PRELIMINARY ASSESSMENT OF POTENTIAL ENVIRONMENTAL EFFECTS OF THE BOREALIS IRON ORE DEVELOPMENT PROPOSAL ON BIRDS OF MELVILLE PENINSULA, N.W.T.

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CANADIAN WILDLIFE SERVICE

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ABSTRACT

Vegetation communities in the Parry Bay area of Melville Peninsula, N.W.T. were segregated into 10 classes through a combined biophysical and automatic computer classification approach using LANDSAT imagery. The colour-coded, 1:70 000 scale maps produced from the classification were used to prepare a derivative map showing the distribution of habitat most attractive to water-oriented birds in the Parry Bay area.

Aerial surveys were conducted of the shorefast ice edge in Parry Bay, along the shoreline from Hall Beach to Cape Jermain and along transects established in terrestrial areas of the Parry Bay region to determine the significance of the area to birds. A reconnaissance survey of the Ajaqutalik River was also flown. Results of the survey are discussed and areas within the study area which appear to be most important to loon, waterfowl and other bird species are described and mapped.

A technique of environmental impact assessment, referred to as the Biophysical LANDSAT Technique, is described and used to assess the environmental implications of developing the iron ore bodies near Roche Bay as proposed by Borealis Exploration Limited. The most significant potential impacts would result from: oil spills occurring in Roche and Parry bays, and especially south Foxe Basin and Hudson Strait; construction of a road from the mine development to Hall Beach; aircraft traffic; and hydroelectric development of the Ajaqutalik River. Studies are recommended to provide the data necessary for evaluation of these impacts and for minimizing the adverse effects of the project on birds.

ACKNOWLEDGEMENTS

I acknowledge the Polar Continental Shelf Project, which provided the necessary helicopter support for the study, and Mr. H. Massecar of Quasar Aviation Ltd. who did the flying.

I thank Mr. P. Dupuis, Canadian Wildlife Service, for acting as an observer during the aerial surveys and for supplying useful data on Foxe Basin snow geese. I am grateful to Mr. D. Jaques, Ecosat Geobotanical Surveys Inc. who contributed greatly to the study through his biophysical classification work using LANDSAT.

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1. INTRODUCTION

Borealis Exploration Limited plans to develop several iron deposits located on Melville Peninsula in the Northwest Territories. The company is optimistic about starting production from its eastern deposits at Roche Bay by 1985 or 1986. As part of the development plans, Borealis initially contemplated harnessing the hydroelectric potential of the Ajaqutalik River entering Roche Bay, as well as the construction of townsite, airstrip and docking facilities and a road to the hamlet of Hall Beach. Hydroelectric development has since been dropped from current plans.

Aerial surveys conducted by Reed _et al_. (1980) showed that breeding and non-breeding brant (_Branta bernicla hrota_) and greater snow geese (_Chen caerulescens atlanticus_) occurred in the Roche Bay area. The Canadian Wildlife Service became concerned that construction of certain facilities required to support the mine operation, such as a road connecting the mine site and Hall Beach, could adversely affect habitat use by these and other waterfowl species. Because the importance of the Roche Bay area to birds was poorly known, and because of the potential impacts of the proposed mine operation, a series of aerial surveys and ground reconnaissance were planned for the 1981 breeding season. The surveys were designed to:

(1) determine the importance to loons and waterfowl of coastal habitat in Roche Bay relative to habitat north and south of Roche Bay;

(2) determine the extent to which waterfowl used the Ajaqutalik River in 1981;

(3) determine the use of coastal ice-edge habitat by non-breeding sea ducks in 1981; and

(4) obtain general knowledge of the abundance of other non-waterfowl birds in the Roche Bay area.

Late in the planning stages, an opportunity arose to test the feasibility of using LANDSAT imagery and digital data to classify and map the distribution of vegetation communities. Mr. D. Jaques of Ecosat Geobotanical Surveys Inc. was retained to produce vegetation distribution maps from LANDSAT data available for the Roche Bay area. It was felt that, in addition to testing the usefulness of this technique in mapping bird habitat, this work would provide valuable pre-development baseline data and would assist in the assessment of potential impacts of the mine proposal.

2. THE STUDY AREA

2.1 Geographic Location

The study area is located in northeastern Melville Peninsula, Northwest Territories (Figure 1). Roche Bay, the main area of interest, lies approximately 50 km southwest of the nearest community, the hamlet of Hall Beach. A DEW-Line base still operates a few kilometres from the community itself. Parry Bay connects Roche Bay to a large body of water called Foxe Basin which is bounded to the north and east by Baffin Island. To the south, the basin is connected to Hudson Bay by Roes Welcome Sound west of Southampton Island. Figure 2 shows locations of geographic features referred to in the text.

2.2 Climate

The Roche Bay study area lies within the south-central macroclimatic region and the Melville Peninsula - Southampton Island sub-region defined by Maxwell (1981). General climatic characteristics of this sub-region are given in Table 1. The sub-region is basically a transition zone between continental and marine climatic conditions. Although sea ice persists near the centre of Foxe Basin during the summer, open ice areas along the eastern shoreline of Melville Peninsula produce ameliorating influences on the summer climate (Maxwell 1981).

Jaques (1982) roughly estimated present meso- and microclimatic characteristics of the study area from work completed on the Truelove Lowland area of Devon Island by Courtin and Labine (1977). Mean temperatures on the uplands are lower than on the lowlands; however, the amplitude of temperature fluctuations is greater. In other words, the uplands possess a somewhat more continental climate than the lowlands. Snowmelt is about two weeks

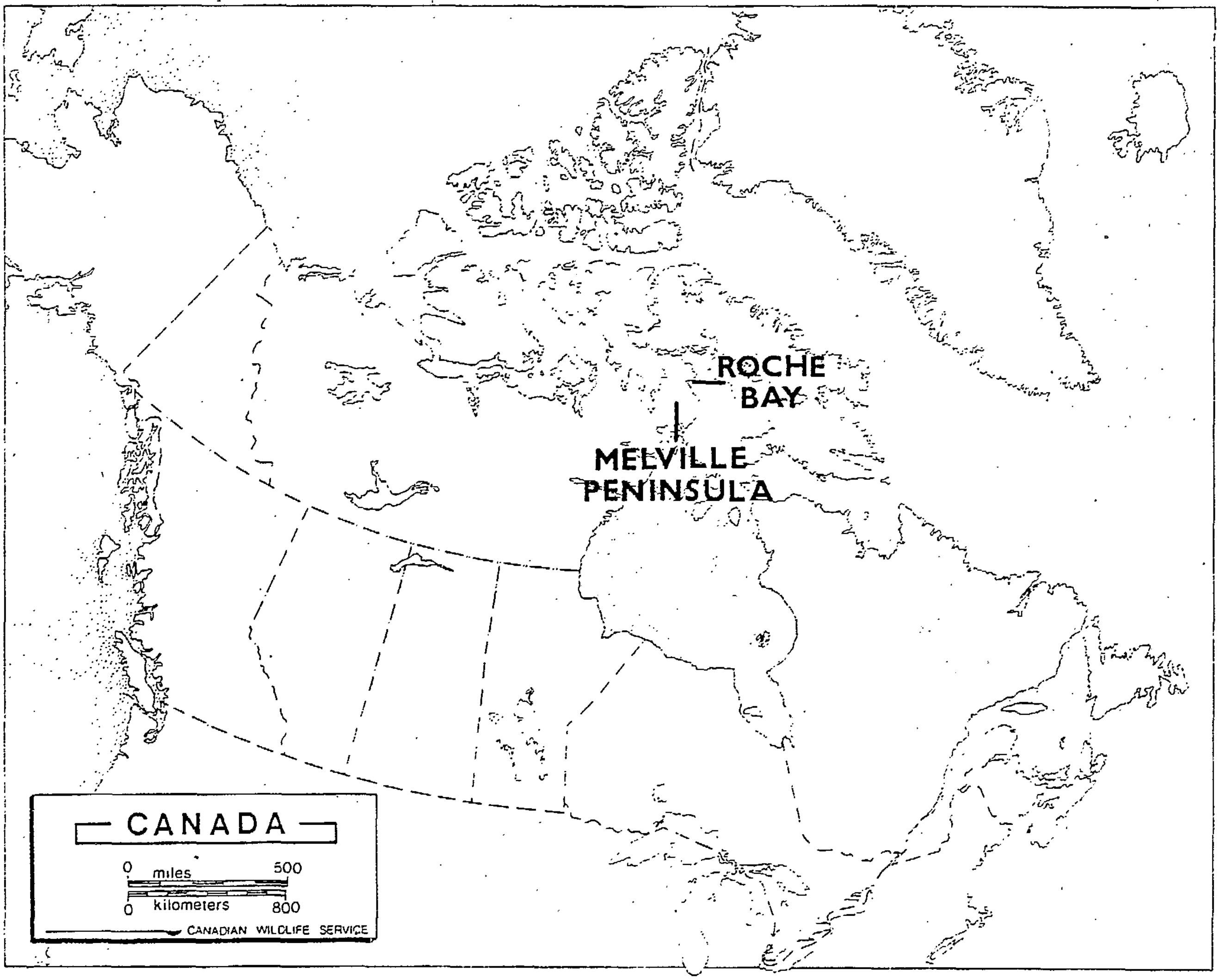

Figure 1 . Location of the Roche Bay study area, Melville Peninsula, N.W.T.

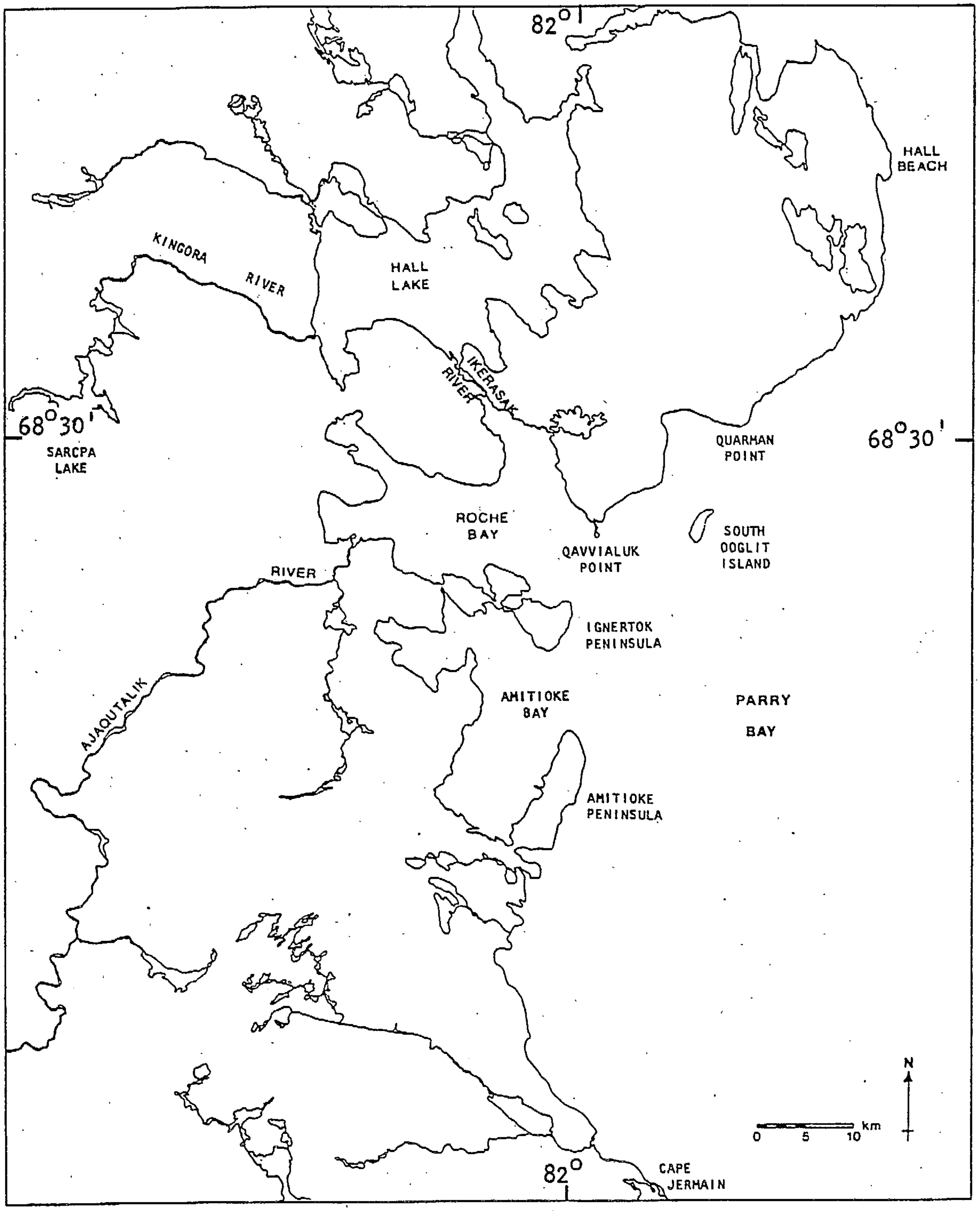

Figure 2. Locations of geographic features referred to in the text.

Table 1. General climatic characteristics of the Melville Peninsula sub-region in the south-central climatic region.

Mean annual range	Mean daily temperature (°C)	Winter	Percentage frequency of occurrence of winds ≥40 km/h	Annual precip-itation	Percentage frequency of occurrence of fog or ice fog
36 to 39°C	January: -33 to -30 from west to east	Begins: Sept. 5-20 from north to south	January: Coral Harbour - 9[a], Hall Beach - 9, Mackar Inlet - 6[b]	200-300mm from north to south	Dec.-Feb.: Coral Harbour - 5, Hall Beach - 14, Mackar Inlet - 17
	July: +5 to +8 from north to south	Ends: June 10-15 from south to north	July: Coral Harbour - 5, Hall Beach - 2, Mackar Inlet - 2	40-50% falls as liquid precipitation	June-Aug.: Coral Harbour - 7, Hall Beach - 11, Mackar Inlet - 27

a/ located on Southampton Island
b/ located on west coast of Melville Peninsula
Source: Maxwell (1981)

later and refreeze one week earlier on the uplands. Since the uplands receive slightly higher precipitation, incoming radiation is used largely to melt the snow cover and, consequently, the upland soils warm up very little in comparison to the lowland area. Sites with quite warm conditions include large beach ridges, limestone cliffs and areas adjacent to the ocean which are free of ice very early in the spring.

From a bird standpoint, the lowlands are the most important part of the study area. Data collected at the Hall Beach A meteorological station are representative of climatic conditions experienced in areas most important to birds (Tables 2 and 3). January and February are the coldest months and July and August are the warmest. Total precipitation is lowest in the winter, increases in the spring and reaches a maximum in August. Precipitation in August falls almost entirely as rain.

2.3 Landforms and Vegetation

2.3.1 Landforms

Jaques (1982) provided a comprehensive description of geology, topography, surficial materials and vegetation of the study area. This information is summarized in this section.

Two major bedrock regions exist in the Roche Bay area, separated by a major fault. The oldest rocks are part of the Canadian Precambrian Shield and consist of granites, gneisses and volcanics. The younger rocks, of the Foxe Basin geologic province, are Ordovician-aged consisting of dolomites, limestones shales and other sedimentary, lithologic types (Trettin 1974).

Table 2. Mean daily temperatures (°C) - Hall Beach A meteorological station, 1951-1980.

J	F	M	A	M	J	J	A	S	O	N	D	Year
-31.0	-32.1	-29.5	-20.9	-9.1	0.1	5.4	4.6	-0.6	-10.5	-21.5	-27.4	-14.4

Source: Atmospheric Environment Service (1982a)

Table 3. Mean monthly precipitation - Hall Beach A meteorological station, 1951-1980.

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Precipitation falling as snow (cm)	8.8	8.5	12.3	11.5	16.2	6.2	0.3	1.8	12.1	21.5	12.9	9.2	121.3
Precipitation falling as rain (mm)	T[a/]	0.0	0.0	0.1	0.4	10.5	34.1	39.1	15.0	0.3	T	0.1	99.5
Total precipitation (mm)	8.7	8.3	11.7	10.9	16.2	16.7	34.4	40.8	27.4	21.2	12.6	8.7	217.6

[a/] T = trace (<0.1)

Source: Atmospheric Environment Service (1982b)

The fault is also the dividing line between the two broadest physiographic regions which make up the study area: Melville Plateau and Foxe Basin (Sanford and Grant 1976). The Melville Plateau is entirely composed of Canadian Shield fold belts and volcanics that form a plateau ranging from about 50 m to 350 m elevation in the study area. The region is comprised of ridges and undulating plateaus with a few major river valleys cutting through. Evidence of glaciation is mostly in the form of striations and linear structures produced by the scraping of the surface with ice.

