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PROGRESS REPORT 1.

Evaluation of effect of Vancouver International Airport expansion on wildlife and wetland environment of the Fraser River estuary, British Columbia.

September 31, 1973

Entech
Environmental Consultants Ltd.
Vancouver, Canada

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INTRODUCTION

This preliminary environmental assessment of the proposed expansion of Vancouver International Airport, British Columbia, was initiated in May 1973 and will terminate March 15, 1973. The first part of the study has been severely constrained due to insufficient funding, and the uncertainty regarding the continuation of the studies.

The terms of reference for this study were broad and flexible as outlined by Canadian Wildlife Service. The consultants were asked to initiate the following aspects of the study to later assess the impact on wildlife of the proposed airport expansion.

To census the:

a. summer, fall and winter populations of species and number of birds.

b. to examine the food habits of waterfowl using the Sea Island foreshore.

c. to review the available literature related to the habitat, wildlife and proposed airport expansion.

DESCRIPTION OF STUDY AREA

1. Location

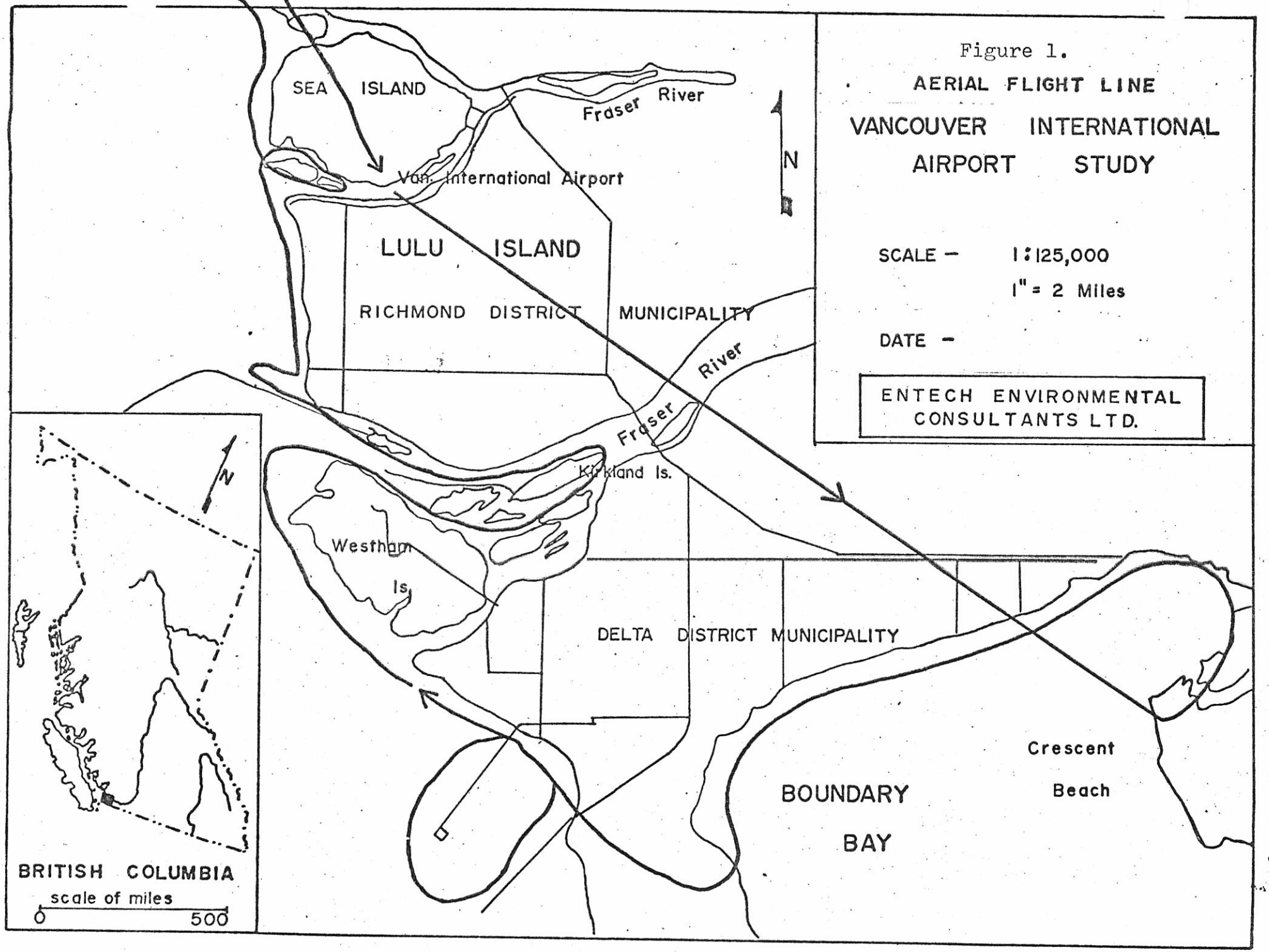
The study area is located along the foreshore of Fraser

River delta and Boundary Bay in the Lower Mainland region of British Columbia. It includes the waters from north arm of Fraser River, south to U.S. boarder at Point Roberts, north and east from U.S. boarder on east side of Point Roberts including the foreshore off Boundary Bay, Mud Bay and Crescent Beach (figure 1).

The salt marshes of Fraser River encompass some 32,000 acres of intertidal habitat, namely Sturgon and Roberts Bank, and of this only a narrow strip along the foreshore is vegetated. In addition the approximately 14,500 acres of foreshore area of Boundary and Mud Bay has a minor salt marsh, however, this area is of particular importance to the aquatic birds requiring a broad intertidal zone for food and shelter.

2. Climate

The maritime climate of the general foreshore area has the longest growing season in Canada, about 230 days (Luttmerding and Sprout, 1969), characterized by rain, heavy overcast, but warm winters, while the summers are relatively cool and dry. The mean temperatures for the coldest and warmest months are respectively 37.2°F (January) and 63.8°F (July). The mean annual precipitation includes some 37.7 inches, of which some 70% occurs during October - March, inclusive, and July - August are droughty and receive less than two inches of precipitation (Luttmerding and Sprout, 1969).


SEA ISLAND
Fraser River
Van. International Airport
N
LULU ISLAND
RICHMOND DISTRICT MUNICIPALITY
Fraser River
Kirkland Is.
Westham Is.
DELTA DISTRICT MUNICIPALITY
BOUNDARY BAY
Crescent Beach
N
BRITISH COLUMBIA
scale of miles
0
500
Figure 1.
AERIAL FLIGHT LINE
VANCOUVER INTERNATIONAL AIRPORT STUDY
SCALE – 1:125,000
1" = 2 Miles
DATE –
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3. Soil

Luttmerding and Sprout (1969) classified the foreshore area under consideration as RECENT ALLUVIUM and the texture varied from silt clay loam or silt loam to fine loam sand.

4. Wildlife value

Fraser Delta foreshore areas with their fragile salt marshes are the most valuable wildlife habitat in Canada. Nowhere else in this country can an area more extensively and intensively utilized by such a great variety of migrating birds be found. Birds from three continents (North Eastern Asia, North America and South America) depend upon the protection and proper management of the Fraser River delta in British Columbia to ensure their survival. This limited area can be considered the bottleneck or site most important in the life history of the migrating birds.

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Literature Review

1. Land Use:

The Lower Fraser Valley contains more than half of British Columbia's population and much of its agriculture and industry. In order to prevent the damage resulting from periodic flooding of the Fraser River a vast system of dyking, pumping, ditching and bank protection has been established by federal, provincial and local governments. At present, sea dykes border Sea Island, Lulu Island, Westham Island and the mainland portion of the Municipality of Delta (anonymous, 1968).

The importance of the Fraser Delta as an agricultural, industrial, residential and recreational area has been documented by a number of government reports. Reports by the Lower Mainland Regional Planning Board (1968) and Ecological and Environmental Systems Consultants (1970) outline the land use and ecological systems of the area emphasizing the need for careful planning.

The Fraser Delta has long been recognized as an important waterfowl area and concern has been expressed over the destruction of wildfowl habitat for industrial or residentail purposes (Canadian Wildlife Service 1971, Ecological and Environmental Systems Consultants 1970, Gates 1967, Halladay and Harris 1972, Russell and Paish 1968). The construction of the Tsawwassen Terminal, the Roberts Bank port facilities, the Iona Sewage Treatment plant and numerous other industrial and residentail developments have all resulted in a number of ecological changes, some of which are described in "A Review of Our Southwestern Shores".

