THE IMPORTANCE OF SPRING STAGING AREAS OF BRANT *(BRANTA BERNICLA)* AND THE DISTRIBUTION OF OTHER MARINE BIRDS NEAR SANDSPIT, QUEEN CHARLOTTE ISLANDS

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ABSTRACT

The distribution, feeding activities and disturbance of Brant (*Branta bernicla*), and the distribution of other waterbird species, were investigated in the spring of 1991 at Shingle Bay and surrounding region (Skidegate Inlet, Spit Point to Gray Bay) in the Queen Charlotte Islands in relation to the establishment of a potential harbour. Of all species, Brant may suffer most from the establishment of a harbour at Shingle Bay, as that site is a major feeding ground for those geese. Brant prefer to feed at low and falling tides and early in the morning at Shingle Bay. Another important spring feeding area of Brant is located at the Spit. Brant use Shingle Bay and the Spit interchangeably; they feed mostly on intertidal *Zostera* spp. at Shingle Bay and on *Ulva lactuca* at the Spit. We estimate that up to 2000 Brant use the study area on some days, but the overall numbers of Brant during spring migration may consist of many thousands of geese. No other spring staging area for migratory Brant of the magnitude observed at Shingle Bay and the Spit has been observed in northern British Columbia. We therefore recommend that both areas be given protection from disturbance. We suggest that a harbour be built elsewhere in Skidegate Inlet. However, before a new harbour site is selected, a winter study of Brant should be conducted to determine their numbers, distribution and habitat use in the region.

RESUME

Nous avons étudié la distribution, le comportement alimentaire et le dérangement des bernaches cravant (*Branta bernicla*), ainsi que la distribution d'autres espèces d'oiseaux aquatiques à Shingle Bay et aux environs (Skidegate Inlet, de Spit Point à Gray Bay) dans les îles de la Reine Charlotte, au printemps 1991, par rapport à l'éventuel établissement d'un port

à Shingle Bay. De toutes les espèces recensées, les bernaches cravant seraient les plus menacées par l'établissement du port, du à l'importance de Shingle Bay pour l'alimentation de l'espèce. A Shingle Bay, les bernaches préfèrent s'alimenter aux marées basses ou baissantes, ou tôt le matin. Spit Point est également un important site d'alimentation pour les bernaches. Ces 2 sites sont utilisés de façon comparable: les bernaches s'alimentent principalement de *Zostera* à Shingle Bay et de *Ulva lactucca* à Spit Point. Nous estimons que, certains jours, jusqu'à 2000 bernaches sont présentes dans la région d'étude, mais le nombre total de bernaches durant la migration printanière peut consister de plusieurs milliers d'individus. Pour les bernaches cravant en migration printanière, aucun autre site de repos d'une importance comparable à celle de Shingle Bay et de Spit Point n'a jusqu'à maintenant été localisé dans le nord de la Colombie-Britannique. Nous recommendons donc que les 2 sites soient protégés du dérangement. Nous suggérons qu'un autre site dans Skidegate Inlet soit choisi pour la construction du port. Une étude visant à déterminer le nombre, la distribution, et l'utilisation de l'habitat par les bernaches cravant hivernant dans la région devrait cependant être conduite avant de sélectionner ce nouveau site.

INTRODUCTION

The Small Craft Harbour Branch of the Department of Fisheries and Oceans requested that Public Works Canada undertake an assessment of the potential impacts associated with the construction and operation of a boat harbour near Sandspit on the Queen Charlotte Islands. Public Works Canada requested Environment Canada, Canadian Wildlife Service, to conduct a spring study of staging Brant Geese (*Branta bernicla*) at and in the general vicinity of a proposed harbour site at Shingle Bay. The main objective of the study was to determine the spring use by Brant of Shingle Bay, eastern Skidegate Inlet, and the east coast of Moresby Island (Spit Point to Gray Bay). Other objectives were to investigate the feeding activities and the response of Brant to disturbance, and to document the distribution and abundance of all waterbird species in the above areas. The important issue of the overwintering population of Brant in the Shingle Bay area was not addressed in this study.

METHODS

An inventory of Brant and other waterbirds was conducted by boat at the eastern portion of Skidegate Inlet, including the proposed harbour site in Shingle Bay from 1 April through 15 May 1991. The study area was divided into 22 transects, of which 15 transects were considered to be within (S transects) and 7 outside Skidegate Inlet (A transects). The transects within the inlet were censused on 24 days, except for three transects which were censused less frequently (17, 18 and 23 days) because of rough seas. The transects outside the inlet were censused between 6 and 8 times. Originally, the area from Spit Point to Cape Croustcheff had been included in the inventory area. However, the presence of a broad shelf forced the survey boat so far

