Food and populations of Surf Scoters in British Columbia

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Introduction

The Surf Scoter *Melanitta perspicillata* a nearctic duck, breeds in Alaska and northern Canada and winters on the Atlantic and Pacific coasts of North America. On the Pacific, Surf Scoters winter in large numbers from southeastern Alaska to California (see Bellrose 1976). McGilvry (1967) found that *Yoldia* sp. and *Mytilus edulis* mussels composed 64% of their diet on the North Atlantic coast, whereas Stott and Olson (1973) reported that clams made up 84% while *Mytilus edulis* composed only 8%. Cottam (1939) found that 28% of the food volume of 168 Surf Scoters, collected all over North America, contained *Mytilus edulis* and other mytilids. Glude (1964) reported that of 21 Surf Scoters collected at Dabob Bay, Washington, 86% contained *Venerupis semidecussata* and 38% *Mytilus edulis*. Vermeer and Levings (1977) found that *Mytilus edulis* constituted 56% of the Surf Scoter diet at the Fraser Delta estuary, British Columbia.

The aim of the present study was to determine if mussels are also an important prey of Surf Scoters elsewhere in British Columbia, and since Surf Scoters in large numbers frequent areas where herring spawn in the spring, to determine the importance of herring eggs as a food. Comparisons are also made with other birds feeding on the same principal foods. An attempt was made to quantify Surf Scoter numbers in relation to those of other marine birds visiting British Columbia.

Methods

Surf Scoters were obtained from: the south coast of Cortes Island and from Jervis Inlet, spring and autumn 1977; the south coast of Saltspring Island, autumn 1977; the east coast of Moresby Island, spring 1977; and Alice Arm, summer 1976. These areas represent different coastal habitats. Cortes island is at the north end of the Strait of Georgia, Jervis Inlet is a deep fjord entering that Strait, Moresby Island is exposed to open seas, Alice Arm is a deep northern inlet, and Saltspring Island is representative of the Gulf Island region (Fig. 1). Barrow's Goldeneyes *Bucephala clangula* were collected at Jervis Inlet as they are known to feed upon the same food (mussels) as Surf Scoters (Vermeer & Levings 1977). Stomachs and oesophagi of the birds were dissected within one hour of collection and the food contents stored in glass jars with 10% formaldehyde. Food items were identified to the lowest taxon possible. The total food (inclusive of mollusc shells) from each bird was obtained by weighing stomach and oesophagus contents. The wet weight of each taxon was then measured to the nearest 0·1 g on a Mettler H_5 macrobalance. The length of mussels were measured to the nearest millimetre.

Coastal aerial surveys were conducted by many observers along the whole British Columbia coast January–February and March 1978. Observations were made with the aid of binoculars by two persons, seated on each side of the aircraft. Cruising speed varied according to type of aircraft used, from 140 to 200 km/hr. Flights were conducted 30 to 60 m from shore at 40 to 80 m altitude depending on weather conditions. Transit width was not fixed. Bimonthly boat surveys were conducted by the author along the coast of Saanich peninsula and adjacent Gulf Islands from September 1977 to May 1978. Additional surveys by boat were conducted by several observers and the author along the coast of the Strait of Georgia and adjacent fjords, March and November 1977. Observations were made with binoculars, 20 to 100 m from shore depending on how close the boat could approach land. Results of both aerial and boat surveys are shown on basis of numbers per linear kilometre.

Results

Food

Bivalves constituted the main food of Surf Scoters except where herring eggs dominated the birds' diet in spring at Saltspring and Moresby Islands (Table 1). Surf Scoters at Cortes Island were obtained at the end of the herring spawning season in spring, and few eggs were encountered in

them probably because eggs are quickly digested. Large quantities of grit occurred in gizzards when the birds were not feeding on bivalves. In stomachs containing bivalves, grit was low perhaps because shell fragments suffice for food grinding. The absence of herring eggs in spring at Jervis Inlet probably relates to the fact that herring do not usually spawn in deep fjord waters.

Mytilus edulis mussels were the most prominent bivalve prey, except at Cortes Island in spring, where *Protothaca staminea* and *Clinocardium nuttallii* were equally as important as mussels (Table 1). Surf Scoters fed predominantly on 1–3 cm mussels at Saltspring Island and the Fraser Delta and on 0·6–1 cm mussels at Jervis Inlet (Table 2). Mussels in British Columbia are from 2·5 to 4·5 cm long in their first summer and gain another 3 cm in their second summer (Quale 1978). The vast majority of mussels eaten by scoters appear therefore to be in their first year. A typical random sample from a piling near Nanaimo gave an average mussel length of about 4 cm while one third of the mussels were 5 cm or more in length (Quale 1978). Perhaps the birds avoid eating large mussels because they are harder to grind and they may block or cut the bird's alimentary system. The Barrow's Goldeneye which also had a predominant mussel diet in Jervis Inlet fed upon significantly smaller mussels than Surf Scoters ($p < 0{\cdot}05$). However, most of the mussels came from a few ducks (Table 2). Surf Scoters and Barrow's Goldeneyes are the most numerous ducks (Fig. 2) during the autumn and spring in British Columbia fjords, and

