Clam Predation by Scoter Ducks in the Strait of Georgia, British Columbia, Canada

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ABSTRACT

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Collections were made of three species of scoter ducks, white-winged, surf and black, Melanitta deglandi, M. perspicillata and M. nigra, wintering at two clam beaches in southern British Columbia. Analysis of the crop and gizzard contents showed these ducks were feeding primarily on bivalves in the intertidal area. The commercially-important littleneck and manila clams, Protothaca staminea and Tapes philippinarum, comprised over half the gut contents of scoters. It was estimated that a wintering flock of 200 scoters could remove 5.3 to 15.9 tonnes of littleneck and/or manila clams from these two beaches in a six month period.

Key words: bivalves, duck predation, British Columbia, Canada

RÉSUMÉ

Bourne, N. 1984. Clam predation by scoter ducks in the Strait of Georgia, British Columbia, Canada. Can. Tech. Rep. Fish. Aquat. Sci. 1331: 17 p.

Trois espèces de macreuse (Melanitta deglandi, la macreuse à ailes blanches, M. perspicillata, la macreuse à front blanc, M. nigra, la macreuse à bec jaune) qui passent l'hiver sur deux plages coquillières du sud de la Colombie-Britannique, ont fait l'objet d'un échantillonnage. L'analyse du contenu de la gave et du gésier a révélé que les macreuses se nourrissaient surtout de bivalves dans la zone intertidale. La praire du Pacifique (Protothaca staminea) et l'asari (Tapes philippinarum), deux espèces d'importance commerciale, constituaient plus de la moitié des contenus stomacaux. Selon les estimations, une volée hivernate de 200 macreuses peut consommer de 5,3 à 15,9 tonnes de praires du Pacifique et d'asaris au cours de six mois d'occupation de ces deux plages.

Mots-clés: bivalves, prédation par les macreuses, Colombie-Britannique, Canada

INTRODUCTION

Food of diving ducks has been determined by analysis of crop and gizzard contents of birds collected over wide geographic ranges (Bent 1925; Cottam 1939) and specific locations (Madsen 1954; Glude 1964; Nilsson 1969, 1970; Brun 1971; Grosz and Yocom 1972; Vermeer and Levings 1978; Vermeer 1981; and Vermeer and Bourne 1984). These studies have shown that molluscs, especially bivalves form a significant part of the diet of scoters; commercially important bivalves frequently form a considerable portion of their diet (Glude 1964; Grosz and Yocom 1972; Vermeer and Levings 1978; Vermeer and Bourne 1984).

The Strait of Georgia in British Columbia is a wintering area for large flocks of scoters (Munro and Cowan 1947; Vermeer 1981). All three species are found there, although white-winged, *Melanitta deglandi*, and surf, *M. perspicillata*, are more numerous than the black *M. nigra*. The Strait of Georgia is also an important clam producing area (Quayle and Bourne 1972) and large flocks of scoters are frequently observed feeding over clam beaches. Many beaches have a pitted appearance, evidence of extensive feeding by scoters (Glude 1964).

The objective of the present study was to determine if wintering scoters are serious predators of three commercially-important clams, butter, *Saxidomus giganteus*, littleneck, *Protothaca staminea*, and manila, *Tapes philippinarum*, in the Strait of Georgia.

STUDY AREA

Feeding scoters were collected at Henry Bay and Seal Island, located at the northern end of Denman Island on the western side of the Strait of Georgia (Fig. 1).

The intertidal beach along the northern and eastern sides of Henry Bay is sandy and has few bivalves. The southern portion of intertidal beach has an area of about 20 hectares; the bottom is sand-mud to mud-gravel, with several small gravel ridges occurring along the gently sloping beach, some rock outcrop is evident at the southern end of the Bay. Littleneck and manila clams occur in the southern part of the Bay, mostly in the gravel ridges, butter clams are scarce and occur only in the gravel ridges. Total area of the clam beds is about five hectares. The portion of beach at the low water line is sand-mud-gravel with eel grass, *Zostera marina*. Most of the intertidal beach along the south side of the Bay is used for Pacific oyster, *Crassostrea gigas*, culture.