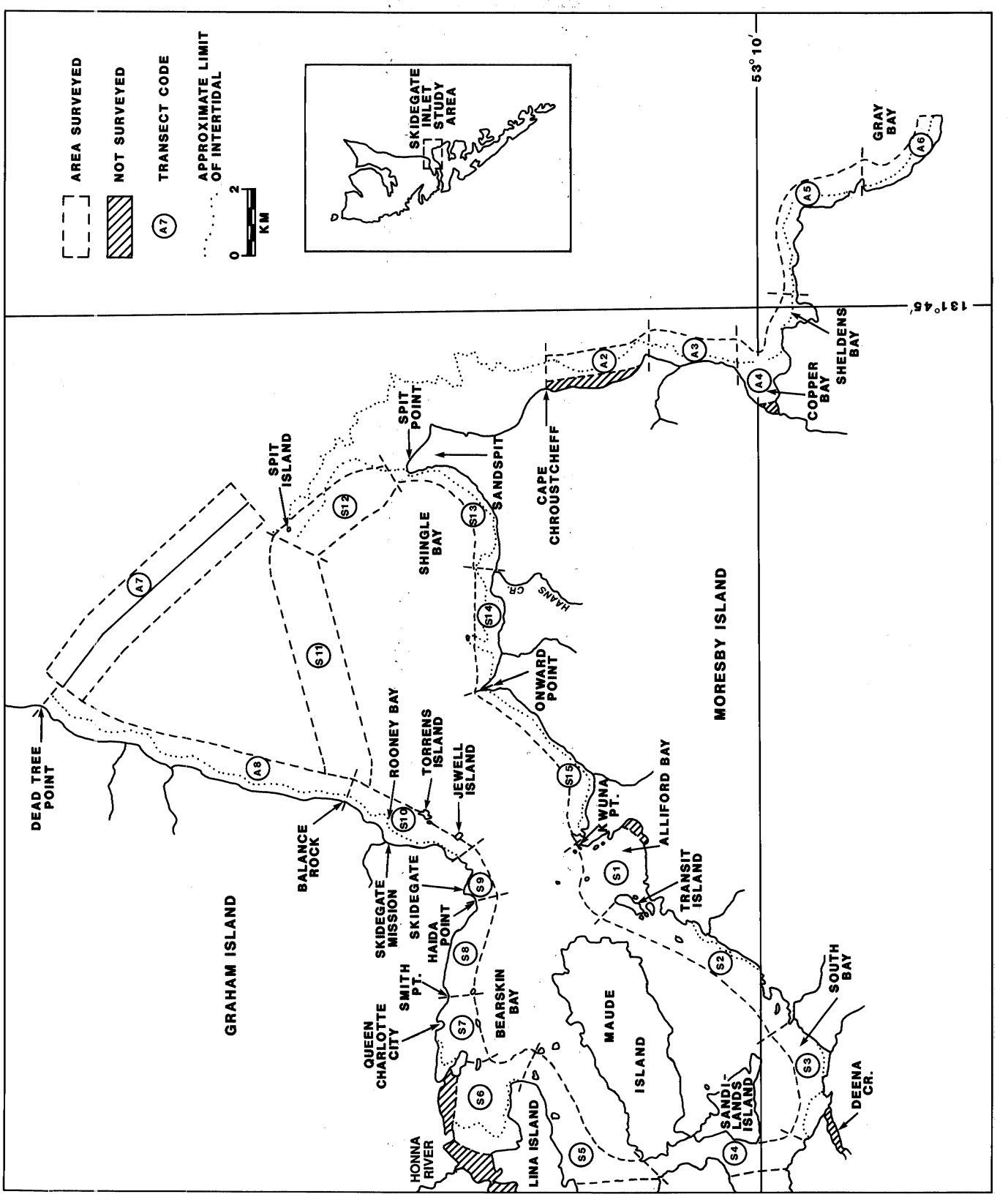

Fig. 1. LOCATION OF SURVEY TRANSECTS IN SKIDEGATE INLET AND CAPE CHROUSTCHEFF - GRAY RAY AREA, 1 APRIL-15 MAY 1991

offshore that censusing was impossible (Fig. 1). All birds were counted in an approximately 500 m wide zone from shore, except for most bays which were censused in their entirety. Three offshore transects were surveyed approximately 500 m on either side of the transect route.

In addition to the boat census, either Shingle Bay or the east side of Spit Point were surveyed by one observer or both areas were surveyed simultaneously by two observers for Brant during the study period (Fig. 2). Brant at those locations were counted each hour during an 8 hr period per day, to determine if their numbers and presence/absence related to time of day (minutes after sunrise) and/or tide height and direction.

To determine activity budgets, flocks of Brant were observed by telescope on five days at the Spit and on two days at Shingle Bay. The number of birds in each of the following categories were recorded at 15 minute intervals: feeding, preening, vigilance and swimming. These activities were examined for correlations with tide level and direction. Only activities by Brant on the ground or in the water were recorded as budget activities, whereas for the purpose of determining the effects of disturbance on Brant the occurrence of flight was recorded separately. Sources of disturbance and their effects on Brant were also recorded. Numbers on leg bands of Brant were read with a telescope to determine where the geese had been banded.