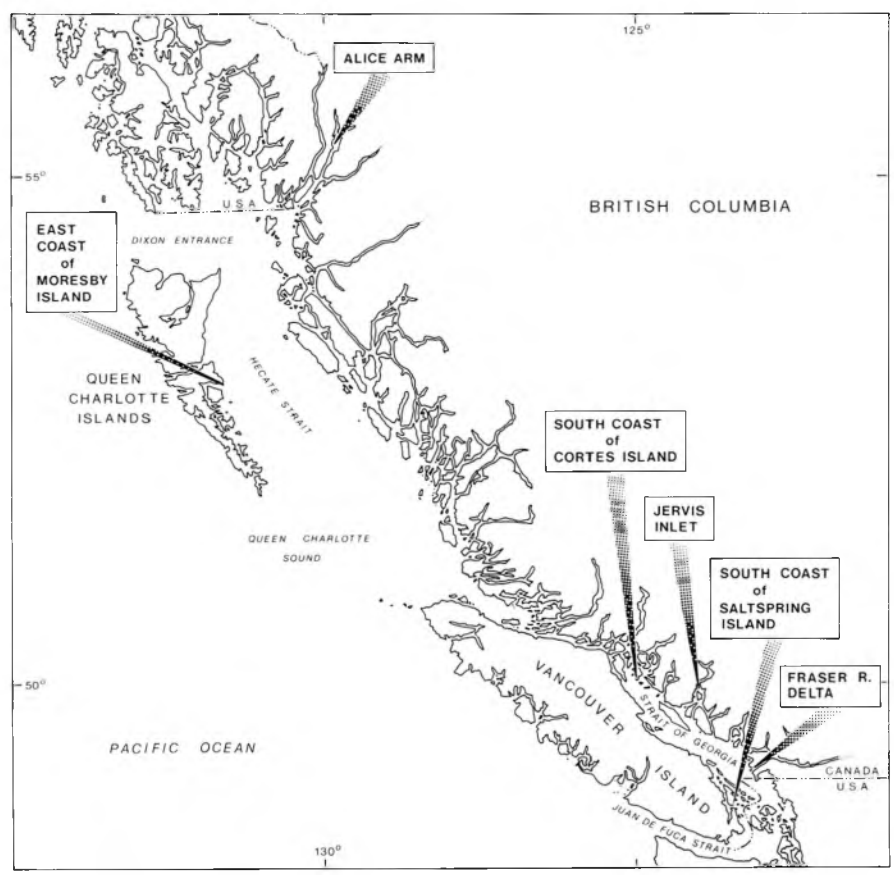

Figure 1. Surf Scoter sample locations on the British Columbia coast.

Table 1. Percentage wet weight of prey items and grit in Surf Scoters at four locations in Strait of Georgia, at eastern Moresby Island in the Queen Charlotte Islands and at Alice Arm in northern British Columbia