Below 50 meters elevation, the Foxe Basin physiographic province dominates the study area. The landscape consists of flat plateaus of Paleozoic sedimentary rocks and nearly level flats, mostly below 30m. Extensive lake deposits and ponds cover the area. Numerous lagoons and beach ridges exist from past and present marine activity. Almost no direct evidence of Pleistocene glacial activity is evident in the Foxe Basin Lowlands of the study area.

Jaques (1982) recognized 15 major surficial material types in the study area which included: upland and lowland moraines; marine beaches; alluvial slopes and outwash deposits; calcareous and crystalline deposits; and wet and dry organic deposits, including high-centered polygons. Developing upon these various parent materials are numerous soils which can be broadly divided into eight major soil sub-groups: regosolic, brunosolic and gleysolic static cryosols; fibric organo cryosols; regosolic, brunisolic and gleysolic turbic cryosols; and lithic regosolic static cryosols. The reader is referred to Jaques (1982) for a description of the characteristics of each of these sub-groups.

2.3.2 Vegetation

Extremely diverse and fairly numerous plant assemblages occur in the Roche Bay area. The diversity is due to differences in topography, geomorphic processes, substrate mineral composition, aspect, soil textural and structural variability, micro-and meso-climatic variability and animal influences (Jaques 1982). Thirteen vegetation community types were defined in the Roche Bay area by Jaques (1982): six in the crystalline Precambrian bedrock uplands and seven in the sedimentary Paleozoic lowlands. Since the focus of this study is on the lowland region, the upland vegetation community types will not be discussed here. The following sections describe the lowland vegetation types as provided by Jaques (1982).

2.3.2.1 Cryoturbated sedge-moss

These meadows occur in the lowlands on the undifferentiated plain deposits. Nearly barren frost-boils and blue-green algal growth are characteristic of this community type. Sedges form a dense cover on the stable sites between frost boils. The dominant species are *Carex stans*, *C. membranacea* *Eriophorum triste*, and *Drepanocladus revolvens*. Shallow lakes and ponds are common features of the land area occupied by this community type. Patterned ground is also common. Snow cover is moderate throughout the entire winter and the sites are wet throughout most of the summer. Other species common in this community type include *Salix arctica*, *Carex misandra*, *Juncus biglumis*, *Arctagrostis* spp., *Ditrichium flexicaule*, and *Cinclidium arcticum*.

2.3.2.2 Hummocky sedge-moss

The hummocky sedge-moss community type is very abundant in the lowlands.

It forms on slopes which are slightly better drained than the cryoturbated sedge-moss community type. Carex stans completely dominates this community. Cinclidium arcticum and Drepanocladus revolvens form hummocks which frequently possess a moderate cover of Salix arctica. Other abundant species include Eriophorum angustifolium, Arctagrostis latifolia, Carex membranacea, C. misandra and Polygonum viviparum along with numerous other moss species. Winter snow cover is not quite as deep as the cryoturbated sedge-moss community type; neither is this community type as wet as the other.

2.3.2.3 Wet sedge-moss

Continuous water cover exists throughout the summer adjacent to ponds in the lowlands. At these sites, Carex stans, Dupontia fischeri and Eriophorum angustifolium form the dominant cover. Eriophorum scheuchzeri, Arctagrostis latifolia, Drepanocladus revolvens, and Campylium arcticum form significant amounts of cover in this variant of the cryoturbated sedge-moss community type. Other abundant mosses include Messia triquetra, Cinclidium arcticum and Calliergon giganteum.

2.3.2.4 Cushion plant-lichen

The cushion plant-lichen community type develops on the crests and upper slopes of dry or disintegrated beach ridges. Very little winter snow cover remains on these sites due to wind action. The regosolic soils are relatively warm early in the growing season and are rapidly to well drained. Lichens dominate the cover of these sites but structurally Dryas integrifolia is very important although its cover rarely exceeds 10%. The dominant lichens include Alectoria pubescens along with Thamnolia subliformis, Umbilicaria arctica, Hypogymnia subfusca and Rhizocarpon geographicum. Common vascular plants include Saxifraga oppositifolia, Carex nardina, Salix arctica and Arenaria rubella. Several other species of Alectoria and Cetraria nivalis add significantly to the lichen cover.

2.3.2.5 Cushion plant-sedge-moss

The cushion plant-sedge-moss community type occupies the middle to lower slopes of raised beaches and also the extensive dry areas between well-formed raised beaches (disintegrated old beaches) and well-weathered residual deposits of least resistant bedrock. Dryas integrifolia is the dominant plant species along with numerous mosses. The mosses include Distichium capillaceum, Oncophorus wahlenbergii, Rhacomitrium spp., Mnium spp., Bryum spp., Ditrichium flexicaule, Tomenthypnum nitens and many others. Total plant cover is always quite high, ranging from 80-100%. Important vascular plants which contribute significant cover to this total include Carex rupestris, C. misandra, Saxifraga oppositifolia, Salix arctica, Pedicularis lanata and Polygonum viviparum.

2.3.2.6 Tidal salt marsh

In coastal sites affected directly by salt water (lagoons, spits, beaches, etc.), a distinctive diversity of plant community types develop. Sites with sandy loam to silty sandy loam soils and abundant coarse fragments develop a solid turf dominated by Puccinellia phryganodes. Other species occur scattered throughout this turf. The most common and abundant are Carex ursina, C. subspathacea, Cochlearia officinalis, and Stellaria humifusa. Sites which are less saline, further upslope from high tides or direct ocean influence form grass meadows. Dupontia fischeri and Alopecurus alpinus are the dominant grasses. Numerous mosses are also abundant in these less saline grasslands and include *Meesia uliginosa*, *Ditrichium flexicaule*, *Drepanocladus* spp., and *Bryum* spp.

2.3.2.7 Nitrophilous meadows

Sites which serve as major nesting, feeding or staging areas for waterfowl, gulls, owls and various other bird species are much enriched in nitrogen. As a result these sites exhibit lush and dense plant growth. Numerous species of vascular plants are found associated with sedges, grasses and mosses which are dominant here. They are probably characteristic of nitrogen-enriched areas. Some of the most conspicuous species include *Eutrema edwardsii*, *Draba bellii*, *D. lactea*, *D. alpina*, *Cerastium alpinum*, *Papaver radicatum*, *Braya purpurescens*, *Saxifraga cernua*, *S. caespitosa*, *S. hirculus*, *S. hieracifolia*, *Stellaria longipes*, *Hierochloe pauciflora*, *Cochlearia officinalis* and *Arctagrostis latifolia*. Total plant cover is always near 100 percent and total biomass significantly exceeds that of adjacent sites not enriched with nitrogen.

3. METHODS

3.1 Biophysical Land Classification and Mapping

Classification and mapping of vegetation communities in the study area was performed by Jaques (1982). A detailed description of the methodology used is given in Jaques' report. However, the following briefly summarizes the methods employed.

Conventional black and white aerial photographs of the study area were first studied prior to field reconnaissance to identify general vegetation and physiographic features. A short field reconnaissance was carried out on July 9, 10 and 11, 1981 to establish a number of ground-control points. At each point, vegetation cover and composition was analyzed using the methodology of Franklin et al. (1970) and data was collected on slope, aspect, position on slope, parent material composition, coarse fragment content, patterned ground features, soil texture and soil horizon characteristics.

LANDSAT multispectral scanner imagery was selected for use in the study. The imagery is obtained from multispectral scanners on board satellites[a/] which are continuously scanning and recording images of the earth's surface in "pixels". For the first three LANDSAT satellites, each pixel corresponded to an area of the earth's surface approximately 79 X 56 meters (0.4424 hectares) in size. Data is received in four discreet spectral bands. The new LANDSAT-4, launched on July 16, 1982, is providing this same type of imagery as well as seven band data with 30 meter resolution. Digital data, corresponding to selected images of the study area, were obtained in the form of computer compatible tapes from the Canada Centre for Remote Sensing in Ottawa.

[a/] LANDSAT-1 and 2 are no longer functioning. LANDSAT-3 is only partially functioning. LANDSAT-4 was launched on July 16, 1982.

Geometric and radiometric corrections were applied to the data to produce precision-processed imagery.

Photographic products were produced from the precision-processed imagery for visual interpretation of ecoregions and ecodistricts of the study area as defined by the Canada Committee on Ecological (Biophysical) Land Classification (Environmental Conservation Service Task Force 1981). In defining these biophysical units, climatic factors, landforms, soils, topography, vegetation, and fauna were considered along with the LANDSAT imagery.

A statistical classification analysis was performed on the digital data using the MacDonald-Dettwiler and Associates Image Analysis System. This system sorted the spectral intensities from each pixel into "clusters". Each cluster corresponded to a distinct vegetation and land surface feature class. The classification results were displayed on a colour monitor and the clusters were split or merged in an iterative process to produce the optimum classification results.

3.2 Migratory Bird Use

3.2.1 Literature Search

A thorough search of the literature was made, and biological researchers contacted, to develop a provisional checklist of birds of the Roche Bay area. The following publications were the most useful: Bray (1943); Snyder (1957); Ellis and Evans (1960); Godfrey (1966); Reed et al. (1980); Montgomerie et al. (1983). The literature was also searched for information on nesting and food preferences of species occurring in the Roche Bay area. This information was compiled to permit evaluation of the capability of the habitat in the study area to supply the nesting and food requirements of the resident bird species. Knowledge of available habitat was obtained through the work described in section 3.1.

3.2.2 Aerial Surveys

A number of aerial surveys were conducted in the study area between July 5 and 11, 1981. All surveys were flown using a Bell 206B helicopter at elevations ranging from 15 to 35 m above ground level and at ground speeds ranging from 120 and 160 kph. Except for the shorefast ice edge survey, two observers recorded all birds located within 0.2 km of each side of the helicopter. During the ice edge survey, observations were made by one observer on one side of the helicopter only.

An aerial survey was conducted of the shorefast ice edge on July 5, 1981. Ice edge location shown in Figure 3 was drawn from a LANDSAT photograph taken on July 9 and reflects on eastward shift of the ice, since July 5. The purpose of the survey was to determine the use of the ice/water interface by non-breeding seaducks entering the moulting stage.

A survey was conducted of the shoreline between a point three kilometres southwest of Hall Beach and Cape Jermain on July 9 and 10, 1981 (Figure 4). The survey route was divided into 31 segments to permit comparison of bird densities in the Roche Bay shoreline segments with densities in segments north and south of Roche Bay.

A series of straight-line surveys (transects) were flown over terrestrial portions of the study area on July 9, 10 and 11, 1981 (Figure 5). These

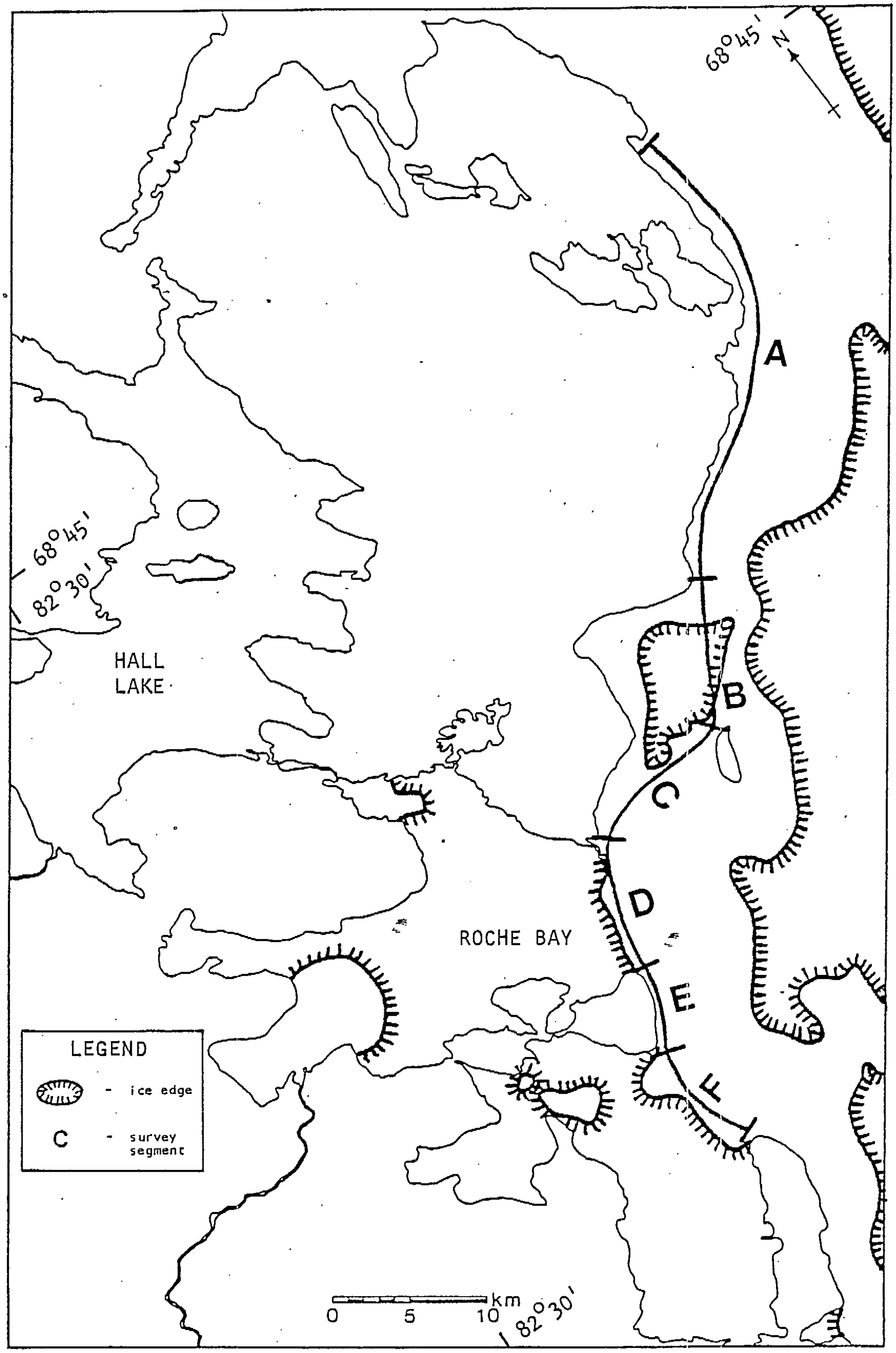

Figure 3 . Route followed during the shorefast ice edge survey, July 5, 1981.

