*

Red Crossbill *Loxia curvirostra*

Sea Otter - At least 4 seen; 1 with a pup.

WV-140 CLARA ISLET 92 L/4

Including rocks south of Clara Islet.

Location: Southwest of Bunsby Islands at the northwest end of the Barrier Islands. 50°04'22"N 127°35'10"W

Land status: Part of Checleset Bay Ecological Reserve.

Date of visit: 10 July 1988 (1155-1410 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: This cluster of exposed, bare rocks, rise to a maximum elevation of 14 m.

Nesting species:

Black Oystercatcher: We found two nests with one egg and one empty nest on Clara Islet, and another empty nest on the 46' rock at the southeast end of the chain. All four nests were made solely of rock chips.

Glaucous-winged Gull: Gulls were nesting on five rocks in the Clara Islet chain (Table WV140-1). Most birds were incubating full clutches; few chicks had hatched. Nests were made of seaweeds, surfgrass, grass, redcedar fronds, and small sticks. We found seven depredated eggs. There were 250 immatures roosting on low rocks.

Table WV140-1. Glaucous-winged Gull nests on Clara Islet and the rocks south of it in 1988.

	Emp	1E	2E	3E	4E	1E2Y	2Y	1Y	Total
Clara Islet	1	4	3	28	1		1		38
37' rock	1	1		5					7
36' rock	1	3	4	26		1	1	1	37
30' rock			3	7					10
46' rock				1					1
Total	3	8	10	67	1	1	2	1	93

Pigeon Guillemot: We found one nest containing one chick and one pipping egg on Clara Islet, and one nest with one egg and another with two eggs on the 36' rock south of Clara Islet. A total of 29 adults were counted around the rocks.

Associated species:

Brandt's Cormorant *Phalacrocorax penicillatus* - 1 nonbreeding flying by.

Pelagic Cormorant - 38 nonbreeding.

Common Murre - 13 on water.

Marbled Murrelet - 2 in summer plumage.

Ancient Murrelet - 2 juveniles diving.

Tufted Puffin - 5 in feeding ball.

Other birds and mammals sighted:

Sooty Shearwater *Puffinus griseus* - There were constant streams of shearwaters flying north. We identified 36 Sooty Shearwaters flying plus 120 sitting on the water.

Harlequin Duck - 44

Black Turnstone - 6

Western Sandpiper - 5

California Gull - 1 third-year bird.

Sea Otter - 15

Harbour Seal - 15 plus 1 pup.

WV-150 THOMAS ISLAND 92 L/3

Location: South of the entrance to Malksope Inlet. 50°03'35"N 127°28'54"W

Land status: Part of Checleset Bay Ecological Reserve.

Date of visit: 11 July 1988 (1150-1630 h).

Colony access: Drop-off from boat; possible boat landing on north beach.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force, H. Hay.

Census method: Line transects: 12 quadrats, 2x2 m, surveyed at 15 m intervals along three parallel transects (Fig. WV150-1). Transects were spaced 75 m apart and were run at a bearing of 247°. Transects 1,2 and 3 were 56, 83 and 35 m long respectively. All storm-petrel burrows within plots were examined to determine occupancy. Total counts were made of gulls and oystercatchers.

Description: Thomas Island has steep, rocky shores with a sea-cave cutting through the island from east to west. There are small knolls connected by a boulder beach on the northeast corner, and an extensive tidal area stetches to a small islet further north. The island rises to a maximum elevation of 44 m, and has a total area of 2.0 ha, 1.2 ha of which are vegetated. The understory of the spruce forest varies. Thick salal, mixed with willow

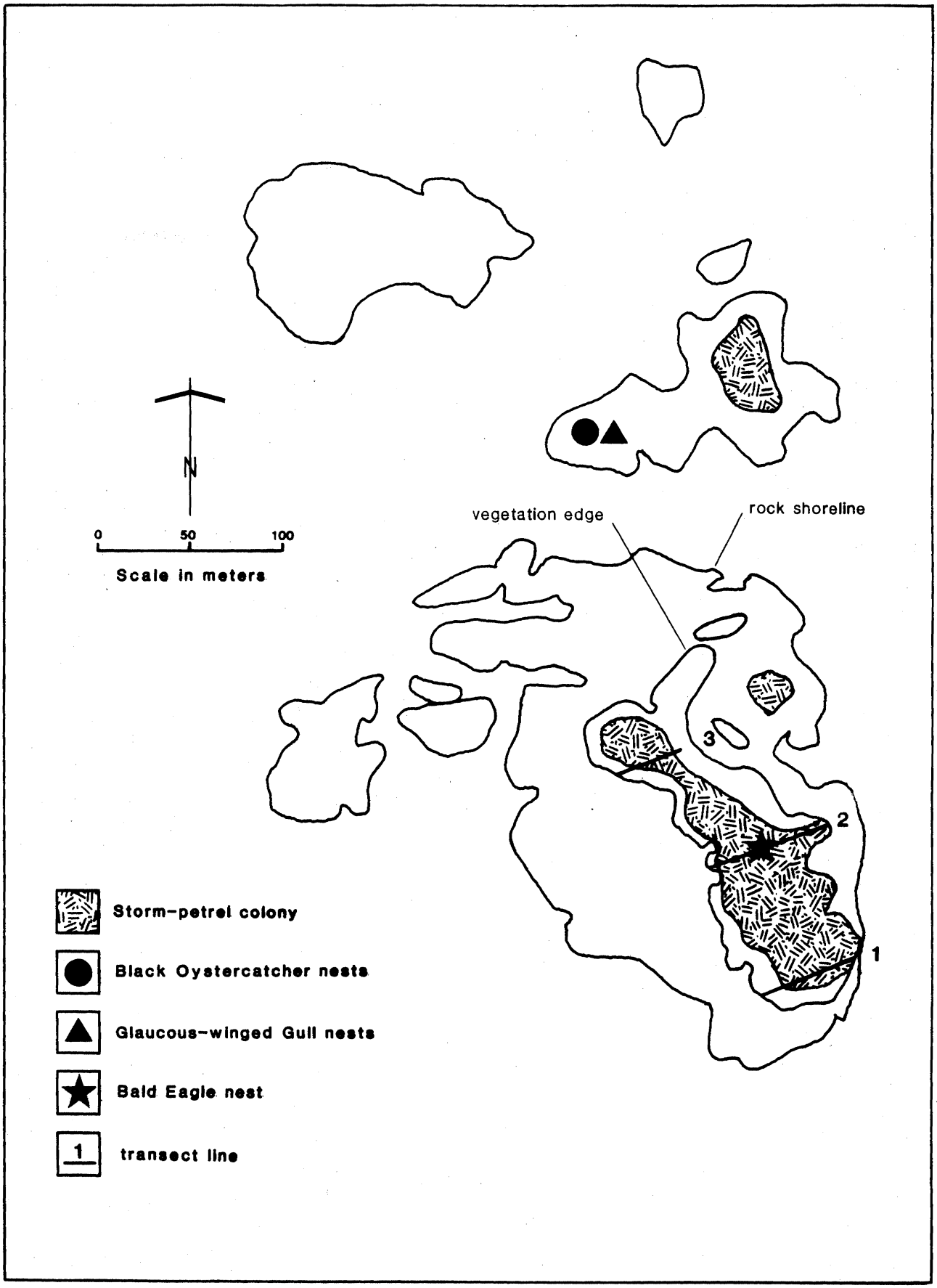

Figure WV150-1. Seabird colony areas on Thomas Island in 1988.

(*Salix* sp.), twinberry (*Lonicera involucrata*) and thimbleberry (*Rubus parviflorus*) covers south, west and north slopes, plus the northern end of the east side. The southern half of the east side has more open habitat with grass above the steep shore rock, changing to *Maianthemum* and *Montia* further inland, and then to sparse salmonberry, which extends over the middle of the island. Much of the salmonberry had wilted leaves and little green growth. Except for the rocky area on the north islet, thick shrubs under spruce cover the northern knolls.

Nesting species:

Fork-tailed Storm-Petrel: We found no evidence of this species in 1988, though they had been confirmed nesting in 1975 (Campbell 1976), and seven adults with brood patches were mist-netted in 1985 (Kaiser unpubl.).

Leach's Storm-Petrel: Leach's Storm-Petrels were nesting over much of the vegetated area, but were absent from perimeter sections where salal and other shrubs were especially dense (Fig. WV150-1). Burrows were most abundant on the east side in grass and *Maianthemum* habitat (Table WV150-1). Birds were incubating at the time of our survey; no chicks were found (Table WV150-2).

1988 Population estimate:

Number of sample plots:	9 (36 m^2 - 0.5% of colony)
Average density:	10,833 ± 3118 burrows/ha
Colony area:	0.79 ha
Total burrows:	8,552 ± 2461
1988 Occupancy rate:	84.6 ± 3.0% (22 of 26 known)
1988 Nesting population:	7,269 ± 2107 pairs

Table WV150-1. Number of storm-petrel burrows in 2x2 m plots along transects on Thomas Island in 1989. Plots considered outside the colony are indicated by a dash.

Plot	Transect		
	1	2	3
1	6	4	-
2	4	11	1
3	1	9	-
4	-	3	
5		0	
6		-	

Table WV150-2. Occupancy of storm-petrel burrows along transects on Thomas Island in 1989.

Location			Leach's Storm-Petrel				
Transect	Plot	Empty	Adult + egg	Warm egg	Cold egg	Total occup.	Total known
1	1	1	2	1	1	4	5
1	2		2		1	3	3
2	1		1			1	1
2	2	2	8			8	10
2	3	1	5			5	6
2	4		1			1	1
Total		4	19	1	2	22	26

Black Oystercatcher: Ten oystercatcher nests were located on the northeast rock: 5 empty scrapes; 2 with 1 egg; and 2 with 2 eggs. One depredated egg was found.

Glaucous-winged Gull: There were seven gull nests on the northeast rock: 3 only partially constructed; and 4 empty. Two depredated eggs were found.

Pigeon Guillemot: Sixteen guillemots were sitting on rocks and on the water along the east side of the island. No nests were found.

Predation:

Evidence of predation on Leach's Storm-Petrels was abundant. During our exploration of the island, we counted 77 single wings, one attached pair of wings, five feather piles, and 27 burrows that had been partially dug-up. Five of the 12 plots surveyed along transects contained prey remains, which totalled six single wings and one pair of wings. Those remains were considered to represent a minimum of five birds, which, if extrapolated gives a density of 1042 ± 372 dead birds/ha, or a total estimate of 823 ± 294 Leach's Storm-Petrels preyed upon at the time of our survey.

Judging from scats and dug-up burrows, river otters and mink were thought to be responsible for most of the predation. Petrel wings were also found under the Bald Eagle nest.

Associated species:

Bald Eagle - One nest 20 m high in 25 m spruce at 40 m along transect 2. One full grown young was standing in the nest and one adult was perched nearby.

Marbled Murrelet - 14 in summer plumage to the north.

Northwestern Crow - 1 young heard calling.

Mink - Small scats of feathers, fish bones and crab shells found near the south end of the island were thought to be of mink.

River Otter - We found one den under a fallen spruce near the beginning of transect 3, and well trodden pathways in other areas. Numerous old and fresh scats were full of petrel feathers.

Other birds and mammals sighted:

Rufous Hummingbird *Selasphorus rufus*

Song Sparrow

WV-160 "ST. PAULS" ISLETS 92 L/3

Location: West of St. Pauls Dome, east of Thomas Island. 50°03'27"N 127°27'20"W

Land status: Part of Checleset Bay Ecological Reserve.

Date of visit: 11 July 1988 (1640 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Boat around islets.

Description: Salal and salmonberry grow on higher rocks, which reach 14 m elevation.