	Strait of Georgia								
	Saltspring Is.		Cortez Is.		Jervis Inlet		Fraser Delta[a]	Moresby Is.	Alice Arm
Prey Items	Spring 1977	Fall 1977	Spring 1977	Fall 1977	Spring 1977	Fall 1977	All Seasons 1974–1976	Spring 1977	Summer 1976
Bivalves									
Mytilus edulis	–	78	2	96	71	95	56	–	95
Mya arenaria	–	–	–	–	–	–	8	–	–
Protothaca staminea	–	Trace	2	–	2	–	4	–	–
Venerupis japonica	–	–	–	–	10	–	–	–	–
Clinocardium nuttallii	–	–	2	–	–	–	Trace	–	–
Yoldia sp.	–	–	–	–	–	–	Trace	–	–
Glycymeris subobsoleta	–	–	–	–	–	–	Trace	–	–
Ponderosa filosa	–	Trace	–	–	–	–	–	–	–
Telinidae	–	–	Trace	–	–	–	–	–	–
Unidentified bivalve fragments	–	2	11	–	1	–	6	–	–
Gastropods									
Batillaria zonalis	–	–	–	–	–	–	2	–	–
Turbiniella escholtzii	–	–	–	–	–	–	1	–	–
Nassarius obsoletes	–	–	–	–	–	–	Trace	–	–
Acmaea testudinalis scutum	–	–	–	–	Trace	–	–	–	–
Amphissa versicolor	–	–	Trace	–	1	–	–	–	–
Bittium estrechtii	–	–	1	–	1	–	–	–	–
Mitrella gouldii	–	–	1	–	Trace	–	–	–	–
Margarites succinctes	–	–	Trace	–	–	–	–	–	–
Littorina scutulata	–	–	1	–	–	–	–	–	–
Littorina sitkana	–	–	Trace	–	–	–	–	–	–
Lirularia lirulata	–	–	5	–	Trace	–	–	–	–
Olivella beatica	–	–	Trace	–	–	–	–	–	–
Unidentified snails	–	–	–	–	–	–	Trace	–	–
Crustaceans									
Barnacles	–	9	Trace	–	0·5	–	1	–	–
Crabs	–	Trace	2	–	Trace	–	–	–	–
Shrimp	–	–	–	–	–	–	Trace	–	–
Amphipods	–	–	Trace	–	–	–	–	–	–
Isopods	–	–	Trace	–	–	–	3	–	–
Unidentified crustacean fragments	–	–	3	4	0·5	–	–	–	–
Echinoderms	–	4	–	–	–	–	–	–	–
Polychaetes	–	–	–	–	–	–	5	–	–
Herring eggs	70	–	2	–	–	–	–	59	–
Vascular plants	–	Trace	4	–	Trace	–	2	–	–
Algae	–	Trace	17	–	4	–	Trace	1	–
Digested matter	–	5	5	–	4	–	6	–	–
Grit	30	2	42b	–	5	5	6	40	5
No. of birds analysed	2[c]	20	22	2[d]	20	3[d]	58	7	7
Wet weight (g)	71	708	405	33	327	61	808	51	132

[a] Vermeer and Levings (1977).
[b] Includes large numbers of unidentified shell fragments.
[c] As scoters fed in area where herring spawned, author did not feel justified to increase sample size.
[d] Ditto for scoters feeding predominantly on mussels.

there they chiefly feed on mussels attached to the rocky fjord walls. Besides those two species, the much less numerous Black Scoter *Melanitta nigra* feed upon mussels (Vermeer and Levings 1977). Except for the female Barrow's Goldeneye which is smaller, these ducks are of similar size ($x \pm SE$, n: Surf Scoter males 1153 ± 12g, n = 64; females 1025 ± 15 g, n = 26; Barrow's Goldeneye males 1173 ± 4, n = 18; females 823 ± 18 g, n = 13; Black Scoters males 1214 ± 18, n = 13; females 1076 ± 106 g, n = 3). A 750–800 g duck is perhaps the smallest that can grind up 1–3 cm mussel shells.

Surf Scoters are not the only marine birds feeding upon herring spawn in British Columbia. Large numbers of several species of gulls, cormorants and ducks feed upon herring and their eggs (Munro & Clemens 1931). In March 1978 I observed thousands of marine birds doing this at

Table 2. Percentage frequency distribution of *Mytilus edulis* length in Surf Scoters and Barrow's Goldeneyes at three Strait of Georgia locations.

	Surf Scoter			Barrow's Goldeneye
Length in cm.	Saltspring Island 1977	Fraser Delta 1974–1976	Jervis Inlet 1977	Jervis Inlet 1977
0·1–0·5	0·9	–	4·5	51·7 (48·3)*
0·6–1·0	12·4	5·9	80·3 (73·6)*	32·2
1·1–1·5	40·4	28·2	10·2	7·5
1·6–2·0	27·0	22·4	1·0	4·0
2·1–2·5	11·5	17·6	–	2·4
2·6–3·0	5·5	15·3	1·5	2·2
3·1–3·5	1·4	7·1	1·5	–
3·6–4·0	0·9	3·5	0·5	–
4·1–4·5	–	–	–	–
4·6–5·0	–	–	0·5	–
No. of mussels	218	85	197	373
Average length and SE of mussels	1·61±0·04	2·02±0·08	0·94±0·03	0·70±0·03
Sample no. of birds with mussels	9	10	7	13

* From one individual duck.

Table 3. Numbers of birds observed concentrated in herring spawn area at Ganges Harbour, Saltspring Island, 22 February–31 March, 1978.