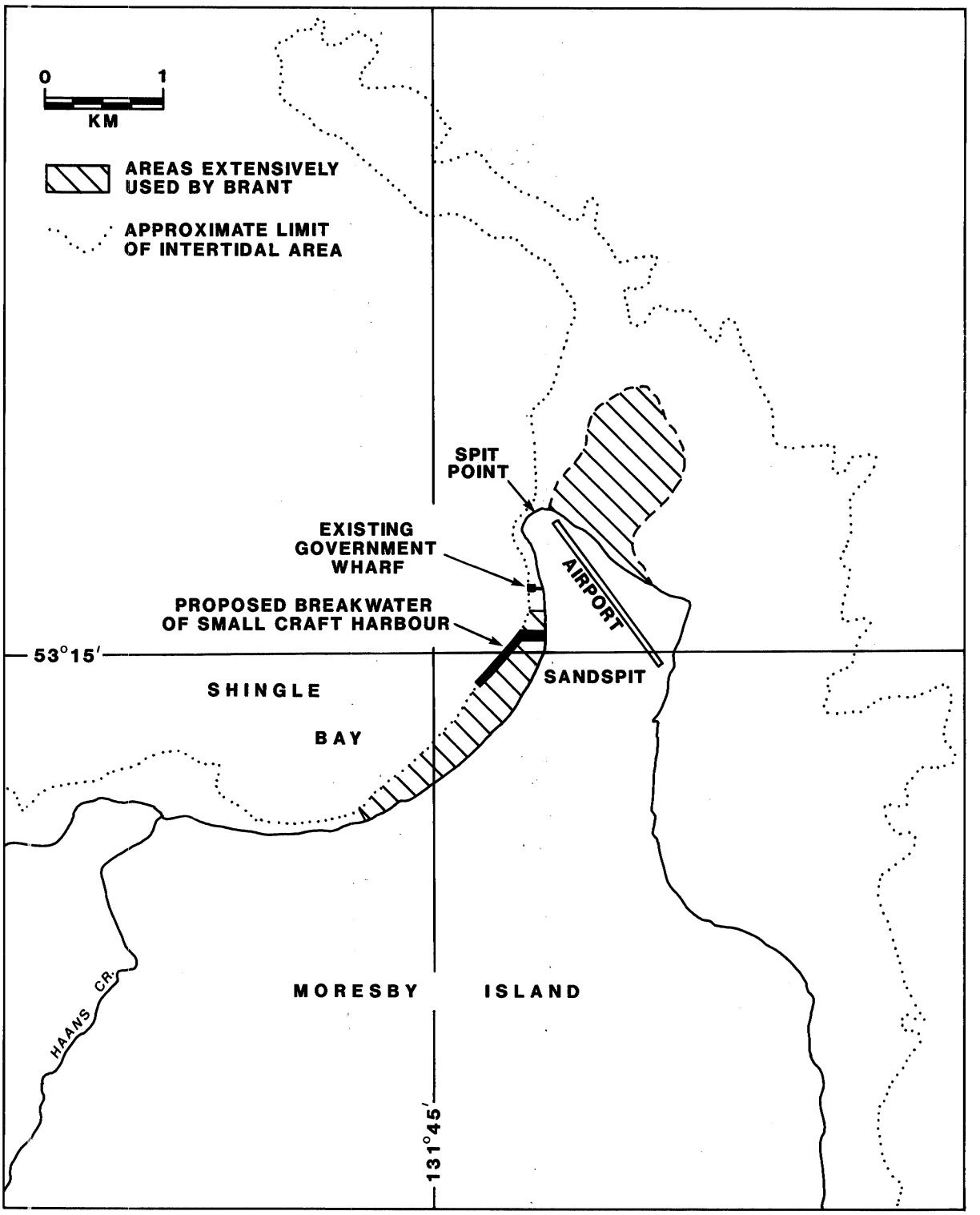

Fig. 2. STUDY AREA OF THE SPIT AND SHINGLE BAY, 1 APRIL-15 MAY 1991

RESULTS

Waterbird densities

The Common Loon (*Gavia immer*) was the most common species of loon observed (Table 1), while other loons, (Pacific *G. pacificus*, Red-throated *G. stellata* and Yellow-billed *G. adamsii*) were scarce. The predominantly pelagic Northern Fulmar (*Fulmarus glacialis*) was seen only twice on offshore transects. Three grebe species, Horned (*Podiceps auritus*), Red-necked (*P. grisegena*) and Western (*Aechmophorus occidentalis*) commonly occurred in the study area. Among cormorants, Pelagic (*Phalacrocorax pelagicus*) was most common, followed by Double-crested (*P. auritus*). Brandt's Cormorant (*P. penicillatus*) was only occasionally seen.

Brant, the most numerous goose species, reached its highest density in Shingle Bay (Table 1). Of the dabbling ducks, the Mallard (*Anas platyrhynchos*) was most common. Deena Creek of the South Bay area generally had the highest density of dabbling ducks, as well as maximal densities of diving ducks such as Barrow's Goldeneye (*Bucephala islandica*), Bufflehead (*B. albeola*) and Common Merganser (*Mergus mergus*). Of the diving ducks, Surf Scoters (*Melanitta perspicillata*) and Greater Scaup (*Aythya marila*) had the highest densities, followed by Harlequin Ducks (*Histrionicus histrionicus*), White-winged Scoters (*Melanitta fusca*), Buffleheads and Common Goldeneyes (*Bucephala clangula*). Thousands of Surf Scoters and Greater Scaup, and hundreds of Black Scoters (*Melanitta nigra*), White-winged Scoters and Harlequin Ducks concentrated over spawn areas of Pacific Herring (*Clupea harengus*) in Rooney Bay from 9 to 22 April. The highest densities of Harlequin Ducks and Common Goldeneyes occurred in Gray Bay.

Table 1. Average densities of waterbirds (number of birds/km^2) in surveyed transects of Skidegate Inlet and the area from Cape Croustcheff to Gray Bay, 1 April - 15 May 1991. Transects with the highest density for a species are underlined. The location of each transect is shown in Figure 1.

Species	Transects and average densities																				
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	A2	A3	A4	A5	A6	A7	A8
Pacific Loon	0.01	0.01		0.58	0.10					0.04			0.01									0.04
Common Loon	0.56	0.46	0.43	0.66	1.30	1.44	0.96	0.61	1.52	3.98	0.20	0.86	2.57	3.03	2.72	0.40	6.34	3.45	1.49	2.94	0.34	1.37
Red-throated Loon				0.01		0.02	0.19	0.03					0.01		0.02				0.05			
Yellow-billed Loon				0.01	0.01																	
Northern Fulmar											0.02										0.06	
Horned Grebe	0.76	0.49	1.32	0.81	0.48	2.28	0.58	0.07	0.17	0.18			1.53	0.37	0.03		0.08	1.61	0.62	1.77		0.17
Red-necked Grebe	0.13	0.34	0.28	1.28	2.08	0.08	0.06	0.02	0.21	0.01	0.01	0.03	0.11	0.11	0.09			0.14	0.10			0.09
Western Grebe	3.84	4.94	1.62	0.10	3.25	0.01	0.08	0.10		1.05	1.38	0.11	4.27	0.10	2.26						0.06	3.02
Double-crested Cormorant	0.20	0.01		0.03		0.07	0.04		0.13	0.02		0.10		0.08	0.02						0.03	0.30
Pelagic Cormorant	0.19	0.21	0.09	0.15	0.34	0.18	0.55	0.10	0.08	0.22	0.06	0.32	0.03	0.40	0.03	2.05	0.31	0.05	1.54	0.17	0.44	0.54
Brandt's Cormorant					0.01												0.08				0.07	
Unidentified Cormorant	0.16										0.06										0.05	0.60
Brant					0.34	25.58	3.34	20.86		44.39	2.99	0.98	80.82	10.39	0.51					2.69	0.70	0.43
Canada Goose			0.05			0.04						0.20	0.08									
Mallard	0.04	0.23	11.98	0.62	0.19	3.44	0.06			3.58			0.31	0.19	0.31			0.47				
American Wigeon	0.01		2.93			1.57												0.10		0.25		0.04
Gadwall			0.06																			
Green-winged Teal	0.05		3.15									0.03										
Northern Shoveler			0.02					0.10		0.19												
Northern Pintail			0.05			0.10					0.01	0.12										0.45
Greater Scaup	1.28	0.02	0.59	0.66	0.22	36.59	19.83	50.74	0.46	97.30	0.11	0.03	21.06	3.35	2.99		1.60	15.14	0.41	3.53	0.04	0.73
Harlequin Duck	1.00	0.29	0.27	0.91	1.61	0.16	5.35	1.67	0.04	8.69	0.02	0.49	3.08	1.28	2.74	4.03	4.74	0.33	2.77	40.92	0.07	1.09
Oldsquaw	0.01				0.55	2.16	2.51	1.59	0.04	0.41	0.04	0.04	0.03		0.03	0.47	2.45	0.99	1.33	1.01	0.43	10.68
Black Scoter	0.08	0.11	0.13	1.62	0.42	0.63	1.96	3.59		21.98	0.85	1.76	8.40	0.99	2.37	2.53	2.45	19.16		0.17	0.08	11.15
Surf Scoter	4.62	2.57	0.27	5.03	1.55	10.57	5.66	66.34	0.46	278.31	0.24	5.91	24.15	19.43	36.40	2.92	3.97	11.68	2.00	0.50	0.21	6.97
White-winged Scoter	0.43	0.02	1.16	0.44	1.27	14.30	0.79	6.13	0.13	11.92	1.12	0.73	2.08	0.61	2.83	0.40	4.28	4.64	2.15	0.67	0.05	5.83
Common Goldeneye	0.47	0.31	4.37	0.72	0.05	1.55	0.34	0.21	0.08	1.31	0.01	0.03	2.06	1.34	1.19	7.35	11.46	7.62	4.62	38.40	0.18	7.44
Barrow's Goldeneye			2.69	0.38	0.04																	
Bufflehead	0.73	0.74	26.51	0.38	0.77	7.82	1.13	0.31	0.13	0.61		0.14	4.90	2.00	0.55	1.42	0.92	1.70	0.26	5.88	0.06	0.15
Common Merganser	0.04	0.13	0.98	0.11	0.18	0.04	0.02	0.02	0.13	0.12			0.06	0.02	0.10							
Red-breasted Merganser	0.60	0.52	0.33	0.75	1.73	0.58	0.36	0.16	0.46	0.16		0.23	1.37	1.64	0.86	0.32	2.14	0.62	0.31	0.59	0.02	0.32
Mew Gull		0.02	0.33	0.10	0.02	0.99	0.25	0.22	0.17	1.68	0.01		0.04	0.06	0.12			0.10				
Glaucous-winged Gull	3.52	0.87	2.20	1.94	1.65	2.43	5.71	1.80	2.74	4.27	0.22	3.18	3.12	8.73	3.47	0.08	1.76	0.80	0.62	0.50	0.27	1.05
California Gull						0.03	0.02															
Herring Gull	0.31								0.13	0.02	0.04	0.26	0.01						0.05			
Thayer's Gull									0.04													
Unidentified Gull						1.43	0.94			0.18	0.03	0.26	0.57					0.52		6.30	0.63	
Black-legged Kittiwake					0.74						0.20	0.14									0.17	
Caspian Tern												0.03										
Common Murre	0.05	0.01		0.01	0.04	0.04					0.01	0.01	0.04		0.04						0.02	
Pigeon Guillemot	6.76	42.63	0.49	1.58	5.68	0.20	3.49	0.58	12.96	14.64	0.26	0.47	0.52	0.42	0.49						0.90	0.79
Ancient Murrelet	0.02																					
Marbled Murrelet	0.24	0.80	3.54	0.51	0.09		0.06			0.07	0.12	0.18	0.33	0.53	0.18					0.17	0.14	0.02
Rhinoceros Auklet											0.01				0.02							
Average density/transect	26.11	55.73	65.84	19.39	24.71	114.33	54.28	155.25	20.08	495.27	8.02	16.64	161.56	55.07	60.37	21.97	42.58	69.12	18.32	106.47	5.02	53.27
Standard deviation	9.39	36.49	31.93	13.53	11.21	43.66	51.11	212.83	13.56	468.83	9.91	13.92	114.81	71.68	106.79	18.35	23.18	70.86	9.94	86.51	3.90	21.01
No. of surveys/transect	24	24	24	24	24	23	24	24	24	24	17	18	24	24	24	6	7	7	6	7	8	6