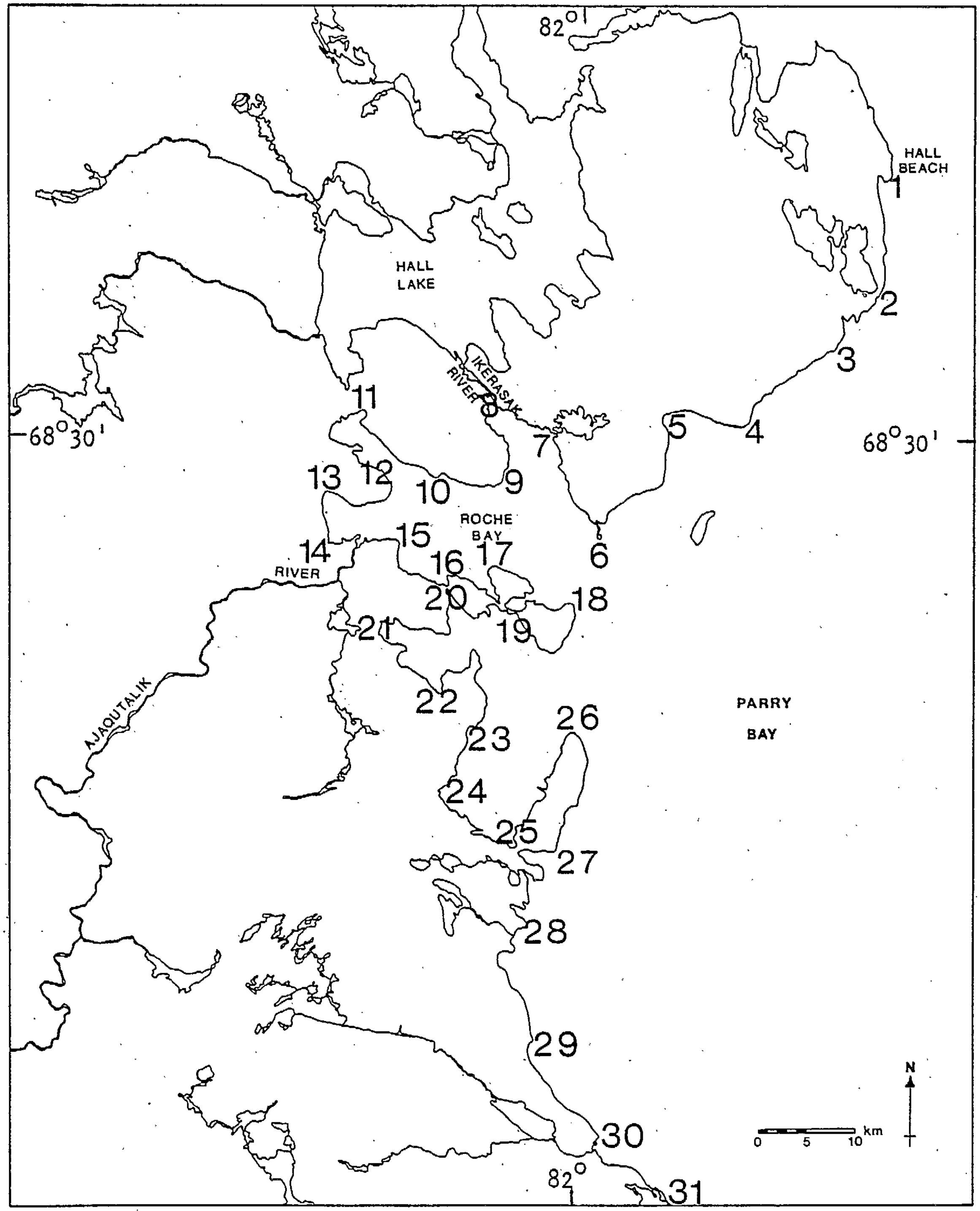

Figure 4 . Locations of stations used to divide the shoreline survey into coastal segments.

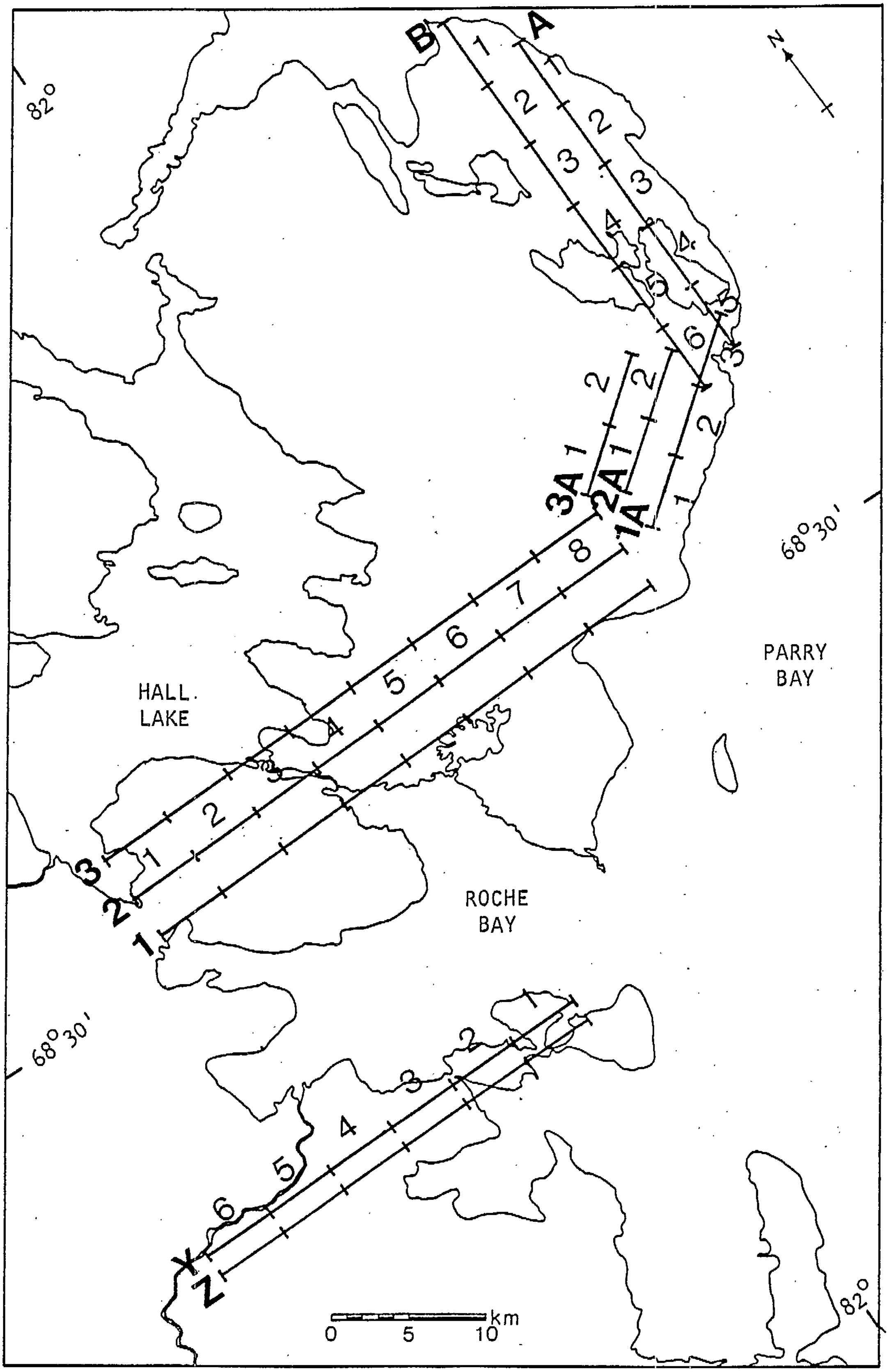

Figure 5 . Straight-line aerial transects flown on July 9, 10 and 11, 1981.

surveys were conducted to determine the extent of breeding and non-breeding bird use of terrestrial habitat in the study area.

On July 10, 1982, a survey was flown of the Ajaqutalik River (Figure 6). This survey was conducted to obtain information on waterfowl use of the river during the breeding season. It was felt that such information would be useful for assessing the potential effects of hydroelectric development of the river should this option be reconsidered in the future.

3.2.3 Ground Observations

Between July 2 and 11, 1981, limited observations of birds were made opportunistically at various ground locations within the study area. Where possible, notes were made of the habitat types that various bird species were seen associating with. As well as providing information on bird-habitat associations, the observations contributed to compilation of a provisional bird checklist for the area.

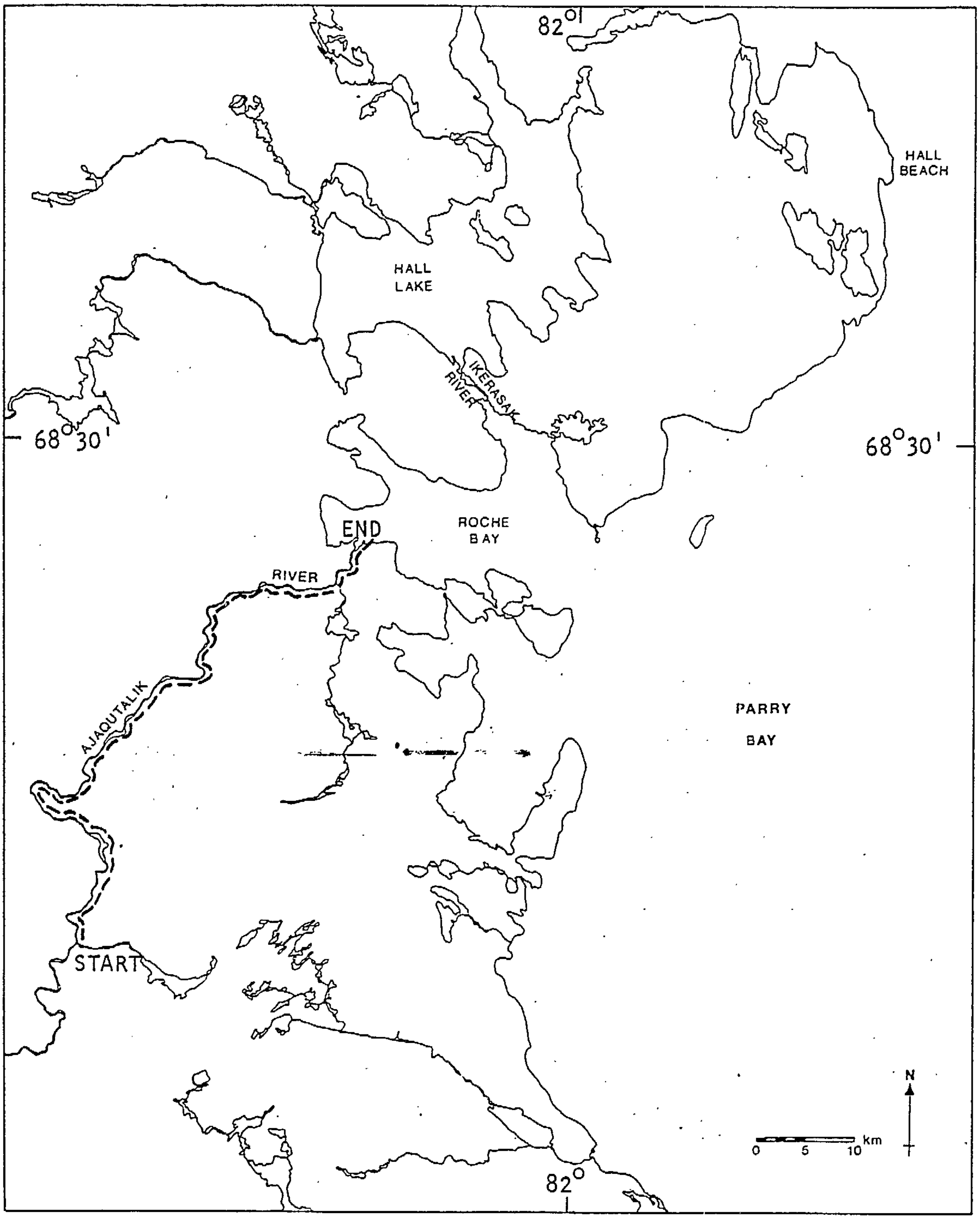

Figure 6. Route followed during the Ajaqutalik River survey, July 10, 1981.

4. DESCRIPTION OF IRON ORE DEVELOPMENT PROPOSAL

Engineering details of the various elements of the development had not been finalized when this report was being drafted. The following description is based largely on information contained in an Initial Environmental Evaluation (Borealis 1981a) submitted to the Department of Indian and Northern Affairs by Borealis on April 5, 1981, and an update submitted in December 1982 (Borealis 1982).

Because of its proximity to Roche Bay and the quality of the ore, the "A" deposit will be the first to be mined (Figure 7). The deposit is located about 215 m above sea level on the Precambrian Shield approximately five kilometres from Roche Bay. Using an open pit mining approach, the ore material would be fed into portable crushers. A conveyor belt system would carry the crushed ore down to the head of Roche Bay for milling. Grinding of the ore and further magnetic separation would produce a 62%+ magnetite concentrate (Scott-Ortech 1982), which would then be moved on another conveyor to a storage facility. From the storage facility, the concentrate would be loaded onto ocean-going ore carriers for transportation to market. It is likely that the mill, storage facilities, dock, town site and air strip would be located on the peninsula at the head of Roche Bay (Figure 7).

Although somewhat controversial, it appears likely that a road would be constructed from the mine site to Hall Beach; the residents of Hall Beach seem to be generally in favour of having a road built (Borealis 1981b). A route for the road has not yet been selected but it would run south of Hall Lake, generally following the extensive beach ridge formations.

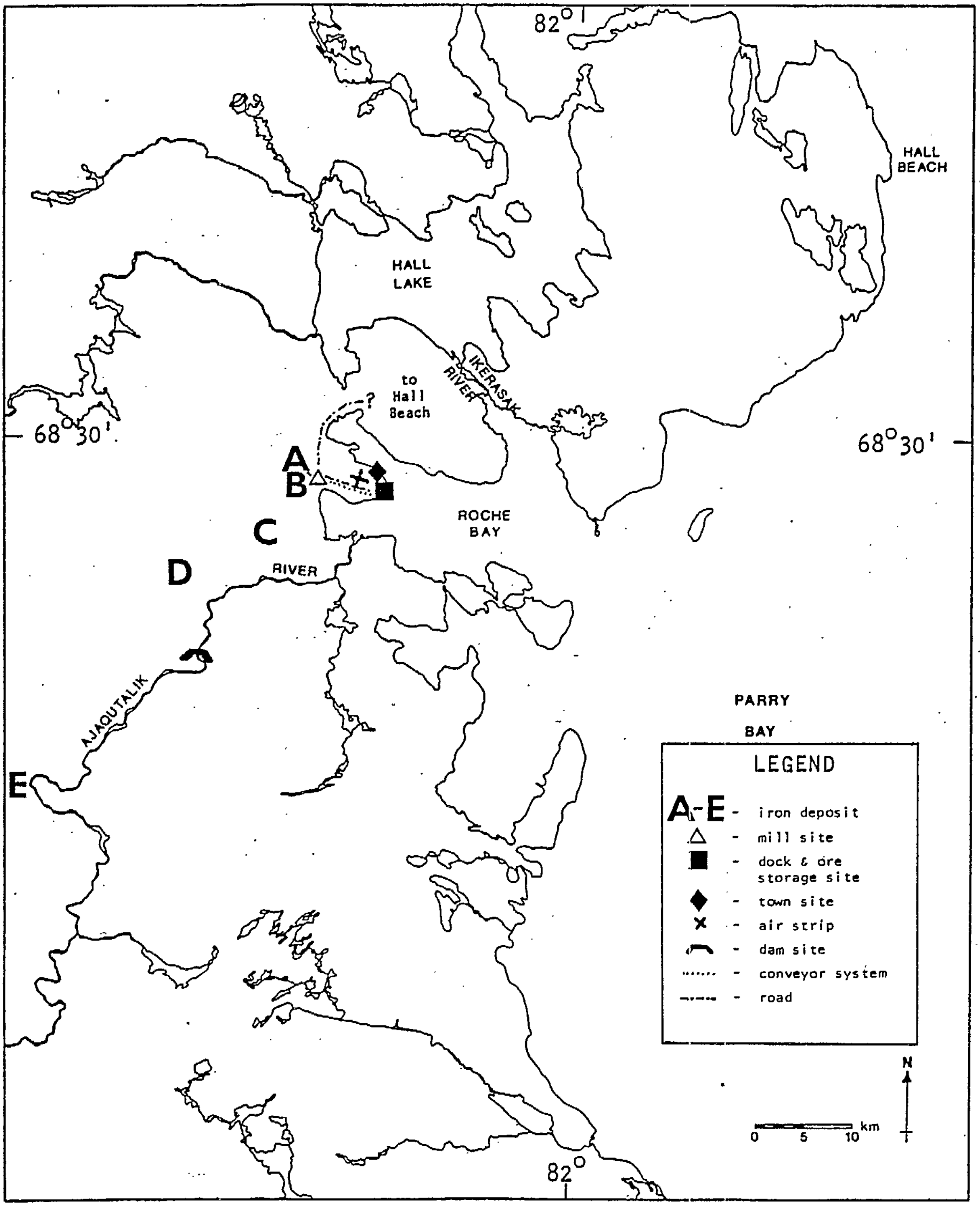

Figure 7 . Locations of iron ore deposits and possible locations of facilities associated with iron ore development.

Source: Borealis Exploration Limited

The ore would be shipped during the 62 day open water season using conventional non-ice reinforced vessels. It may become economically feasible to extend the shipping season to 102 days using class A ice-breaker assisted vessels (Borealis 1982).

5. RESULTS

5.1 Biophysical Land Classification

Results of the biophysical land classification and mapping work have been reported in detail by Jaques (1982). These results are partially reproduced in this section.