Nesting species: No seabirds were seen around the islets.

WV-170 "FAVOURITE" ISLETS 92 L/3

Location: Either side of Favourite Entrance south of Kamils Anchorage.
49°59'40"N 127°23'50"W (west island)

Land status: Crown land.

Date of visit: 11 July 1988 (1700-1730 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Boat around islets.

Description: The 5.3 ha wooded island on the west side of Favourite Entrance has a rocky shoreline with rocky promontories and small beaches. Lower islets to the east are rocky with scant vegetation and comprise an area of 0.5 ha.

Nesting species: No sign of nesting seabirds was seen.

Associated species:

Pelagic Cormorant - 26 nonbreeding birds roosting.

Glaucous-winged Gull - 14 adults scattered around tidal rocks.

Common Murre - 4 in summer plumage on the water.

Pigeon Guillemot - 5 offshore.

Marbled Murrelet - 86 in summer plumage on the water.

Northwestern Crow - 5 flying.

Other birds and mammals sighted:

White-winged Scoter - 25 on water.

WV-180 "AMOS" REEFS 92 L/3

Location: Southeast of Amos Island in Nicolaye Channel. 50°00'34"N 127°20'25"W

Land status: Crown land.

Date of visit: 15 July 1988 (1610 and 1930-1940 h).

Colony access: Drop-off from boat.

Observers: M. Rodway.

Census method: Exploration.

Description: "Amos" Reefs are 15 m high rock bluffs.

Nesting species: No seabirds were nesting.

Associated species:

Pelagic Cormorant: Four birds in breeding plumage plus 39 nonbreeding birds were roosting, but no nests were located.

Glaucous-winged Gull - One adult was standing on the top of the rock, but quickly flew off. There was no sign of nesting.

WV-190 HOHOAE ISLAND 92 L/3

Location: Northwest of Union Island. Cliffs are on the southwest side of the island. 50°02'N 127°13'15"W

Land status: Crown land.

Date of visit: 15 July 1988 (1540-1550 h).

Colony access: Cliffs can be inspected from the water.

Observers: M. Rodway.

Census method: Inspection from boat.

Description: The nesting area is on 30 m high cliffs.

Nesting species:

Pelagic Cormorant: There were two recently constructed nests with signs of recent activity on the cliffs, but no cormorants were in the vicinity.

WV-200 WHITE CLIFF HEAD 92 E/14

Location: South tip of Union Island. 49°58'25"N 127°16'54"W

Land status: Crown land.

Date of visit: 15 July 1988 (1515-1530 h).

Colony access: Cliffs can be inspected from the water.

Observers: M. Rodway.

Census method: Inspection from boat.

Description: The 30 m high cliffs are deeply dissected.

Nesting species:

Pelagic Cormorant: One bird was sitting on a nest in an obscured crevice. No other birds were present.

Other birds and mammals sighted:

Wandering Tattler *Heteroscelus incanus* - 1 on low rocks.

WV-210 MOOS ISLET 92 E/14

Including unnamed rocks off the north and east sides.

Location: West of Kyuquot Bay on the south end of Union Island. 49°58'30"N 127°19'07"W

Land status: Crown land.

Date of visit: 15 July 1988 (2005-2130 h - count on outer rocks), 17 July (1420-1515 h - exploration of main islet).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Exploration and total count.

Description: Moos Islet has an area of 2.8 ha and rises to a maximum elevation of 32 m. A sparse spruce forest extends over the undulating top of the islet above a steep, convoluted, rocky shoreline. Salmonberry and salal are dense in valleys and along perimeters. Wild rose (*Rosa* sp.) is also abundant along the west side. Open areas of grass, bracken (*Pteridium aquilinum*) and *Maianthemum* occur in the southern interior and along the east side. Offshore rocks are mainly bare with pockets of grass and forbs on higher sections.

Nesting species:

Leach's Storm-Petrel: Four old Leach's Storm-Petrel wings, and two possible old burrows were discovered, but no sign of current nesting was observed. Nesting was confirmed in 1975 (Campbell 1976) and 1982 (Kaiser unpubl.). Intensive predation by river otters was suspected in both years.

Pelagic Cormorant: One bird in breeding plumage was roosting on the rocks northeast of Moos Islet, but no nests were found.

Black Oystercatcher: We located a total of 17 oystercatcher nests on the rocks off Moos Islet (Table WV210-1). Most nests were made of rock chips; some also contained limpet, barnacle and mussel shells.

Table WV210-1. Black Oystercatcher nests on Moos Islet in 1988.

	Contents								
Area	Empty	1E	2E	1E2Y	1E1Y	3Y	2Y	1Y	Total
Northeast rocks	3	1	1			2[a]		2[b]	9
West rocks	3	1		1	1		1	1	8
Total	6	2	1	1	1	2	1	3	17

[a] one chick was dead in one nest.
[b] chick was dead in one nest; only freshly hatched eggshell was found in other nest.

Glaucous-winged Gull: A total of 148 nests were counted on the rocks off Moos Islet and on the southwest corner of the main islet (Table WV210-2). Nests were built of grass with some seaweed in lower nests. The majority of young had hatched. We found three dead chicks and two broken eggs.

Table WV210-2. Glaucous-winged Gull nests on Moos Islet in 1988.

	Contents											
Area	Empty unused	Empty used[a]	1E	2E	3E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	Total
Northeast rocks	1	4	6	9	29	6	9	4	13	10	9	100
West rocks	2	5	1	3	8		3		10	5	8	45
SW end of main islet	1				2							3
Total	4	9	7	12	39	6	12	4	23	15	17	148

[a] obviously trampled by chicks.

Pigeon Guillemot: Five guillemots were seen around the offshore rocks. Nesting was suspected but not confirmed.

Tufted Puffin - No puffins were seen.

Associated species:

Bald Eagle - One nest 20 m high in 25 m spruce, 20 m from shore on the east side of the island towards the north end. Two adults perched nearby.

Marbled Murrelet - Four birds were seen off the northeast rock - three were carrying fish.

Ancient Murrelet - 2 adults on water.

Northwestern Crow - 6

River Otter - Runways and scats of fish observed.

Other birds and mammals sighted:

Wandering Tattler - 1

Black Turnstone - 32

Surfbird - 1

Western Sandpiper - 1

Dowitcher sp. - 2

Winter Wren

Song Sparrow

Fox Sparrow

WV-220 THORNTON ISLANDS 92 E/14

Including rock to the south.

Location: Southwest of Union Island, southwest of Moos Islet. 49°57'52"N 127°20'34"W

Land status: Crown land.

Date of visit: 11-17 July 1988 (base camp): 13 July - exploration; 14 July - transect for storm-petrels; 14,15 July - total count for surface-nesters.

Colony access: Boat landing on beaches at north end; drop-off from boat for isolated north and south rocks.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Line transects: 5 quadrats, 2x2 m, surveyed at 10 m intervals along one transect run at a bearing of 325° through the storm-petrel colony (Fig. WV220-1). The transect was 47 m long, and slope within the plots averaged 10° (range = 0-15°). The width of the colony perpendicular to the transect was measured at 10 and 30 m along the transect. Total counts were made of cormorant, oystercatcher and gull nests.

Description: Thornton Islands are composed of round-topped, steep-sided, granitic rock cut by many crevices and cliffs. The southern peninsula of the main island, and most areas on the north and west islets are bare rock, with few pockets of herbaceous vegetation. Beach and tidal rock join the closer, northern islets to the main island. The higher portion of the main island, which rises to 38 m elevation, is arranged in a cross-like pattern, with intersecting valleys, forested with spruce, running between rocky domes. Tops and outer faces of these domes are primarily bare, or have scant vegetation over shallow soil, while interior facing slopes are covered with thick salal. Overall, 2.1 ha are vegetated, of the total area of 8.9 ha. Most of the east-west running valley is wet and supports an extensive bed of sedge and salmonberry. There is an open, drier area of grass, *Maianthemum* and *Montia* in the southern facing valley.

A small cabin, built by G. Sirk, sits perched on the north corner of the main island.

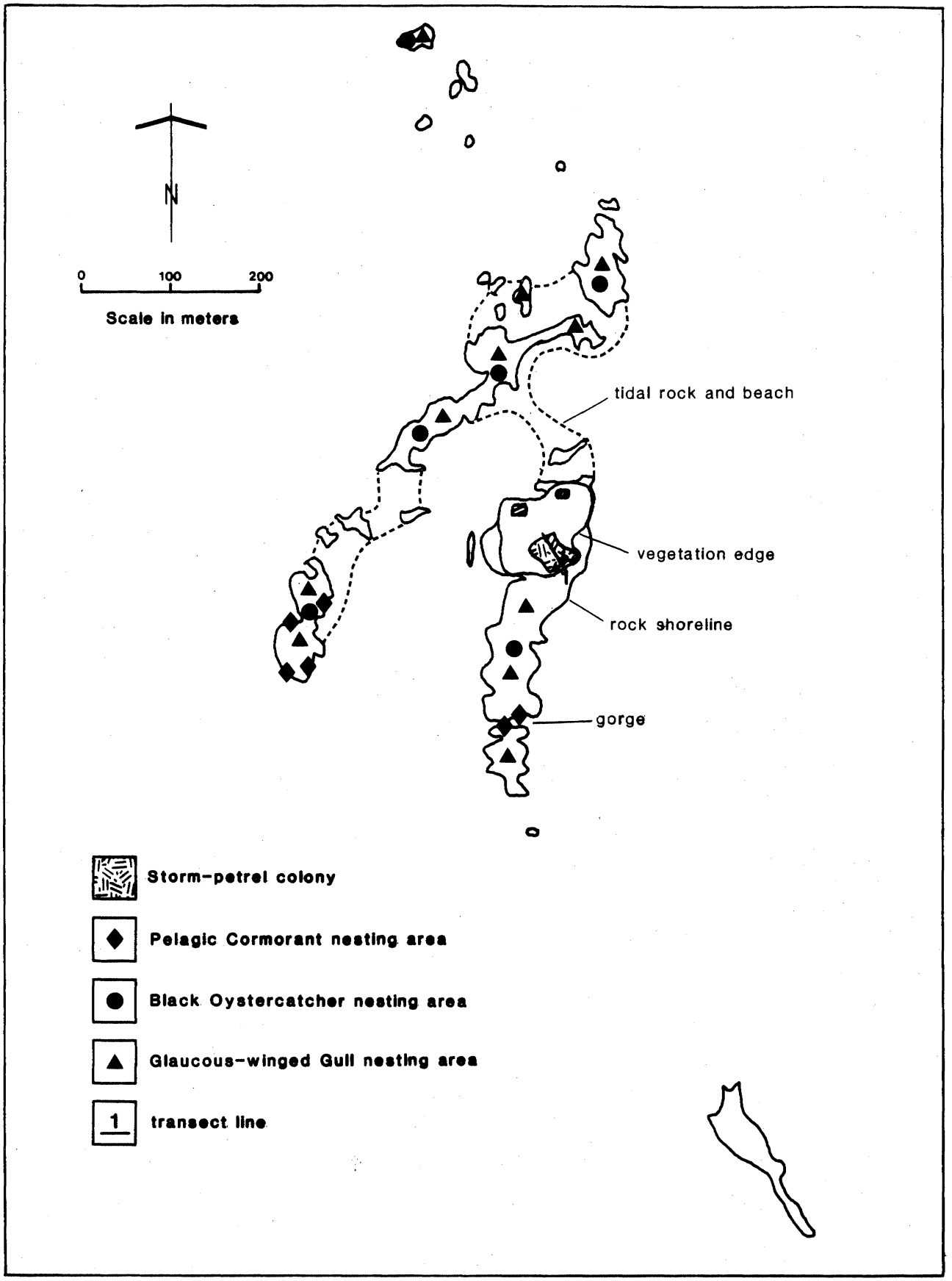

Figure WV220-1. Seabird colony areas on Thornton Islands in 1988.