Of the gulls, Glaucous-winged (*Larus glaucescens*) and Mew (*L. canus*) gulls were most common. The Glaucous-winged Gull is a common nester on islands in Skidegate Inlet. Vermeer *et al.* (in prep.a) estimated that 182 pairs of those gulls nested there in 1990. Mew Gulls nest in small numbers on islands in lakes in the Queen Charlotte Islands (M. Rodway, pers. comm.). Four other species, California (*L. californicus*), Herring (*L. argentatus*), Thayer's (*L. thayeri*) gulls and Black-legged Kittiwakes (*Rissa tridactyla*) were seen in low numbers in the study area. Caspian Terns (*Hydroprogne caspia*) were seen only once on an offshore transect.

Pigeon Guillemots (*Cepphus columba*) were by far the most numerous alcids, undoubtedly related to the fact that they are the most abundant nesting seabird in Skidegate Inlet (Vermeer *et al.* in prep.b). The high density of Pigeon Guillemots observed on the transect between Transit Island and South Bay, most likely relates to the proximity of Lillihorn Island, the site of the largest nesting colony in Skidegate Inlet (unpublished observations). Marbled Murrelets (*Brachyramphus marmoratus*) were the second most common alcid, while Common Murres (*Uria aalge*), Ancient Murrelets (*Synthliboramphus antiquus*) and Rhinoceros Auklets (*Cerorhinca monocerata*) were seen in low numbers. The latter also breed on Lillihorn Island, but only visit that island at dusk (unpublished observations).

Overall bird densities observed on all transects in Skidegate Inlet (all S transects and A8 transect) are shown for comparison in Table 2. Surf Scoters had by far the highest density (28.4 birds/km^2), followed by Greater Scaup (14.5 birds/km^2), Brant (11.5 birds/km^2) and Pigeon Guillemots (7.1 birds/km^2) during the study period. Rooney Bay (S10) with 495 birds/km^2 supported the highest overall bird density, probably as a result of herring spawning

Table 2. Average density of birds (number of birds/km²) observed in Skidegate Inlet, April 1 - May 15, 1991.

Species observed	Mean density ± SD	No. days observed
Red-throated Loon	0.006 ± 0.012	6
Pacific Loon	0.049 ± 0.081	14
Common Loon	1.264 ± 0.844	24
Yellow-billed Loon	0.002 ± 0.006	2
Northern Fulmar	0.003 ± 0.014	1
Horned Grebe	0.606 ± 0.597	23
Red-necked Grebe	0.346 ± 0.322	22
Western Grebe	1.782 ± 1.558	23
Double-crested Cormorant	0.049 ± 0.075	14
Brandt's Cormorant	0.001 ± 0.005	1
Pelagic Cormorant	0.193 ± 0.214	22
Unidentified cormorants	0.036 ± 0.103	5
Brant	11.535 ± 7.403	21
Canada Goose	0.019 ± 0.059	4
Green-winged Teal	0.174 ± 0.535	8
Mallard	0.872 ± 0.953	21
Northern Pintail	0.035 ± 0.095	4
Gadwall	0.003 ± 0.013	1
American Wigeon	0.268 ± 0.569	11
Northern Shoveler	0.021 ± 0.075	5
Greater Scaup	14.515 ± 9.076	24
Harlequin Duck	1.641 ± 2.072	24
Oldsquaw	0.738 ± 1.106	24
Black Scoter	2.418 ± 1.755	24
Surf Scoter	28.429 ±26.367	24
White-winged Scoter	3.286 ± 1.228	24
Common Goldeneye	1.064 ± 1.293	24
Barrow's Goldeneye	0.165 ± 0.199	13
Bufflehead	2.729 ± 1.081	24
Common Merganser	0.119 ± 0.095	22
Red-breasted Merganser	0.613 ± 0.361	24
Mew Gull	0.248 ± 0.271	20
California Gull	0.004 ± 0.015	2
Herring Gull	0.045 ± 0.078	11
Thayer's Gull	0.001 ± 0.004	1
Glaucous-winged Gull	2.584 ± 1.099	24
Black-legged Kittiwake	0.105 ± 0.380	4
Unidentified gulls	0.202 ± 0.559	10
Caspian Tern	0.001 ± 0.007	1
Common Murre	0.014 ± 0.019	13
Pigeon Guillemot	7.126 ± 6.062	23
Marbled Murrelet	0.412 ± 0.383	19
Ancient Murrelet	0.001 ± 0.007	1
Rhinoceros Auklet	0.002 ± 0.008	2
Overall average density	83.728 ±34.892	

there. Of the areas without herring spawning, Shingle Bay (S13) had the highest overall bird density (162 birds/km^2).