	February		March			
Species	22	27	6	14	20	31
Brandt's Cormorant	–	20	6,500	9,000	–	–
Pelagic Cormorant	10	70	500	100	–	–
Double-crested Cormorant	–	–	20	–	–	–
Western Grebe	–	–	–	15,000	–	–
Horned Grebe	–	–	200	50	20	–
Glaucous-winged Gull	100	4,000	5,000	3,500	–	–
Mew Gull	–	2,500	3,000	4,500	–	–
Greater Scaup	1,000	2,000	7,000	9,000	8,000	10
Surf Scoter	500	500	8,500	9,500	20,000	100
White-winged Scoter	–	–	200	500	2,500	–
Oldsquaw	200	400	1,650	3,000	4,800	200
Common Goldeneye	–	400	500	1,500	1,400	100
Barrow's Goldeneye	–	100	150	–	–	–
Bufflehead	–	300	200	–	200	100
Red-breasted Merganser	–	10	100	80	–	10
Total no. birds	1,810	10,300	33,520	55,730	36,920	520

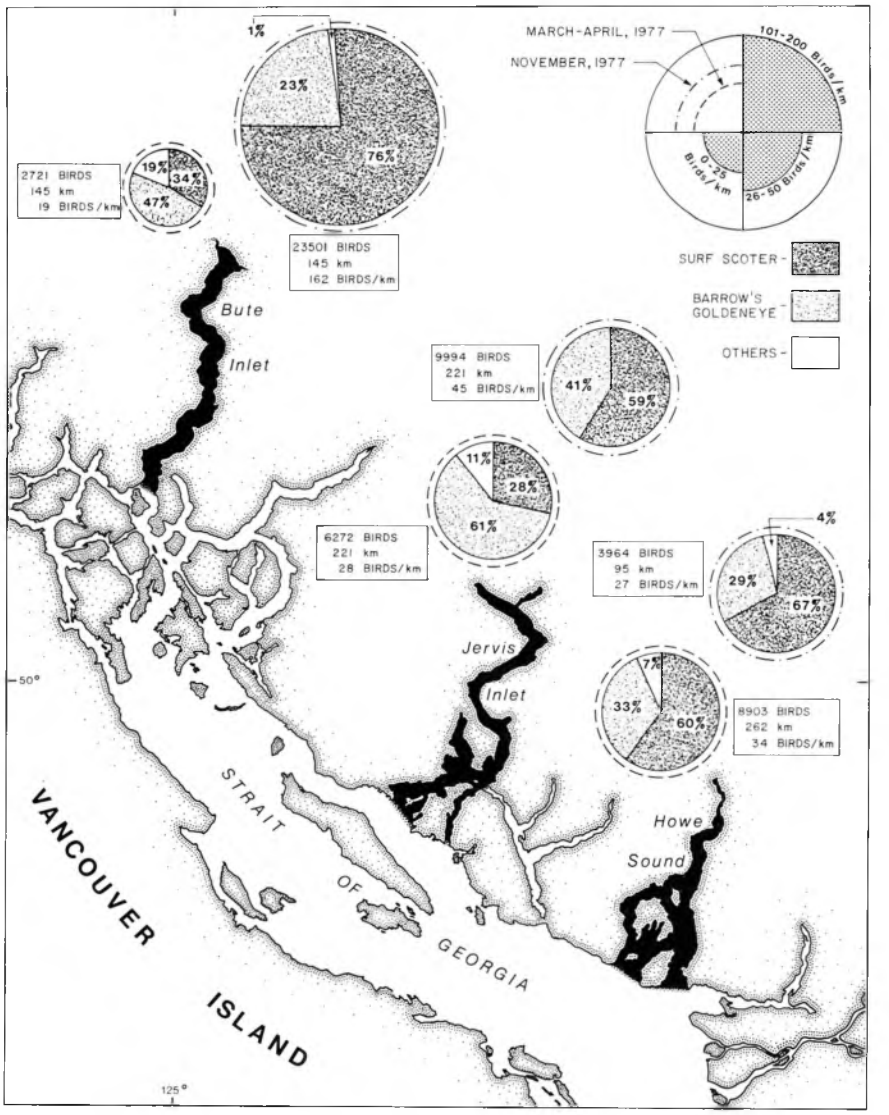

Figure 2. Duck numbers and densities in three fjord systems: Bute Inlet, Jervis Inlet and Howe Sound, March–April and November, 1977, as observed by boat.

Ganges Harbour (Table 3). Glaucous-winged Gulls *Larus glaucescens* and Mew Gulls *L. canus* appeared first in large numbers and fed upon both herring and their eggs. The gulls were followed by Brandt's Cormorants *Phalacrocorax penicillatus* which were observed to forage on herring, and by various diving ducks species which apparently fed mostly on herring eggs. Greater Scaup *Aythya marila* fed closest to shore. Other diving ducks were farther out, and Brandt's Cormorants and Western Grebes *Aechmophorus occidentalis* were farther removed from the spawning area. Most fish eaters had disappeared by 20 March, but tens of thousands of ducks remained. Perhaps herring had then departed, leaving their eggs to the ducks.