Two ecoregions were defined in the study area, based on regional differences in geomorphology, geology and mesoclimate: the Melville Uplands Ecoregion (MU) and the Igloolik Lowlands Ecoregion (IL). Six major ecodistricts were recognized in the Melville Uplands Ecoregion and seven in the Igloolik Lowlands Ecoregion. Each ecodistrict was found to be characterized by a unique assemblage of landform units, vegetation associations, soils and large order micro-climate characteristics.

As has been stated earlier, the Palaeozoic lowlands are the focus of this report. Therefore, only the Igloolik Lowland ecodistricts are described in the following sub-sections. Figure 8 shows the distribution of the lowland ecodistricts.

5.1.1 Hall Beach Ecodistrict (IL 1)

This ecodistrict is dominated by beach ridge parent materials. However, intact, moderately-high relief beach ridges are somewhat limited in extent. The majority of the beach ridge material has been broken down into mainly flat-lying areas. This type of beach material occupies about 85-90 percent of the total land area within this ecodistrict. Cushion plant-lichen and cushion plant-sedge-moss vegetation community types dominate the area. Shallow lakes occupy a significant proportion of the area (about 5-10 percent). The

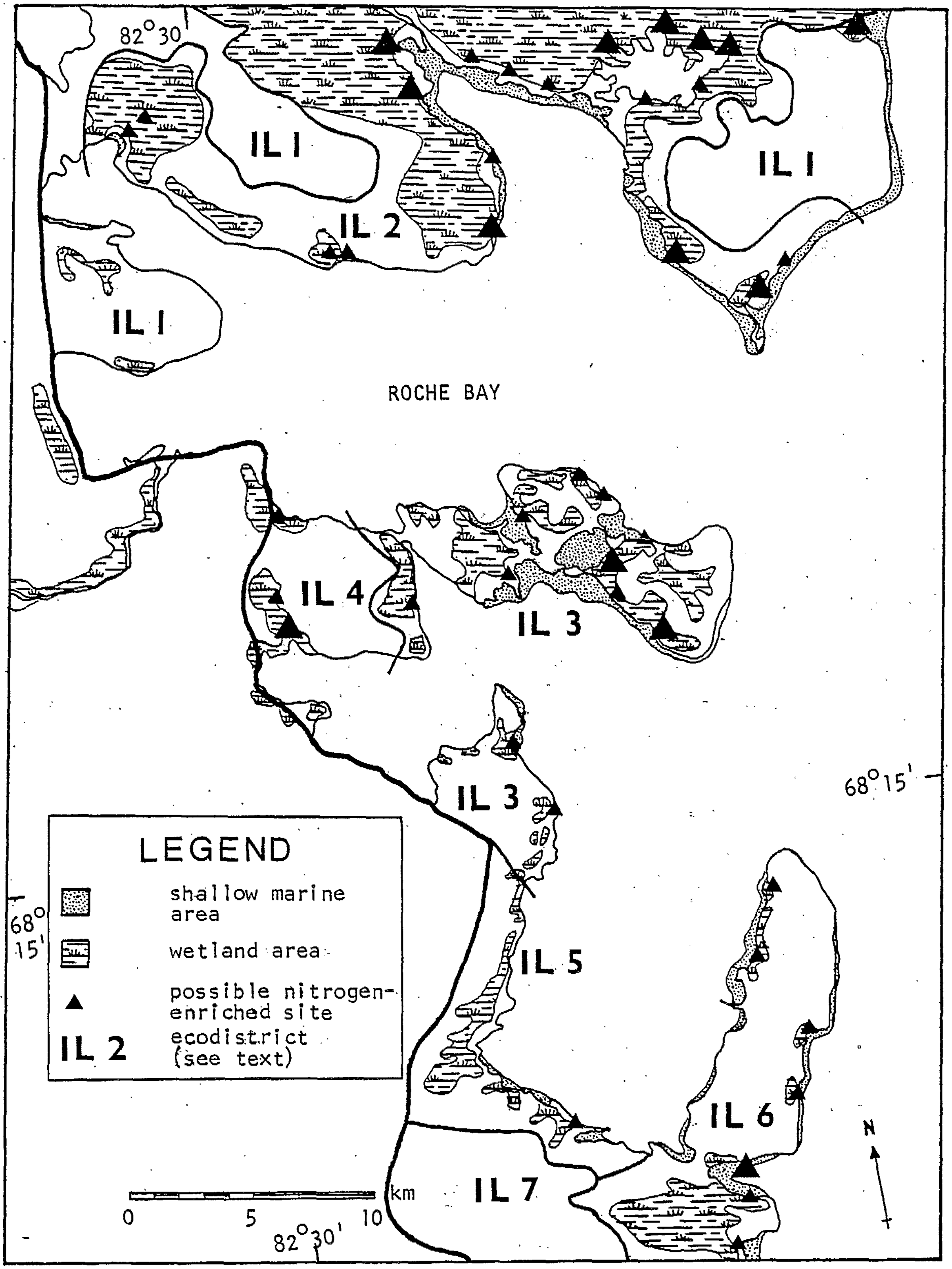

Figure 8 . Distribution of ecodistricts, shallow marine areas, wetlands and possible nitrogen-enriched sites in the Roche Bay area (adapted from a LANDSAT map in Jaques (1982)).

remaining 5 to 10 percent of the ecodistrict is made up of a complex of wetlands on either (1) undifferentiated plain deposits where the cryoturbated sedge-moss vegetation dominates or (2) flats between ridges dominated by the hummocky sedge-moss and wet sedge-moss vegetation types.

5.1.2 Ikerasak Ecodistrict (IL 2)

This ecodistrict is a major wetland region. It is made up of a complex mosaic of shallow lakes and ponds (35 percent of the total area), wetland and tidal marsh vegetation (55 percent) and drier cushion plant-sedge-moss vegetation (about 10 percent). Tidal marsh vegetation occupies a small but significant proportion of the total area (about 3-5 percent). The remaining wetland vegetation is predominantly wet sedge-moss and hummocky sedge-moss. However, isolated areas (some quite sizable) of cryoturbated sedge-moss communities occur on level undifferentiated plain and level beach material areas. Significant numbers of small areas of very lush, nitrogen-enriched sites are found in this ecodistrict.

5.1.3 Ignertok Lowland Ecodistrict (IL 3)

This ecodistrict is very similar to the Hall Beach Ecodistrict except for two important aspects. The first is that the proportion of the land area occupied by wetlands is significantly greater in the Ignertok Lowland Ecodistrict (40 percent) than in the Hall Beach Ecodistrict (5-10 percent). The second important difference is that, in the Ignertok Lowland Ecodistrict, tidal marsh, lush wet sedge-moss and lush nitrogen-enriched sites are numerous, though occupying less than 5 percent of the total land area. Shallow ponds and lakes are found scattered throughout this ecodistrict on about 15 to 20 percent of the total land area. Barren beach ridges, dry cushion plant-lichen and cushion plant-sedge-moss vegetation community types occupy over 40 percent of the land area. Small areas of the cryoturbated sedge-moss community type also exist in this ecodistrict.

5.1.4 Ignertok Upland Ecodistrict (IL 4)

This ecodistrict is characterized by the bedrock outcrop of the Bad Cache Rapids and Ship Point formations. Nearly barren bedrock occupies over 70 percent of the ecodistrict. The remaining area is equally divided between dry beach ridge and wetland vegetation communities. Several small, lush, nitrogen-enriched areas are evident in the wetland area of this ecodistrict. The wetlands are almost entirely confined to a small valley between the Paleozoic rock uplands on the east and the major escarpment formed of Precambrian rock on the west. These structural features provide a natural drainage system leading into the lush valley.

5.1.5 Parry Slope Ecodistrict (IL 5)

This ecodistrict is an area of mixed beach material and colluvial deposits formed on moderately steep slopes trailing off the major Precambrian escarpment. It exists as a narrow belt along the coast two to three kilometers in width. No lakes or ponds are in the ecodistrict. The vegetation cover is equally divided between the hummocky sedge-moss community type on the one hand and the much drier, more rapidly drained cushion plant community types on the other. Only very small isolated sites of wet sedge-moss or lush nitrogen-enriched types exist in the area. The wetland vegetation type, hummocky sedge-moss, is almost entirely confined to the lower two-thirds of the slope, while the drier cushion plant community types form 90 percent of the cover on the upper half of the slope.

5.1.6 Amitioke Lowland Ecodistrict (IL 6)

This ecodistrict is another lowland area, exposed to the open ocean as are the Hall Beach (IL 1) and Ignertok Lowland (IL 3) ecodistricts. Dry beach ridge deposits occupy over 50 percent of the total area. Small lakes and ponds form a significant portion of the ecodistrict (10-15 percent). Between the lakes are wetlands predominantly of the hummocky sedge-moss community types. These wetlands occupy about one third of the land area of the ecodistrict. Tidal salt marsh areas are found in numerous sites in lagoons. The elevation of this ecodistrict is almost entirely below 30 meters above sea level.

5.1.7 Amitioke Upland Ecodistrict (IL 7)

This ecodistrict is an area of stable raised beach ridges and deep, oligotrophic lakes. Although it lies in the Igloolik Lowland Ecoregion, it occurs at higher elevations than the Amitioke Lowland Ecodistrict and is not presently influenced by direct ocean wave action or spray. The large deep lakes occupy about 20 percent of the ecodistrict area. Small shallow lakes and ponds occur between the beach ridges but they only occupy about 5 percent of the total area. Barren beach ridges are extensive and occupy almost 10 percent of the ecodistrict's area while vegetated, beach ridge material is found on about 35 to 40 percent. Wetlands cover the remaining area of the ecodistrict. These wetlands are almost exclusively of the hummocky sedge-moss community type. Smaller areas of the wet sedge-moss community type also exist in the ecodistrict. However, they are localized around the shores of the small shallow ponds and lakes. Very few lush, nitrogen-enriched sites are found in this ecodistrict.

5.2 Biophysical Mapping

Computer analysis of clusters produced 17 classes which corresponded to detailed land-vegetation-water features (Jaques 1982). Careful analysis of each cluster, using computer enlargements of sites studied during the field reconnaissance, resulted in a grouping of some clusters and the desired level of classification. The final classification comprised 10 cluster groups which consistently identified similar biophysical features within all of the ecodistricts of each separate ecoregion. Each group was assigned a different colour and colour-coded maps of the study area were produced at a scale of 1:70 000. These maps are presently stored at the Western and Northern regional office of the Canadian Wildlife Service in Edmonton, Alberta. The biophysical characteristics of each cluster group in each ecoregion are described in detail by Jaques (1982). Table 4 provides a summary of biophysical characteristics of the cluster groups in the Igloolik Lowland ecoregion, the main area of interest.

A map was derived from Jaques' 1:70 000 maps which shows the distribution of shallow marine areas, wetland areas and locations which may have been nitrogen enriched (Figure 8). The purple, dark green and light green cluster groups were combined to form the wetland areas defined on the map. This derivative map therefore displays areas within the portion of the study area classified by Jaques which would be most attractive to water-oriented birds. It is interesting to note that the sites identified as being possibly nitrogen-enriched occur adjacent to or within shallow marine areas or wetlands or both. Such areas would be expected to receive most use by water-oriented birds and therefore would be "fertilized" to the greatest degree. This observation lends credence to the tentative conclusion that areas characterized by the "red"

Table 4. Biophysical characteristics of LANDSAT cluster groups in the Igloolik Lowland Ecoregion (Jaques 1982).

LANDSAT cluster group colour	Mean August moisture gradient (Soil moisture content)	Parent material	Drainage	Permafrost thaw depth (cm)	Vegetation biomass (g/m^2)	pH reaction	Dominant vegetation type
Dark blue	open water	-	-	-	-	-	-
Light blue	shallow water	-	-	-	-	-	-
Gray	littoral zone	organic	very poor	-	30-80	-	wet sedge-moss
Purple	800-400%	organic	very poor	10	80-120	slightly acidic	wet sedge-moss
Dark green	400-150%	organic	very poor -imperfect	10-20	100-250	slightly acidic	cryoturbated sedge-moss and wet sedge-moss
Light green	150-80%	alluvial-lacustrine	poor-imperfect	20-30	225-400	slightly acidic to mild alkaline	hummocky sedge-moss and wet sedge-moss
Red	80-40%	alluvial-lacustrine; plain	imperfect-well	30-50	400-600	neutral to mild alkaline	lush hummocky and wet sedge-moss
Yellow	40-5%	plain; raised beach	well-rapid	40-60	150-400	moderate to strongly alkaline	cushion plant-sedge-moss
Brown	5-0%	raised beach; bedrock	very rapid	60-80 and greater	0-100	strongly alkaline	cushion plant-lichen
White	5-0%	beach	very rapid	60-80	0-50	strongly alkaline	lichen to bare

cluster group are in fact areas of nitrogen-enrichment. However, further field work would be necessary to substantiate this.

5.3 Migratory Bird Use

5.3.1 Shorefast Ice Edge

Numbers of ducks observed during the July 5 shorefast ice edge survey are indicated in Table 5. The flocks consisted of oldsquaws[a/], king eiders, and common eiders and large groups of ducks which could not be identified but were presumably either oldsquaws or eiders. Almost all the identified oldsquaw (98 percent) were associated with the shallow water adjacent to the mainland north of Roche Bay. Common eiders were most numerous between Ignertok and Amitioke peninsulas (Table 5). The highest density of seaducks occurred along the eastern shoreline of Ignertok Peninsula (Figure 9).

Stirling and Cleator (1981) show the presence of a recurring polynya in Parry Bay due east of Roche Bay. The importance of recurring polynyas (areas of open water surrounded by ice which occur in the same locations each year) to seabirds, seaducks and marine mammals is treated by Stirling and Cleator. The attractiveness of the ice edge to marine birds has been documented by Bradstreet and Finley (1977) and Nettleship and Gaston (1978). Polynyas provide important staging and feeding habitat prior to breeding and permit early access to breeding areas. Prach et al. (1981) noted that many of the common eider colonies in Hudson Bay, Foxe Basin and Hudson Strait are located near recurring polynyas. Although not surveyed in 1981, South Ooglit Island was reported by Bray (1943) as being home for "numerous" common eiders. However, the significance of the proximity of this and other

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[a/] scientific names of all bird species are given in Appendix 1 .

Table 5. Seaducks observed on shorefast ice edge survey, July 5, 1981.