Seal Island is a spit at the northern end of Denman Island, north of the three islands, and has an area of about twelve hectares, the beach is covered to a maximum depth of about 4.5 m at high tide. Strong tidal currents sweep over the beach, which is actually a bar whose sides drop off steeply, particularly on the western side, to depths of about 40 m. Most of the beach

is mud-gravel, with some rock, and is firmer than that at Henry Bay. The extreme tip of the spit is fine sand and a ridge of sand and rock extends southward from the tip along the east side of the spit.

Seal Island is an important clam-producing area: most of the commercial catch is butter clams but significant quantities of littleneck and manila clams have been landed, particularly in recent years. Butter clams occur mostly below the 1.5 m tidal level of the intertidal beach (the clam study area, Fig. 1), in an area of approximately seven hectares along the northwest part of Seal Island. Littlenecks occur with butter clams but are most abundant in higher portions of the beach towards the islands. Manila clams are scarce in the lower part of the beach but are abundant in higher portions of the intertidal area (above the 2.3 m intertidal level), towards the islands. Scattered populations of littleneck and manila clams are found in the sand-mud soil between the islands along with moderate populations of soft-shell clams, *Mya arenaria*, mussels, *Mytilus edulis*, and barnacles, *Balanus glandula*.

Seal Island has been a clam study area since 1940 that has included a regular triennial survey of clam populations in the lower part of the beach since 1942.

Flocks of scoters, particularly white-winged and surf, winter in both the Henry Bay and Seal Island areas.

METHODS

Only actively-feeding scoters were collected. Flocks of feeding scoters were approached with a fast boat and shot as they took off. Shooting was random, but an attempt was made to collect individuals of each species whenever possible. Most scoters were collected at Seal Island since the largest flocks were there.

Eight separate collections of approximately 25 scoters each were made at monthly intervals during the period December 1967- April 1968 and October-December 1968. No collections were made during May-September 1968 since few scoters were present in the Strait of Georgia at that time. Estimates of the number of scoters (sight observations) were made at the times of collections as well as on other occasions.

Sex, total length to the nearest mm, and total weight to the nearest g of each bird was recorded. The crop and gizzard were removed and the contents weighed to the nearest 0.1 g:weight of stones, gravel and other inorganic material was subtracted from the weight of the contents to give the weight or organic material.

Organisms in the crop and gizzard were identified to species and the volume of each species estimated. Number, size and weight of bivalves in the gut was determined whenever possible. Frequently only pieces of shell

weighing less than 1 g were found, the species was identified and they were listed as "number not recorded". Numbers of hinges gave an estimate of the number of bivalves ingested but it was difficult to obtain a measurement of size. Except where whole clams were found in the gut, the weight recorded was the weight of clam shell only.

An attempt was made to identify organisms in the intestines of ducks from the first two collections but the pieces were comminuted so finely that identification in most cases was not possible.

RESULTS

DISTRIBUTION OF SCOTERS

A total of 219 scoters were collected: 125 white-winged, 78 surf and 16 black (Table 1). Males comprised 69% of the sample and 70% of the birds were collected at Seal Island. Visual observations indicated this was a reasonable reflection of numbers and species distribution in the two areas. Larger flocks of scoters were observed at Seal Island than at Henry Bay and in both areas white-winged scoters were more plentiful than surf scoters; black scoters were scarce at both localities.

DIET

Organic matter, ranging from a trace to over 80 g wet weight was found in most scoters, eleven ducks had none. Molluscs were the dominant food item occurring in 203 ducks (Table 2); in most instances more than one species was ingested. Bivalves were found in 197 (90%) ducks and were the sole organic material in 92 (42%) scoters; bivalves along with plant material occurred in eleven (5%) birds. Gastropods were ingested by 54 (25%) ducks but were not the sole food item in any scoters.