The present facilities at the Iona Sewage Treatment plant handle up to 400 cfs of effluent which undergoes primary treatment and chlorination before it is directed seaward by a mile long jetty. Although the sewage effluent is believed to have a detrimental effect on vegetation of the area (Government of Canada, 1971), Harris (1966) points out that many birds utilize the area and feed on solids in the outfall channel or in the settling ponds where products from the sludge digesters are dumped. A treatment plant on Lulu Island was opened in 1972 and one is planned for Annacis Island by 1975 (G.V.R.D., 1973).

2. Vegetation:

Although the marshes of the Fraser foreshore are inundated by semi-diurnal tidal flow, the presence of the Fraser River results in the flooding of the marsh with fresh water. This fresh water influence is reflected in the absence of halophytic vegetation. The tidal marsh vegetation covers 3,733 acres of foreshore (Burgess 1970).

Burgess' (1970) study of vegetation related to food potential for four species of ducks observed that the tidal marsh could be separated into upper and lower zones, the division line being a natural drop off at the 10 foot tide level. Vegetative species were different in each zone - with Scirpus americanus and Carex lyngbyei dominant in the lower and upper zones respectively. Seed production of individual species varied annually and was related to degree of tidal flooding. The upper zone was the most productive and fewer seeds were produced towards lower tide levels. The most productive seed producers were Scirpus validus and Carex lyngbyei followed by Scirpus paludosus.

A flora description of the Fraser estuary, Boundary and Mud Bays by Forbes (1972) maps the vegetative communities within the area and contains a good account of the dominant species present. However, collection methods were subjective and the collection was done during a short period of two weeks in late July and early August.

A similar study by McLaren of the islands in the south arm of the Fraser River also lacks quantitative information but does give an indication of the dominant species on the islands studied.

There has been little data collected on quantitative characteristics (frequency, density, ground coverage, species diversity, dispersion, vitality, stratification and periodocity) of the vegetation in the Fraser River estuary foreshores which will lend itself to comparision of vegetation changes caused by human interference. Kellerhals and Murray (1969) mapped the major eel grass beds of Boundary Bay (Zostera marina and Z. latifolia) but Taylor (1970) noted that these beds frequently change in abundance and frequency.

There are some references to changes in vegetation as a result of industrial land fill but again, these are often lacking in quantification. Benson (1961) reports that within eight weeks of the completion of the Iona causeway, the cattails in the original marsh died out. This is presumably the result of an increase in salinity when the supply of fresh water from the north arm was cut off. Russell and Paish (1968) suggest that the construction of the Tsawwassen causeway has resulted in the increase of aquatic vegetation possibly due to increased sedimentation rates. The effects of effluent from the Iona Sewage Plants are not fully known but a report of the Task Force

(Government of Canada, 1971) suggests that although sewage fertilization can be beneficial, in this case the swamping effect appeared to be choking the vegetation.

3. Mammals:

Little is known about the mammal populations of the Fraser Delta. Although no specific mammal studies were done, Halladay (1968) found that Microtus townsendii was a major food item of rough-legged hawks, short-eared owls, snowy owls and great blue herons. On the airports bats were occasionally found in the stomachs of snowy owls as well.

Benson (1962) reported that young harbour seals were born on the mud flats in Boundary Bay and on bars in the river. Becker (1968) estimated that 250 harbour seals were annual residents and stated that killer whales were occasionally seen in Boundary Bay.

4. Birds:

The Fraser Delta has a Canada Land Inventory classification of 3M - the highest classification for wetlands having migratory or wintering waterfowl capacity (Harris and Taylor 1971). Sturgeon Banks has been classified for recreation as 2SWPY, which indicates its high capability for wildlife viewing, agricultural landscape and access to water based activities.

In order to preserve the most important areas of wildlife habitat, 66,400 acres of land and foreshore marsh in the Lower Fraser have been given reserve status. However, only 1,450 acres of this are game reserve - an "inviolate sanctuary". The remaining land under map reserve or protected by Orders-in-Council and interdepartmental agreements is in a more precarious position since its status can be changed (Gates 1967).

General studies of waterfowl in British Columbia were first begun by Munro in the 1930's (Taylor 1970) and since 1950 air surveys have been conducted by both the Canadian Wildlife Service and the Fish and Wildlife Branch. In addition to governmental records, Christmas counts and raptoral counts have been done by the Vancouver Natural History Society (Canadian Wildlife Service 1973).

Birds which breed as far away as northeast Russia and Alaska use the delta exclusively during their migration southward along the Pacific Flyway (Halladay and Harris, 1972). Burgess (1970) estimated that of the over five million birds using the Pacific Flyway during spring and fall migration, at least one million of these pass through the Fraser Delta. Under normal winter conditions Halladay et al (1970) reported that about 80% of the wintering waterfowl population or approximately 200,000 ducks utilize the estuary. Also present are most of the wintering shorebirds whose numbers have been estimated at one million, and about 20,000 snow geese (Halladay and Harris, 1972).

Forty species of swans, geese and ducks have been recorded in the Fraser River Delta, 28 of which are breeding birds or birds that regularly overwinter (Leach 1972).

The diversity of the species reflects the variety of food and habitat available in the Delta area. The eel grass beds of Boundary Bay provide the almost exclusive food of black brant, whose numbers have been recorded as high as 16,000 on their migration through Semiahmoo and Boundary Bay in 1957 (Taylor 1970). However, Leach (1972) reported recent wintering populations of black brant to be only a few dozen birds in contrast to the 500 to 1,000 of ten years

ago.

Food habit studies by Burgess (1970) revealed that mallard, pintail, teal and widgeon depend on both foreshore marshes and agricultural land to varying degrees at different times of the year. From late October until January when the duck population is greatest, the birds utilize inshore areas primarily for feeding and the foreshore for resting. In September and early October and from February until May however, the foreshore becomes the primary feeding area - the most important food species being Carex lyngbyei, Scirpus validus and Scirpus americanus (Burgess 1970). The tubers and stems of S. americanus are also an important food of snow geese in the Delta (Harris 1966).

A number of shorebird species have been recorded regularly including western sandpipers, dunlins, dowitchers, least sandpipers, black-bellied plovers, golden plovers, semi-palmated plovers, killdeer and greater and lesser yellowlegs. Marine species include pigeon guillemots, marbled murrelets, cormorants, western grebes and red-necked grebes (Taylor 1970).

According to studies done by Drent and Ward (1970) the largest wintering population of glaucous-winged gulls in their range are found around Vancouver and the Fraser Delta. As many as 25,500 were observed in a roosting area off Steveston and reportedly fed at meat plants on the north arm and at the Richmond and Delta dumps.

Work by Hughes (1966) and Halladay (1968) reports 129 species of birds that were found on Sea Island from 1963 to 1966. Halladay's study dealt with control methods for species which presented a strike

problem to aircraft and included food habit studies for a number of these species. Additional information on the bird strike problem is found in reports by Solman (1966 and 1969).

5. Airport Expansion:

The Vancouver International Airport opened in 1931 and has expanded continually from that date. Of the 3,800 acres of Sea Island, 3,243 are now airport property (M.O.T. 1970). A further proposed expansion of the airport would extend a runway out into the foreshore area.

Reference is made to such an expansion in "A Review of Our Southwestern Shores" which states that the filling of foreshore that would be required would destroy the biological communities now present. If dredging were to take place destruction of marine life would occur as well. The Canadian Wildlife Service (1971) predicted that the reclamation of 1 square mile of Sea Island foreshore would eliminate all the major Sea Island waterfowl areas. This would, however, reduce the bird hazard to aircraft.

The past history of Iona and Sea Islands as outlined by Harris (1966) was that of good waterfowl areas. Large numbers of snow geese used the Iona Island marshes as resting areas but these marshes were destroyed by the causeway. Sea Island was in the past an excellent hunting area for mallards, pintail, teal and pheasants but hunting is now closed. According to Burgess (1970) however, Iona and Sea Islands together attract an equal number of dabblers to Reifel Island, Westham Island or Lulu Island.

Approximately 50% of the provincial harvest or 200,000 waterfowl

are killed in the Lower Mainland annually (Halladay et al 1970). Detailed waterfowl kill data is available in reports by Mackay (1949-1959). As a result of the year-round availability of lead shot on the mud flats, mortality from lead poisoning is believed to be serious (Pearson 1969).