Survey segment[a]	Oldsquaw	Common eider	King eider	Unidentified eiders	Unidentified seabirds	Total birds
A	1 209	26	4	98	233	1 570
B	-	-	-	-	-	-
C	15	-	-	-	5	20
D	-	-	-	-	370	370
E	5	-	-	-	700	705
F	-	460	-	-	241	701
Total survey	1 229	486	4	98	1 549	1 366

[a] see Figure 3 for location of segments

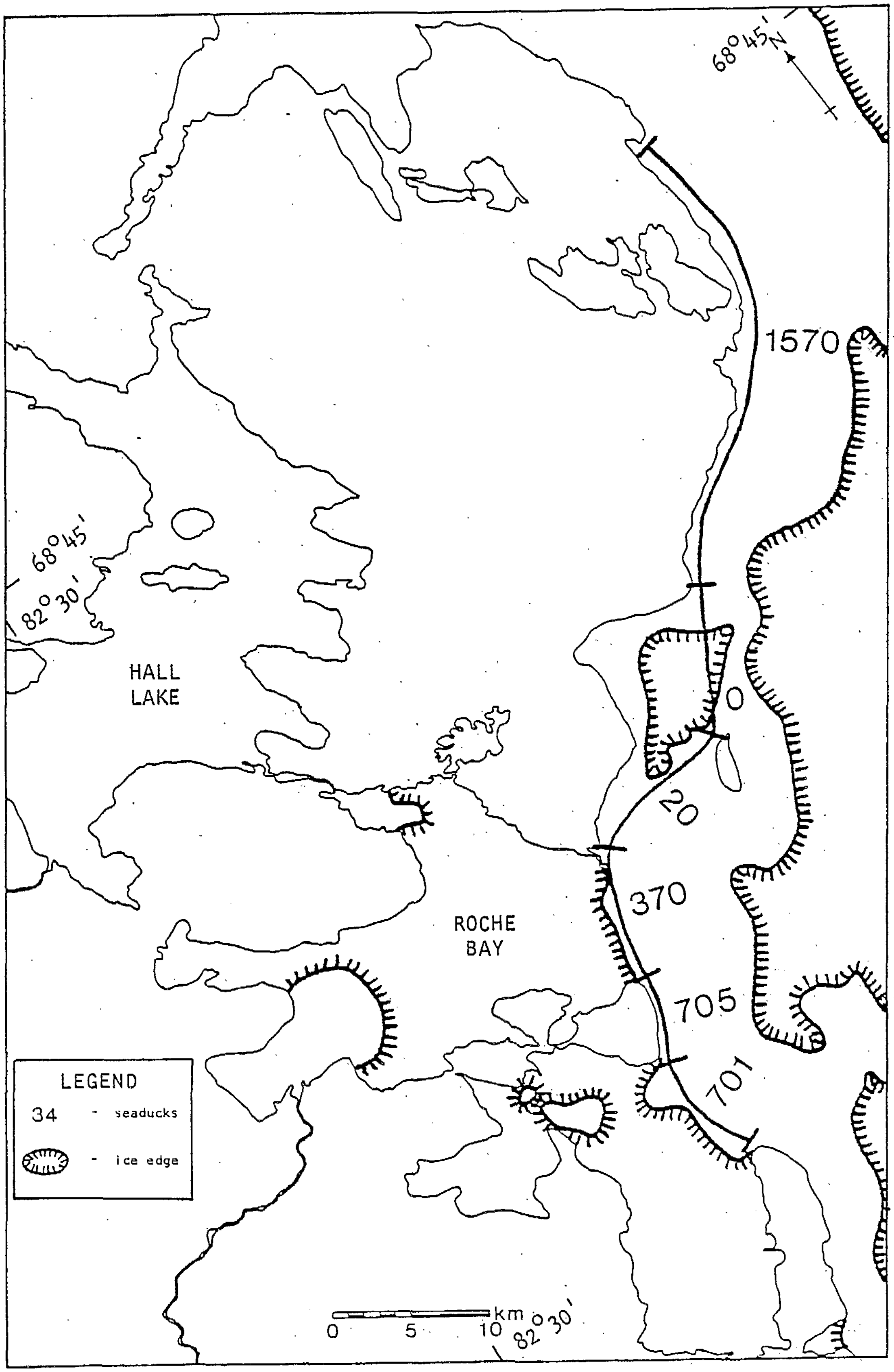

Figure 9. Seaducks observed during the shorefast ice edge survey, July 5, 1981.

eider colonies to recurring polynyas to survival and reproductive success is not clear.

5.3.2 Mainland Shoreline

Densities of birds observed during the shoreline survey are shown in Table 6. Data on densities of all birds seen (breeders plus non-breeders) are presented in graphical form, to facilitate interpretation, in Figures 10-15. Species densities along the shoreline are also shown in map form in Appendices 2-14.

5.3.2.1 Loons and Waterfowl

Densities of loons and waterfowl along the shoreline are shown in Appendix 2. Arctic loons were not numerous, occurring mostly in the vicinity of Amitioke Peninsula. This peninsula and the area around Ignertok Point also appeared to be favoured by red-throated loons. Unidentified loons showed a similar affinity for Amitioke Peninsula, although small numbers were also observed within Roche Bay. Figure 10 illustrates the distribution of loons during the shoreline survey.

Canada geese were infrequently observed along the shoreline; non-breeders were most numerous near Cape Jermain (Figure 11, Appendix 3). Four out of the seven breeding pairs seen during the survey were in the Roche Bay segments (Table 6). Non-breeding brant were seen between Hall Beach and Quarman Point, between Amitioke Point and Cape Jermain and along Ignertok Peninsula (Figure 11, Appendix 4). Most of the breeders occurred between the base of Amitioke Peninsula and Cape Jermain. Only breeding snow geese (indicated by pairs and singles) were observed during the survey. The geese which

Table 6. Densities of birds observed during the shoreline survey, July 9 and 10, 1981.

Coastal segment[a]	arctic loon	red-throated loon	unidentified loon	Canada goose	brant	snow goose	oldsquaw	Common eider	King eider	unidentified eider	TOTAL LOONS and WATERFOWL	sandpiper	herring/ Thayer's gull	glaucous gull	Sabine's gull	arctic tern
1	0.2[b] -[c]	-	-	-	-	-	0.6 -	-	- (0.8)	-	0.8 (0.8)	0.4[d]	3.6	0.8	0.6	5.6
2	-	-	-	-	0.3 (2.4)	-	0.6 (5.6)	-	0.3 (0.9)	-	1.2 (8.8)	-	0.6	0.9	0.3	18.2
3	-	-	-	-	- (0.8)	-	- (0.8)	-	-	-	- (1.6)	10.0	2.8	2.2	0.2	3.8
4	-	-	-	-	- (1.4)	-	0.3 -	-	-	-	0.3 (1.4)	0.8	0.3	0.3	1.6	3.7
5	0.2	-	-	-	-	-	0.1 (2.2)	-	0.1 -	-	0.4 (2.2)	0.9	1.5	0.3	2.2	0.1
6	-	-	-	0.6 -	-	-	-	-	0.4 (0.8)	-	1.0 (0.8)	0.8	0.2	-	-	10.4
7	-	0.3 -	-	-	-	-	-	0.3 -	0.3 (0.9)	-	0.6 (0.9)	0.6	0.6	0.6	-	0.3
8	-	-	-	-	-	-	0.4 -	-	0.5 (0.5)	-	0.9 (0.5)	1.2	0.5	-	-	-
9	-	-	0.3 -	-	-	0.3 -	-	-	- (0.7)	0.3 -	0.9 (0.9)	0.6	-	-	-	-
10	-	-	-	- (2.1)	-	-	-	-	-	-	- (2.1)	-	0.2	-	-	-
11	-	0.2 -	-	-	-	0.2 -	-	-	-	-	0.4 -	-	-	-	-	-
12	-	-	0.2 -	0.2 -	-	0.5	-	-	0.2 -	-	1.2 -	1.0	-	-	-	0.2
13	-	-	-	-	-	-	0.5 (3.6)	-	0.5 -	-	0.9 (3.6)	-	-	-	-	-
14	-	-	-	-	-	0.3 -	0.3 -	-	-	-	0.6 -	-	-	-	-	17.1
15	-	-	-	-	-	0.3 -	-	-	0.3 -	-	0.6 -	0.3	-	-	0.3	-
16	-	-	0.4 -	-	-	0.2 -	-	-	-	-	0.7 -	-	-	-	-	-
17	-	0.2 -	-	-	0.2 (3.0)	-	0.8 -	-	-	-	1.2 (3.0)	0.2	-	-	-	-
18	-	0.6 (0.6)	-	-	- (0.8)	-	0.4 -	-	0.2 -	-	1.3 (1.5)	0.6	0.2	-	-	-
19	-	-	-	0.5 -	- (5.2)	-	- (5.2)	-	-	0.2 (2.4)	0.7 (12.9)	0.2	0.2	-	-	-
20	-	-	-	-	-	0.7 -	- (3.7)	-	-	-	0.7 (3.7)	-	-	-	-	-
21	-	0.2 -	-	-	- (2.0)	-	-	-	-	-	0.2 (2.0)	-	-	-	-	-
22	-	-	-	-	-	-	0.2 -	-	-	-	0.2 -	-	-	-	-	-
23	-	-	0.3 -	-	-	-	-	-	-	-	0.3 -	-	0.6	-	-	-
24	-	-	-	0.2	-	0.4 -	0.4 -	-	- (3.3)	-	1.1 (3.3)	-	-	-	-	-
25	0.2 -	-	0.3 -	-	-	0.2 -	0.7 (0.8)	-	0.7 (0.7)	0.3 (0.3)	2.3 (1.8)	0.2	-	-	-	-
26	0.2 -	0.5 -	0.7 -	-	- (8.4)	-	1.2 (2.8)	-	0.4 (3.0)	0.5 -	3.5 (14.2)	-	0.2	-	-	-
27	0.2 -	0.5 -	0.2 (0.5)	-	0.2 (2.6)	-	-	0.2 -	0.5 (0.3)	0.6 -	2.0 (3.4)	0.2	1.9	-	-	0.2
28	0.2 -	0.5 -	-	-	0.8 (1.8)	0.3 -	0.3 -	-	-	- (0.5)	1.6 (2.2)	-	-	-	-	-
29	-	-	-	-	0.2 -	-	-	-	-	-	0.2 -	0.2	5.0	-	-	-
30	-	-	0.2 -	- (10.9)	-	-	0.9 -	-	-	-	1.1 (10.9)	-	0.6	1.1	-	-
TOTAL	<0.1	0.1 (<0.1)	0.1 (<0.1)	<0.1 (0.4)	0.1 (1.0)	0.1 -	0.3 (0.8)	<0.1 -	0.1 (0.4)	0.1 (0.1)	0.9 (2.8)	0.6	0.2	0.7	0.2	1.8

a/ see Figure 4.
b/ indicated breeding pairs/km^2
c/ non-breeders/km^2 (in parentheses)
d/ birds/km^2

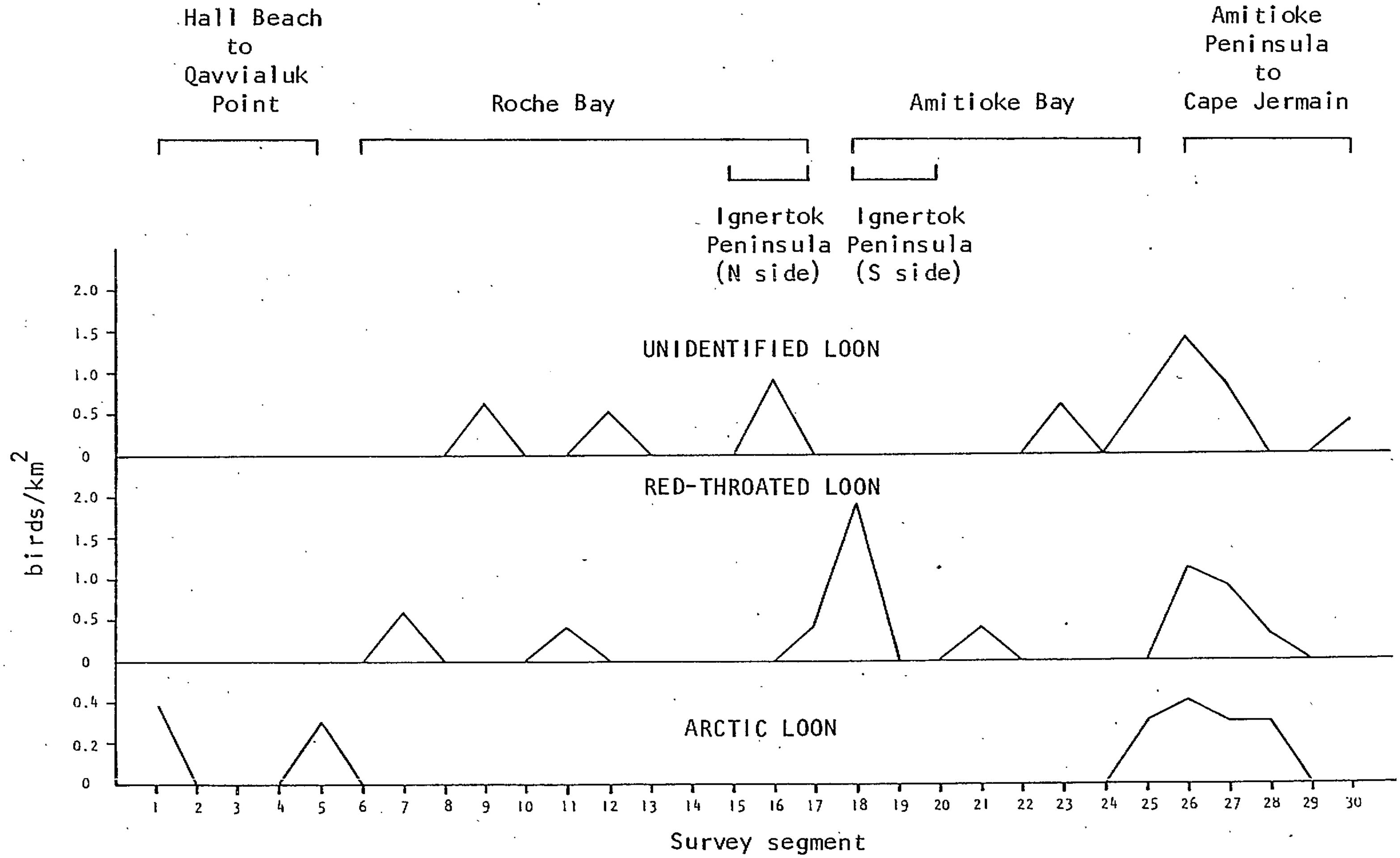

Figure 10 . Distribution of loons during the shoreline survey, July 9-10, 1981.

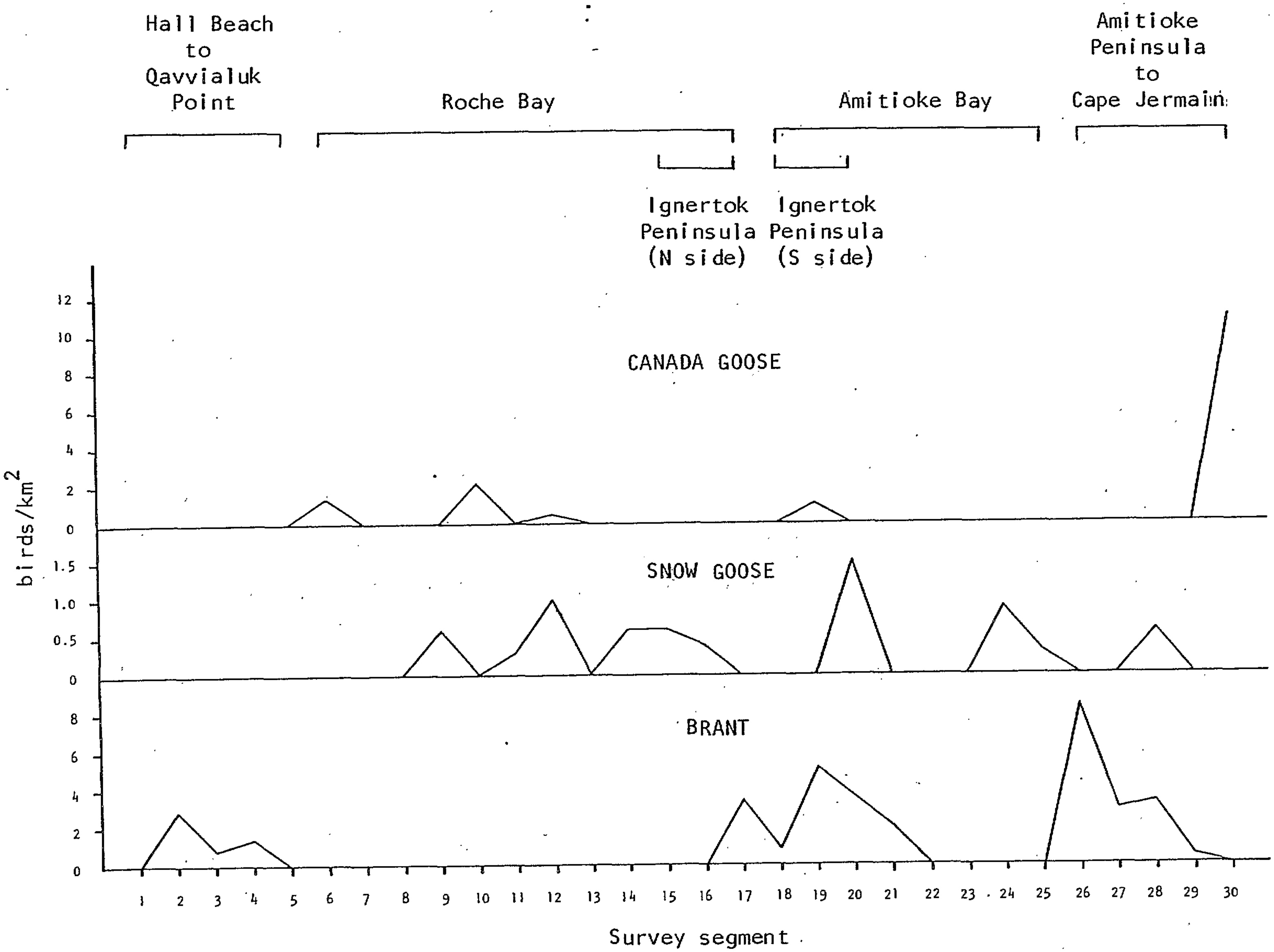

Figure 11. Distribution of geese during the shoreline survey, July 9-10, 1981.

were believed to be of the atlantica race, occurred mostly in Roche Bay and along Ignertok Peninsula (Figure 11, Appendix 5).