Commercially-important bivalves, littleneck, manila and butter clams, were the most frequent molluscs eaten by scoters and were found in 152 (69%) ducks: manila clams in 123 (56%) scoters, littlenecks in 95 (43%) and butter in only five (2%). White-winged scoters ingested the greatest number of commercially important clams, black scoters the least.

Mussels were also eaten frequently and occurred in 84 (38%) scoters, they were the most important food item in black scoters. Cockles, *Clinocardium nuttalli*, were found in 15 (7%) ducks.

Gastropods occurred in 54 (25%) scoters but most were small and formed a minor part of the inorganic matter in the gut.

Barnacles of a single species, Balanus glandula, were the most abundant non-molluscan food item. Some were undoubtedly eaten incidentally since barnacles attached to mussel shells were found in several scoters. However, about half the ducks with barnacles in the gut were apparently feeding primarily on them and one large group weighing 83 g was found in a white-winged scoter. Barnacles were found more frequently in white-winged and black than in surf scoters.

Crab, worms and echinoderms formed a minor part of the diet and may have been taken incidentally. Plant material occurred in 20 (9%) ducks, most frequently in surf scoters.

Numerous small stones, some of which measured 25 mm in diameter, were found in several scoters. Many of the stones may have been ingested with mussels or barnacles attached to them since they were frequently enmeshed with byssal threads or had barnacle scars.

The diet of scoters collected from the two areas was similar. Minor differences in the number of commercially-important bivalves consumed by white-winged and surf scoters in the two areas were not significant (Table 2).

There was no significant variation in the diet during the period of sampling. Littleneck and manila clams along with mussels, barnacles and Littorina were the commonest organisms ingested during the study period.

Clam predation by scoters

All three species of scoters ingested food organisms directly off the bottom, this feeding habit was more prevalent in black scoters. White-winged and surf scoters dug actively in the soil and fed more extensively on buried clams, littleneck and manila clams formed a major part of the food.

Almost half (44%) the scoters with commercially-important bivalves in the gut had consumed both littleneck and manila clams but when only one species of commercially-important clam was found in the gut, manila clams occurred more frequently in surf scoters and female white-singed scoters (Table 3). Manila clams comprised 50% or more of the gut contents in almost half (43%) of the ducks with commercially-important bivalves (Table 4). In only a few instances (16%) did little neck clams form more than 50% of the gut contents and this was mainly in male white-winged scoters. Littleneck clams burrow deeper in the soil than manila clams, down to 15 cm, but are more widespread and occur at lower intertidal levels on the beach. Possibly because white-winged scoters are larger birds they are able to dig deeper and feed more extensively on littlenecks than the other two species.

Scoters frequently had more than one clam in the gut: some birds had as many as six (Table 5). Where numbers of clams ingested could be determined, 64% had more than one manila clam and 45% had more than one littleneck. White-winged scoters generally had the greatest weight of clams in the gut, they frequently had over 5 g of manila or littleneck clams. Weights of over 5 g of manila clams were common in surf scoters.

Clams were ingested whole and some rather large ones were consumed, the largest was a littleneck in a male white-winged scoter from Seal Island (shell length, height and thickness, 48 x 40 x 28 mm). A male surf scoter collected at Seal Island had four manila clams, 32, 31, 8 and 8 mm shell lengths. Mussels were generally comminuted too finely to determine their size but most that could be measured were under 30 mm shell length, one in a white-winged scoter was 45 mm in length. Frequently scoters had obviously ingested groups of mussels since masses of byssal threads were found in the gut contents.

DISCUSSION

AREA OF FEEDING

Most organisms found in the gut contents are common intertidal organisms of the area indicating the ducks were feeding primarily in the intertidal zone. The primary feeding area was apparently above the 1 m intertidal level since manila clams rarely occur below this (Quayle 1960). On Seal Island major populations of littleneck and manila clams are between the 2.0 - 3.5 m intertidal level.