Nesting species:

Fork-tailed Storm-Petrel: We heard this species calling at night, but no other evidence of nesting was discovered. Nesting was confirmed in 1982, when two chicks were found in burrows (Kaiser unpubl.), and small numbers may have been nesting in 1988.

Leach's Storm-Petrel: The main colony area was located in the southern half of the valley running northwest/southeast through the middle of the main section of the island. Burrows also were found in a 15x20 m area near the northwest corner, and a 10x15 m area at the north corner of the vegetated portion of the island (Fig. WV220-1). The number of burrows counted in plots 1-5 along the transect were 0, 3, 3, 0, and 0 respectively. The contents of only three burrows were determined and no occupancy rate was calculated. Burrows contained incubating adults.

1988 Population estimate:

Number of sample plots:	5 (20 m^2 - 0.8% of colony)
Average density:	3000 ± 1800 burrows/ha
Colony area:	0.26 ha
Total burrows:	782 ± 469
1988 Occupancy rate:	not determined
Use median rate for British Columbia:	91% (Rodway *et al.* 1988)
1988 Nesting population:	712 ± 427 pairs

Pelagic Cormorant: A total of 125 cormorant nests were counted on the west and south rocks (Table WV220-1). Most birds were incubating eggs; six young were seen.

Table WV220-1. Pelagic Cormorant nests on Thornton Islands in 1988.

	Contents										
	Unk[a]	Emp	1E	2E	3E	4E	6E	1E1Y	1E2Y	1Y	Total
West rocks	73	1		2	2	1	1				80
South rocks	16	6	1	8	8	2		1	2	1	45
Total	89	7	1	10	10	3	1	1	2	1	125

[a] unknown

Black Oystercatcher: We estimated 13 pairs of oystercatchers nesting (Table WV220-2). A total of eight empty scrapes were found on the north rocks, five of which appeared to belong to separate pairs. One depredated egg was found in the vicinity of one empty nest. Nest materials were primarily rock chips; some nests contained gooseneck barnacle and mussel shells.

Table WV220-2. Black Oystercatcher nests on Thornton Islands in 1988.

	Contents							
Area	Empty	1E	2E	1E1Y	3Y	2Y	1Y	Total
Offshore N rocks		1			1			2
North rocks	5		2	1			1[a]	9
West rocks		1						1
South rocks						1		1
Total	5	2	2	1	1	1	1	13

[a] chick was dead.

Glaucous-winged Gull: Gulls were nesting in most rocky areas around the island. We counted a total of 1053 nests (Table WV220-3). Nests were built of grass and forbs. Many nests had been refurbished after torrential rains and gale force winds on 12 and 13 July. Many nests with small young looked freshly built. We observed two addled eggs, three broken eggs, 13 dead chicks, and two vagrant young that were not associated with nests.

Table WV220-3. Glaucous-winged Gull nests on Thornton Islands in 1988.

			Contents											
Area	Empty unused	Empty used[a]	1E	2E	3E	2E1Y	1E3Y	1E2Y	1E1Y	4Y	3Y	2Y	1Y	Total
Offshore N rocks	2	16	6	13	12			1	1		2	3	16	72
North rocks	17	7	5	9	37	9		8	2		25	24	11	154
West rocks	1	19	14	26	54	9		8	12		36	44	37	260
South rocks														
- to gorge	7	24	31	58	143	13		24	18	1	49	62	48	478
- S of gorge		4	5	7	13	3	1	8	5		14	13	16	89
Total	27	70	61	113	259	34	1	49	38	1	126	146	128	1053

[a] obviously trampled by chicks.

Pigeon Guillemot: We counted 19 adults around the north and west rocks. One bird flew into a crevice.

Tufted Puffin: We saw four puffins along the west and south rocks on 13 and 14 July. Nesting was suspected but not confirmed.

Predation: We saw little evidence of predation on storm-petrels in 1988 (three Leach's Storm-Petrel wings were found), unlike 1982, when the number of Leach's Storm-Petrel wings found was estimated to be about half the number of burrows present (Kaiser unpubl.). Northwestern Crows were taking cormorant eggs in 1988; 39 depredated eggshells were counted under salmonberry habitat where crows were nesting.

Associated species:

Brandt's Cormorant - 200 immature and nonbreeding adults regularly roosted on the west rocks while we were present. They tended to disperse in the morning and gather in the late afternoon. One immature was gathering nesting material and attempting to build a nest on 14 July.

Bald Eagle - One adult was present on 13 July. Two nests were located in the middle of the island: 20 m high in 25 m spruce, and 15 m high in 20 m spruce. Neither nest appeared active. Two Common Ravens were frequently sighted in the vicinity of the nests, and we wondered if the nests may have belonged to ravens rather than eagles. Nests were large enough, though relatively small for eagle nests.

Glaucous-winged/Western Gull hybrid - 1 third year bird.

Common Murre - On 13 July we counted 122 in a tight raft off the south side of the island at 1125 h, and 500 flying north in groups of 30-60 between 1840 and 1920 h.

Marbled Murrelet - Three in winter (possible juveniles) and seven in summer plumage on water on 15 July.

Rhinoceros Auklet - 1 on water.

Northwestern Crow - 12 were harassing two ravens on 11 July. There were a number of crow nests in the salmonberry and sedge habitat in the middle of the island. One nest inspected contained one recently hatched, naked young.

Common Raven - 2 frequently seen in forested area (see Bald Eagle).

Other birds and mammals sighted:

Brant - 5 flying by on 11 July.

Harlequin Duck - 14 molting males; mostly eclipse plumage.

Black-bellied Plover *Pluvialis squatarola* - 1 flying.

Semipalmated Plover *Charadrius semipalmatus* - 1

Greater Yellowlegs *Tringa melanoleuca* - 10

Wandering Tattler - 2

Whimbrel *Numenius phaeopus* - 21

Black Turnstone - 23

Surfbird - 10

Western Sandpiper - Flock of 30 including some Least Sandpipers.

Least Sandpiper - 2+

Short-billed Dowitcher - 4 flying and calling.

Caspian Tern - 1 flying and calling.

Winter Wren

Fox Sparrow

Sea Otter - 1 in northwest bay on 14 and 15 July.

WV-230 "MIMULUS" ISLETS 92 E/14

Location: East of Thornton Island, south of Moos Islet. 49°57'48"N 127°19'16"W

Land status: Crown land.

Date of visit: 17 July 1988 (1025-1145 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: These islets are bare, dissected rock, rising to a maximum elevation of 9 m. Scattered forbs grow in higher cracks. Observers in 1975 noted patches of *Mimulus*, but no trace of this forb was found in 1988.

Nesting species:

Black Oystercatcher: Five oystercatcher nests were found: one empty and one with two eggs on the northwest (30') rock; and three empty on the middle rocks. An adult was scared off one empty nest; we suspected young nearby. Nests were accumulations of rock chips.

Glaucous-winged Gull: A total of 222 nests were counted (Table WV230-1). Nests were made of grass and seaweed. We found four depredated eggs, and one dead chick that had become tangled in a piece of surfgrass in the nest. The nest was on a ledge and may have been built by Pelagic Cormorants, as it appeared similar to typical cormorant nests. The dead gull chick was dangling by its foot from the edge of the nest.

Table WV230-1. Glaucous-winged Gull nests on "Mimulus" Islets in 1988.

			Contents									
Area	Empty unused	Empty used[a]	1E	2E	3E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	Total
Northwest rock	8	18	7	8	25	2	3	1	8	2	1	83
Middle rocks		7	6	11	31	9	13	3	20	10	8	118
South rock		1	2	3	3	2	3	1	3	1	2	21
Total	8	26	15	22	59	13	19	5	31	13	11	222

[a] obviously trampled by chicks.

Associated species:

Brandt's Cormorant - 1 flying by.

Northwestern Crow - 1

Other birds and mammals sighted:

Wandering Tattler - 1

Black Turnstone - 4

Surfbird - 3

Dowitcher sp. - 12

WV-240 "CRAG" ROCKS 92 E/14

Location: Southeast of "Mimulus" Islets, west of Munsie Rocks at the entrance to Kyuquot Channel. 49°57'37"N 127°19'02"W

Land status: Crown land.

Date of visit: 17 July 1988 (1152-1245 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: These are rugged, 8 m high, volcanic rocks with jagged pinnacles and crevices.

Nesting species:

Pelagic Cormorant: One Pelagic Cormorant in breeding plumage was roosting but no evidence of nesting was found.

Black Oystercatcher: There were three nests: one with two pipping eggs; one with three chicks; and one empty attended by two aggressive adults - chicks were probably close by. Nests were made of rock chips plus some gooseneck barnacle shells in one nest.

Glaucous-winged Gull: Seventy-five nests were counted (Table WV240-1). Nest were built of grass, seaweed, redcedar leaves, and salal leaves. Lower nests were made entirely of seaweeds. We found two addled eggs and one dead chick.

Table WV240-1. Glaucous-winged Gull nests on "Crag" Rocks in 1988.

	Contents									
Empty used[a]	1E	2E	3E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	Total
3	6	10	17	4	9	4	9	9	4	75

[a] obviously trampled by chicks.

Associated species:
Brandt's Cormorant - 29 immatures roosting.

Other birds and mammals sighted:

Harlequin Duck - 4 in female plumage.

Black Turnstone - 15

Surfbird - 3

Harbour Seal - 2

WV-250 MUNSIE ROCKS 92 E/14

Location: Southwest of White Cliff Head at the entrance to Kyuquot Channel.
49°57'43"N 127°18'10"W

Land status: Crown land.

Date of visit: 17 July 1988 (1340-1415 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: This is a group of about six, bare, dissected rocks, with steep bluffs on the southwest rock that rises to 14 m elevation.

Nesting species:

Pelagic Cormorant: No cormorants were nesting. Eight nonbreeding birds were roosting on the southwest rock.

Black Oystercatcher: Nine nests were located: 2 empty; 3 with 1 egg; 2 with 2 eggs; 1 with 3 eggs; and 1 with 1 young. One depredated egg was found. Nests were made of rock chips plus some gooseneck barnacle and mussel shells.

Glaucous-winged Gull: We counted 28 nests distributed over the group of rocks (Table WV250-1). Six depredated eggs were seen.

Table WV250-1. Glaucous-winged Gull nests on Munsie Rocks in 1988.

		Contents							
Empty unused	Empty used[a]	2E	3E	2E1Y	1E2Y	1E1Y	2Y	1Y	Total
3	4	4	7	3	2	3	1	1	28

[a] obviously trampled by chicks.

Pigeon Guillemot: Three birds seen but nesting not confirmed.

Other birds and mammals sighted:

Harlequin Duck - 6 in female plumage.

Wandering Tattler - 1

Black Turnstone - 10

WV-260 NIPPLE ROCKS 92 E/14

Location: Southwest of Rugged Point at the entrance to Kyuquot Channel.
49°57'09"N 127°15'40"W

Land status: Crown land.

Date of visit: 16 July 1988 (1900-2100 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: The northern of these three jagged, volcanic rocks is the highest, rising to 13 m, and has the most cliff habitat.

Nesting species:

Pelagic Cormorant: No cormorants were nesting. Five nonbreeding birds were roosting on the north rock.

Black Oystercatcher: There was one nest on each rock: one with a broken egg and suspected young on the south rock; one with a small chick on the middle rock; and one empty scrape defended by two adults on the north rock. Nests were made of rock chips.

Glaucous-winged Gull: Gulls were nesting on all three rocks, though most nests were located on the south rock (Table WV260-1). Six addled eggs and two dead chicks were recorded.