In past years waterfowl management has dealt mainly with the regulation of hunting but with the gradual loss of tidal marsh habitat, waterfowl are becoming increasingly threatened. In their recommendations Russell and Paish (1968) suggested that waterfowl management must be concerned not only with bag limits but with habitat preservation as well.

factual but not specific

METHODOLOGY

1. Bird Census

From May 18 to September 14, 1973, a total of 10 ground surveys and five air surveys were conducted. From May until July 19th ground surveys were made on Sea Island and Iona Island only. Observations on Sea Island were made from 5 (1-5) observation points (figure 2) while counts of Iona were conducted along the length of the causeway road.

On July 23, a ground survey from Mud Bay to the middle arm of the Fraser River was conducted and 7 observation points (A-G) were established (figure 3) after this date, all ground studies covered included the area from Crescent Beach (Mud Bay) to the north arm of the Fraser River. Binoculars and a 20 power spotting scope were used for ground surveys.

Aerial surveys of the entire study area were generally carried out in a Cesna 172 at an altitude of 100' - 200' and an airspeed of 60 to 100 mph. A regular flight path (figure 1) was followed and counts made by 2 observers were later averaged.

Both ground surveys and aerial surveys were started just prior to high tide at which time the birds were grouped at the shore line. (One air survey on May 18 was conducted at low tide to record the number of birds utilizing the mudflats.)

Data from these surveys were recorded on respective ground and air census forms.

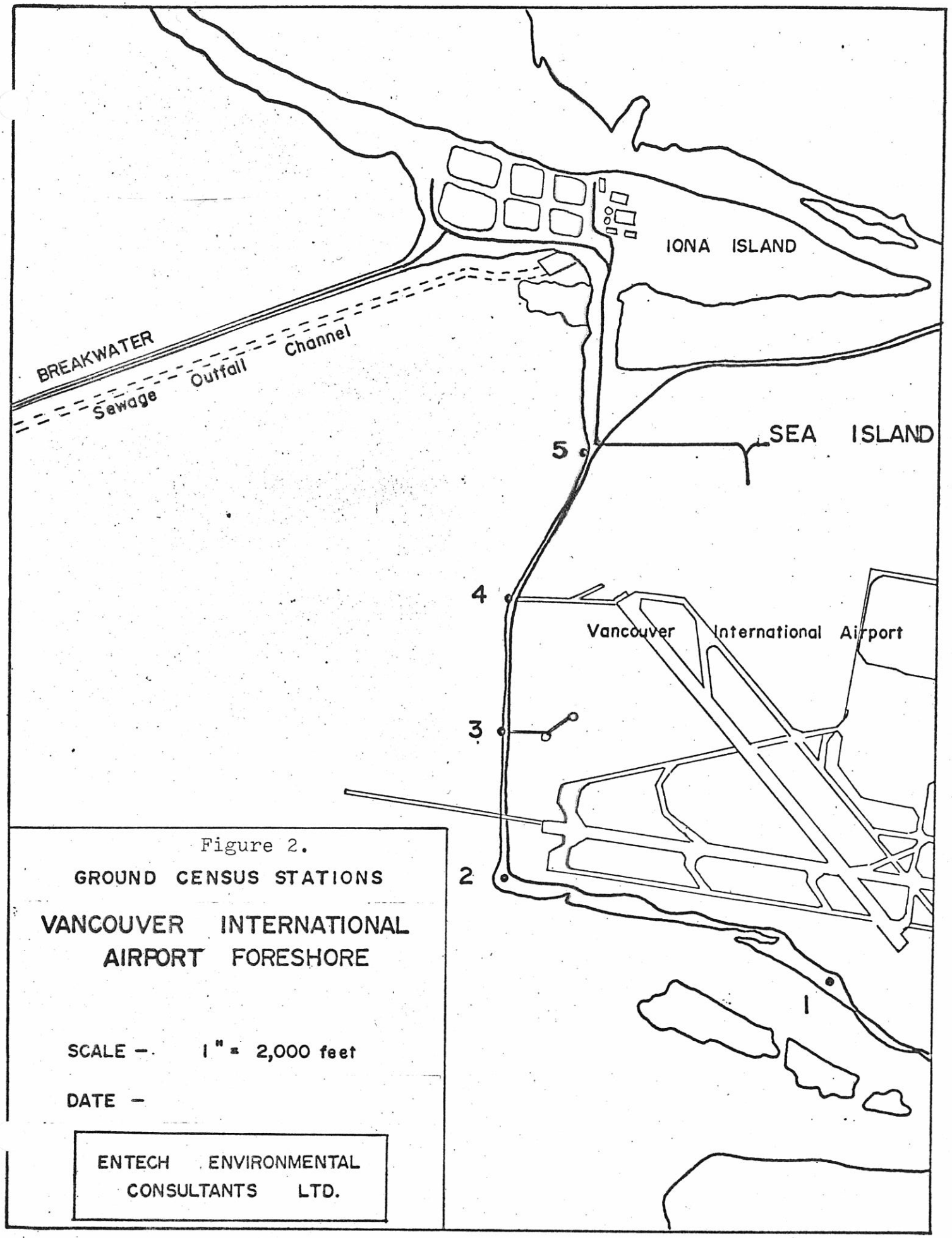

Figure 2.

GROUND CENSUS STATIONS

VANCOUVER INTERNATIONAL AIRPORT FORESHORE

SCALE – 1" = 2,000 feet

DATE –

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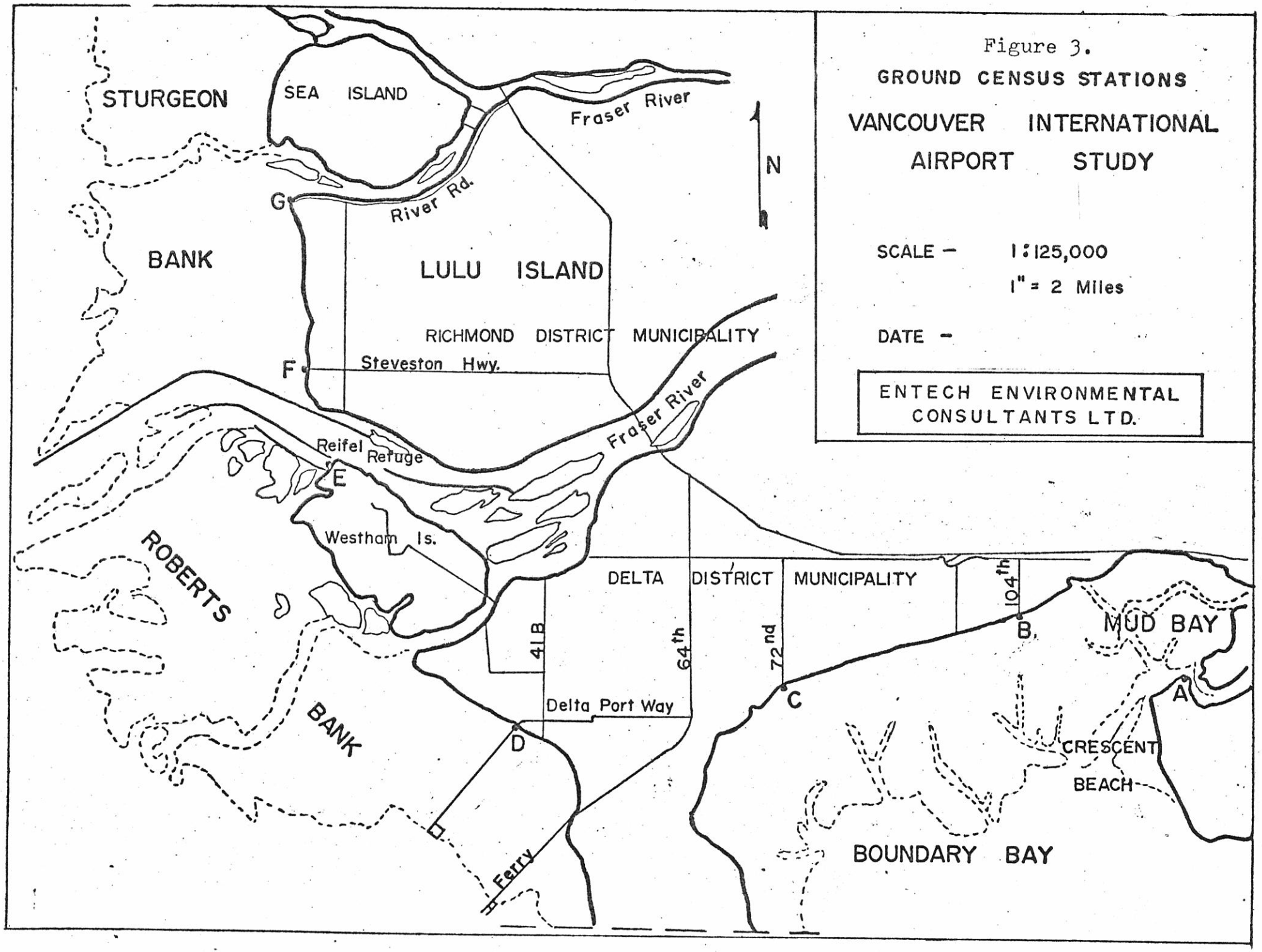
STURGEON
SEA ISLAND
Fraser River
N
River Rd.
G
BANK
LULU ISLAND
RICHMOND DISTRICT MUNICIPALITY
F
Steveston Hwy.
Fraser River
Reifel Refuge
E
Westham Is.
ROBERTS
BANK
DELTA DISTRICT MUNICIPALITY
41B
64th
72nd
104th
B
MUD BAY
A
C
Delta Port Way
D
CRESCENT
BEACH
Ferry
BOUNDARY BAY
Figure 3.
GROUND CENSUS STATIONS
VANCOUVER INTERNATIONAL
AIRPORT STUDY
SCALE – 1:125,000
1" = 2 Miles
DATE –
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CONSULTANTS LTD.