Populations

The distribution of scoter densities along

the British Columbia coast in January–February 1977 and March 1978 is shown in Table 4. The different scoter species were distinguished in March 1978 but not in January and February 1977. Of a total of 95,380 scoters observed in March 1978, 80,760 (85%) were identified as Surf Scoters. Scoter density was 3½ times as high in the spring of 1978 (17·8 birds/km) as in the winter of 1977 (4·7 birds/km, see Table 4).

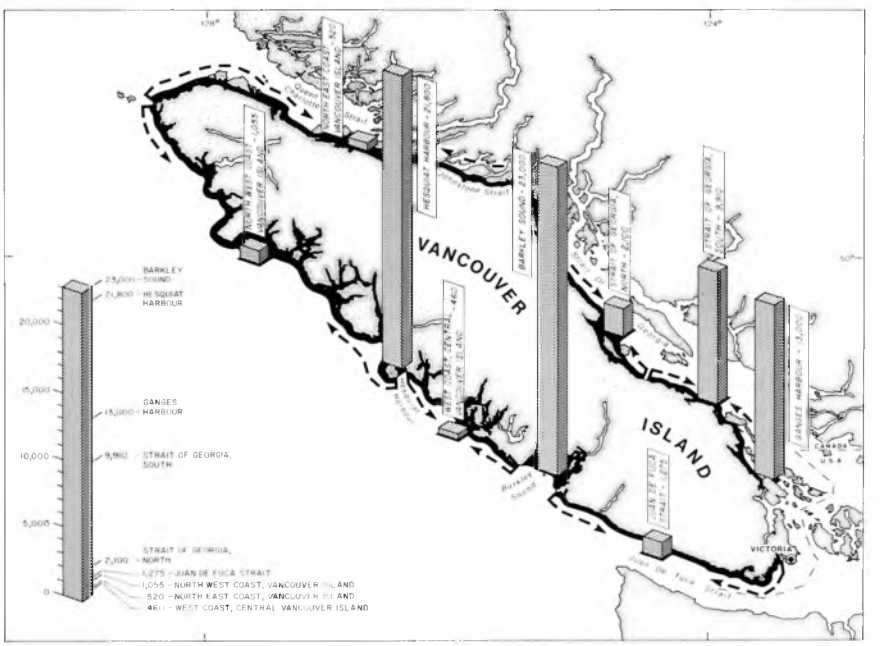

Figure 3. Surf Scoter distribution around Vancouver Island on March 21 and 22, 1978 as observed by plane.

Table 4. Distribution of scoter densities in various British Columbia coastal habitats as observed by airplane, January–February, 1977 and March, 1978.

	January–February 1977			March 1978		
Location	No. birds	No. km surveyed	Birds/km	No. birds	No. km surveyed	Birds/km
Vancouver Island	20,073	2,181	9·2	78,644	1,523	51·6
East coast (St. of Georgia) and Gulf Island area	14,457	839	17·2	30,414	362	84·0
N.E. coast (Queen Charlotte St.)	1,350	155	8·7	777	147	5·3
West and S.W. coast	548	497	1·1	1,371	528	2·6
West coast inlets	3,718	690	5·4	46,082	486	94·8
Mainland	12,142	4,054	3·0	13,729	3,534	3·9
Strait of Georgia coast	4,345	239	18·2	3,437	228	15·1
Queen Charlotte Sound and Hecate Strait coast	583	821	0·7	6,693	908	7·4
Mainland inlets	7,214	2,994	2·4	3,599	2,398	1·5
Queen Charlotte Islands	1,257	904	1·4	3,007	280	10·7
Coast	492	594	0·8	1,284	159	8·1
Inlets	765	310	2·5	1,723	121	14·2
British Columbia coast	33,472	7,138	4·7	95,380	5,337	17·8

The higher density in spring apparently results from an influx of scoters from the United States west coast on their way to northern breeding grounds. Scoters were most numerous in sheltered waters (Table 4). The large numbers of scoters off Vancouver Island in the spring of 1978, however, reflects birds feeding on herring eggs there. Extensive spawning of herring took place at Ganges Harbour, Loudoun Channel in Barkley Sound and Hesquiat Harbour in mid-March 1978 (Fig. 3).