Table WV260-1. Glaucous-winged Gull nests on Nipple Rocks in 1988.

			Contents										
Area	Empty unused	Empty used[a]	1E	2E	3E	4E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	Total
North rock		1		1	1			3		3	2	5	16
Middle rock		4	1	4	11		3	1	1	8	2	4	39
South rock	2	7	5	5	25	1	3	10	3	14	14	5	94
Total	2	12	6	10	37	1	6	14	4	25	18	14	149

[a] obviously trampled by chicks.

Pigeon Guillemot: Single birds were sighted around the north and south rocks.

Other birds and mammals sighted:

Wandering Tattler - 1

Surfbird - 1

WV-270 VOLCANIC ISLETS 92 E/14

Location: West of Kapoose, south of Rugged Point. 49°57'09"N 127°15'40"W

Land status: Crown land.

Date of visit: 16 July 1988 (1725-1835 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count for surface-nesting species; partial count for storm-petrels.

Description: The main islet, which rises to 19 m elevation, is composed of two major knobs separated by a narrow gorge. The south knob is cliff-bound on the west, south and east sides, while the north knob has an extensive low rocky area on the north and west sides. Total area of the islets is 0.9 ha. Higher portions are covered with grass and forbs, plus pockets of salmonberry, salal and Saskatoon berry (*Amelanchier* sp.). Patches of vegetation on the south knob had been denuded by gulls plucking nesting material, and soil along the cliff tops had been eroded by nesting cormorants. The small islet to the south is bare, jagged rock.

Nesting species:

Leach's Storm-Petrel: Storm-petrel burrows were scattered through an 8x12 m area of 1 m high salmonberry, shorter salal, and some grass and forbs on the top of the north section. A small Leach's Storm-Petrel chick was pulled from one burrow. Twelve burrows were counted, and a total of 50 was estimated.

Pelagic Cormorant: We counted 89 cormorant nests from the boat. Most were on the south end of the island; 25 were on the west side. Adults were sitting on nests, often accompanied by mates standing nearby. To minimize disturbance, only 27 nests were inspected: 3 with 2 eggs; 8 with 3 eggs; 11 with 4 eggs; 1 with 5 eggs; 1 with 1 egg 2 young; 1 with 3 eggs 1 young; 1 with 4 eggs 1 young; and 1 with 1 egg 4 young. Twenty nonbreeding birds were roosting on the west side.

Black Oystercatcher: There were six pairs nesting: 4 on the main island - 3 empty scrapes close together; 1 nest with 1 egg; and 2 nests with 2 eggs; and two pairs on the south rock - 1 nest with 1 young, and 1 nest with suspected young. Nests were made of rock chips.

Glaucous-winged Gull: There were 151 nests on the main island plus two on the south rock (Table WV270-1). We found one dead chick.

Table WV270-1. Glaucous-winged Gull nests on Volcanic Islets in 1988.

Area	Empty unused	Empty used[a]	Contents 1E	2E	3E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	Total
Main islet	7	13	8	20	37	1	9	8	19	16	13	151
South rock									2			2
Total	7	13	8	20	37	1	9	8	21	16	13	153

[a] obviously trampled by chicks.

Pigeon Guillemot: Twelve birds were counted. We found one nest with one egg in a crevice.

Tufted Puffin: Two nests were located: one with one egg under a rock; and one with a downy chick in a burrow in Tufted Hairgrass habitat. Both nests were on the east side near the top of the islet. Two adults were present.

Associated species:

Double-crested Cormorant *Phalacrocorax auritus* - 1 immature roosting with nonbreeding Pelagic Cormorants.

Brandt's Cormorant - 1 nonbreeding bird flying by.

Other birds and mammals sighted:

Black Turnstone - 2

Song Sparrow - 1 nest with 1 egg and 1 young. Nest was made of woven grass in a patch of *Elymus*.

WV-280 DIVER ISLET 92 E/14

Location: North of Grassy and Clarke Islands, west of Mushroom Point.
49°55'46"N 127°14'55"W

Land status: Crown land.

Date of visit: 16 July 1988 (1630-1645 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: Diver Islet is a bare, 9 m high rock with few tufts of grass.

Nesting species:

Black Oystercatcher: Three empty scrapes and two nests with two eggs each were found. Nests were made of rock chips and mussel and gooseneck barnacle shells.

Glaucous-winged Gull: We counted 33 nests (Table WV280-1). Nests were constructed of grass and some seaweed. One feather pile of an adult was found.

Table WV280-1. Glaucous-winged Gull nests on Diver Islet in 1988.

	Contents							
Empty used[a]	1E	2E	3E	1E2Y	3Y	2Y	1Y	Total
3	3	7	11	2	4	2	1	33

[a] obviously trampled by chicks.

Pigeon Guillemot: No Pigeon Guillemots were seen.

Associated species:

Pelagic Cormorant - One in breeding plumage and three in nonbreeding plumage were roosting.

Other birds and mammals sighted:

Wandering Tattler - 1

Black Turnstone - 11

Surfbird - 1

Western Sandpiper - 8

WV-290 "CALM" ROCKS 92 E/14

Location: Between Diver Islet and Clark Island. 49°55'29"N 127°14'43"W

Land status: Crown land.

Date of visit: 16 July 1988 (1602-1620 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: These are 5 m high rocks.

Nesting species:

Black Oystercatcher: There were six empty nests made of rock chips and mussel shells. One depredated egg was found. Thirteen adults were present.

Glaucous-winged Gull: Of five nests found, three were empty, one contained three eggs, and one had one egg and two small young. There were 10 adults.

Pigeon Guillemot: Four guillemots were suspected nesting.

Other birds and mammals sighted:

Black Turnstone - 1

WV-300 GRASSY ISLAND 92 E/14

Including all tidally connected rock.

Location: West of Clark Island, west of Mushroom Point, south of Rugged Point.
49°55'25"N 127°15'W

Land status: Crown land.

Date of visit: 15 July 1988 (1055-1330 h)

Colony access: Boat landing on beach on east side.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: The main vegetated island has a steep west face above high tide beach and rock, low east and north sides above white shell and sand beaches, and a flattish top covered with thick salal, salmonberry, twinberry and other shrubs, plus a small stand of spruce on the south end. The high point of the island is 16 m in elevation. Grass and forbs occur on fringes above shore rock, and, mixed with shrubs, extend over the low slopes above the east beach. To the west of the higher, vegetated section is an extensive complex of flat tidal rock, with many low, above-tide ridges. The rock is sedimentary with numerous outcroppings of *Buccia* fossil. Total area of the islands is about 4.2 ha.

Nesting species:

Leach's Storm-Petrel: We found no evidence of nesting by storm-petrels. In 1982, a pair of Leach's Storm-Petrels occupied one of an estimated 25 burrows located in dirt cliffs on the north end of the island (Kaiser unpubl.).

Black Oystercatcher: We estimated 16 pairs of oystercatchers nesting on the extensive, western rock shelves. Seven empty nests found were considered to represent five territories. Young were suspected at three of those nests. Other nests contained: 1 egg - 4; 2 eggs - 2; 1 egg 2 young - 1; 1 egg 1 young - 1; and 1 young - 3. Most nests were just collections of rock chips; three also included some shells.

Glaucous-winged Gull: Gulls were nesting along the higher ridges of the western rock shelf. A total of 188 nests were counted (Table WV300-1). Nests were constructed of grass with some forbs and moss. We encountered three depredated eggs, one dead young, and one adult feather pile.

Table WV300-1. Glaucous-winged Gull nests on Grassy Island in 1988.

		Contents								
Empty unused	Empty used[a]	1E	2E	3E	2E1Y	1E2Y	1E1Y	2Y	1Y	Total
9	14	20	33	80	3	3	3	8	15	188

[a] obviously trampled by chicks.

Pigeon Guillemot: Twenty-three birds were on the water and rocks, mostly along the southeast end. No nests were found.

Associated species:

Pelagic Cormorant - 2 in breeding plumage plus 22 nonbreeding.

Common Murre - 25 flying.

Marbled Murrelet - 2 on water.

Tufted Puffin - 1 off west side.

Northwestern Crow - 18; some feeding young.

Other birds and mammals sighted:

Brant - 2

White-winged Scoter - 1 male.

Common Merganser *Mergus merganser* - 1 adult with 2 small, downy young.

Semipalmated Plover - 4

Greater Yellowlegs - 1

Whimbrel - 4

Black Turnstone - 5

Surfbird - 7

Western Sandpiper - 7; plus 60 unidentified Western or Least Sandpipers.

Least Sandpiper - 3

Short-billed Dowitcher - 1 calling

Long-billed Dowitcher *Limnodromus scolopaceus* - 1 calling

Dowitcher sp. - 6

California Gull - 20 immature

Fox Sparrow

Song Sparrow

Harbour Seal - 22

WV-310 CLARK ISLAND 92 E/14

Location: West of Mushroom Point across Clear Passage. 49°55'22"N 127°14'23"W

Land status: Crown land.

Date of visit: 16 July 1988 (1435-1600 h).

Colony access: Boat landing on southeast beach.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: Clark Island has a rocky shoreline with small, high-tide beaches. It has an area of 2.7 ha. Steep-sided knobs of fossilized *Buccia* rise from the south-west corner to an elevation of 12 m, and flat-topped, grassy knolls project from lower beaches on the south side. The lower northern end is covered with thimbleberry, twinberrry, salal and other shrubs, plus *Elymus*, *Calamagrostis* and other grasses and forbs through a central meadow and around the perimeter. There are a couple of spruce trees near the north end.

Nesting species:

Pelagic Cormorant: There was no evidence of nesting by cormorants.

Black Oystercatcher: Five nests were located on high tide beaches around the island: 4 empty scrapes (2 were close together and probably belonged to one pair); 1 with 1 egg; and 1 with 2 eggs. Nests materials included pebbles and clam, mussel and barnacle shells.

Glaucous-winged Gull: Gulls were nesting sporadically around perimeter rocky areas. Sixteen nests and 32 adults were counted (Table WV310-1).

Table WV310-1. Glaucous-winged Gull nests on Clark Island in 1988.

	Contents							
Empty used[a]	1E	2E	3E	1E1Y	3Y	2Y	1Y	Total
3	2	1	3	1	2	3	1	16

[a] obviously trampled by chicks.

Pigeon Guillemot: Three nest sites were located: 1 with 1 egg under a rock; 1 hatched eggshell in a crevice; and 3 broken eggs in a crevice. Twenty-nine adults were sitting on rocks at the southwest and southeast corners.

Tufted Puffin: Five puffins were sitting on the high rock at the southwest corner. They were suspected nesting in rock crevices. Grass nesting material had been dragged into one obviously worn tunnel in the rock, but the end of the tunnel could not be reached to determine its contents.

Associated species:

Pelagic Cormorant - 1 nonbreeding bird roosting.

Northwestern Crow - 4

Other birds and mammals sighted:

Wandering Tattler - 1

Whimbrel - 3

Black Turnstone - 5

Song Sparrow

WV-320 McQUARRIE ISLETS 92 E/14

Location: Southern end of the Barrier Islands and Clear Passage, west of Gregoire Point. 49°54'05"N 127°13'30"W

Land status: Crown land.

Date of visit: 16 July 1988 (1000-1310 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, M. Force.

Census method: Total count.

Description: These islets are formed by an extensive, low, sedimentary rock shelf with many protrusions, knobs and ridges. Their total area is 5.1 ha. Ridges are highest, steepest and most dissected at the south end where they rise to 12 m elevation. *Buccia* is abundant on the southern ridges.