2. Vegetative Sampling

During the period from August 7 to September 15/73, a total of 22 vegetation sampling stations were established. Seven of these (numbers 2 to 8) were stationed at permanently numbered stakes set up by B.C. Research. Compass bearings were taken at each sampling location and later plotted on figure 4.

At stations # 2-18, 4 transects (radiating at right angles from a centre point) were sampled at stations #19-22 and #24 only one transect at each point was sampled. Transect lines of 10 meters were marked out by a tape measure. Every 1/10 meter a metal needle was lowered to the ground and any plant which stem it touched or pierced at ground level was identified and counted. The number of seed heads on the counted plants were also recorded. From the data the frequency of each plant species (the percentage of transects in which the plant was observed) the basal area covered and the number of seed heads per plant, was calculated.

At stations #19-22 + 24 all the vegetation (Scirpus americanus) within one (1) square meter plots was collected. The plants including tubers, but not the roots, were pulled by hand but occasionally part of the stem remained in the mud. The wet and dry weight of the samples (1 or 2 at each station) were recorded.

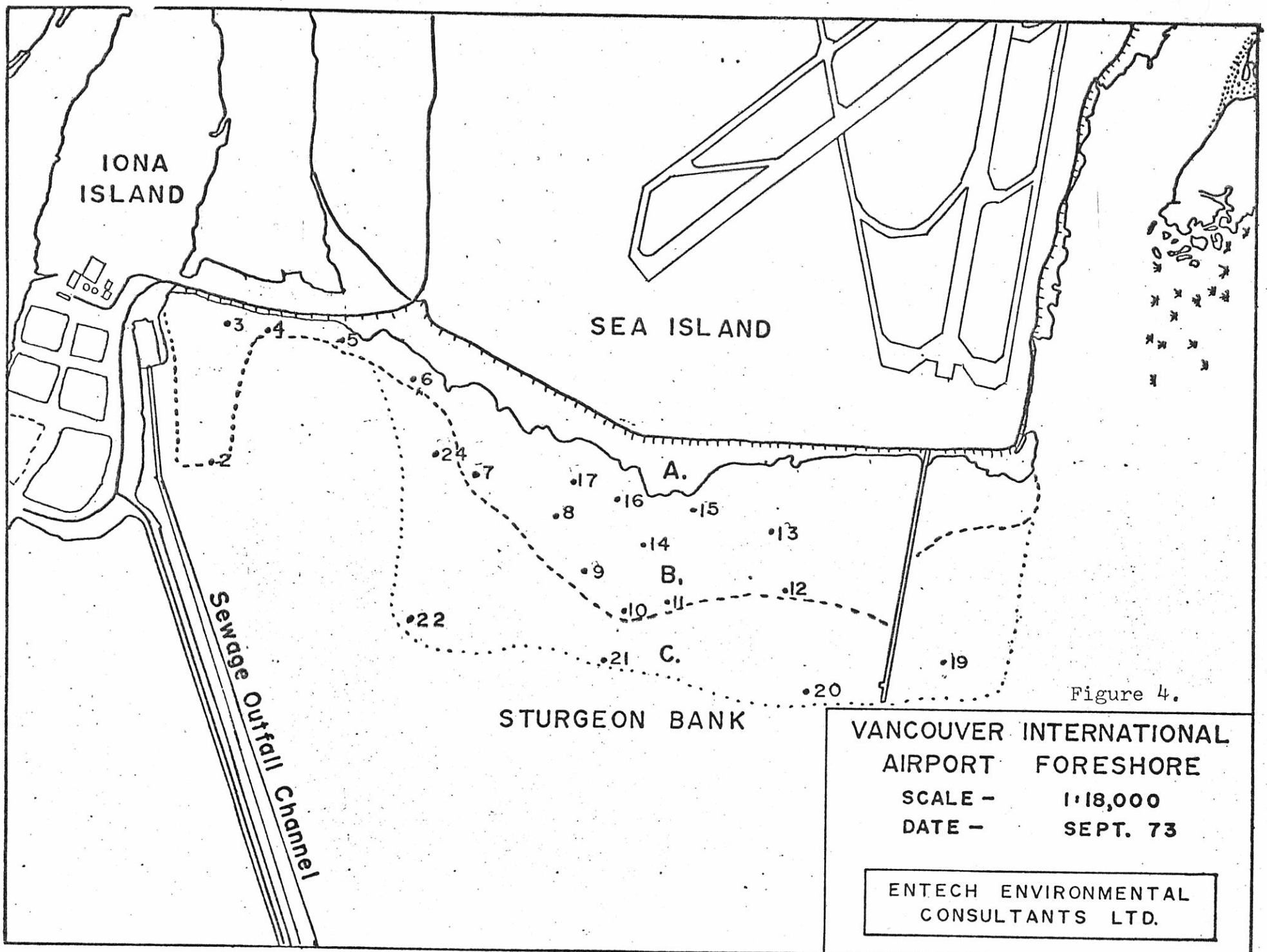
IONA ISLAND
SEA ISLAND
STURGEON BANK
Sewage Outfall Channel
A.
B.
C.
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
19
20
21
22
24
VANCOUVER INTERNATIONAL AIRPORT FORESHORE
SCALE - 1:18,000
DATE - SEPT. 73
ENTECH ENVIRONMENTAL CONSULTANTS LTD.

Figure 4.

RESULTS

1. Bird census

a. Waterfowl

Ground counts were usually higher than aerial counts, despite observation difficulties due to dense vegetation, the distances involved and the absence of sufficient observation points to effectively cover the entire study area. This may be accounted for by the greater length of time spent on ground counts (approximately 6 hours to conduct a ground survey) than an aerial survey (1 hours). Although it was not possible to integrate actual ground and aerial census figures, it was possible to confirm general population trends.

A decline in total bird numbers after the first aerial count in middle of May indicates the departure of the birds from the area until early July (figure 5).

In July, numbers of birds increased and reached a peak in middle of August. This peak was followed by a decrease in numbers in later August and early September but in middle of September counts were the highest of the study period (figure 5).

A total of 50 bird species were recorded from the start of the study to middle of September. The most numerous species observed fall into 3 major categories; ducks, shorebirds and gulls.