Breeding and non-breeding oldsquaw were observed throughout most of the survey. Clustering of non-breeders occurred in the shoreline section between Hall Beach and Qavvialuk Point, along the south side of Ignertok Peninsula and along the west side of Amitioke Peninsula (Figure 12, Appendix 6). Only two breeding pairs of common eiders were seen: one near the Ikerasak River and one at the base of Amitioke Peninsula (Appendix 7). Almost one-half of the breeding king eiders were associated with Amitioke Peninsula; eight of the 20 breeding pairs were in Roche Bay (Appendix 8). The greatest proportion of non-breeders were found on or near Amitioke Peninsula. This peninsula wás also the favoured location of unidentified breeding and non-breeding eiders (Appendix 9).

In summary, Ignertok and Amitioke peninsulas were popular areas for loons and waterfowl generally (Figure 13). The section of shoreline between Hall Beach and Qavvialuk Point appeared to be attractive to some species, notably brant and oldsquaw. In general, Roche Bay defined as comprising segments six to 17 inclusive, received less use by loons and waterfowl than the remainder of the coastline to the north and south. Table 7 illustrates this conclusion.

5.3.2.2 Other Birds

Sandpipers were abundant south of Hall beach, but occurred in low numbers within the remainder of the shoreline (Figure 14, Appendix 10). Most of the

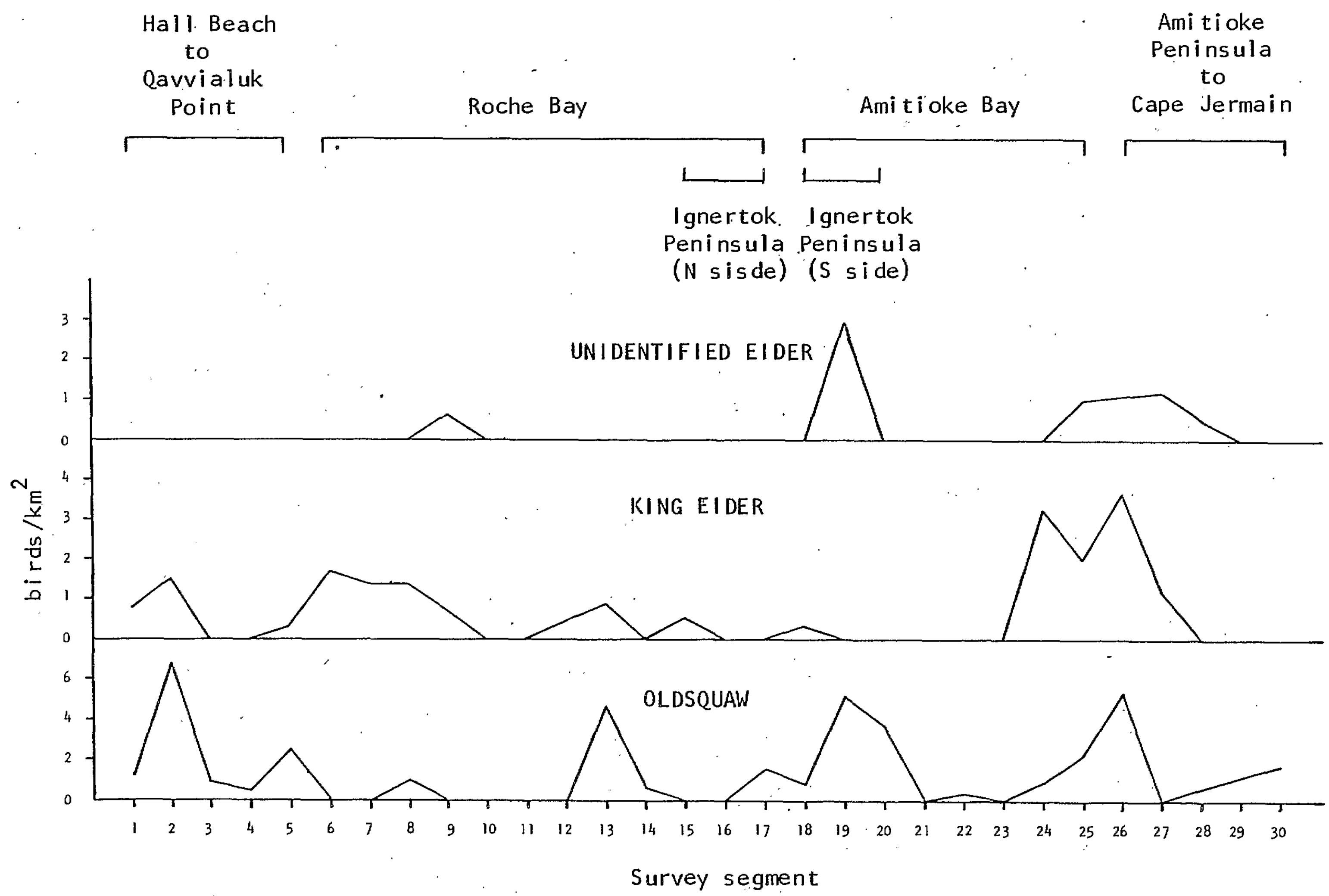

Figure 12 . Distribution of oldsquaw and eiders during the shoreline survey, July 9-10, 1981.

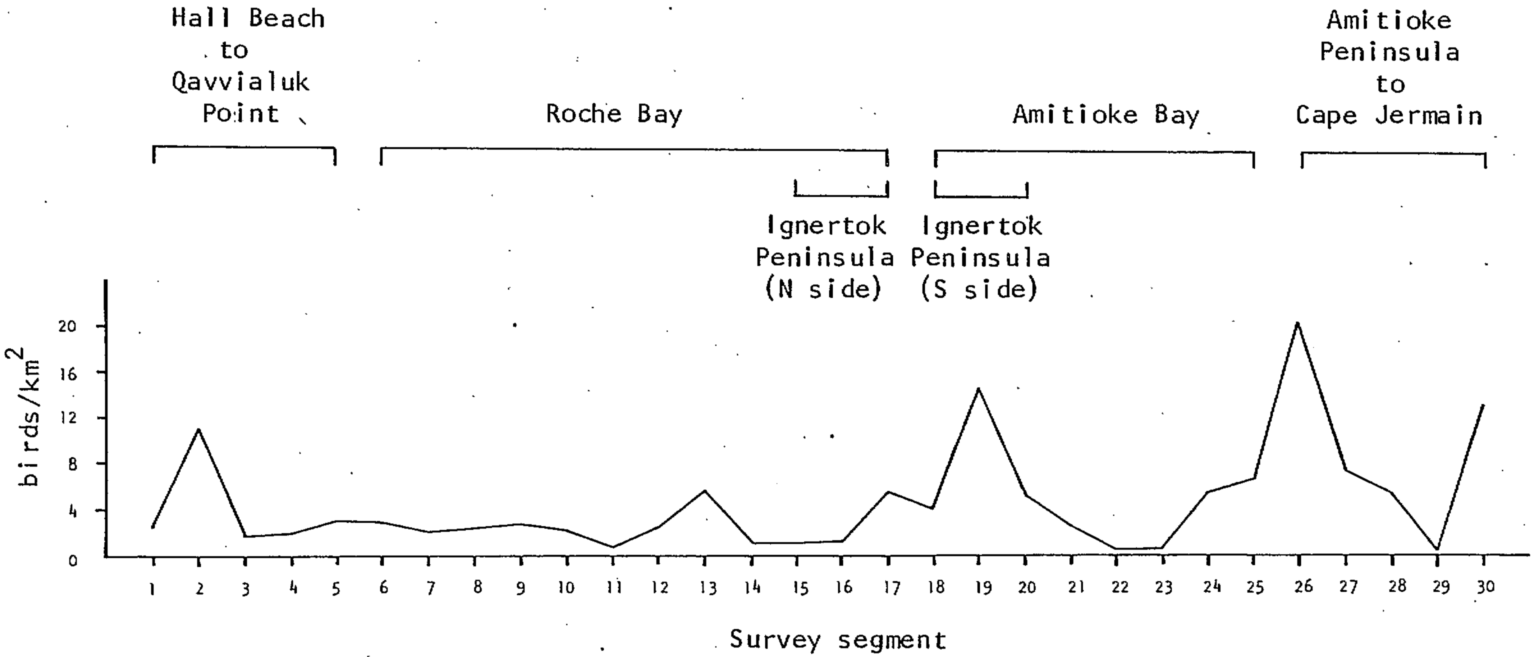

Figure 13. Distribution of loons and waterfowl during the shoreline survey, July 9-10, 1981.

Table 7. Numbers of birds observed in Roche Bay during the shoreline survey compared to areas to the north and south, July 9-10, 1981.

Species	Shoreline section		
	North of Roche Bay[a/]	Roche Bay[b/]	South of Roche Bay[c/]
Arctic loon	4 (0.2)[d/]	0	8 (0.1)
Red-throated loon	0	6 (0.1)	25 (0.4)
Unidentifed loon	0	8 (0.2)	21 (0.3)
Canada goose	0	17 (0.4)	57 (0.8)
Brant	19 (0.8)	17 (0.4)	126 (1.9)
Snow goose	0	14 (0.3)	18 (0.3)
Oldsquaw	52 (2.2)	24 (0.5)	107 (1.6)
Common eider	2 (0.1)	0	2 (<0.1)
King eider	11 (0.5)	28 (0.6)	58 (0.9)
Unidentified eider	0	2 (<0.1)	35 (0.5)
Sandpiper	61 (2.5)	19 (0.4)	7 (0.1)
Herring/Thayer's gull	45 (1.9)	6 (0.1)	45 (0.7)
Glaucous gull	21 (0.9)	2 (<0.1)	5 (0.1)
Sabine's gull	26 (1.1)	1 (<0.1)	0
Arctic tern	133 (5.5)	112 (2.3)	1 (<0.1)

[a/] segments 1-5 of shoreline survey

[b/] segments 6-17 of shoreline survey

[c/] segments 18-30 of shoreline survey

[d/] birds/km^2

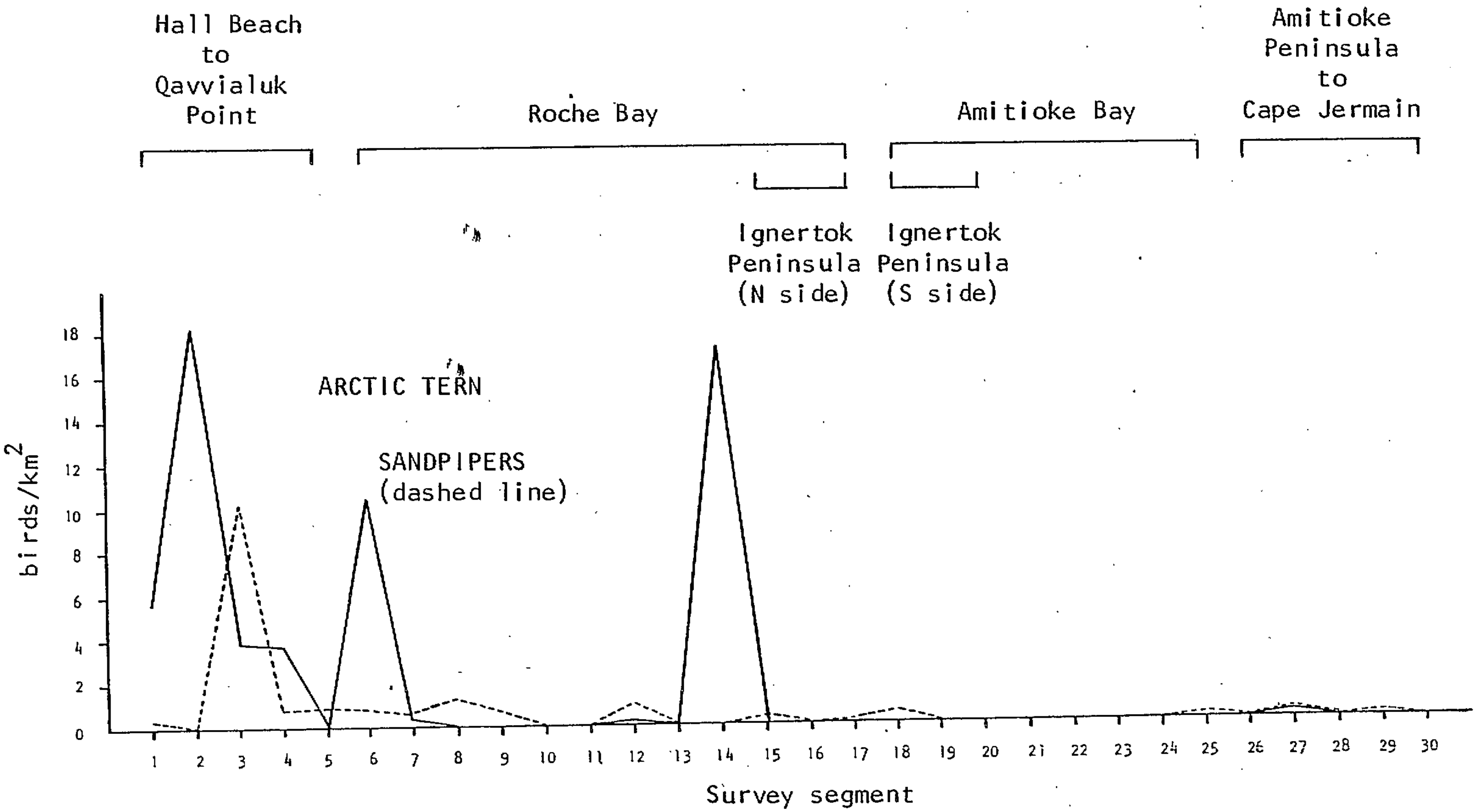

Figure 14 . Distribution of sandpipers and Arctic terns during the shoreline survey, July 9-10, 1981.

herring/Thayer's gulls[a/] and glaucous gulls were located south of Hall Beach as far as the Ikerasak River (Figure 15, Appendices 11 and 12). Herring/Thayer's gulls were also present between Amitioke Peninsula and Cape Jermain. Sabine's gulls occurred mostly south of Hall Beach (Appendix 13) and most of the arctic terns were in colonies near Hall Beach, the Ajaqutalik River and Qavvialuk Point (Appendix 14).

In summary, the section of shoreline between Hall Beach and Qavvialuk Point was most favoured by sandpipers, gulls and terns (Table 7). Arctic terns were the most common species in Roche Bay.

5.3.3 Terrestrial Habitat

Numbers of loons and waterfowl observed during aerial surveys of the 10 straight-line transects are summarized in Table 8. Observations of other birds are presented in Table 9. Numbers of breeding and non-breeding loons and waterfowl recorded on each transect are indicated in Appendices 15 to 24.

5.3.3.1 Loons and Waterfowl

Loons were not numerous in the study area. The few Arctic and red-throated loons that were observed showed an affinity for coastal areas (Figures 16 and 17). However, unidentified loons were found on transects 2A and 3A where a complex of ponds and raised beaches exists (Figure 18).

Only three pairs of whistling swans were recorded during the surveys. Two pairs were located in the wet shallow lake and pond area near the Ikerasak

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[a/] although recognized as separate species by the American Ornithologists' Union (1962), these two species were considered as one due to similar appearance in the field.