Brant distribution and diet

Brant were observed at many different locations throughout the study area (Table 3). The largest number occurred at the Spit and in Shingle Bay. The distribution pattern of Brant changed throughout the study. During the first twelve days of April, Brant occurred mostly at the Spit, whereas for the next two weeks, they were concentrated at both the Spit and Shingle Bay. From 26 April on, Brant began to disperse more throughout the study area, although they were still numerous at both the Spit and Shingle Bay (Table 3). Other areas selected by Brant (after 25 April) were Rooney Bay and the Honna River estuary.

Brant were observed flying between the Spit and Shingle Bay after 12 April. Because of the possibility of counting birds twice, it is difficult to provide an accurate total of the birds present in the whole study area from that date on. It is estimated, however, that up to 2000 Brant used the study area on some days. Brant were still common in the study area at least until the end of May, as evidenced from the following observations: we counted 800, 200, 350, 800, 250, 250 and 300 Brant at the Spit on May 18, 20, 25, 26, 28, 29 and 30, respectively, and 300, 450, 450 and 300 Brant near Gillatt Island (S14) on May 22, 23, 24 and 26, respectively. Small flocks of Brant (10-60 birds) were still seen in Skidegate Inlet or at the Spit until 19 June, and stragglers until 1 July.

Table 3. Numbers of Brant observed in Skidegate Inlet area from April 1 through May 15, 1991. Data for Shingle Bay (S13) and the area northeast of Spit Point represent maximal numbers counted from shore during daylight hours. For all other areas, the data refer to the number of birds counted during each boat survey. See Figure 1 for locations of transects.

	Location name or transect number										
Date	Spit	Shingle Bay	S6	S7	S8	S10	S11	S12	S14	S15	A8
April 1	-	0	0	0	0	0	0	0	0	0	-
2	2	0	0	0	0	0	400	0	0	0	-
3	772	0	0	0	0	0	0	0	0	0	-
4	835	0	-	-	-	-	-	-	-	-	-
5	836	0	-	-	-	-	-	-	-	-	0
8	744	0	-	-	-	-	-	-	-	-	-
9	1602	0	0	0	0	0	0	0	0	0	-
10	927	0	-	-	-	-	-	-	-	-	0
11	-	-	0	0	0	0	12	7	0	0	-
12	-	0	0	0	0	0	-	-	31	0	-
13	-	65	-	-	-	-	-	-	-	-	-
14	-	580	-	-	-	-	-	-	-	-	-
15	918	1225	-	-	-	-	-	-	-	-	-
16	1255	1370	-	-	-	-	-	-	-	-	-
17	1250	1546	0	0	0	0	0	0	0	0	0
18	946	873	0	0	0	0	7	-	0	0	-
19	844	1074	-	-	-	-	-	-	-	-	-
20	-	800	-	-	-	-	-	-	-	-	-
21	-	515	-	-	-	-	-	-	-	-	-
22	400	500	0	0	0	200	46	0	9	0	-
23	367	225	30	0	0	60	-	-	0	7	-
24	81*	215	-	-	-	-	-	-	-	-	0
25	-	430	14	0	0	68	-	-	57	0	-
26	0	100	500	0	6	130	0	16	6	4	-
29	463*	854	250	0	0	0	-	-	25	0	-
30	-	768	250	0	133	0	64	2	260	23	-
May 1	28	330	150	0	175	0	0	2	117	0	-
2	79	735	100	0	160	4	3	0	0	0	-
3	150	840	70	0	300	5	0	0	9	0	0
6	170	200	198	0	317	225	0	43	30	0	-
7	193	62	145	15	181	500	-	-	10	0	-
8	573	87	67	8	66	833	-	16	0	0	-
9	212	136	-	-	-	-	-	-	-	-	20
10	85	190	215	126	34	383	3	9	74	0	-
13	253	204	250	0	0	260	4	3	20	0	-
14	194	127	250	0	0	450	0	0	3	0	-
15	98	175	230	28	0	600	8	0	50	0	-
No. of surveys	28	36	24	24	24	24	18	18	24	24	6
Mean	510	395	113	7	57	154	30	5	29	1	3
S.D.	447	438	131	27	99	234	94	11	57	5	8
Frequency of occurrence	.97	.75	.63	.17	.38	.54	.50	.58	.58	.13	.17

- Not counted.
* one count only.

Brant fed mostly upon *Ulva lactuca* (algae) at the Spit at both high and low tides, and mostly upon intertidal *Zostera* spp. (eelgrass) beds in Shingle Bay at low tide. Occasionally they were also observed feeding upon *Enteromorpha* sp. (algae) at the Spit. At the Spit, Brant chiefly foraged in the northern section of the broad intertidal shelf, while in Shingle Bay the birds foraged all over the broadest portion of the intertidal zone (Fig. 2). Brant concentrated at Rooney Bay when herring were spawning, and probably fed upon spawn there as they have been observed to take herring eggs in Lambert Channel in the Strait of Georgia (C. Haegele, pers. comm.).

Numbers of Brant as related to tide height and time of day

The numbers of Brant present from 8:00 (Pacific Daylight Saving Time, PDT) to 16:00 hr at the Spit and Shingle Bay in relation to tide height (at all tide directions) are presented in Table 4. These data refer to times at which Brant were counted at one area or the other but not simultaneously. There was no significant correlation between the number of Brant and tide height at the Spit regardless of tide direction, but Brant numbers at Shingle Bay increased significantly with low tide at all tide directions. Hence tide height appears to be a determining factor when Brant are present at Shingle Bay, but not for the Spit.

The numbers of Brant present at the Spit and Shingle Bay were also related to tide height and time of day when birds were simultaneously counted there from 8:00 to 16:00 hrs. Again, there was no significant correlation between the number of Brant and tide height at the Spit, but there was a highly significant correlation between the number of Brant present at all and falling tides at Shingle Bay (Table 5). There was also a significant and positive correlation between

Table 4. Correlations between the number of Brant present at the Spit and Shingle Bay and tide height, at all tide directions, 3 April-15 May 1991. The data refer to times when counts were conducted at either location, but not simultaneously.