A few ducks were feeding subtidally off the beaches since they had eaten *Pandora filosa*, *Nucula tenuis*, and *Acila castrensis* which are found at depths at least 5 m below the low tide line (Bernard 1983). This is well within the diving range of scoters (Bent 1925; Cottam 1939; Madsen 1954).

Scoters probably feed on intertidal beaches because of the shallow depths and the abundance of preferred food organisms.

Food of scoters

The diet of scoters collected in this study was similar to that reported by others (Bent 1925; Cottam 1939; Crosz and Yocom 1972; Vermeer and Levings 1977; Vermeer 1981; Vermeer and Bourne 1984). The absence or scarcity of some bivalves in the diet is of interest. Butter clams were found in only five scoters, although they have been recorded more frequently in the diet of scoters collected in another area of the Strait of Georgia (Vermeer and Bourne 1984). White-winged scoters were observed feeding on butter clams of 20-40 mm shell length which were left exposed on the bottom by a hydraulic clam harvester at False Narrows in the Strait of Georgia (Bourne unpublished MS). Butter clams of this length and smaller occurred in densities up to $70/m^2$ at Seal Island in 1968. They may have been buried too deeply for scoters to dig out. Evidence of this is seen in that butter clams were only found in white-winged scoters which are probably stronger divers and diggers.

Oysters occur commonly in the area but none was found in any scoters, although both Bent (1925) and Cottam (1939) report oysters are frequently eaten by scoters. Few single oysters are found at either Seal Island or Henry Bay, usually they are attached to old shell or occur in clumps of two or more, probably too large for ducks to ingest.

In 1968 a dominant year class of horse clams, Tresus capax, settled in the Strait of Georgia and in October measured 20-30 mm shell length (Bourne and Smith 1972). At Seal Island they occurred in the lower half of the intertidal beach in the upper 10 cm of soil at densities up to 680/m^2, but only two were found in scoters. Horse clams of this size may have been buried too deeply to be an important food of scoters.

Cockles and Macoma are important food items of scoters in some areas (Vermeer and Levings 1977). They are moderately abundant at Henry Bay and Seal Island, occurring in densities up to 20/m^2, at shallow depths in the substrate. In the present study cockles were only found in 15 scoters and Macoma in ten.

Extent of predation

Only a rough estimate can be given for the extent of scoter predation on littleneck and manila clams stocks at the two sites. Daily ingestion rates have not been determined for scoters although they have been for eider ducks that have similar diets to scoters (Cottam 1939; Cantin et al. 1974). Belopolski (1957) considered the single intake of the eider, Somateria mollisima, to be 75 g of molluscs (round weight) and the daily consumption as 300 g of whole molluscs (about 15-20% of the body weight). Swennen (1976) considers this figure low and found that eiders consume about 30% of the body weight in fresh shellfish flesh per day (approximately 60% of the body weight in whole clams). These two ingestions rates for eiders have been used here for scoters.

In the present study, white-winged and surf scoters were the most serious clam predators. Mean weight of 82 male white-winged scoters was 1765 g and of 43 females 1595 g; mean weight of 57 male surf scoters was 1172 g and of 21 females 1069 g. Assuming a sex ratio of 50:50 for both species, mean weights of 1680 g and 1120 g for white-winged and surf scoters were used in the calculations. The amount of clams ingested varied but a reasonable estimate is that 50% of the diet was littleneck and/or manila clams; approximately half the weight of these clams is shell. Assuming these parameters and a daily ingestion rate of 20% of the body weight in whole shellfish, white-winged scoters would eat 168 g and surf scoters 112 g of littleneck and/or manila clams per day. Using an ingestion rate of 30% of the body weight in shellfish flesh per day, white-winged scoters would eat 504 g and surf scoters 336 g of whole littleneck and/or manilla clams per day.

No daily estimates of the number of scoters wintering over these two clam beaches are available but flocks totalling 200 were frequently observed over the two beds. The species composition varied slightly but was generally about 60% white-winged and 40% surf, with only a few black scoters. A flock of this size with the given species ratio could consume 5.3 - 15.9 tonnes of littleneck and/or manila clams in a six month period.