Coastal and pelagic surveys indicate that the vast majority of scoters on the Canadian Pacific coast occur within 1 km from land. It is therefore possible to estimate the total number of scoters visiting British Columbia waters. Many birds are missed during aerial surveys because of weather condition, sun position, wave action, fatigue, and other factors interfering with the observer's performance. The counts may represent approximately 2/3 of the birds present. The scoter population along

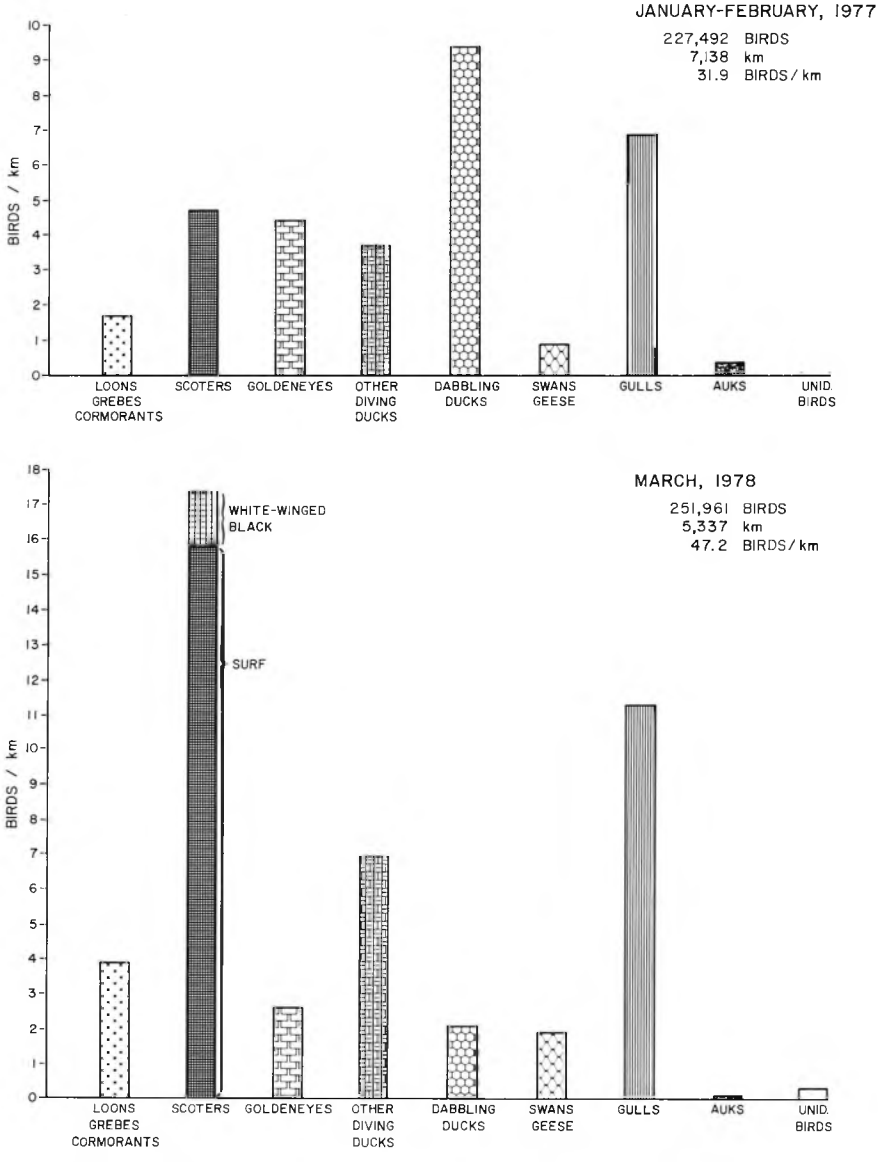

Figure 4. Marine bird densities on the British Columbia coast as observed by plane January–February, 1977 and March, 1978.

the approximate 27,000 km British Columbia shoreline was thus roughly estimated at 200,000 birds in January–February 1977 and at 700,000 birds in March 1978, of which 650,000 were Surf Scoters. Surf Scoters were the most numerous marine birds in March 1978, while dabbling ducks occurred in highest densities in January–February 1977 (Fig. 4). Most Surf Scoters occur on the British Columbia coast in spring and fall (Fig. 5) when they frequently outnumber all other marine birds (Fig. 6). White-winged Scoters, *Melanitta deglandi*, were observed to outnumber all other ducks on the east coast of the Queen Charlotte Islands, autumn 1976.

Discussion

Several hundreds of thousands of Surf Scoters consume large quantities of food. Determination of the daily consumption rate from esophagi and stomach contents is unreliable as food intake in seaducks continues over long periods (see, e.g. Swennen 1976). Daily food consumption for wild piscivorous birds has been estimated by Nilsson & Nilsson (1976) using the formula Log F = −0·293 + 0·85 Log W, where F = food consumption in g/day and W = weight of bird in g. Since the mean weight of adult Surf Scoters is about 1100 g, the daily net food consumption (minus shells) of Surf Scoters can be estimated at approximately 196 g/day. At that rate 200,000 Surf Scoters would consume 39 metric tons of mussel meat daily. Mussel cultures for human consumption have recently been started in British Columbia (Quale 1978). Surf Scoters are attracted to the cultures and attempts have been made to deter the birds. One of the methods being tested is to insert wires through the plastic mesh sock or tubing containing mussels (G. D. Heritage, pers. com.). The success of this deterrent has still to be determined.