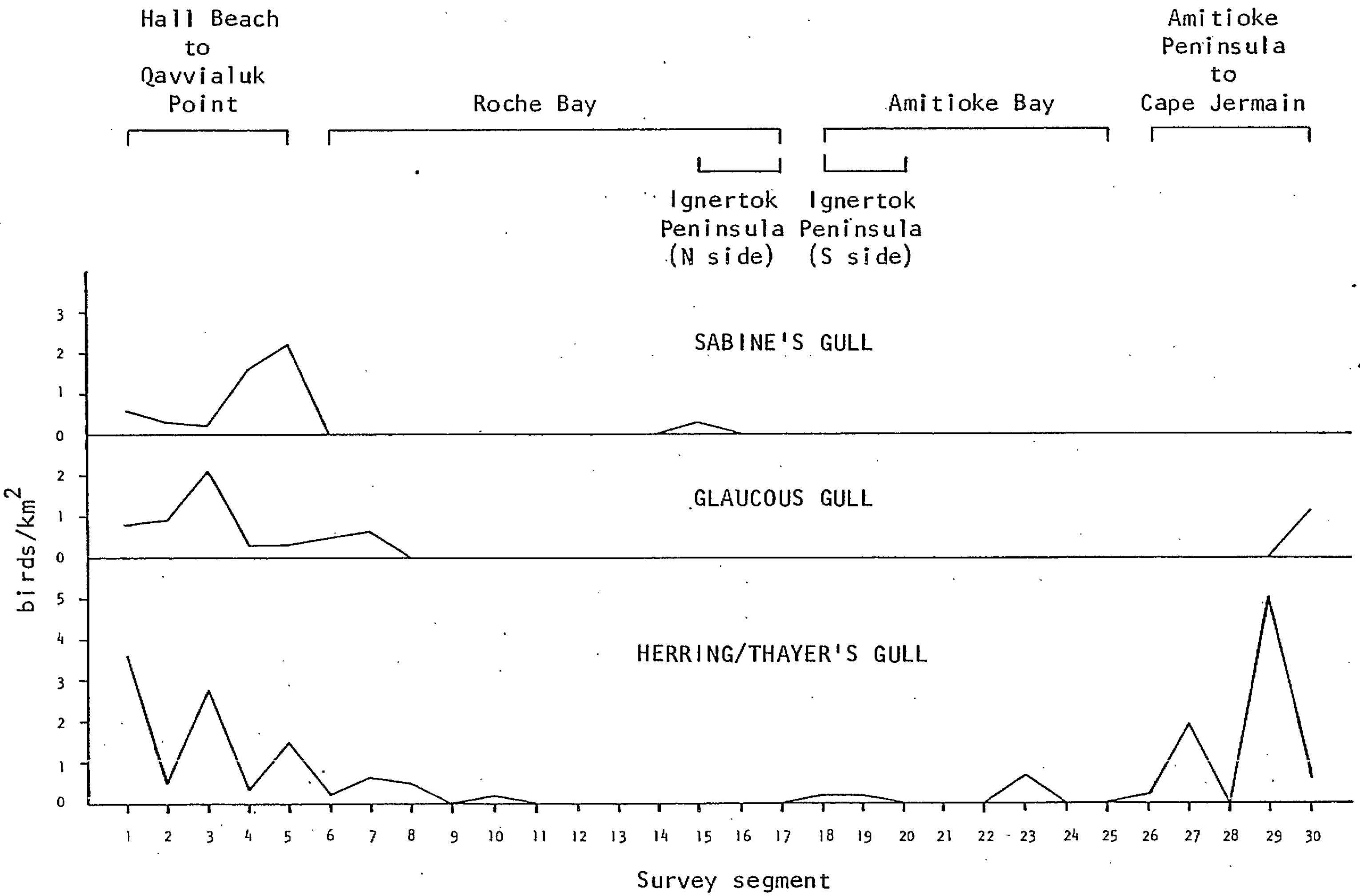

Figure 15 . Distribution of gulls during the shoreline survey, July 9-10, 1981.

Table 8. Numbers of loons and waterfowl observed during aerial transect surveys - July 9, 10, 11, 1982

Survey transect[a/]	arctic loon	red-throated loon	unidentified loon	whistling swan	Canada goose	brant	snow goose	oldsquaw	common eider	king eider	unidentified eider	seaduck	TOTAL LOONS AND WATERFOWL
1	-	-	4 (0.3)[b/]	2 (0.1)	-	4 (0.3)	12 (0.8)	29 (1.8)	-	12 (0.8)	-	4 (0.3)	67 (4.2)
2	-	-	-	2 (0.1)	-	-	2 (0.1)	-	2 (0.1)	4 (0.3)	-	-	10 (0.6)
3	-	-	-	-	5 (0.3)	-	-	4 (0.3)	2 (0.1)	4 (0.3)	4 (0.3)	12 (0.8)	31 (1.9)
1A	-	-	-	-	-	2 (0.3)	-	-	-	4 (0.7)	-	-	6 (1.0)
2A	-	-	9 (2.3)	2 (0.5)	-	-	-	4 (1.0)	-	-	-	-	15 (3.8)
3A	-	-	4 (1.0)	-	-	-	-	-	-	-	-	-	4 (1.0)
Y	2 (0.2)	-	-	-	-	2 (0.2)	2 (0.2)	2 (0.2)	-	2 (0.2)	3 (0.3)	-	13 (1.1)
Z	-	4 (0.3)	-	-	-	23 (1.9)	16 (1.3)	22 (1.8)	-	6 (0.5)	17 (1.4)	-	88 (7.3)
A	-	-	-	-	26 (2.6)	52 (5.2)	2 (0.2)	23 (2.3)	2 (0.2)	8 (0.6)	-	-	113 (11.3)
B	2 (0.2)	2 (0.2)	2 (0.2)	-	4 (0.3)	20 (1.7)	-	4 (0.3)	16 (1.3)	-	12 (1.0)	-	62 (5.2)

a/ see Figure 5 for transect locations

b/ birds/km^2

Table 9. Numbers of birds other than loons and waterfowl observed during aerial transect surveys - July 9,10,11, 1982.

Survey transect[a/]	rough-legged hawk	sandhill crane	plover	ruddy turnstone	sandpiper	dunlin	red phalarope	pomarine jaeger	parasitic jaeger	long-tailed jaeger	jaeger	herring/ Thayer's gull	glaucous gull	Sabine's gull	gull	arctic tern	snowy owl
1	-	-	-	5 (0.3)[b/]	9 (0.6)	-	-	-	-	-	-	15 (0.9)	2 (0.1)	3 (0.2)	2 (0.1)	4 (0.3)	1 (0.1)
2	-	1 (0.1)	-	-	1 (0.1)	-	1 (0.1)	-	-	1 (0.1)	-	2 (0.1)	1 (0.1)	-	3 (0.2)	-	-
3	-	-	-	-	1 (0.1)	-	-	-	-	-	1 (0.1)	1 (0.1)	-	-	-	2 (0.1)	2 (0.1)
1A	-	-	-	-	96 (16.0)	-	-	-	-	-	-	-	1 (0.2)	-	-	-	-
2A	-	-	-	-	1 (0.3)	-	-	-	-	-	1 (0.3)	-	-	-	-	1 (0.3)	1 (0.3)
3A	-	-	-	-	13 (3.3)	-	8 (2.0)	2 (0.5)	-	-	-	3 (0.8)	-	-	-	-	2 (0.5)
Y	-	-	-	-	2 (0.2)	1 (0.1)	-	1 (0.1)	-	2 (0.2)	-	2 (0.2)	-	-	-	-	5 (0.4)
Z	1 (0.1)	-	-	-	-	-	-	-	-	2 (0.2)	-	1 (0.1)	-	-	-	4 (0.3)	4 (0.3)
A	-	-	-	-	5 (0.5)	-	-	-	-	2 (0.2)	-	21 (2.1)	-	-	-	92 (9.2)	2 (0.2)
B	-	-	1 (0.1)	-	-	3 (0.3)	5 (0.4)	-	1 (0.1)	1 (0.1)	1 (0.1)	20 (1.7)	-	23 (1.9)	3 (0.3)	20 (1.7)	-

a/ see Figure 5 for transect locations

b/ $birds/km^2$

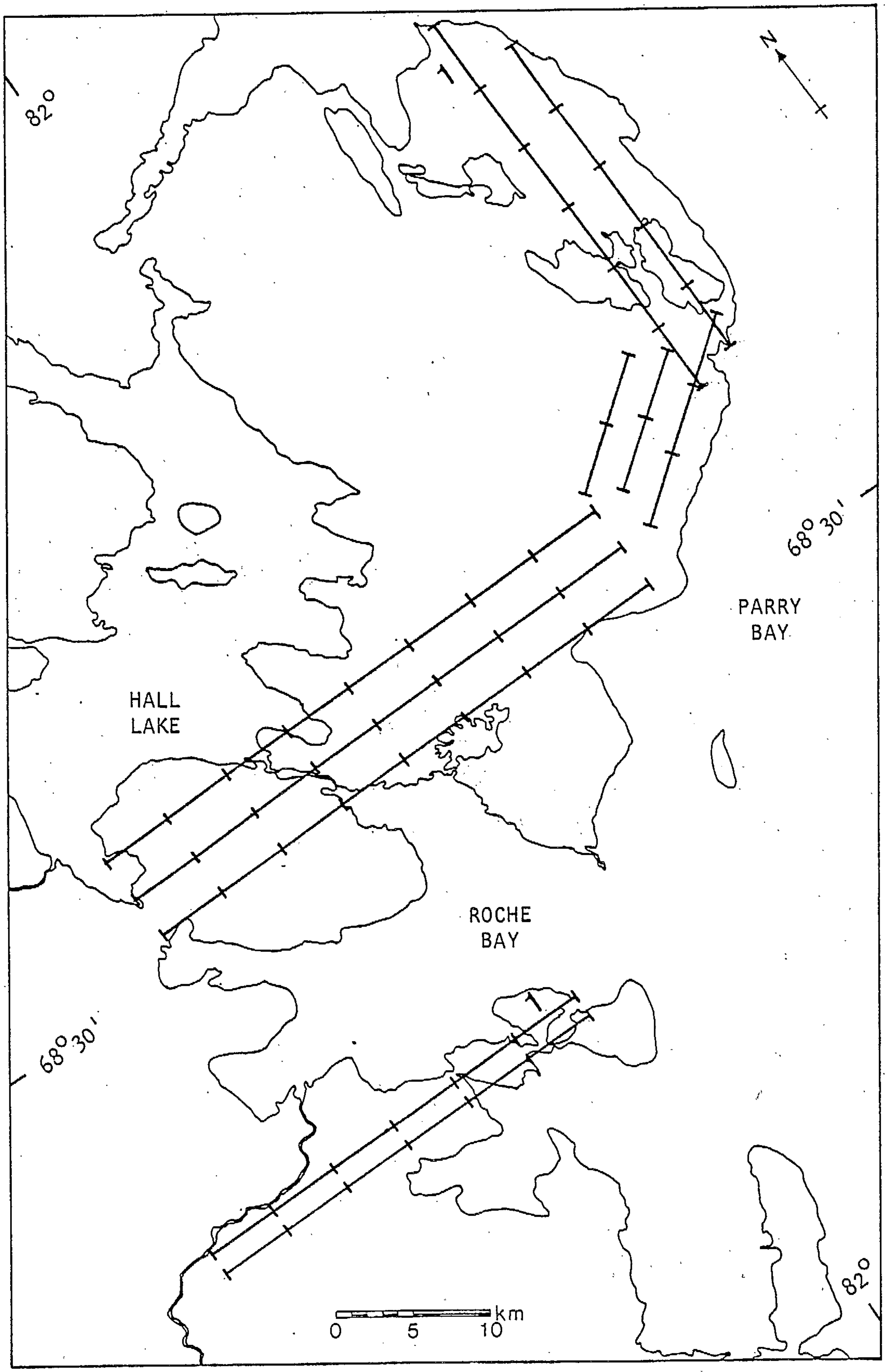

Figure 16 . Arctic loon pairs observed on transects in the Parry Bay area, July 9-11, 1981.

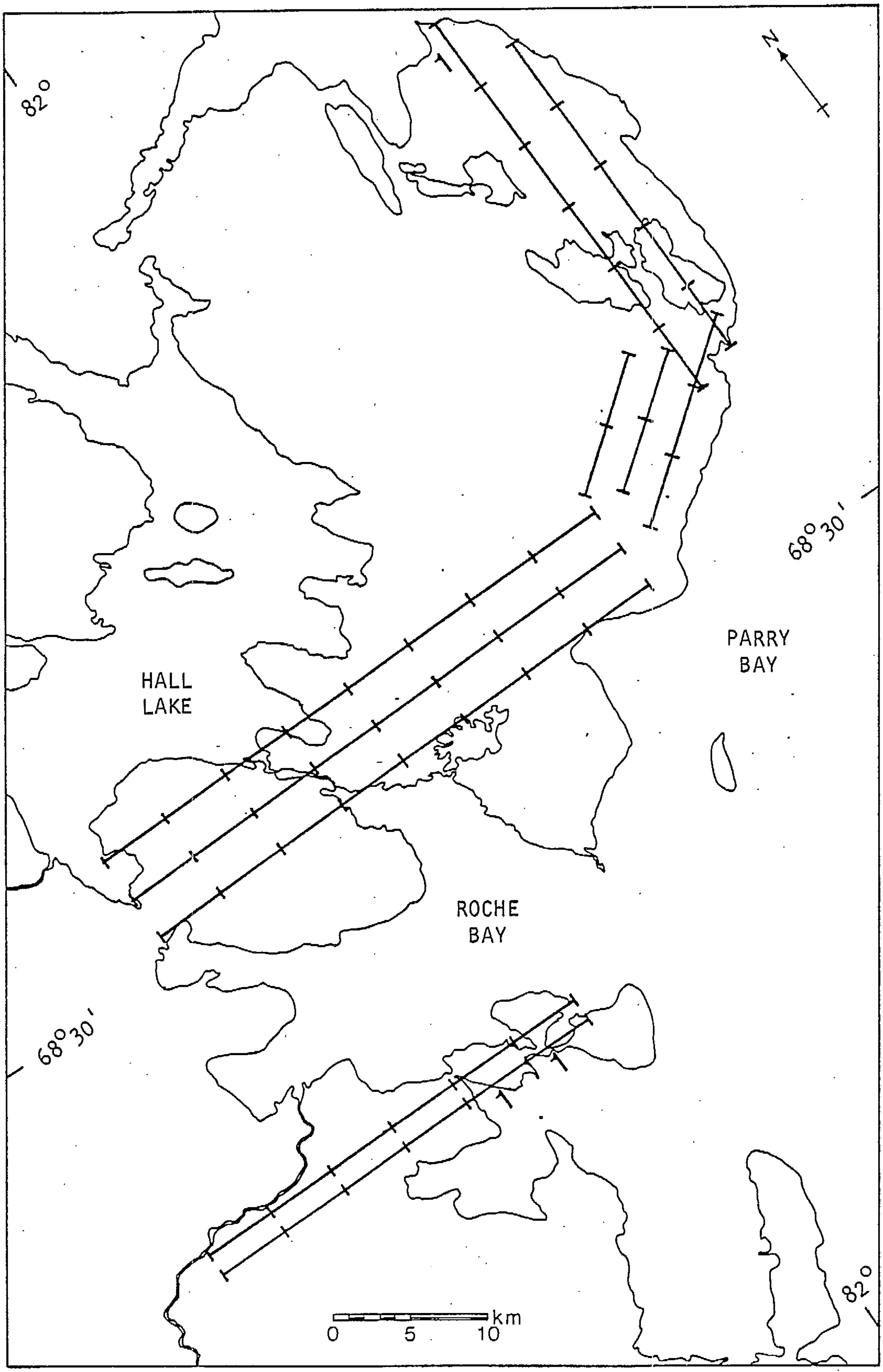

Figure 17 . Red-throated loon pairs observed on transects in the Parry Bay area, July 9-11, 1981.