Of the duck population, the diving ducks (scaup and scoters) were seen occasionally late in May and again in mid September. However, during the rest of the study period only the dabbling

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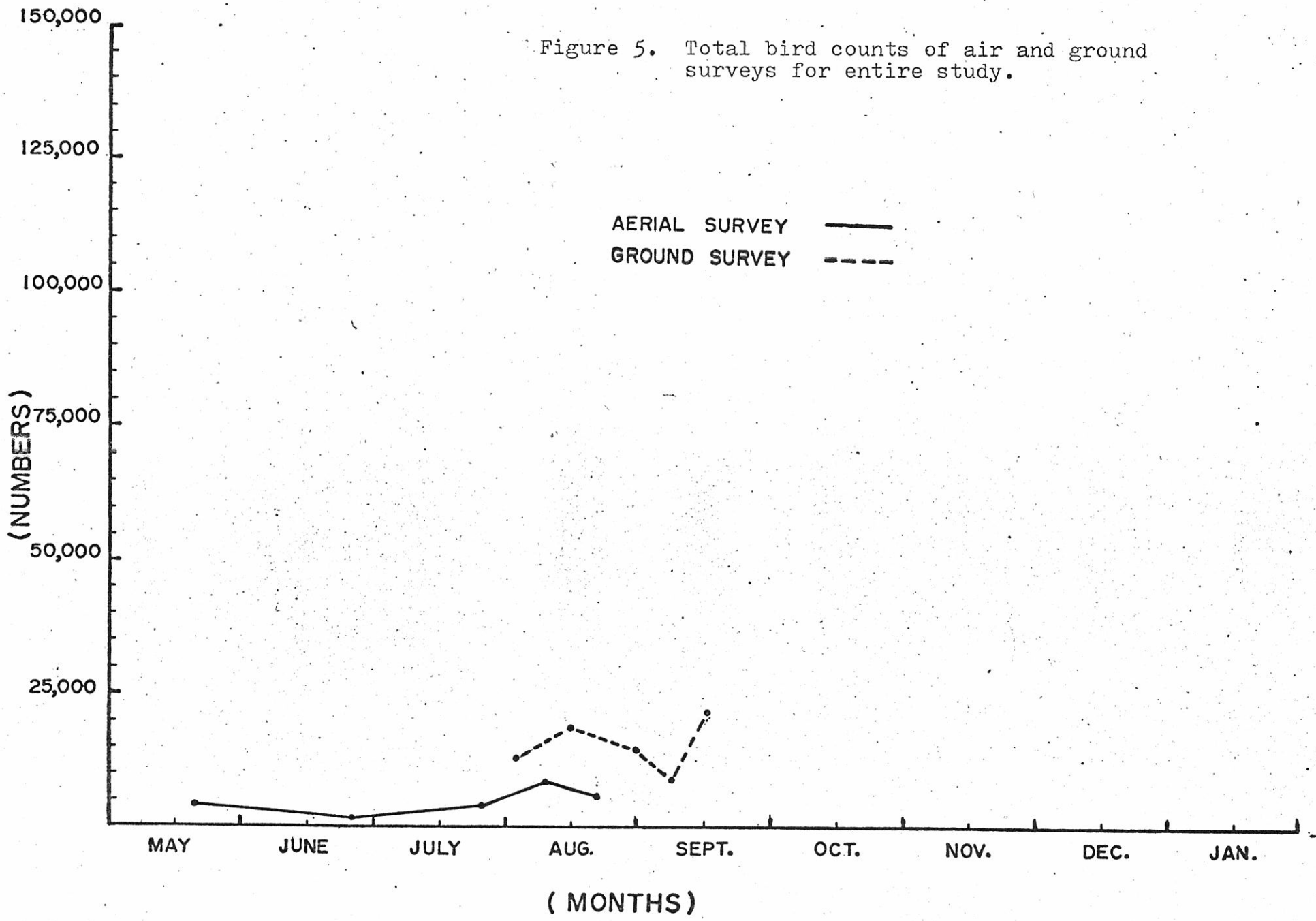
Figure 5. Total bird counts of air and ground surveys for entire study.



ducks, mallard, pintail, gadwall and teal were seen.

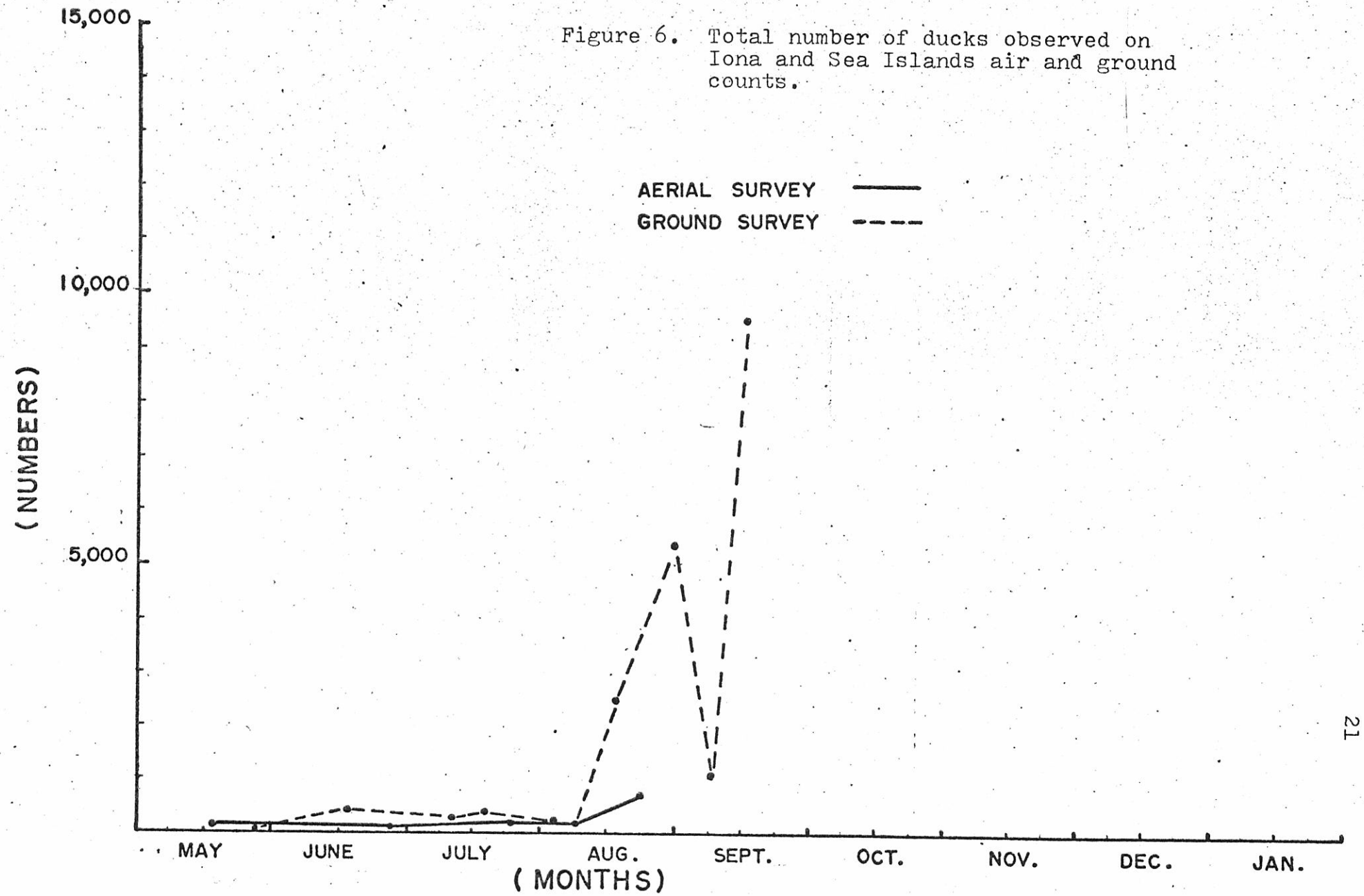
On air surveys in May, June and July, 29.8%, 39.5% and 63.0% respectively, of all the ducks observed on the study area were seen on Iona and Sea Islands. In August, air and ground counts of both Iona and Sea Islands accounted for 35% and 48.5% of the total ducks seen. This percentage rose to 57.7 on the average of two ground counts in September.

Duck numbers fluctuated somewhat in May, June and July but numbers for Iona and Sea Islands never totaled more than 450 birds (figure 6). By August, more birds had come into the area and by the end of the month counts reached over 5,000 ducks (ground count). This was followed by a decline in numbers in early September and a sudden increase in mid September to a total of over 9,000 dabblers (figure 6).

From May until mid July, mallard and gadwall were the main species present at Sea and Iona Islands. In mid July teal were observed in small numbers and several broods were seen in the sewage settling ponds and the drainage ditches on Sea Island. In influx of pintail was noticed from early to mid August and was followed by an increase in green-winged teal (3,000 at Iona and Sea Islands on August 31). In early September, the first american widgeon were seen off Sea Island.

Dabblers were observed along the foreshore of Sea Island but were most commonly seen on the sewage settling ponds and off Iona Island. At low tide, mallard, gadwall and pintail have been observed feeding on the open mudflat south of the sewage

Figure 6. Total number of ducks observed on Iona and Sea Islands air and ground counts.



outfall and off the shore of Sea Island. The ducks move in with the upcoming tide but have been observed to move further south off Sea Island to loaf at the high tide line. A discrepancy exists between numbers present at low and high tides. On one occasion approximately 5,000 ducks were seen feeding at low tide off Iona Island. At high tide the same day the ducks had moved south off Sea Island but only about 1/4 of the original total were present. The location of the missing birds was not determined.