Tide direction, sample number	Correlation coefficients between number of Brant and tide height			
	Spit		Shingle Bay	
	r	P	r	P
All directions, n=161	-.022	ns	-.433	<.001
Rising tides, n=78	-.008	ns	-.301	<.005
Falling tides, n=62	-.214	ns	-.656	<.005
Slack tides, n=21	.299	ns	-.522	<.01

Table 5. Correlations between the number of Brant present at the Spit and Shingle Bay and tide height and time of day during simultaneous counts at those locations, 15 April-15 May 1991.

Tide direction, sample number	Correlation coefficients between number of Brant and tide height and time of day: Spit r	Spit P	Shingle Bay r	Shingle Bay P
Tide height				
All directions, n=93	-.005	ns	-.270	<.01
Rising tides, n=49	.086	ns	.012	ns
Falling tides, n=30	-.107	ns	-.683	<.001
Slack tides, n=14	-.166	ns	-.495	ns
Time of day				
All directions, n=93	.256	<.02	-.373	<.001
Rising tides, n=49	.369	<.01	-.348	<.02
Falling tides, n=30	.166	ns	-.511	<.005
Slack tides, n=14	-.135	ns	-.651	<.01

the number of Brant present and the time of day (especially on rising tides) at the Spit. In contrast, there were significant negative correlations between the number of Brant and the time of day at Shingle Bay. That suggests that Brant prefer to feed at low and falling tides, and early in the morning at Shingle Bay, while at the Spit, Brant numbers increased later on in the day. An example of the number of Brant present at both the Spit and Shingle Bay in relation to the tide cycle is shown in Fig. 3. It can be seen that most Brant occurred at low tide at Shingle Bay, but as the tide rose, the Brant departed. The number of Brant present at the Spit was relatively low compared to that at Shingle Bay at low tide in the morning, but increased with a rising tide in the afternoon. Brant at Shingle Bay were seen leaving that day for the Spit as well as for other destinations around noon.

Activity budget and disturbance of Brant

The overall activities of 30 flocks (average flock size $\pm$ standard deviation: 135 $\pm$ 90 birds) observed during a total of 18 hours at the Spit, indicated that on average 56% $\pm$ 26% of the Brant were feeding, 15% $\pm$ 15% were preening, 13% $\pm$ 11% were vigilant, and 16 $\pm$ 27% were swimming. When flight, as a result of disturbance was added to the ground activities, the proportions changed to 53% $\pm$ 32% feeding, 11% $\pm$ 16% preening, 11 $\pm$ 12% being vigilant, 19% $\pm$ 29% swimming and 6% $\pm$ 22% flying. Feeding and preening activity correlated negatively with tide height at the Spit, indicating that both activities increased with low tide (Table 6). Feeding activity of Brant at the Spit only increased significantly when the tide was falling. Swimming on the other hand increased significantly at both the Spit and Shingle Bay with high tide.

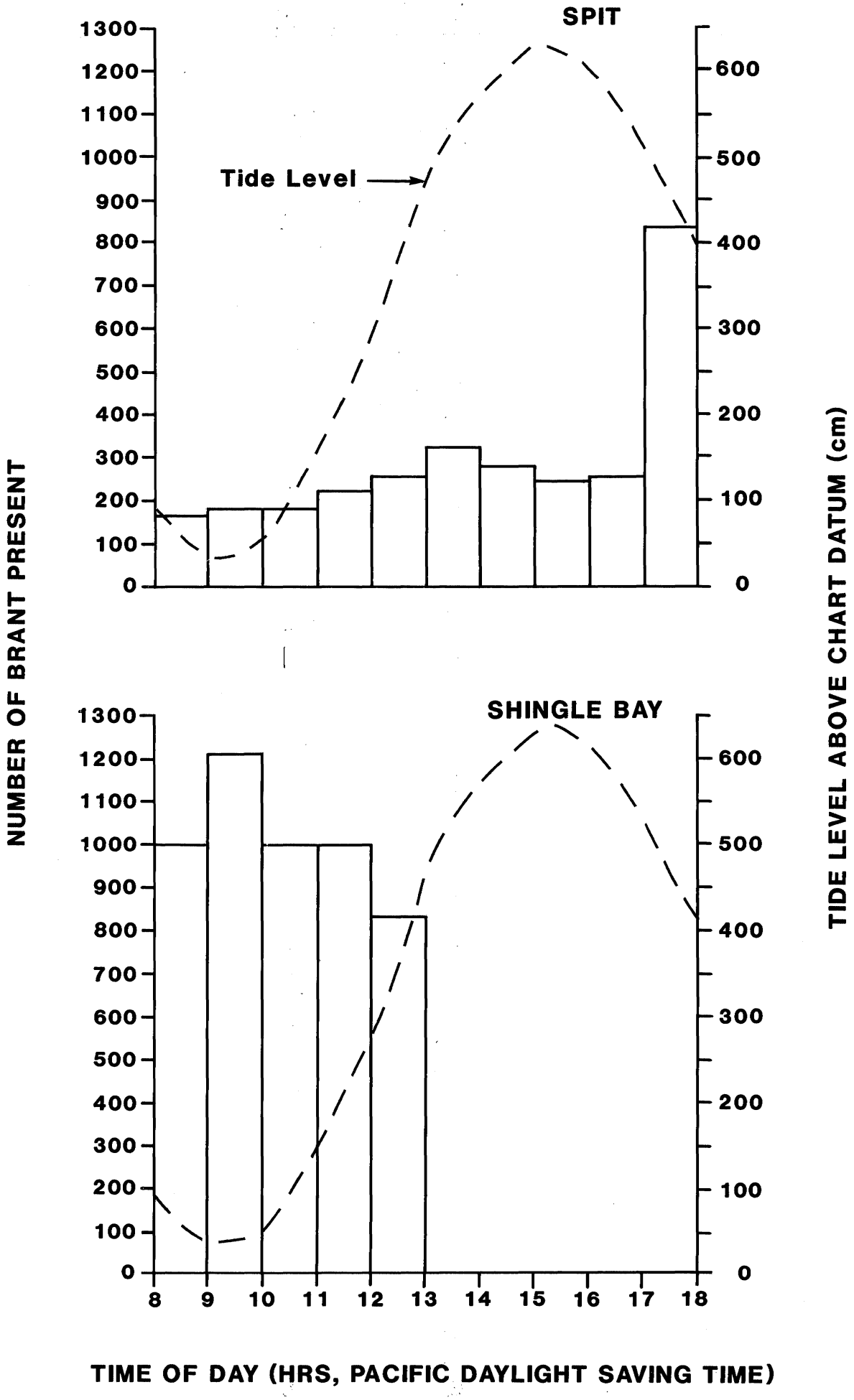

Fig. 3. NUMBERS OF BRANT PRESENT AT THE SPIT AND SHINGLE BAY AS RELATED TO TIDE LEVEL ON APRIL 15, 1991

Table 6. Correlations between Brant activities and tide height at the Spit and Shingle Bay.