Nesting species:

Pelagic Cormorant: There were two nests, with two and three eggs each, on steep rock faces at the south end. Four adults in breeding plumage were present, plus 52 nonbreeding birds.

Black Oystercatcher: A total of 37 oystercatcher nests were found (Table WV320-1). Most nests were made of rock chips; some held a few shells. We saw two depredated and one broken egg and two dead chicks.

Table WV320-1. Black Oystercatcher nests on McQuarrie Islets in 1988.

	Contents							
Empty	1E	2E	3E	1E2Y	1E1Y	2Y	1Y	Total
22[a]	2	6	1	1	1	1	3[b]	37

[a] two nests had depredated eggs; young were suspected at two nests.
[b] chick was dead in two nests.

Glaucous-winged Gull: The majority of 203 nests counted still held eggs (Table WV320-2). Hatched young were small, most only a few days old. Eight addled eggs, six broken eggs, and 10 dead chicks were tallied. By one nest of one young was a collection of 11 Pacific sandlance (*Ammodytes hexapterus*), 12-14 cm long. Most nests were constucted of a wide variety of seaweeds; few were composed of grasses and forbs, especially *Potentilla*. One contained bits of driftwood. We recorded 150 immatures roosting.

Table WV320-2. Glaucous-winged Gull nests on McQuarrie Islets in 1988.

		Contents									
Empty unused	Empty used[a]	1E	2E	3E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	Total
5	12	22	46	67	2	6	10	11	13	9	203

[a] obviously trampled by chicks.

Pigeon Guillemot: Three nests were discovered under boulders with: 1 egg; 2 warm and 1 cold eggs; and 2 young. Eighteen adults were present.

Tufted Puffin: No puffins were seen.

Associated species:

Common Murre - 22 to north; mostly summer plumage; some molting.

Marbled Murrelet - 48 to north; mostly summer plumage; 5 in winter plumage (possible juveniles).

Ancient Murrelet - 1 adult with a full-grown juvenile to north.

Rhinoceros Auklet - 1 to north.

Other birds and mammals sighted:

Pacific Loon -1

Brant - 1 bird with very weathered plumage.

Harlequin Duck - 1 molting male, and 4 in eclipse or female plumage.

Wandering Tattler - 2

Black Turnstone - 1

Western Sandpiper - 1

Least Sandpiper - 1

Dowitcher sp. - 8

California Gull - 480 immatures, mostly second and third year.

Harbour Seal - 11 adults plus 2 live and 1 dead pups.

WV-410 CLELAND ISLAND 92 E/1

Including rock off northwest corner (named "Murre Reef")

Location: Clayoquot Sound west of Vargas Island. 49°10'20"N 126°05'24"W

Land status: Provincial Ecological Reserve.

Date of visit: 7-9 July 1988.

Colony access: Boat landings on the southeast beach and on the northwest beach at high tide.

Base camp: There is a small research cabin above the northwest beach. No water is available.

Observers: A. Burger, D. Garnier.

Census method: Line transects: 33 quadrats, 3x3 m (except for plots 7 & 8 on transect 2 which were 1x1 m for storm-petrels and 3x3 m for other species), surveyed at 15 m intervals along 5 parallel transects run 50 m apart across the island at 76 or 256° (Fig. WV410-1). Transects 1,3 and 5 were begun on the west side, and transects 2 and 4 were begun on the east side. Lengths of transects in order from 1 to 5 were 63, 131, 126, 100, and 32 m. Burrow occupancy was determined in arbitrarily selected plots along transects. Contents of additional Rhinoceros Auklet burrows were determined in a 5x5 m plot located at the northwest corner of the colony (Fig. WV410-1). A total count was conducted of Glaucous-winged Gull nests.

Description: Cleland Island has been described and lists of flora and fauna given by Campbell and Stirling (1968), Ward (1973) and Hartwick (1974). The island, formerly known as Bare Island, is devoid of trees, but has a lush covering of grass, forbs and shrubs over the higher central area, which rises to 10 m elevation, surrounded by extensive perimeter rock. There are small, shell beaches around the island. The total area of the island is 7.7 ha, 3.2 of which are vegetated. Salmonberry and wild rose (*Rosa* sp.) form a thicket down the middle of the vegetated section, with *Elymus*, *Heracleum*, *Maianthemum* and other forbs covering areas to either side. Bracken mixes with shrubs and herbs in some areas.

Nesting species:

Storm-petrel: Storm-petrels were nesting in grass and forb habitat along the west and southeast sides of the island (Fig. WV410-1). Burrows occurred along the perimeter but not in the center of the salmonberry and rose thicket. Density tended to be higher along transects 2 and 3 between 15 and 45 m from the western edge of the vegetation (Table WV410-1). In the nine burrows in which species were identified, Leach's Storm-Petrels outnumbered Fork-tailed Storm-Petrels 8 to 1 (Table WV410-2). All Leach's Storm-Petrels were incubating; the Fork-tailed Storm-Petrel burrow held a chick.

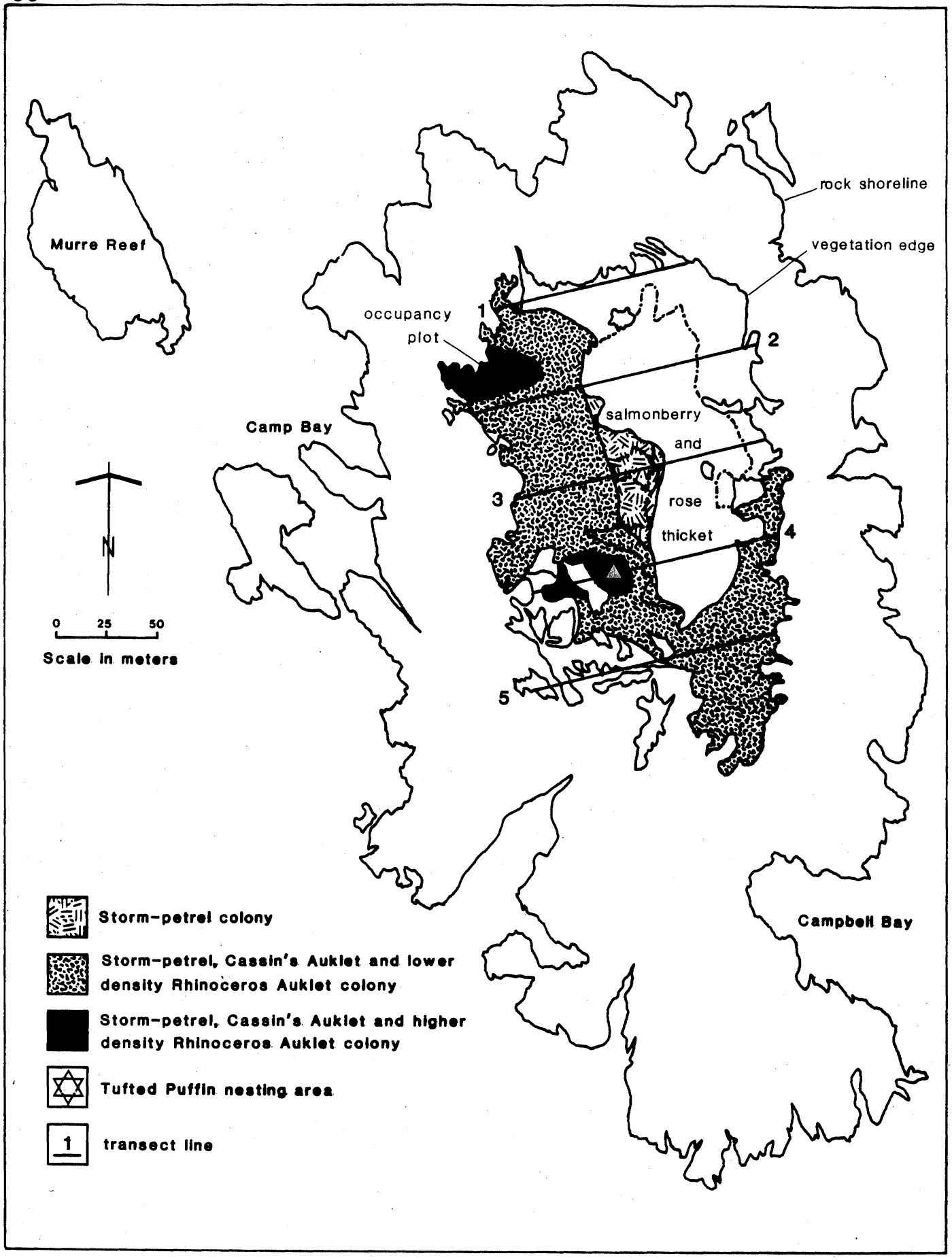

Figure WV410-1. Seabird colony areas on Cleland Island in 1988. Scale is distorted between the main island and "Murre Reef".

1988 Population estimate:

Number of sample plots: 17 (137 m^2 - 0.9% of colony)

Average density: 4765 ± 2338 burrows/ha

Colony area: 1.6 ha

Total burrows: 7624 ± 3741

1988 Occupancy rate: 83.3 ± 17.5% (10 of 12 known)

Species ratio: 11% Fork-tailed to 89% Leach's Storm-Petrels

1988 Nesting population:

Fork-tailed Storm-Petrel: 699 ± 366 pairs

Leach's Storm-Petrel: 5652 ± 2960 pairs

Table WV410-1. Number of storm-petrel burrows in 3x3 m plots along transects on Cleland Island in 1988. Plots considered outside the colony are indicated by a dash.

	Plot								
Transect	1	2	3	4	5	6	7	8	9
1	-	-	-	-	-				
2	-	-	-	-	-	-	3[a]	3[a]	1
3	0	3	3	5	0	2	-	-	-
4	0	1	-	-	0	0	1		
5	0	3	0						

[a] plots were 1x1 m.

Table WV410-2. Occupancy of storm-petrel burrows on Cleland Island in 1989.

			Fork-tailed	Leach's			
Location Transect	Plot	Empty	chick	Adult +egg	Cold egg	Total Occup.	Total known
2	8			1		1	1
3	3			2		2	2
3	4		1	3	1	5	5
3	6	2				0	2
4	2			1		1	1
4	7			1		1	1
Total		2	1	8	1	10	12

Black Oystercatcher: An overall count of oystercatcher nests was not obtained. Five nests were confirmed: 1 held 1 egg; 2 held 2 eggs; 1 held 3 eggs; and 1 held 1 egg 1 chick. Nests were composed primarily of shell chips with some rock bits.

Glaucous-winged Gull: Gulls were nesting in perimeter rocky and grassy areas. A total of 1622 nests were counted (Table WV410-3). Nests were made of grass plus some *Fucus* in nests close to the water. The majority of birds were still incubating. Two dead chicks were recorded.

Table WV410-3. Glaucous-winged Gull nests on Cleland Island in 1988.

		Contents								
Start	Empty	1E	2E	3E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	Total
32	55	156	387	664	23	46	49	46	89	75	1622

Common Murre: No murres were observed nesting.

Pigeon Guillemot: A total of 205 birds were counted around the island at 1430 h on 8 July. Two nests were found: 1 under a log with 1 egg; and 1 with 2 eggs in a burrow.

Cassin's Auklet: Cassin's Auklets burrows were found over most of the same area as storm-petrels. They did not extend as far from shore along transect 3 as storm-petrels, and tended to be most abundant near the shore edge of the vegetation (Fig. WV410-1; Table WV410-4). Chicks had already fledged at the time the survey was conducted and no occupancy was determined.

1988 Population estimate:

Number of sample plots:	15 (135 m^2 - 0.9% of colony)
Average density:	733 ± 277 burrows/ha
Colony area:	1.5 ha
Total burrows:	1073 ± 406
1988 Occupancy rate:	not determined
Use median British Columbia rate:	75% (Rodway *et al.* 1988)
1988 Nesting population:	805 ± 305 pairs

Table WV410-4. Number of Cassin's Auklet burrows in 3x3 m plots along transects on Cleland Island in 1988. Plots considered outside the colony are indicated by a dash.