Although the estimate of predation is a rough approximation it does show that scoters can be important predators of commercially-valuable bivalves. Clam studies at Seal Island have not shown that fluctuations in clam populations can be attributed to this source of predation although the studies have been confined to the butter clam area (the lower part of the intertidal beach), an area where scoters apparently do not feed extensively. However, scoters could be serious predators to potential molluscan mariculture operations. Lutz (1980) stated predation by sea ducks is perhaps the largest biological problem facing the North American mussel culture industry at the present time and it has been a major problem in attempts to develop this industry in British Columbia (G. D. Heritage per. comm.). Initial attempts at clam culture on the Pacific coast have been primarily with manila clams. If large scale clam culture is to develop, protection must be provided during culture operations or scoter populations controlled, otherwise extensive predation could occur.

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Table 1. Numbers and sex of three species of scoters collected at Seal Island and Henry Bay, British Columbia, December 1967 to December 1968 (M = male, F = female).

Time of Collection	White-winged Scoter				Surf Scoter				Black Scoter			
	Seal Island		Henry Bay		Seal Island		Henry Bay		Seal Island		Henry Bay	
	M	F	M	F	M	F	M	F	M	F	M	F
December 13, 1967	6	1	3	2	6	0	0	0	1	0	0	0
January 10, 1968	5	0	5	4	6	1	1	1	0	0	0	0
February 5, 1968	7	6	5	2	1	2	3	1	1	0	2	0
March 20, 1968	16	4	0	0	11	2	0	0	1	1	0	0
April 23, 1968	3	0	6	6	4	1	6	1	0	0	0	0
October 1, 1968	7	4	1	1	7	5	3	1	0	0	1	0
November 5, 1968	5	3	4	4	4	3	0	0	6	3	0	0
December 5, 1986	9	5	0	1	4	2	1	1	0	0	0	0
Total numbers of Scoters	58	23	24	20	43	16	14	5	9	4	3	0

Table 2. Frequency of food organisms found in crops and gizzards of white-winged, surf and black scoter collected at Henry Bay and Seal Island, British Columbia, 1967 and 1968.

	White-winged scoter		Surf Scoter		Black Scoter	
	M	F	M	F	M	F
Number of birds	82	43	57	21	12	4
Crop and gizzard empty or containing only stones or gravel	1	1	6	2	0	1
Molluscs present	79	40	50	19	12	3
Bivalves present	78	37	49	19	11	3
Commercially important bivalves present	68	31	35	14	3	1
Gastropods present	22	18	10	2	2	0
Species						
Commercially important bivalves						
Tapes philippinarum	51	27	31	12	1	1
Protothaca staminea	49	18	19	6	3	0
Saxidomus giganteus	4	1	0	0	0	0
Other bivalves						
Mytilus edulis	21	15	28	16	11	3
Clinocardium nuttatlli	6	1	5	3	0	0
Tresus capax	1	0	0	1	0	0
Macoma nasuta	1	0	0	0	0	0
Macoma insonspicua	0	0	2	1	0	0
Macoma sp	2	0	2	2	0	0
Gari californica	1	0	0	0	0	0
Pandora filosa	0	0	2	0	0	0
Transennella tantilla	0	0	1	1	0	0
Nucula tenuis	0	0	1	0	0	0
Acila castrensis	0	1	0	0	0	0
Unidentified bivalve shell	1	1	1	0	0	0
Gastropods						
Littorina scutulata	10	11	1	0	1	0
Olivella boetica	1	3	6	0	0	0
Nassarius mendicus	6	5	2	0	0	0
Batillaria zonalis	3	2	2	1	0	0
Mitrella gausaoata	1	1	1	0	1	0
Bittium attenuatum	1	0	0	0	0	0
Acmaea personna	0	0	1	0	0	0
Unidentified gastropods	1	1	0	1	0	0
Barnacles						
Balanus glandula	12	9	1	0	4	0
Unidentified barnacles	17	13	7	3	4	1
Crustaceans						
Hemigrapsus sp	2	3	1	1	0	0