The quantity of herring eggs that Surf Scoters consume in British Columbia must be considerable as the birds feed upon eggs for about three weeks. A population of 75,000 Surf Scoters along Vancouver Island during one week in March (see Fig. 3) could be calculated to consume 103 metric tons of herring eggs. The increase of Surf Scoters at herring spawning areas has been observed at Ganges Harbour in the Gulf Islands and at Barkley Sound on the west coast of Vancouver Island (Fig. 3, Table 3). Large numbers of Surf Scoters remained in those regions for about two weeks in March. Thereafter they migrated northward apparently with the progress of the spawning herring. Herring eggs therefore, not only provide the Surf Scoter with a change from its staple diet of mussels but also appear to provide a boost to the birds during spring migration. Herring roe is at present an expensive commodity for human consumption, which British Columbia exports chiefly to Japan. Surf Scoters may

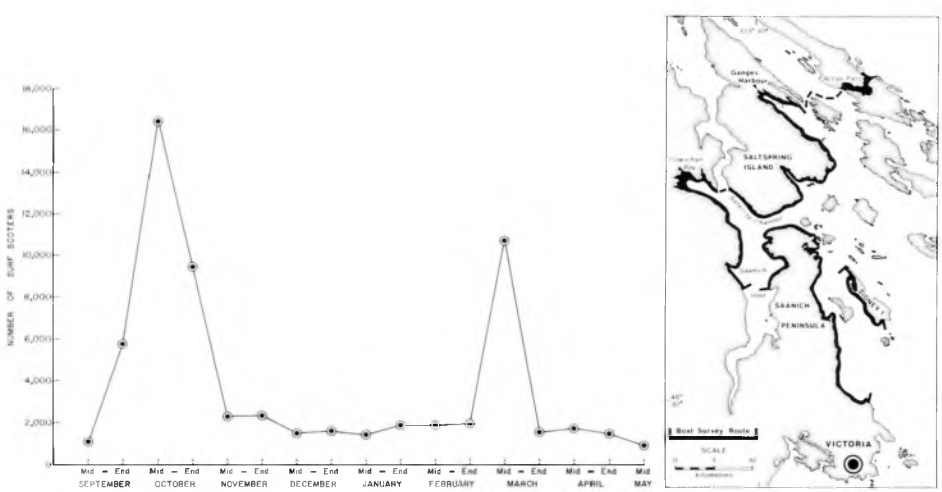

Figure 5. Surf Scoter fluctuations along 132 km of south-eastern Vancouver Island and adjacent Gulf Island shorelines as observed from bimonthly boat surveys, September, 1977 to May, 1978.