Transect	Plot 1	2	3	4	5	6	7	8	9
1	-	-	-	-	-				
2	-	-	-	-	-	-	1	0	1
3	3	0	0	0	-	-	-	-	-
4	2	0	-	-	2	0	0		
5	0	0	1						

Rhinoceros Auklet: Rhinoceros Auklets were nesting in the same area as Cassin's Auklets (Fig. WV410-1; Table WV410-5). Two areas near the northwest (940 m^2) and southwest (680 m^2) ends of the colony were identified as having higher density burrowing during exploration (Fig. WV410-1). Sampling of those areas along transects was not sufficient to allow calculation of different densities. The contents of 4 burrows were determined along transects: 3 held chicks and 1 held an incubating adult. Of 6 burrows in the 5x5 m occupancy plot, 2 held chicks, 1 held an incubating adult, and 3 were too deep to dig. This sample of 7 burrows with known contents was considered too small to calculate an occupancy rate, and the median rate for British Columbia was used to estimate nesting population.

1988 Population estimate:

Number of sample plots:	15 (135 m^2 - 0.9% of colony)
Average density:	880 ± 370 burrows/ha
Colony area:	1.5 ha
Total burrows:	1288 ± 542
1988 Occupancy rate:	not determined
Use median British Columbia rate:	77% (Rodway *et al.* 1988)
1988 Nesting population:	992 ± 417 pairs

Table WV410-5. Number of Rhinoceros Auklet burrows in 3x3 m plots along transects on Cleland Island in 1988. Plots considered outside the colony are indicated by a dash.

Transect	Plot 1	2	3	4	5	6	7	8	9
1	-	-	-	-	-				
2	-	-	-	-	-	-	0	0	1
3	0	3	4	0	-	-	-	-	-
4	0	0	-	-	0	0	2		
5	0	2	0						

Tufted Puffin: A maximum of 10 puffins were seen. Two burrows were encountered in plot 7 on transect 4, and a total of six pairs were estimated nesting in that area (Fig WV410-1). Breeding was not confirmed.

Predation: No predation was recorded in 1988. A mink was observed on the island in 1982, and at least 12 Rhinoceros Auklets were suspected to have been killed by mink (Kaiser unpubl.). In 1985, four decapitated Tufted Puffins were found in burrows, also suspected to have been killed by mink (Kaiser unpubl.).

Associated species:

Brandt's Cormorant

Peregrine Falcon - 1 female

Western Gull - 2

Glaucous-winged/Western Gull hybrid - some

Ancient Murrelet - 1 adult

Northwestern Crow - 10

Other birds and mammals sighted:

Sooty Shearwater - 1

Brant - 3

Harlequin Duck - 5

Whimbrel - 2

Black Turnstone - 1

Western Sandpiper - 1

Least Sandpiper - 4

California Gull - some

Caspian Tern - 3 adults

Song Sparrow

WV-850 SEABIRD ROCKS 92 C/14

Location: Mouth of Pachena Bay, southeast of Cape Beale. 48°45'00"N 125°09'10"W

Land status: Crown land.

Date of visit: 26, 30 July 1988.

Colony access: Boat landing on beach on east side.

Observers: A. Burger, D. Garnier.

Census method: Total count for surface-nesting species. For burrowing species, total burrows were counted in some areas; 3x3 m or 5x5 m plots were surveyed in other areas to sample small patches of habitat (Fig. WV850-1). Plots were arbitrarily placed within those areas, and densities within each plot were extrapolated to the specific area it was meant to sample (Fig. WV850-1). Occupancy for storm-petrels was determined in arbitrarily selected burrows in each area.

Description: Seabird Rocks are a cluster of rocky knobs, connected at low tide, which rise to a maximum elevation of 15 m. They have a total area of 0.3 ha, 0.1 of which are vegetated. Higher portions support a lush growth of grasses and forbs (mostly *Elymus* and *Heracleum*), surrounding a central band of salmonberry (sections 1 and 2 - Fig. WV850-1). There is a navigation light on the highest grassy knoll.

Nesting species:

Storm-petrel: Storm-petrels were nesting throughout vegetated areas with enough soil to support burrows (Fig. WV850-1; Table WV850-1). Both species were nesting, though Leach's outnumbered Fork-tailed storm-petrels more than two-to-one. All known Fork-tailed Storm-Petrel burrows held large young; most Leach's Storm-Petrels were still incubating, except in two burrows which held recently hatched young (Table WV850-2).

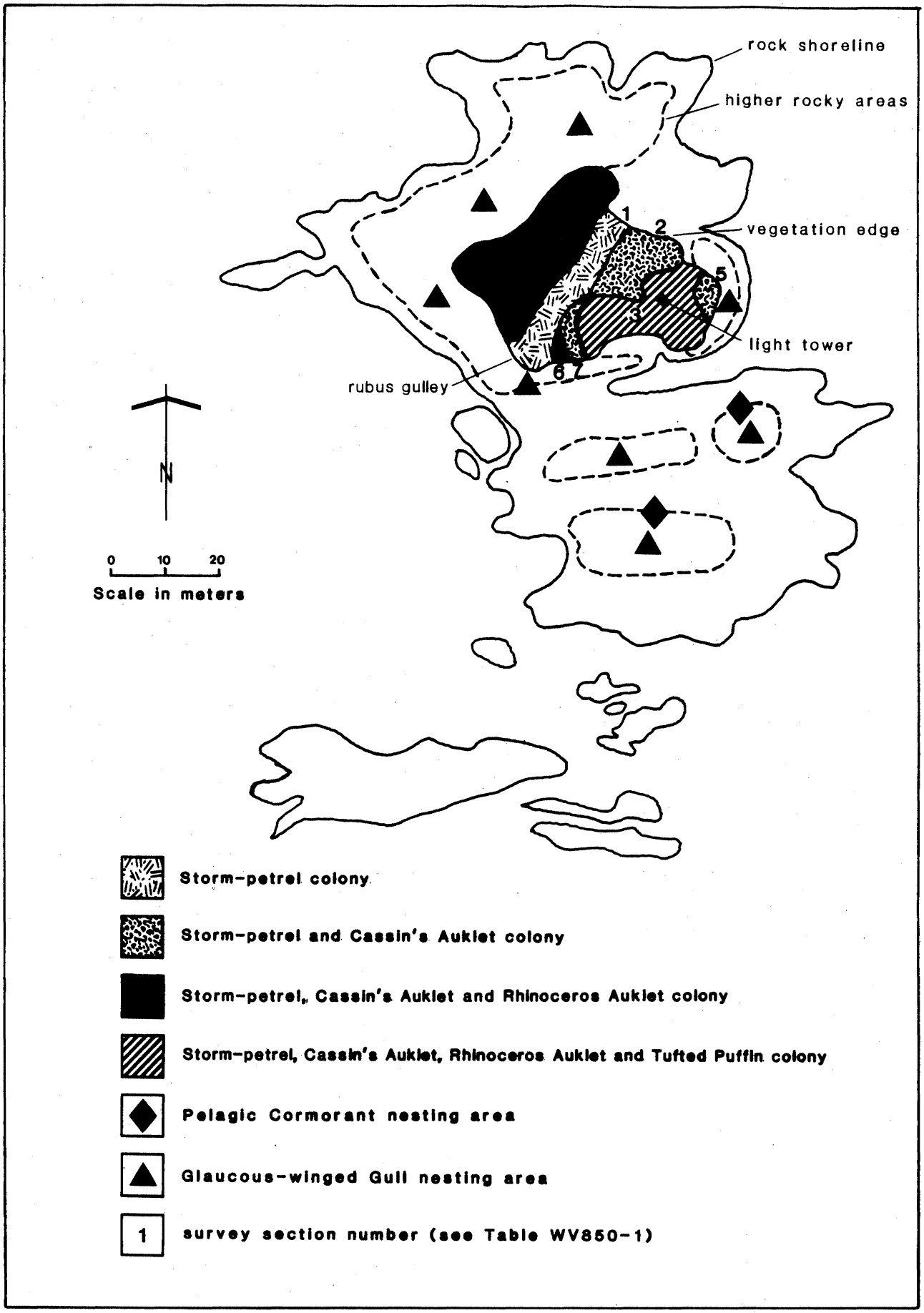

Figure WV850-1. Seabird colony areas on Seabird Rocks in 1988.

1988 Population estimate:

Total burrows: 626

1988 Occupancy rate: 100% (14 of 14 known)

Species ratio: 31% Fork-tailed to 69% Leach's Storm-Petrels

1988 Nesting population:

Fork-tailed Storm-Petrel: 194 pairs

Leach's Storm-Petrel: 432 pairs

Table WV850-1. Numbers of storm-petrel, Cassin's Auklet, Rhinoceros Auklet and Tufted Puffin burrows on Seabird Rocks in 1988. Areas correspond to those mapped on Figure WV850-1.

Area	Census method	Species Storm-petrel	Cassin's Auklet	Rhinoceros Auklet	Tufted Puffin
1	5x5 m plot	54			
2	3x3 m plot	151	44		
3	Total count	88	78	8	8
4	Total count	133	29	156	
5	3x3 m plot	103	9		
6	Total count	4	18	9	
7	3x3 m plot	93	40		
Total		626	218	173	8

Table WV850-2. Occupancy of storm-petrel burrows on Seabird Rocks in 1989.

	Fork-tailed	Leach's				
Area	Empty	Chick	Adult +egg	Chick	Unid. chick	Total Occup.	Total known
2		1	3			4	4
3		1		1		2	2
4		1	3	1		5	5
5		1				1	1
7			1		1	2	2
Total	0	4	7	2	1	14	14

Pelagic Cormorant: Pelagic Cormorants were nesting on the steep sides of southern rocky knolls (Fig. WV850-1). Sixteen nests were counted: 3 empty; 1 with 2 eggs; 8 with 3 eggs; and 4 with 4 eggs.

Black Oystercatcher: Five oystercatcher nests were found: 3 with 1 egg and 2 with 2 eggs. Nest materials were primarily shells with some rock chips.

Glaucous-winged Gull: Gulls were nesting in all rocky areas (Fig. WV850-1). A total of 181 nests were counted (Table WV850-3). Chicks were large and some were wandering. Nests were made of grasses.

Table WV850-3. Glaucous-winged Gull nests on Seabird Rocks in 1988.

		Contents									
Area	Start	Empty	1E	2E	3E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	Total
North section	4	12	9	11	3	1	1	2	14	23	21	101
South section	5	11		10	3	5	1	2	11	11	21	80
Total	9	23	9	21	6	6	2	4	25	34	42	181

Pigeon Guillemot: Sixty-five birds were counted around the island at noon on 30 July. Nesting was not confirmed.

Cassin's Auklet: Cassin's Auklets were found nesting in most areas except the salmonberry gully (Fig. WV850-1; Table WV850-1). Chicks would have fledged from most burrows at the time the survey was conducted and no occupancy rate was determined. Two chicks were found in burrows in area 6.

1988 Population estimate:

Total burrows:	218
1988 Occupancy rate:	not determined
Use median British Columbia rate:	75% (Rodway *et al.* 1988)
1988 Nesting population:	164 pairs

Rhinoceros Auklet: Rhinoceros Auklets were nesting mainly in the grassy area at the northwest corner of the vegetated section (Fig. WV850-1; Table WV850-1). No burrow contents were determined, but many adults were observed at night flying in with fish.