	Correlation coefficients with Brant activites and tide height			
Brant activities,	Spit		Shingle Bay	
tide directions	r	P	r	P
All tide directions	n=67		n=15	
% feeding	-.332	<.01	-.386	ns
% preening	-.417	<.001	-.487	ns
% vigilance	-.194	ns	-.660	<.01
% swimming	.662	<.001	.787	<.001
Falling tides, n=25				
% feeding	-.540	<.005		
% preening	-.096	ns		
% vigilance	-.436	<.05		
% swimming	.769	<.001		
Rising tides, n=32				
% feeding	-.111	ns		
% preening	-.593	<.001		
% vigilance	-.191	ns		
% swimming	.519	<.001		
Slack tides, n=10				
% feeding	-.515	ns		
% preening	-.299	ns		
% vigilance	.108	ns		
% swimming	.981	<.001		

Table 7. Summary of disturbance observations. Total of 155 hours of observations over 19 days. If Brant flushed and then returned to same location, flight distance equals 0. If Brant left area, then distance equals >1000 m, and time >60 sec.

Causes of disturbances	No. disturbances	No. disturbances/hr.	Estimated flight distances (m) $\bar{X}$ ± SD	Estimated flight distances (m) Range	Estimated flight time (sec) $\bar{X}$ ± SD	Estimated flight time (sec) Range
Human on foot	10	0.06	424 ± 380	10->1000m	31 ± 18	5->60 sec
Automobile	1	0.01	150		15	
Boat	1	0.01	300		20	
Plane	9	0.06	189 ± 319	0->1000m	21 ± 17	10->60 sec
Helicopter	7	0.05	171 ± 369	10->1000m	34 ± 15	10->60 sec
Dog	6	0.04	270 ± 383	40->1000m	22 ± 19	10->60 sec
Raven	2	0.001	5	0-10	15	5-25 sec
Peregrine Falcon	1	0.01	50		15	
Bald Eagle	113	0.73	167 ± 209	0->1000m	27 ± 20	3-95 sec

Disturbances of Brant were recorded during 155 hrs of observation over 19 days (Table 7). Brant were most frequently disturbed by Bald Eagles (*Haliaeetus leucocephalus*), but disturbances by humans and dogs caused the longest flights. We examined how close we could approach the birds before they took flight. When we walked quickly and directly toward them, the Brant would take flight when we were approximately 78 m away, and would fly for an average of 319 m before landing (Table 8). If we approached slowly and indirectly, Brant could be approached on average 35 m before taking flight and then they would land on average 86 m from the point of departure. On two occasions when we had casually approached the Brant, the birds either walked or swam slowly away.

Banding locations

A total of 46 banded Brant were observed at the Spit and Shingle Bay during April and May 1991. Of those 46 birds, 39 were seen only once, three were seen one day after, two four days after, one ten and another fifteen days after. Most Brant (76.1%) had been banded at the Yukon-Kuskokwim Delta in Alaska, while 15.2% were banded on the Alaskan North Slope, and 8.7% were banded on Wrangel Island in the northeastern USSR. Hence, it appears that most banded Brant observed near Sandspit in April and May, were on their way to their nesting grounds in the Yukon-Kuskokwim Delta. Approximately 27-50% of the Pacific Flyway Brant population nest in the Yukon-Kuskokwim Delta (Brant Subcommittee 1991), while most others nest in northern Canada.

Table 8. Deliberate disturbance of Brant by observers walking towards flock.

Type of approach	Estimated closest approach (m) X ± SD	Range	Estimated flight distance (m) X ± SD	Range	Flight duration (sec) X ± SD	Range
Quick direct approach, n=8	78 ± 34	50-150	319 ± 285	100->1000	29 ± 21	10->60
Slow, indirect approach, n=5	35 ± 27	10-80	86 ± 68	10-150	20 ± 16	3-40

DISCUSSION

Waterbird densities

In the Initial Environmental Evaluation (IEE), three marine species besides Brant, namely Pacific Loon, Pigeon Guillemot and Black Oystercatcher (*Haematopus bachmani*) were considered for potential impacts that construction and operation of a harbour would have upon them (Public Works Canada, February 1991). Pacific Loons are scarce in the study area; Pigeon Guillemots are abundant and appear to be minimally affected by human activities, as they often nest in man-made structures (e.g. the government wharves at Shingle Bay and Queen Charlotte City, and in openings of the B.C. Ferry dock at Skidegate), and the Black Oystercatcher is a common species nesting on islands throughout all of Skidegate Inlet (Vermeer *et al.* in prep.a). Our study showed that of the marine birds in Shingle Bay; Greater Scaup, Harlequin Duck, Bufflehead, Black and Surf Scoters were common, but only Brant reached their highest density (Table 1).

Brant distribution as related to tide height and diet

The reason that Brant used the Spit more than any other location during early April, probably relates to *Ulva lactuca* being available to the geese at both high and low tides. During high and moderate low tides, Brant swam and fed over the *Ulva* beds, while following the incoming and outgoing tides. It was not until April 13 that Brant were observed grazing on *Ulva* on the dry intertidal shelf at the Spit.

The reason that Brant were not observed at Shingle Bay during the first twelve days of April, probably relates to the low tides being predominantly above 0 m, when most of the

Zostera is unavailable to Brant, and possibly also to the limited quantity of young eelgrass being available. *Zostera* spp. were observed still to have short stems at that time. During the 15-19 April period, the tides reached their monthly minimum levels. That coincided with the period when the highest numbers of Brant were observed foraging on eelgrass in Shingle Bay. After 19 April, Brant were still observed feeding at Shingle Bay, but in much lower numbers than in the previous four days. Tides during those days were not as low as earlier described. When the tides reached their next lowest levels (13-17 May), far fewer Brant were observed feeding at Shingle Bay, even though large areas of eelgrass were exposed. By then the eelgrass had grown considerably in length, and may have been either less nutritious, more vascularized and/or less palatable to the Brant. Hence it is suggested that Brant were not just attracted to the amount of available eelgrass at Shingle Bay, but more to its nutritive value and early accessibility.