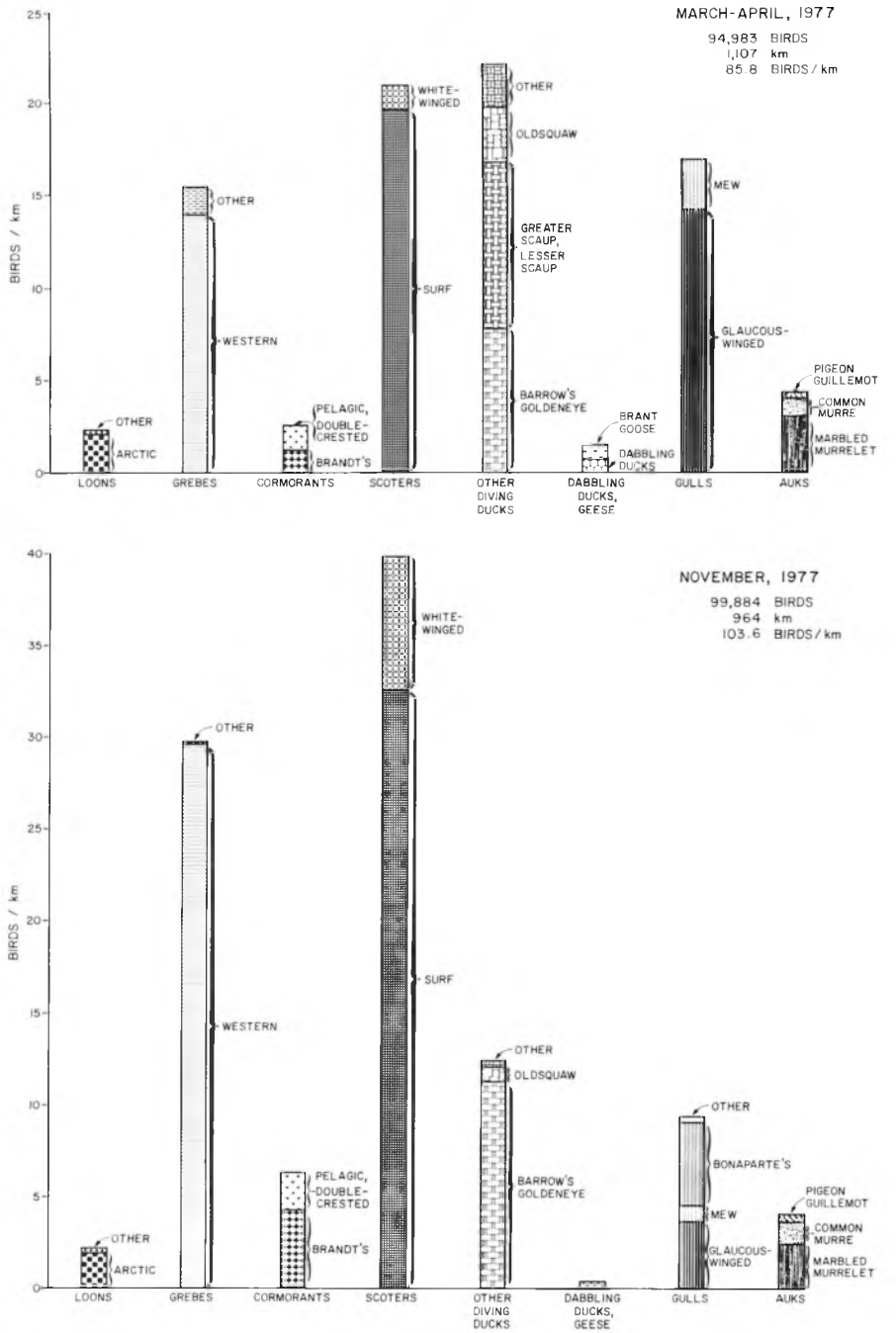

Figure 6. Marine bird densities in the Strait of Georgia and adjacent inlets as observed by boat, March–April and November, 1977.

therefore not be allowed to continue to feed upon herring eggs as extensively as they have done until now.

Acknowledgements

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Summary

Population densities and the food of Surf Scote *Melanitta perspicillata* were investigated on th British Columbia coast. Surf Scoters are th most numerous marine birds there in autum and spring. Six hundred and fifty thousand wer estimated in March 1978.

The principal food is the mussel *Mytilus edul* except for about three weeks in spring whe herring eggs form the main diet. Mar thousands of ducks, cormorants, gulls an grebes also feed on herring and their eggs. Oth mussel-eating ducks in British Columbia ar Black Scoters *Melanitta nigra* and Barrow's Go deneyes *Bucephala clangula*. In the fjords Ba row's Goldeneyes and Surf Scoters feed chiefl upon 0·5–1 cm sized mussels attached to th fjord walls. Mussel and herring spawn dail intakes of Surf Scoters are estimated.

References

Cottam, C. 1939. Food habits of North American diving ducks. *U.S. Dept. Agric. Tech. Bull.* 64 140 p.

Bellrose, F. C. 1976. *Ducks, geese and swans of North America.* Stockpole Books, Harrisburg, Pa

Glude, J. B. 1964. The effect of scoter duck predation on a clam population in Dabob Ba Washington. *Proc. Natl. Shellfish Assoc.* 5: 73–86.

McGilvrey, F. B. 1967. Food habits of seaducks from the north-eastern United States. *Wildfo Trust Ann. Rep.* 18: 142–5.

Munro, J. A. & Clemens, W. A. 1931. Waterfowl in relation to the spawning of herring, Britis Columbia. *Biol Bd. Canada Bull.* 17: 1–46.

Nilsson, S. G. & Nilsson, I. N. 1976. Numbers, food consumption, and fish predation by birds i Lake Möckeln, Southern Sweden. *Ornis. Scand.* 7: 61–70.

Quayle, D. B. 1978. A preliminary report on the possibilities of mussel culture in British Columbi *Fish. and Mar. Serv. Tech. Rep.* 815: 1–37. Pac. Biol. Stat. Nanaimo.

Stott, R. S. & Olson, D. P. 1973. Food habitat relationship of seaducks on the New Hampshir coastline. *Ecology* 54: 996–1007.

Swennen, C. 1976. Populatie-structuur en voedsel van de eidereend, *Somateria m. mollissima* in th Nederlandse Waddenzee. *Ardea* 64: 311–71.

Vermeer, K. & Levings, C. D. 1977. Populations, biomass and food habits of ducks on the Fras Delta intertidal area, British Columbia. *Wildfowl* 28: 49–60.

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