1988 Population estimate:

Total burrows:	173
1988 Occupancy rate:	not determined
Use median British Columbia rate:	77% (Rodway *et al.* 1988)
1988 Nesting population:	133 pairs

Tufted Puffin: Eight puffin burrows were located in grassy habitat around the highest section of the island (area 3 - Fig. WV850-1; Table WV850-1). Burrow contents were not determined.

Predation: No predation was recorded in 1988.

Associated species:

Northwestern Crow - 1 on 30 July

Other birds and mammals sighted:

Wandering Tattler - 2 on 26 and 30 July

Whimbrel - 1 on 26 and 30 July

Black Turnstone - several on 26 July

Western Sandpiper - 1 on 30 July

Dowitcher sp. - 4 on 30 July

Heerman's Gull *Larus heermanni* - 1 adult on 30 July

Gray Whale *Eschrichtius robustus* - 1 on 26 July

SUMMARY AND CONCLUSIONS

The West Coast Vancouver Island region supports almost half a million breeding seabirds. Storm-petrels, predominantly Leach's Storm-Petrels, comprise 80% of the total seabird population, 90% of which nests on only two colonies, Gillam Islands and Solander Island. Solander Island supports most of the Cassin's Auklet and Tufted Puffin populations breeding in the region (Table WV-1).

Storm-petrels have disappeared from Moos Islet, possibly as a result of intensive predation by river otters. Mink have been reported on Cleland Island and were suspected on Thomas Island. The impact of mammalian predators on nesting seabird populations should be investigated. Mortality during the Nestucca oil spill had no apparent impact on breeding populations on Solander Island.

To present a current estimate of breeding populations in the region, we have summarized all data collected during this study, plus previous estimates of surface-nesting species at colonies south of McQuarrie Islets that were not surveyed during this study (Table WV-1). This study included all colonies of storm-petrels, Cassin's Auklets, Rhinoceros Auklets and Tufted Puffins in the region, and estimates for those species are complete. Data for colonies of cormorants, Black Oystercatchers, Glaucous-winged Gulls and Pigeon Guillemots not surveyed during this study were collected between 1970 and 1987. That data has been compiled in Rodway *et al.* (in prep) and all data sources and colony locations have been listed there.

Vermeer *et al.* (in prep.) surveyed nesting populations of Pelagic Cormorants and Glaucous-winged Gulls along the west coast of Vancouver Island in 1989, and reported reduced populations (382 pairs of Pelagic Cormorants and 5972 pairs of Glaucous-winged Gulls) compared to 1988. Table WV-1 does not include data from that survey because we prefer to present an overall population estimate for those species based on the surveys conducted in 1988. We suspect the larger overall estimates from 1988 are more indicative of actual populations normally using the area than the reduced numbers found breeding in 1989. Breeding populations recorded in 1975 (1260 pairs of Pelagic Cormorants and 6835 pairs of Glaucous-winged Gulls - Campbell 1976) were similar to those summarized in 1988.

During 1989 surveys, nesting populations of Brandt's Cormorants were also censused (Vermeer and Morgan unpubl.). We have included 1989 counts for that species on Table WV-1 because numbers were similar to previous records, no Brandt's Cormorant colonies were surveyed in 1988, and 1989 counts will not be presented in upcoming publications by Vermeer and Morgan.

The following codes have been used on Table WV-1 to indicate the type of population estimates presented. A more detailed definition of these codes can be found in Rodway *et al.* (in prep). Acronyms for species names follow Campbell and Harcombe (1985 - Appendix II).

S: breeding suspected but not directly observed

x: breeding confirmed but population not estimated

e: population estimated without systematic sampling or total counts

t: population estimated from systematic sampling along transects

26: a number without a code indicates a total count

E: extinct

(): number of birds in breeding plumage on or near the colony

Table WV-1. Summary of seabird breeding populations on the west coast of Vancouver Island. Estimates are of breeding pairs, except numbers in brackets for Pigeon Guillemots and Tufted Puffins, which represent individual birds. Total populations are given as individual birds to include numbers of Pigeon Guillemots and Tufted Puffins at colonies where no breeding population estimate was obtained. Data codes and sources are explained on previous page.

SITE CODE	SITE NAME	FTSP	LSPE	BRCO	PECO	BLOY	GWGU	COMU	PIGU	CAAU	RHAU	TUPU	HOPU	TOTAL BIRDS	SURVEY YEAR(S)
WV-010	Gillam Islands	42000t	72000t		8	13	646		11x(45)			S(3)		229382	1988
WV-020	Rowley Reefs				1	2								6	1988
WV-030	Rugged Islands					1	2		S(2)					8	1988
WV-040	Gould Rock					4	0							8	1988
WV-050	Clerke Islet					3	29		2x(8)					72	1988
WV-060	Hackett I.						0							0	1988
WV-070	Guilliams I.					0(4)								0	1988
WV-080	Solander I.	0t	70000t		464	1	347e		1x(107)	34000t		3100t(700)	S(6)	215937	1988,89
WV-090	Yule Rock					(2)	0		(0)					0	1988
WV-100	O'Leary Its.				41	1	117		4x(5)					326	1988
WV-110	Cuttle Its.					0	0		(0)					0	1988
WV-120	Skirmish Its.					1								2	1988
WV-130	Bunsby Is.					7	124							262	1988
WV-140	Clara It.					4	93		3x(29)					223	1988
WV-150	Thomas I.	0t	7300t			10	7		S(16)					14650	1988
WV-160	"St. Pauls" Its.					0	0		(0)					0	1988
WV-170	"Favourite" Its.					0	0							0	1988
WV-180	"Amos" Reefs				0				(0)					0	1988
WV-190	Hohoae I.				0									0	1988
WV-200	White Cliff Head				1				(0)					2	1988
WV-210	Moos It.			E	0	17	148		S(5)			(0)		335	1988
WV-220	Thornton Is.	S	700t		125	13	1053		1x(19)			S(4)		3805	1988
WV-230	"Mimulus" Its.					5	222							454	1988
WV-240	"Crag" Rocks				0	3	75							156	1988
WV-250	Munsie Rocks				0	9	28		S(3)					77	1988
WV-260	Nipple Rks.				0	3	149		S(2)					306	1988
WV-270	Volcanic Its.			50e	89	6	153		1x(12)			2 (2)		612	1988
WV-280	Diver It.					5	33		(0)					76	1988
WV-290	"Calm" Rocks					6	5		S(4)					26	1988
WV-300	Grassy I.			0		16	188		S(23)					431	1988
WV-310	Clark I.				0	5	16		3x(29)			S(5)		76	1988
WV-320	McQuarrie Its.				2	37	203		3x(18)			(0)		502	1988
WV-330	White Rock					1								2	1975
WV-340	Ensanada It.					1	1		5e(6)					10	1975
WV-350	Cameron Rks.					1								2	1975

cont'd

Table xx. (cont'd)

SITE CODE	SITE NAME	FTSP	LSPE	BRCO	PECO	BLOY	GWGU	COMU	PIGU	CAAU	RHAU	TUPU	HOPU	TOTAL BIRDS	SURVEY YEAR(S)
WV-360	Justice Rk.					2								4	1975
WV-370	"Kanim" Coast				24+				S(49)					97	1982
WV-380	Monks It.					1	54							110	1982
WV-390	Leeke Its.					1								2	1975
WV-400	Plover Reefs					2	10		2S(2)					26	1975
WV-410	Cleland I.	700t	5700t			45e	1622	0	2x(205)	800t	1000t	S(10)		19949	1986,88
WV-420	La Croix Group					5	1							12	1975
WV-430	Clayoquot Spit					1								2	1970
WV-440	Gowlland Rocks					1	2		(1)					7	1975
WV-450	"Portland" Rock					1								2	1975
WV-460	"White" I.			0	9	2	61							144	1975,77
WV-470	"Schooner" I.					1	1S							4	1975
WV-480	Lovekin Rk.						0							0	1966
WV-490	Green Point					1								2	1972
WV-500	Sea Lion Rks.			5	25	1	133							328	1977,82,89
WV-510	Cormorant Rock				0	1								2	1972,73
WV-520	Florencia It.				79	7	346	0	S(12)			S(1)		877	1975,82
WV-530	Fletcher's Beach				24									48	1970
WV-540	George Fraser Is.						0							0	1975
WV-550	Starlight Reef			51		10	279	0	S(11)					691	1982,88,89
WV-560	Great Bear Rk.			0	0	4	247		S(8)					510	1982
WV-570	Alley Rock				0	0	20e		S(4)					44	1982
WV-580	Hankin I.				0									0	1975
WV-590	Willis I.					0								0	1975
WV-600	Turtle I.					0	0							0	1975
WV-610	Wouwer I.						0		(1)					1	1975
WV-620	Cree Island								(0)					0	1975
WV-630	Austin I.				0									0	1982
WV-640	Effingham I.				0									0	1982
WV-650	Village Reef					4								8	1975
WV-660	Faber Islets					1	2							6	1975
WV-670	Dempster I.				5									10	1982
WV-680	Gibralter I.				0									0	1982
WV-690	Swale Rock					0								0	1975
WV-700	Rutley Is.				6+									12	1982
WV-710	Baeria Rocks				0	2	175							354	1988
WV-720	Weld Island				0									0	1982

cont'd

Table xx. (cont'd)

SITE CODE	SITE NAME	FTSP	LSPE	BRCO	PECO	BLOY	GWGU	COMU	PIGU	CAAU	RHAU	TUPU	HOPU	TOTAL BIRDS	SURVEY YEAR(S)
WV-730	Swiss Boy I.				0									0	1982
WV-740	Tzartus I.								x(15)					15	1982
WV-750	Hosie Is.				3									6	1975
WV-760	San Jose Its.					1S	1							4	1975,81
WV-770	Fleming I.				1									2	1982
WV-780	Wizard I.					6	2							16	1975
WV-790	Folger I.				7	2S	1S							20	1975
WV-800	Edward King I.				0									0	1982
WV-810	Bordelais Its.				0	12S	1S		(0)					26	1970,75,82
WV-820	"Execution" Rk.				8									16	1988
WV-830	Lawton Point				9									18	1979
WV-840	Cape Beale				14									28	1959
WV-850	Seabird Rks.	190e	430e		16	5	181		S(65)	160e	130e	8		2305	1988
WV-860	Whyac				50e									100	1973
WV-870	"Parkinson" Cliff				15e									30	1973
WV-880	San Simon Pt.				12e									24	1973
WV-890	"Sooke Bay" Its.						1							2	1962
WV-900	Argyle Islets						1							2	1978
WV-910	Bedford Is.					1	25							52	1978
WV-920	Church I.					1	0(6)							2	1978
WV-930	Race Rocks			0	120	3	471		S(78)					1266	1981,87,89
	TOTAL NESTING PAIRS	42890	156180	56	1158	299	7276	0		34960	1130	3110			
	TOTAL BREEDING BIRDS	85780	312360	112	2316	598	14552	0	787	69920	2260		6243	6	494934
	NUMBER OF SITES	4	7	2	26	54	44	0	29	3	2	3	8	1	72

METHODOLOGICAL CONSIDERATIONS AND RECOMMENDATIONS

The goal of the inventory program was to establish baseline estimates of breeding seabird populations using replicable survey techniques. Total counts conducted at the appropriate time are readily compared. Partial counts are adequate to detect substantial changes in nesting distribution and population on small colonies. Changes in population estimates for large colonies are more difficult to interpret. The level of precision of estimates derived from systematic sampling along transects depends on the precision of three components which enter into their calculation: colony area, burrow density and burrow occupancy rate. Each component has its own sources of error.