Table 2 (cont'd)

	White-winged scoter		Surf Scoter		Black Scoter	
	M	F	M	F	M	F
Echinoderms						
Echinicarius excentricus	0	0	0	0	1	0
Annelida worms						
Unidentified polychaete	0	0	1	0	0	0
Plant material						
Ulva latissima	1	0	2	1	0	0
Unidentified seaweed	3	2	8	0	1	1
Zostrea marina	0	0	1	0	0	0
Unidentified plant material	0	0	1	1	0	0

Table 3. Frequency of manila, littleneck and butter clams in white-winged, surf and black scoters collected at Henry Bay and Seal Island, British Columbia, 1967 and 1968.

	White-winged Scoter		Surf Scoter		Black Scoter	
	M	F	M	F	M	F
Henry Bay						
Number of ducks	24	20	14	5	3	0
Number with bivalves	22	17	12	5	2	0
Number with commercial bivalves	18	14	10	5	1	0
With manila but no littleneck	7	7	4	3	0	0
With littleneck but no manilla	6	3	3	0	0	0
With both manila and littleneck	5	4	3	2	1	0
With butter	2	0	0	0	0	0
Seal Island						
Number of ducks	58	23	43	16	9	4
Number with bivalves	56	20	37	14	9	3
Number with commercial bivalves	50	17	25	9	2	1
With manila but no littleneck	11	6	12	5	0	1
With littleneck but no manila	10	1	1	2	2	0
With both manila and littleneck	28	10	12	2	0	0
With butter	2	1	0	0	0	0

Table 4. Occurrence and portion manila, littleneck and butter clams occupied in gut contents of white-winged, surf and black scoters collected at Henry Bay and Seal Island, British Columbia, 1967 and 1968.

	White-winged Scoter		Surf Scoter		Black Scoter	
	M	F	M	F	M	F
Ducks with bivalves	78	37	49	19	11	3
Ducks with commercial bivalves	68	31	35	14	3	1
Manila clams						
Less than 25%	18	8	5	2	0	1
25 - 50%	10	4	2	2	1	0
50 - 75%	12	4	7	4	0	0
75 - 100%	5	9	10	1	0	0
100%	6	2	2	3	0	0
Littleneck clam						
Less than 25%	17	11	14	4	3	0
25 - 50%	12	5	2	2	0	0
50 - 75%	7	2	2	0	0	0
75 - 100%	6	0	1	0	0	0
100%	7	0	0	0	0	0
Butter						
Less than 25%	2	0	0	0	0	0
25 - 50%	0	1	0	0	0	0
50 - 75%	1	0	0	0	0	0
75 - 100%	1	0	0	0	0	0

Table 5. Number, weight and length of manila and littleneck clams in white-winged, surf and black scoters collected at Henry Bay and Sea Island, British Columbia, 1967 and 1968.

Species and sex of scoters		Not recorded	Number of clams in gut						Weight (g)					Shell length mm				
			1	2	3	4	5	6	Less than 1	1-5	5-10	10-20	20+	Less than 10	10-20	20-30	30-40	40+
									Manila clams									
White-winged	M	19	13	12	5	0	2	0	7	8	8	11	17	0	3	24	11	6
	F	10	7	4	4	0	0	2	5	6	2	5	9	0	5	7	2	2
Surf	M	14	3	4	4	1	2	1	4	3	8	10	4	13	1	15	6	1
	F	5	3	1	2	1	0	0	2	4	0	5	0	1	1	0	0	0
Black	M	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
	F	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
									Littleneck clams									
White-winged	M	11	19	10	5	3	1	0	4	8	8	15	14	1	0	10	10	11
	F	10	6	2	0	0	0	0	3	8	4	3	0	0	0	4	1	0
Surf	M	16	1	1	1	0	1	0	8	9	1	1	0	1	1	1	0	0
	F	4	2	0	0	0	0	0	2	3	0	0	1	0	0	0	0	0
Black	M	2	1	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