Diet, activity budgets and disturbance

In the Strait of Georgia, as at Sandspit, Brant feed upon both *Zostera* and *Ulva* sp. Gut contents of Brant from Boundary Bay in late winter revealed eelgrass, 94% *Z. marina* and 4% *Z. japonica* (Campbell *et al.* 1990), whereas on the east coast of Vancouver Island, Nygren (1990) observed that faecal pellets of Brant in spring contained 55% green algae and 45% eelgrass. The importance of *Zostera* in the diet of Brant has been recognized worldwide (Madge and Burn 1988). M. Adams (pers. comm.) estimated that of all the eelgrass in the Skidegate Inlet study area only about 5% occurred in Shingle Bay. Nevertheless, Brant concentrated their eelgrass feeding in Shingle Bay. Rodway (1989) also observed that Brant fed upon eelgrass at

one location of his study area at Stubbs Island on the west coast of Vancouver Island, although eelgrass beds were present at several other locations.

The activity budget of Brant has been investigated on the east coast of Vancouver Island by Nygren (1990) and on Stubbs Island by Rodway (1989). Nygren (1990) observed that on average 67% of the Brant were feeding, while Rodway (1989) reported that 32% of the Brant were feeding. Our figure of 56% feeding by Brant at Sandspit falls therefore well within that range. The feeding rate observed at Stubbs Island is one of the lowest reported. Rodway (1989) suggested that frequent disturbance accounted for that low activity pattern. In our study, we found little effect of disturbance on the feeding activity of Brant. Stock (1991) also observed no relationship between feeding activity of Brant and the level of disturbance in Schlesswig-Holstein, but he did find, however, that high levels of disturbance caused the geese to move to adjacent undisturbed areas.

We observed Brant to fly an average of 189 and 171 m, when disturbed by planes and helicopters, respectively, and 319 m when observers approached Brant directly (Tables 7 and 8). The distance at which a flock of Brant took flight when an observer deliberately approached, averaged 78 m at the Spit and Shingle Bay. Madsen (1988) reported that the distance Brant flew from an observer in the Danish Wadden Sea averaged 211 m and 367 m in September and October, respectively. Madsen (1988) ascribed the increase in flight distance by Brant in October to hunting activities. Brant are not hunted in the Sandspit area, therefore they may react less strongly to human disturbance than elsewhere. We also deliberately approached Brant by boat in the water to determine their reaction. Although we could not measure their flight

distance from the boat, we noted that when in a mixed flock, Brant were the last species to take flight.

The importance of the staging areas at the Spit and Shingle Bay

Both the Spit and Shingle Bay were observed to be important feeding areas for migrating Brant. Before this investigation, it was thought that Brant migrated directly from the Strait of Georgia to Alaska (Blood and Smith 1966, Einarsen 1965, Nygren 1990). No other spring staging areas for migrating Brant of the magnitude observed at the Spit and Shingle Bay are currently known from northern British Columbia (R.W. McKelvey, pers. comm.). It is unknown how many migrants utilize the Spit and Shingle Bay in April and May. Nygren (1990) estimated that the mean length of stay of Brant in Strait of Georgia staging areas in spring was 7.3 days. If Brant stage for a similar period near Sandspit, many thousands of Brant may use the area during spring migration.

Potential impact of proposed harbour on staging Brant

The site of the proposed harbour is one of the most important feeding areas of spring staging Brant. Construction and operation of a harbour would destroy the eelgrass beds on site and resulting current changes could impact eelgrass elsewhere in Shingle Bay. Chronic pollution associated with the marina could affect birds directly by oiling plumage and/or indirectly by contamination of the food. Frequent boat traffic in and adjacent to the harbour will likely disrupt Brant feeding activities. For example, one Sandspit resident in a small boat, was observed to keep the Brant from feeding by repeatedly racing up and down Shingle Bay.

Although Brant will probably move to other areas in Skidegate Inlet to feed, the nutritive value of the eelgrass may be lower there and/or it may be less accessible at moderately low tides. Moreover, some other feeding grounds in Skidegate Inlet either have already been, or have the potential of being disturbed. For example, the Honna River estuary (used by Brant) is gradually becoming more populated by people and some habitat degredation as a result of human activities may have occurred. Further development along that estuary's shoreline would probably result in habitat deterioration, making the estuary less desirable for Brant and other waterbirds. Rooney Bay is also an important habitat where Brant and thousands of seaducks feed during the spawning of herring. However, the Skidegate Band Council has expressed an interest in a harbor in that area (Norman Dale, pers. comm.). If a harbour is established there it may destroy the herring spawning site, resulting in a reduction of marine bird feeding habitats.

The Spit, a major feeding ground for Brant, probably will not be affected by human development in the near future because of its proximity to the airport, as well as the presence of the broad unnavigable intertidal shelf. Brant, however, utilize the Spit chiefly for feeding upon *Ulva* and not *Zostera* spp. Although there are other areas with eelgrass, such as Gray Bay, these sites appear to be marginally used by Brant.

In conclusion, the loss of one of the most important feeding areas combined with habitat degredation and possible future loss of adjacent areas, would likely make Shingle Bay unsuitable for use by spring staging Brant. Migrating Brant rely upon feeding areas to store fat reserves necessary for breeding (Bélanger and Bédard 1990, Persson 1989). If those areas are destroyed, Brant will be forced to feed in other areas, some of which are threatened by human development, and where the food may be of lower quality or less available. That would result

in Brant reaching their breeding grounds in less than optimal body conditions, thereby reducing their reproductive success and ultimately threatening their survival.

RECOMMENDATIONS

The Spit and Shingle Bay represent important staging areas to north-bound migrating Brant. As they are the most important feeding habitats of Brant in the study area, and because there are no other known spring feeding areas of the same magnitude in northern British Columbia, the habitats must be protected from alienation and disturbance. Alternative locations for the small craft harbour should be sought. Based on our preliminary investigation, the southern shoreline of Skidegate Inlet west of Haans Creek appears to be less important feeding habitat for Brant. Thus the feasibility of building the harbour in an area to the west of Haans Creek (provided that the area is not extensively utilized by wintering Brant) should be investigated.

Campbell *et al.* (1990) stated that Shingle Bay and the Yakoun River estuary near Masset support the largest concentration of overwintering Brant in British Columbia. However, only cursory information exists for the wintering population of Brant in Skidegate Inlet; the maximum flock size observed between December through February, 1975-1990, was of 545 birds (Public Works Canada, February 1991). Because there have been no complete, systematic surveys in Skidegate Inlet, we strongly recommend a complete winter study of Brant be conducted to determine their numbers, distribution and habitat use.

We are currently unable to estimate the total number of migrating Brant using the Spit and Shingle Bay. From the present survey we have insufficient data from banded birds to estimate the average length of stay. Applying average residence periods (determined for southern B.C.)

to calculate the number of north or south-bound migrants may prove to be inappropriate, as we do not know if the residency rate remains constant throughout the year, or at different latitudes. For the above reasons we recommend that a detailed study be conducted on the turn over rates of the Brant population at the Spit and Shingle Bay in the spring as well as in the fall and winter.

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