In the methods presented in this report, there is no measure of error for colony area calculations, and its level of precision is unknown. Distance, slope and elevation measurements taken along transects help delineate nesting areas, but precise identification of colony boundaries depends on thorough exploration, careful observations and detailed and explicit note-taking. Sources of error arise whenever observations or field notes are not comprehensive enough to allow unequivocal definitions of colony limits. Training of observers in what evidence to look for, and how to record it unambiguously, is an essential element of an inventory program and directly influences the quality of data obtained. Having some of the same assistants in sequential years, helped maintain an experienced core of surveyors. Accuracy of mapping and measuring colony areas also depends on the scale and quality of available maps or air photos.

The standard error of the average burrow density has been calculated for each site. The level of precision and accuracy depends on burrow distribution, sampling intensity and appropriate selection of quadrat size and spacing. Compromises were made between the level of precision desired and the time required to obtain that level. Average densities for small colonies often have large standard errors because they were sampled with few plots.

Burrow occupancy rates were determined for storm-petrels at all colonies, and for all species on Solander Island. Storm-petrel burrows are relatively easy to explore and all burrows within surveyed plots were examined except on Cleland Island and Seabird Rocks where time was limited. Some burrows were not accessible because they were located under tree roots or logs, and others were not dug because they were too fragile. Storm-petrel occupancy on Cleland Island and Seabird Rocks was determined in arbitrarily chosen plots or areas.

Digging alcid burrows, especially Rhinoceros Auklet burrows, is a laborious and time-consuming task, and it was generally not feasible to determine the occupancy of burrows within all surveyed quadrats. For Cassin's Auklets on Solander Island, quadrats were selected randomly and a fixed sample size was obtained at each plot selected. This method facilitates statistical analysis and comparison, and we recommend it for future surveys. Time was not available to obtain adequate occupancy samples for Cassin's and Rhinoceros auklets on Cleland Island or Seabird Rocks. Research on the variation in occupancy rates within and between colonies, and over time, is required to assess and improve sampling methodology.

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APPENDIX I. Birds and mammals sighted during seabird nesting surveys along the west coast of Vancouver Island in 1988 and 1989.

The following table is a summary of bird and mammal sightings made while conducting inventories of nesting seabirds on the west coast of Vancouver Island. Sightings are described in more detail in the individual island accounts under Associated species and Other birds and mammals sighted. Dates of sightings correspond to the survey dates listed in the island accounts.

Key to symbols used on table.

x: recorded

S: suspected

Abbreviations used for bird and mammal species follow Campbell and Harcombe 1985 (see Appendix II).

Appendix I (cont'd.)

	PALO	COLO	SOSH	DCCO	BRCO	PECO	GBHE	BRAN	HADU	SUSC	WWSC	COME	BAEA	PEFA	BBPL	SEPL	GRYE	WATA	SDSA	WHIM	BLTU	SURF
WV-010 Gillam Islands									7				2									
WV-020 Rowley Reefs																						
WV-030 Rugged Islands						97			27												1	
WV-040 Gould Rock						10			5													
WV-050 Clerke Islet	400					9			5													2
WV-060 Hackett I.	70																					
WV-070 Guilliams I.	200					2							1									
WV-080 Solander I.	150	1	350							60	1		5	2					1	3		
WV-090 Yule Rock																						
WV-100 O'Leary Its.																						
WV-110 Cuttle Its.													1									
WV-120 Skirmish Its.													1									
WV-130 Bunsby Is.							1	12	2													
WV-140 Clara It.			156		1	38			44												6	
WV-150 Thomas I.													2									
WV-160 "St. Pauls Its.																						
WV-170 "Favourite" Its.						26					25											
WV-180 "Amos" Reefs						43																
WV-190 Hohoae I.																						
WV-200 White Cliff Head																		1				
WV-210 Moos It.													2					1			32	1
WV-220 Thornton Is.					200			5	14				1		1	1	10	2		21	23	10
WV-230 "Mimulus" Its.					1													1			4	3
WV-240 "Crag" Rocks					29				4												15	3
WV-250 Munsie Rocks									6									1			10	
WV-260 Nipple Rks.																		1				1
WV-270 Volcanic Its.				1	1																2	
WV-280 Diver It.						4												1			11	1
WV-290 "Calm" Rocks																					1	
WV-300 Grassy I.						24		2			1	3				4	1			4	5	7
WV-310 Clark I.						1												1		3	5	
WV-320 McQuarrie Its.								1	5									2			1	
WV-410 Cleland I.			1		x			3	5					1						2	1	
WV-850 Seabird Rocks																		2		1	x	

Appendix I (cont'd.)

	WESA	LESA	SB/LBDO	RNPH	HMGU	MEGU	CAGU	HEGU	WEGU	GWGU	GW/WEGU	CATE	COMU	MAMU	ANMU	RHAU	TUPU	BLSW	RUHU	BEKI	NWCR
WV-010 Gillam Islands		1				3	230	1			1		3	14	4	1					1
WV-020 Rowley Reefs										1				12							
WV-030 Rugged Islands							250							35							
WV-040 Gould Rock																					
WV-050 Clerke Islet	9		2				400						5		2	33					
WV-060 Hackett I.														2		1	1				
WV-070 Guilliams I.														49			1				
WV-080 Solander I.				1			60					3	40		4	200					3
WV-090 Yule Rock																					
WV-100 O'Leary Its.																	1				
WV-110 Cuttle Its.																					
WV-120 Skirmish Its.																					
WV-130 Bunsby Is.	7						35				3			30				1		1	
WV-140 Clara It.	5						1						13	2	2		5				
WV-150 Thomas I.														14					x		1
WV-160 "St. Pauls Its.																					
WV-170 "Favourite" Its.										14			4	86							5
WV-180 "Amos" Reefs										1											
WV-190 Hohoae I.																					
WV-200 White Cliff Head																					
WV-210 Moos It.	1		2											4	2						6
WV-220 Thornton Is.	30	2	4								1	1	500	10		1					12
WV-230 "Mimulus" Its.			12																		1
WV-240 "Crag" Rocks																					
WV-250 Munsie Rocks																					
WV-260 Nipple Rks.																					
WV-270 Volcanic Its.																					
WV-280 Diver It.	8																				
WV-290 "Calm" Rocks																					
WV-300 Grassy I.	7	3	8				20						25	2			1				18
WV-310 Clark I.																					4
WV-320 McQuarrie Its.	1	1	8				480						22	48	2	1					
WV-410 Cleland I.	1	4					x		2		x	3			1						10
WV-850 Seabird Rocks	1		4		1																1

Appendix I (cont'd.)

	CORA	CBCH	BRCR	WIWR	SWTH	TOWA	FOSP	SOSP	RECR	PISI	EUJU	MUVI	LUCA	ENLU	PHVT	OROR	ESRO
WV-010 Gillam Islands							x	x					x		2		
WV-020 Rowley Reefs																	
WV-030 Rugged Islands															2		
WV-040 Gould Rock																	
WV-050 Clerke Islet																	
WV-060 Hackett I.																	
WV-070 Guilliams I.															5		
WV-080 Solander I.	5			x			x	x		x	55			1		6	
WV-090 Yule Rock																	
WV-100 O'Leary Its.											8			1			
WV-110 Cuttle Its.																	
WV-120 Skirmish Its.																	
WV-130 Bunsby Is.		x	x	x	x	x			x				x	5			
WV-140 Clara It.														15	16		
WV-150 Thomas I.								x				S	x				
WV-160 "St. Pauls Its.																	
WV-170 "Favourite" Its.																	
WV-180 "Amos" Reefs																	
WV-190 Hohoae I.																	
WV-200 White Cliff Head																	
WV-210 Moos It.				x			x	x					x				
WV-220 Thornton Is.	2			x			x							1			
WV-230 "Mimulus" Its.																	
WV-240 "Crag" Rocks															2		
WV-250 Munsie Rocks																	
WV-260 Nipple Rks.																	
WV-270 Volcanic Its.								x									
WV-280 Diver It.																	
WV-290 "Calm" Rocks																	
WV-300 Grassy I.							x	x							22		
WV-310 Clark I.								x									
WV-320 McQuarrie Its.															14		
WV-410 Cleland I.								x									
WV-850 Seabird Rocks																	1

APPENDIX II. Index to species names and acronyms.

Birds:		
Pacific Loon	*Gavia arctica*	PALO
Common Loon	G. immer	COLO
Sooty Shearwater	*Puffinus griseus*	SOSH
Double-crested Cormorant	*Phalacrocorax auritus*	DCCO
Brandt's Cormorant	*P. penicillatus*	BRCO
Pelagic Cormorant	*P. pelagicus*	PECO
Great Blue Heron	*Ardea herodias*	GBHE
Brant	*Branta bernicula*	BRAN
Harlequin Duck	*Histrionicus histrionicus*	HADU
Surf Scoter	*Melanitta perspicillata*	SUSC
White-winged Scoter	*M. fusca*	WWSC
Common Merganser	*Mergus merganser*	COME
Bald Eagle	*Haliaeetus leucocephalus*	BAEA
Peregrine Falcon	*Falco peregrinus*	PEFA
Black-bellied Plover	*Pluvialis squatarola*	BBPL
Semipalmated Plover	*Charadrius semipalmatus*	SEPL
Greater Yellowlegs	*Tringa melanoleuca*	GRYE
Wandering Tattler	*Heteroscelus incanus*	WATA
Spotted Sandpiper	*Actitis macularia*	SDSA
Whimbrel	*Numenius phaeopus*	WHIM
Black Turnstone	*Arenaria melanocephala*	BLTU
Surfbird	*Aphriza virgata*	SURF
Western Sandpiper	*Calidris mauri*	WESA
Least Sandpiper	*C. minutilla*	LESA
Dowitcher sp.	*Limnodromus griseus/scolopaceus*	SB/LBDO
Red-necked Phalarope	*Phalaropus lobatus*	RNPH
Heerman's Gull	*Larus heermanni*	HMGU
Mew Gull	*L. canus*	MEGU
California Gull	*L. californicus*	CAGU
Herring Gull	*L. argentatus*	HEGU
Western Gull	*L. occidentalis*	WEGU
Glaucous-winged Gull	*L. glaucescens*	GWGU
Caspian Tern	*Sterna caspia*	CATE
Common Murre	*Uria aalge*	COMU
Marbled Murrelet	*Brachyramphus marmoratus*	MAMU
Ancient Murrelet	*Synthliboramphus antiguus*	ANMU
Rhinoceros Auklet	*Cerorhinca monocerata*	RHAU
Tufted Puffin	*Fratercula cirrhata*	TUPU
Black Swift	*Cypseloides niger*	BLSW
Rufous Hummingbird	*Selasphorus rufus*	RUHU
Belted Kingfisher	*Ceryle alcyon*	BEKI
Northwestern Crow	*Corvus caurinus*	NWCR
Common Raven	*C. corax*	CORA
Chestnut-backed Chickadee	*Parus rufescens*	CBCH
Brown Creeper	*Certhia americana*	BRCR
Winter Wren	*Troglodytes troglodytes*	WIWR
Swainson's Thrush	*Cathasus ustulatus*	SWTH
Townsend's Warbler	*Dendroica townsendi*	TOWA
Fox Sparrow	*Passerella iliaca*	FOSP
Song Sparrow	*Melospiza melodia*	SOSP
Red Crossbill	*Loxia cruvirostra*	RECR
Pine Siskin	*Carduelis pinus*	PISI

Appendix II. (cont'd)

Mammals:		
Northern Sea Lion	*Eumetopias jubatus*	EUJU
Mink	*Mustela vison*	MUVI
River Otter	*Lutra canadensis*	LUCA
Sea Otter	*Enhydra lutris*	ENLU
Harbour Seal	*Phoca vitulina*	PHVT
Killer Whale	*Orcinus orca*	OROR
Gray Whale	*Eschrichtius robustus*	ESRO