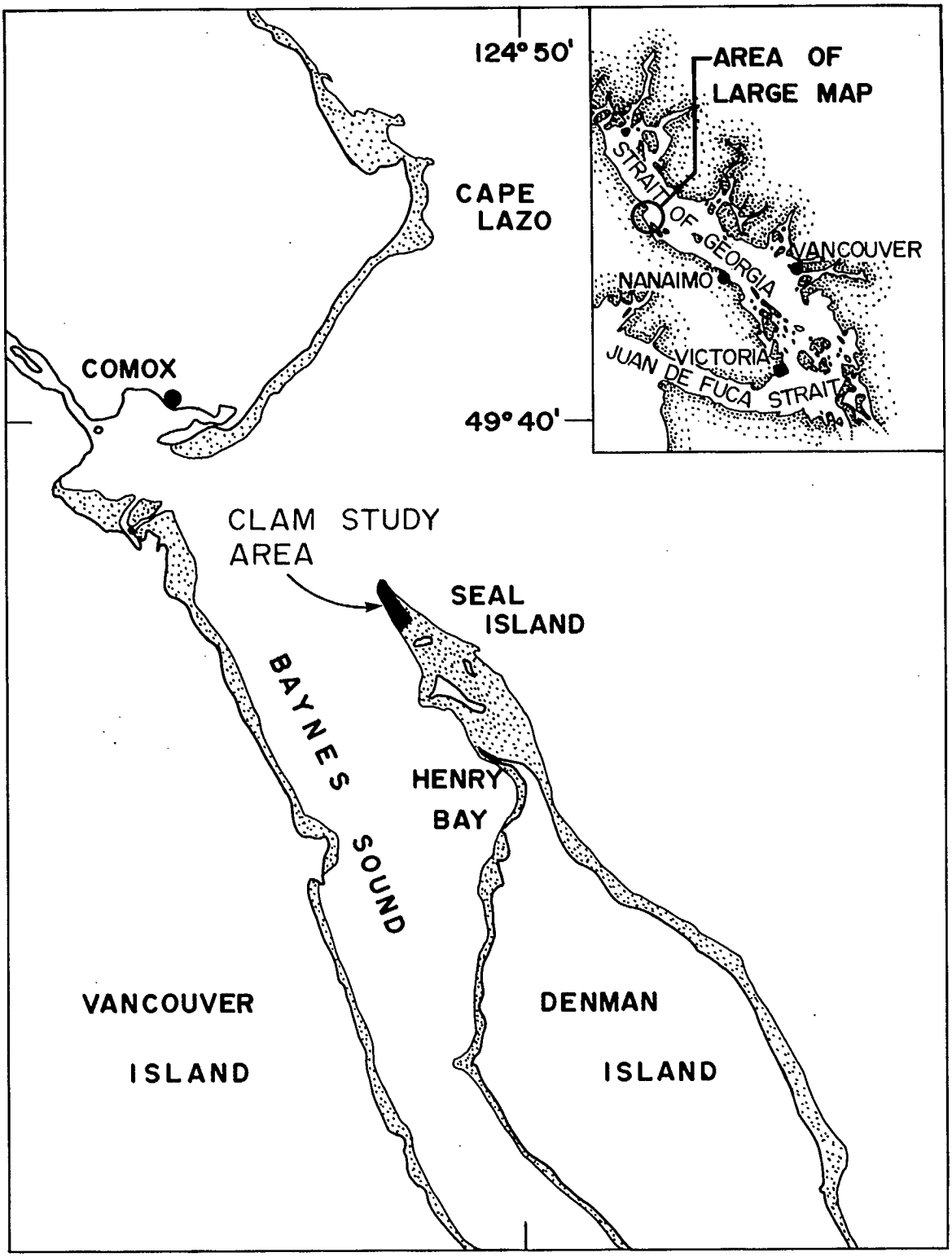

Fig. 1. The Strait of Georgia area of British Columbia and the location of Seal Island and Henry Bay.