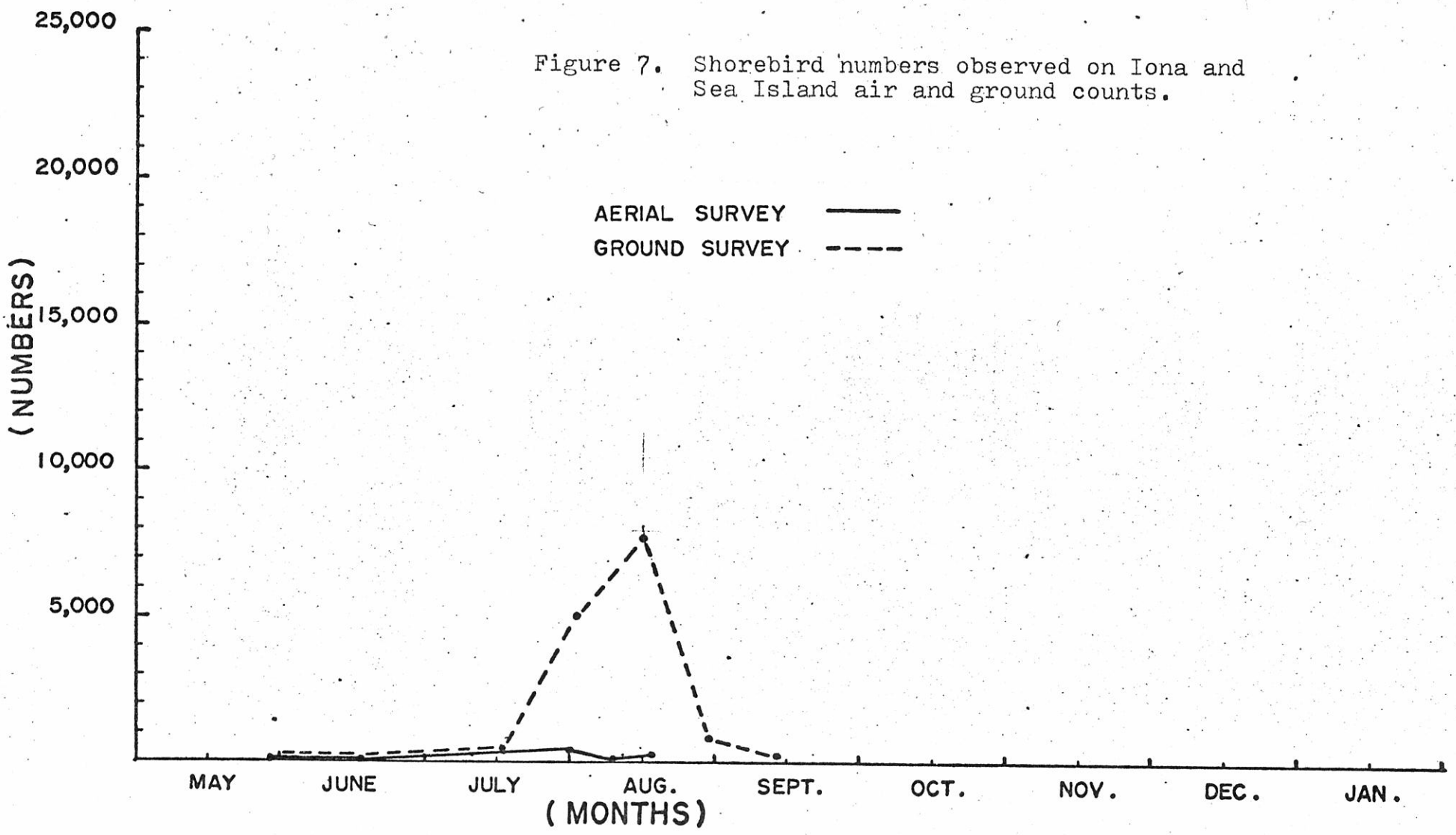
Although much feeding was undertaken at low tide on unvegetated mud flats adjacent to Iona Island sewage outfall channel, dabblers also fed in shallow water of the flooded marsh at high tide. This was especially true for the large numbers of teal present at Iona Island at the end of August.

Mallard and gadwall were seen with broods on the most westerly sewage settling pond. On June 20th six broods were seen with a total of 53 ducklings. One brood of teal (10 young) was seen in a drainage ditch on the south side of Sea Island.

b. Shorebirds.

Few shorebirds were present in May and June but in July numbers began to increase until maximum numbers were reached in mid August after which decline was noticed (figure 7). Large flocks (a total of approximately 7,500) were observed on the mudflats of Iona Island in August while fewer numbers were seen on Sea Island (a maximum of 225). However, since dense vegetation on Sea Island made it difficult to observe shorebirds unless

Figure 7. Shorebird numbers observed on Iona and Sea Island air and ground counts.

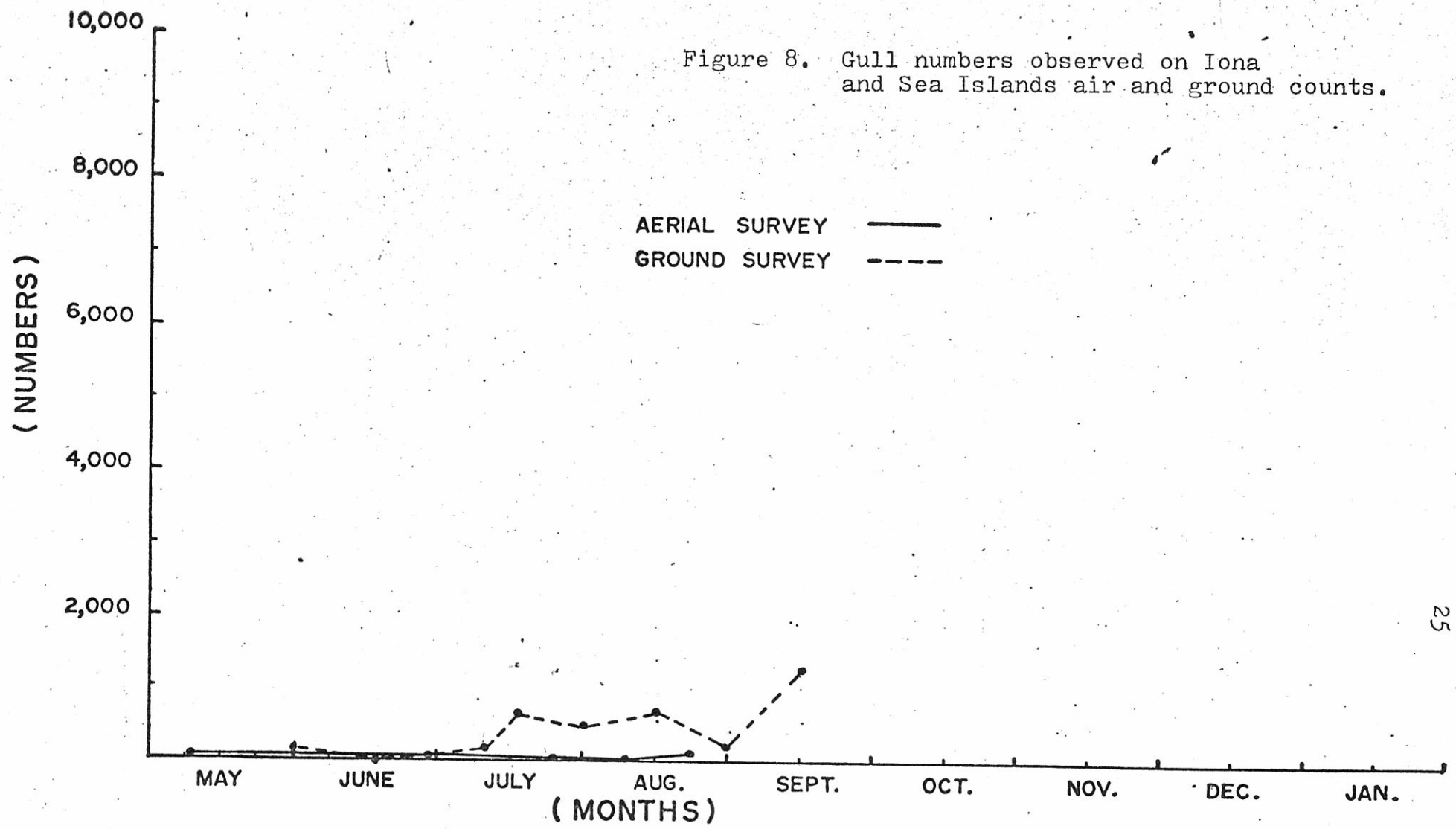


they were flying, counts for this area may be lower than actual numbers present. Shorebirds were also observed in the settling ponds of Iona Island and were most numerous in the most easterly one. On one morning count, several hundred shorebirds were observed on the exposed vegetated islands in this pond and appeared to have used it to rest overnight. The large flocks appeared to be mainly western sandpipers although pectoral and least sandpiper were also identified. Other shorebirds at Sea and Iona Islands included lesser yellowlegs, killdeer, semipalmated plovers and dowitcher.

c. Gulls.

Counts of gulls in both ground and air surveys fluctuated throughout the summer but this was likely due to daily movements to and from inland feeding areas rather than a seasonal migration. On air surveys of the Delta area, over 3,000 gulls were observed in May. This dropped to 700 in June, as the birds moved to their nesting sites. Both ground and air surveys of Iona and Sea Islands revealed few gulls (maximum of 100) from May until the end of June (figure 8). In June, July and August numbers were higher with a daily count of up to 720 while in September counts reached over 1300 (figure 8). Gulls (mainly Bonapartes gulls) were regularly seen in the enclosed area at the sewage outfall (approximately average of 80 birds) while larger flocks of glaucous winged gulls, herring and Bonapartes gulls were found farther out along the outfall channel or in deeper water south of the channel. Most of the gulls were seen off Iona Island

Figure 8. Gull numbers observed on Iona and Sea Islands air and ground counts.



but counts of up to 225 (August 17) were made off the Sea Island foreshore.

A check of the Burns Bog Dump (near Boundary Bay) was made on each air survey to determine if this was a major inland feeding area for gulls. However, gull counts near the dump never exceeded 150 birds.

2. Area Specific Results.

a. Iona and Sea Islands.

Throughout the study period it became apparent that the bird populations of Sea and Iona Islands (figure 2) could not be effectively distinguished since many of the birds utilized both locations at various tide levels each day. This was especially true with dabblers. Iona and Sea Islands both of which encompass the foreshore area proposed for the airport expansion, have therefore been considered as one area (table 1).

Air surveys indicated that few birds utilized Sea and Iona Islands in May (only 3.1% of the total count) but in June and July this percentage rose to 10.4 (115 birds) and 13.7 (584 birds) (Table 1).

Although aerial counts in August showed only an average of 10.3%, the ground count average was 48.8% (7,865 birds) indicating that in August ground counts Sea and Iona Islands contained more birds than any other location in the study area. Although the ground count average in September dropped to 33.9% (6,415 birds) this was again higher than any of the other sub areas studied.

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Table 1.

Percentage of total bird counts observed in specific locations of the study area.

	% of birds using						
	Iona & Sea Islands	St. Bank	R.B.N.	R.B.S.	B.B.	M.B.	Total number of birds
Air Surveys							
May 18	3.1	1	46.9	46.7	1.7	1.3	3,891
June 27	10.4	3.3	7.7	28.9	27.7	21.8	1,108
July 26	13.7	1.2	8.3	18.2	44.3	14.3	4,294
Aug. 9	4.2	7.7	3.4	16.3	61.9	6.5	8,291
Aug. 22	16.4	5.2	9.7	22.2	35,k	11.4	6,202
Ground Surveys							
Aug. 3	45.1	1	1	34.1	2.9	17.5	13,109
Aug. 17	59.4	1	1	27.1	8.9	3,9	18,939
Aug. 31	42.1	1	2.0	6.5	47.6	1.2	15,332
Sept. 6	17.4	1.6	14.1	6.9	45.7	14.3	9,256
Sept. 14	50.4	2.2	22.4	3.1	19.1	2.8	22,226

St. Bank - Sturgeon Bank
R.B.N. - Roberts Bank, North
R.B.S. - Roberts Bank, South
B.B. - Boundary Bay
M.B. - Mud Bay

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b. South Sturgeon Bank - off Lulu Island (figure 3).

Both ground and air surveys indicated that few birds utilized this area during the study period. A maximum average of 6.5% on total aerial counts was observed in August but in other months this percentage was less than 4% (table 1).

c. Roberts Bank North including the South arm of the Fraser River (figure 3).

In May 46.9% of the total aerial count (1,825 birds) was observed on Roberts Bank. N. This was mainly due to large numbers of gulls (1,488). In June, July and August the average percentage never exceded 9% (360 birds). However, in September ground counts indicated that 18.3% (3,132 birds) of the total count utilized this area (table 1). Almost all of the species seen were ducks although on two occasions in late July and early August, 50 and 20 Canada geese were seen off Reifel Refuge. This is the only area where geese were seen.

d. Roberts Bank South (figure 3).

In May aerial counts on Roberts Bank South were almost identical to those of Roberts Bank North. In June, July and August the number of birds decreased but remained higher than those of Roberts Bank North (table 1). However, there appears to be an overall even disbursement of birds along this foreshore.

Aerial counts in August indicated a maximum of approximately 500 ducks and ground surveys a maximum of approximately 5,000

shorebirds. In September, numbers of birds on Roberts Bank South decreased and ground counts showed an average of only 5% (667 birds) of the total count.

e. Boundary Bay (figure 3).

Only 1.7% (65 birds) of the total count were seen in Boundary Bay on an aerial flight in May. This rose to 27.9% (309 birds) in June and to 44.3% (1,904 birds) in July. Two aerial counts in August averaged 48.5% (3,655 birds) but three ground counts averaged only 19.8% (3,131 birds). As many as 4,359 shorebirds and 1,530 gulls (air count) as well as 6,900 ducks (ground count) were recorded for Boundary Bay in August. In September, the ground count average rose to 32.4% (4,240 birds) most of which were ducks (table 1).

f. Mud Bay (figure 3).

Mud Bay contained only 1.3% (150 birds) of birds seen on an aerial survey in May. This percentage rose to 21.8% (309 birds) in June and fell to 14.3% (614 birds) in July. Ground count averages in August and September were 7.5% (3,121 birds) and 8.5% (973 birds) respectively. Shorebirds (a ground count maximum of 602 in August) and gulls (a maximum of 1,465) were the most numerous bird groups (table 1).

g. Airport Property (figure 2).

A thorough census on the airport property was not conducted. However, casual observations included the following species; teal,

marsh hawks, killdeer, black bellied plover, red winged black birds, starlings, gulls, short-eared owls, pheasants, and barn swallows.

↑ Below data available from NRC Bird Study Cites — see W.J.D. Stephen

3. Vegetation Survey

The outer edge of the vegetation is a homogenous community of Scirpus americanus (see C, figure 4). Further in toward the dyke this changes to an almost homogenous community of S. maritimus (see B, figure 4), which gives way to a variety of species near the dyke (see A, figure 4). S. americanus and S. maritimus probably provide the greater part of plant food for ducks off Sea Island.

No seed production was observed in the S. americanus communities (table 2) and only the inner communities of S. maritimus were seed heads in evidence (table 3). It appears that the degree of tidal flooding determines the seed productivity probably through the regulation of exposure to light and photosynthetic activity.

The effect of tidal flooding is also evident in the basal area coverage. Transects at stations number 13 to 17 which were directly inland of stations 8-12, showed a consistenly higher basal area (table 3, and figure 4).

Table 3 also indicates a gradual increase in basal area from transects at the edge of the outfall channel #2 to those farther south (#12) (figure 4). However, the basal areas again decrease at further distances from the outfall channel.

Table 2

Scirpus americanus community

Station number	Frequency of *Scirpus americanus* (%)	Seed heads per plant (%)	Basal area (%)
19	100	-	14.0
20	100	-	4.0
21	100	-	10.0
22	100	-	2.0
24	100	-	12.0
AVERAGE	100	0	10.2

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Table 3

Scirpus maritimus community

Station Number	*Scirpus maritimus* (%)	*Scirpus validus* (%)	*Scirpus americanus*	grass (a) (%)	*Triglochin maritima* (%)	Seed Head/ plant	Basal area (%)
2*	100			75	50		15.25
3*	75						5.0
4*	100					.17	26.25
5*	100					.15	16.75
6*	100					-	29.5
7*	100					-	12.75
8*	100					-	9.75
9	100					.02	17.0
10	100					-	11.75
11	100					-	10.5
12	100					-	16.75
13	100	50				-	20.5
14	100					.22	19.5
15	100					.13	16.75
16	100	25				.13	18.5
17	100					.03	15.0
18	100					.21	19.75
Average	98.5	4.4	-	4.4	2.9	.06	16.54

* B.C. Research sign present — data available from them?

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This would suggest that in the immediate area of the channel the sediment accumulations may have a detremental effect on vegetation but where such accumulations are less concentrated a fertilizing effect may occur. In transects farther away, still where the influence of the sewage outfall is minimal, basal areas were lower.

A comparison of S. americanus samples (air dry weights) from station #19-22 and 29, also indicates the effect of the sewage outfall on this species, table 4 and figure 9.

Sample #22, the closest of the outermost samples to the outfall channel (figure 4), had the lowest dry weight (figure 9). Samples 24, also close to the channel but closer to the dyke than #22, had a higher dry weight than the former. Farther from the outfall area, the dry weight once again increased (#21). A drop in dry weight value at #20 - (farther south near the south jetty) might indicate the lack of sewage fertilization. In contrast to the rich mucky sediment near the outfall channel, the bottom was hard rippled sand at #22 (figure 4).

On the south side of the jetty, the dry weight of samples from station #19 was again higher. It is likely that this area is influenced less by the Iona sewage outfall but it probably receives most fertilization from the middle arm of the Fraser River.

On visual estimation, the foreshore of Sea and Iona Islands can be divided into an inner zone (a variety of species) comprising approximately 1/8 of the area, the middle zone

Table 4

Scirpus americanus from $1m^2$ area of the salt march at Sea Island.

Station #	Sample Wt. (gms) *Scirpus americanus* wet	dry	Mean Wt. (gms) dry	Remarks
19	1658	358.5		
	765	119.3	238.9	
20	312	43.0		
	990	202.8	122.9	
21	1306	194.0	194.0	
22	153	19.4		much of weight is due to algae
	347	37.8	28.6	
24	156	20.0		
	519	74.0	47.0	

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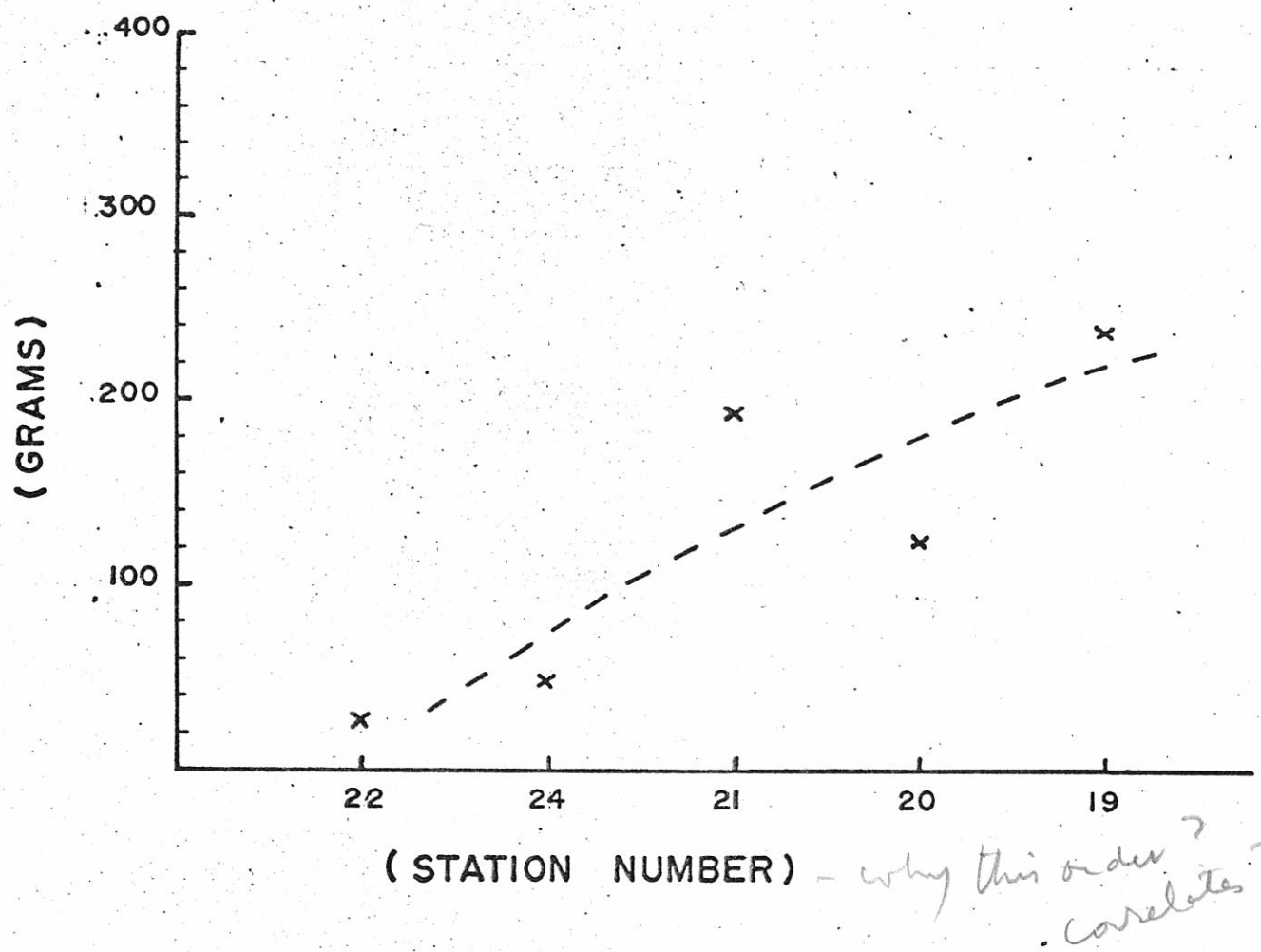

Figure 9. Air dry weights of Scirpus americanus. The samples represent 1 m^2 area from Sea Island salt marsh.

(mainly Scirpus maritimus) of approximately 1/2 the total area and the outer zone (S. americanus often patchy) which accounts for approximately 3/8 of the total area. These figures may be changed greatly when area calculations from aerial photographs taken during August 1973 become available.

Further work is required on the inner zone in order to determine the species diversity of the area. In addition, further studies should be conducted in order to determine the change in plant distribution with time.

An extensive and heavy algae growth was observed in the Sea Island foreshore area. The S. americanus growth appeared to be severly restricted due to the algae covering the plant stalks. It has not been clarified as of yet if this algae growth is related to the sewage outfall from Iona Island or is of general occurrence on the foreshore of Fraser Delta.

4. Photographic Record.

A photographic record in Kodacolour has been kept of the salt marshes of Sea Island and other bird census stations along the Fraser Delta and Boundary Bay foreshore. In addition, pictures were obtained during the vegetation sampling. These pictures will be provided in the final report, due March 15, 1974.

final report due Sept 30 (see contract)

PRELIMINARY RECOMMENDATIONS

Should be preceded by and based on conclusions

1. Moratorium should be placed on all destruction of salt marshes and foreshore areas until such time when the habitat requirements have been clarified and included in a permanent management plan of all the foreshore areas under study.

2. Only a gradual destruction of the Sea Island foreshore should be permitted. This would allow the time needed for a thorough examination of the effect of migratory birds displacement.

3. An indepth examination should be carried out of the primary productivity of the salt marshes over several years to determine the biomass productivity, species diversity, density and range, as well as viability of the plant species of greatest importance to the migratory birds.

4. The least destruction of the salt marshes habitat at Sea Island will be the best type of development for the migrating birds and the Fraser Delta ecosystem as a whole.

5. Mitigation of habitat to displace the affected wildlife should be carried out prior to any extension of the

runway into the foreshore area. In this way the displacement of the wildlife species under consideration would not be deterimental to any single species.

6. A detailed wildlife food study needs to be implemented in the Fraser Delta region to identify the species specific food requirements for the migrating and non-migrating wildlife.

7. To lower the hazard of birds to the air traffic at Vancouver International Airport and prevent deterimental displacement of certain birds, the creation of species specific alternative habitat in another location would safeguard both the aircrafts and the birds.

8. A study needs to be initiated on the reptile, amphibian, and small mammal populations along the foreshore and adjacent land. These animals form an intricate part of the Fraser Delta ecosystem as they provide food for other animals. There is presently only an insignificant amount of data available to assist in preparing environmental impact statements.

9. A clarification of the changes in the intertidal flow patterns from the construction of causeway, jetty, or port terminal is required prior to an effect assessment can be made of the indirect changes to the salt marshes.

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