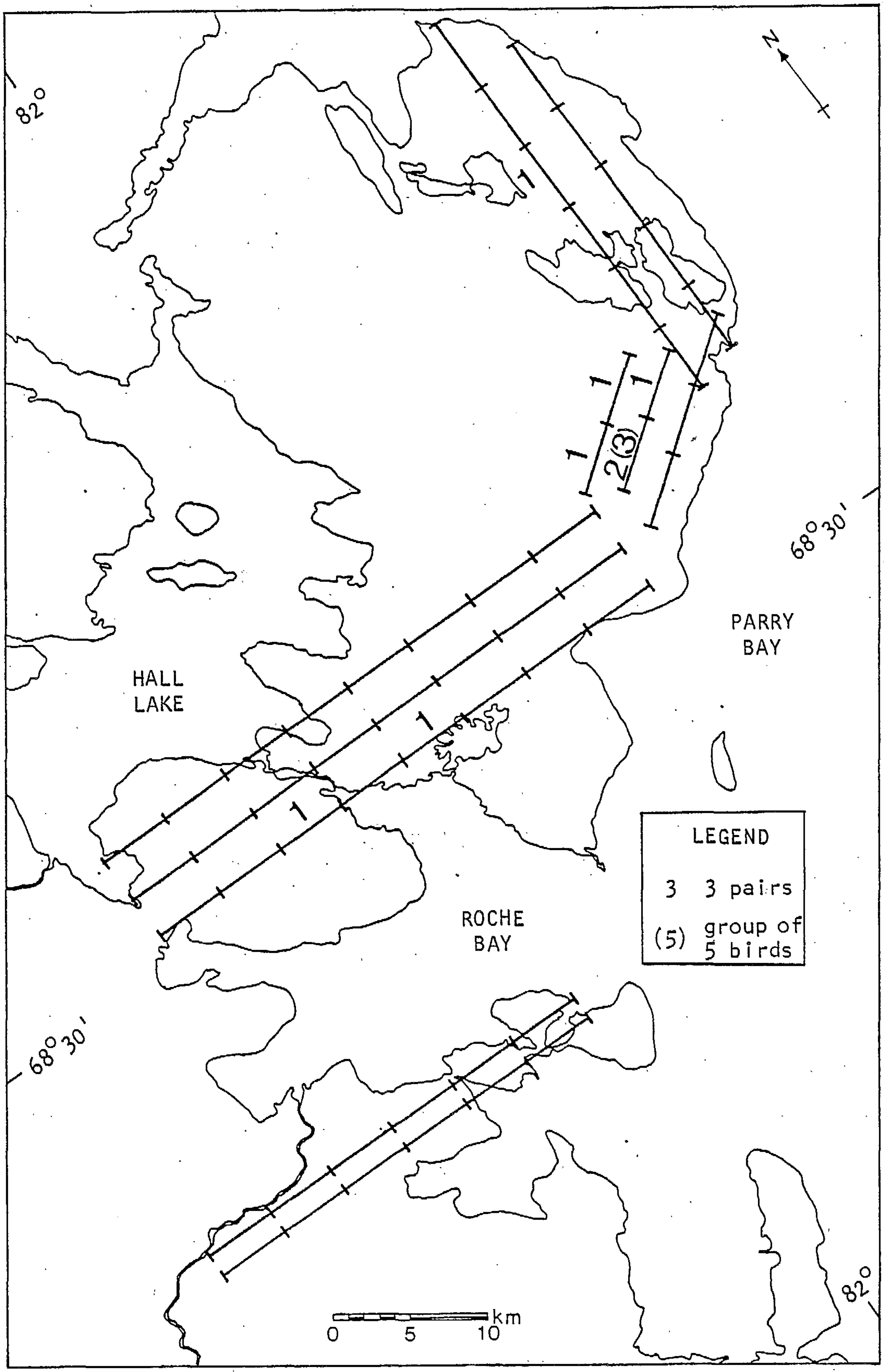

Figure 18 . Unidentified loon pairs and groups observed on tranects in the Parry Bay area, July 9-11,1981.

River. The other was located in the raised beach/pond complex (Figure 19). Canada geese were also few in number; most of them were seen on transects A and B near Hall Beach (Figure 20). Non-breeding groups of brant outnumbered the breeders (see appendices). The species showed a definite affinity for coastal regions of the study area and the two large lakes roughly southwest of Hall Beach (Figure 21). Other observations of non-breeding brant in these two lakes were made opportunistically during flights to and from Roche Bay. On one occasion, 31 brant were seen in the westernmost lake. On another flight, 66 brant were noted in the easternmost lake. The region comprising these lakes and the adjacent coastal area appeared, then, to be favoured by brant. A single occupied brant nest was discovered on a small low island in Hall Lake located near the outflow of the Kingora River (Figure 21). Small numbers of snow goose pairs were located throughout the study area, (Figure 22). Non-breeding groups were not seen. Eight pairs were seen nesting in a colony located in the lush valley situated just west of the major escarpment at the base of the Ignertok Peninsula (see section 5.1.4). Subsequent on-ground investigation revealed that there were in fact 12 nesting pairs. Nests were located in the wet sedge-moss habitat associated with three shallow lakes. Fourteen snow geese (which were not from the colony) were seen flying low over wetland habitat located east of the escarpment. Another small colony of five nesting pairs were discovered by D. Jaques during his vegetation sampling work. The colony was located in similar habitat as the other colony about five kilometres from Hall Beach. It is interesting to note that the site was situated within two kilometres of the flight path of aircraft, including Boeing 737's, using the Hall Beach air strip. On a reconnaissance flight along the Kingora River, eight snow geese were seen below a point where the river flows torrentially

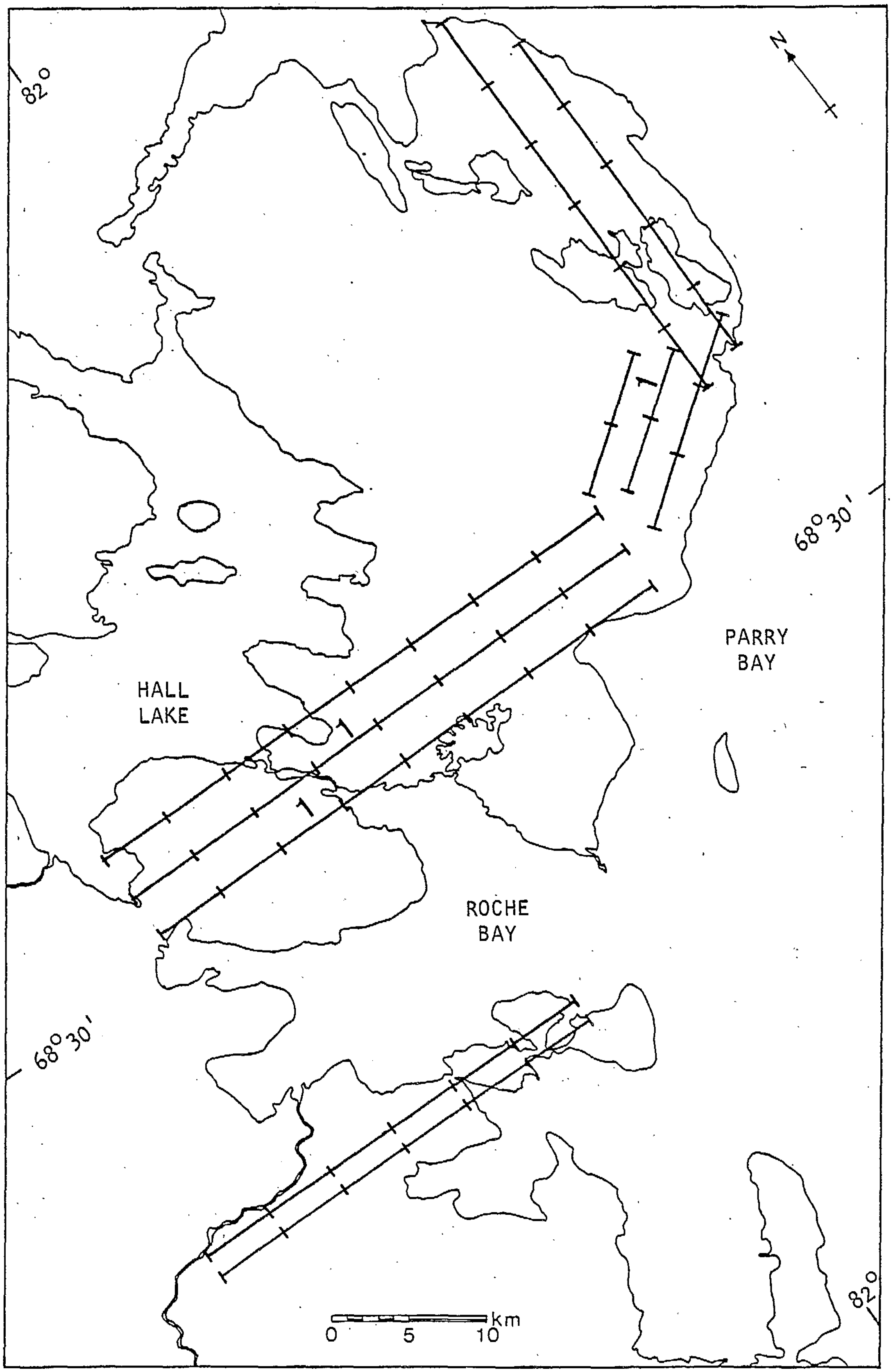

Figure 19 . Whistling swan pairs observed on transects in the Parry Bay area, July 9-11, 1981.

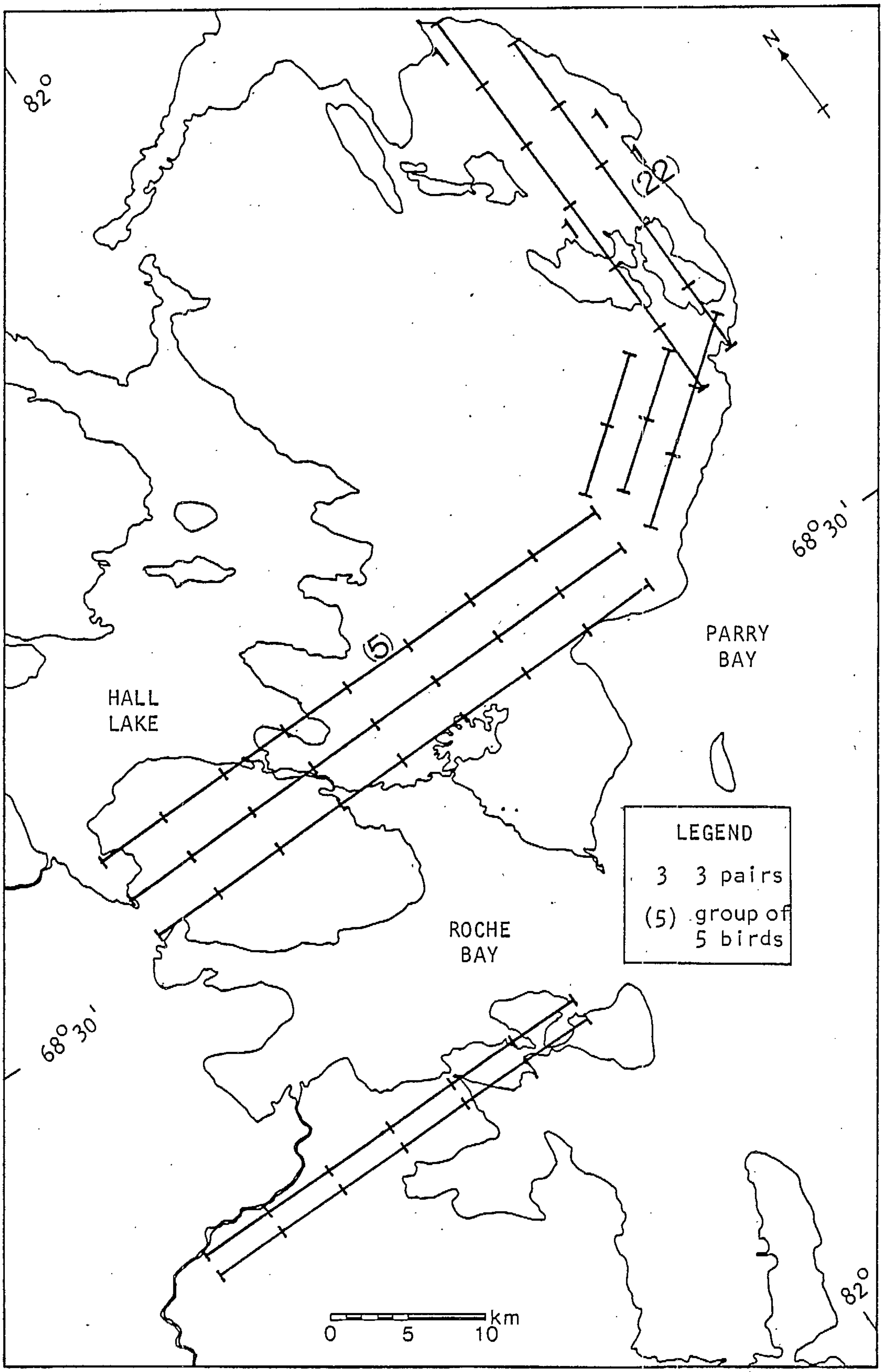

Figure 20 . Canada goose pairs and groups observed on transects in the Parry Bay area, July 9-11, 1981.

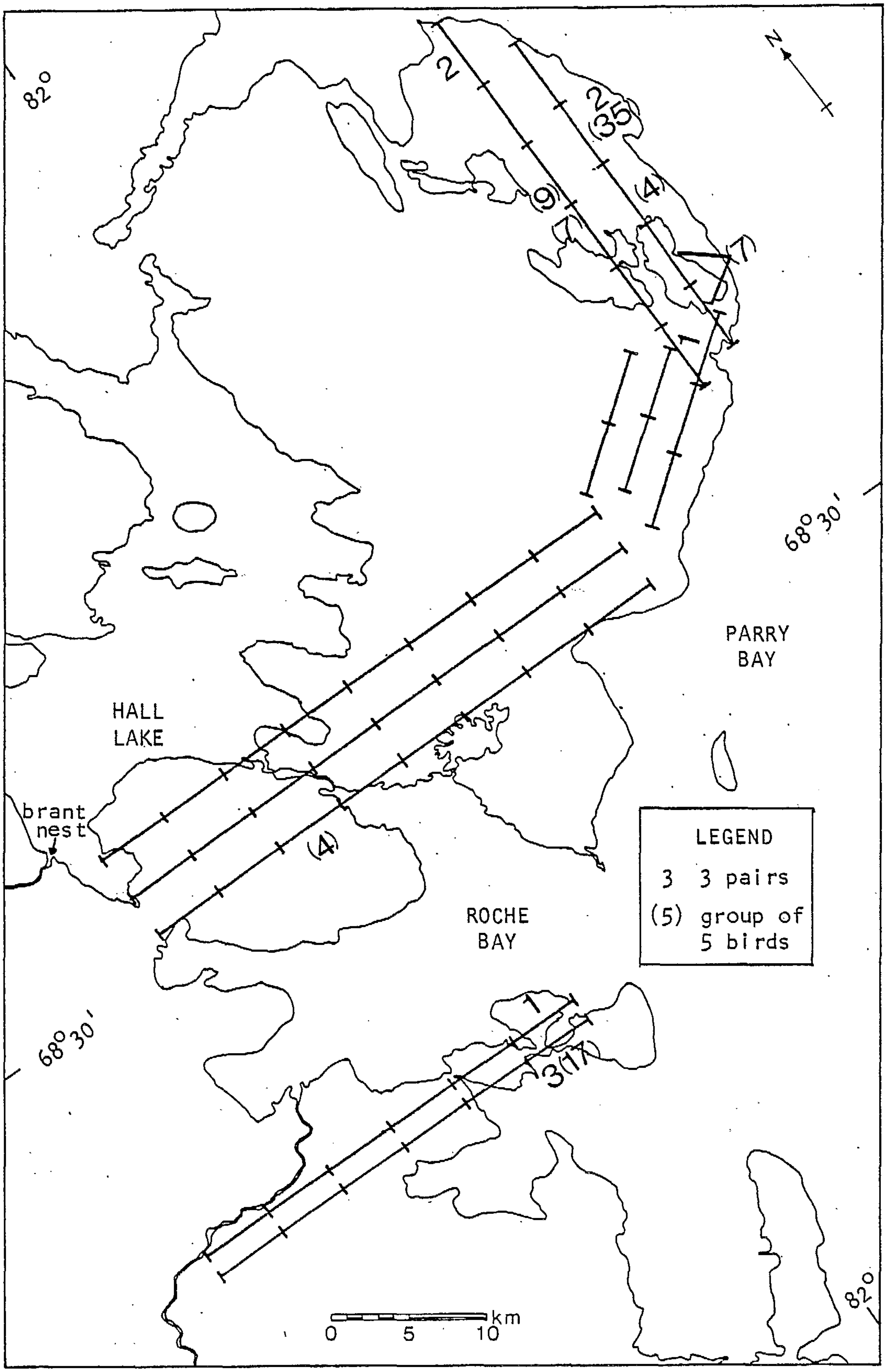

Figure .21 . Brant pairs and groups observed on transects in the Parry Bay area, July 9-11, 1981.

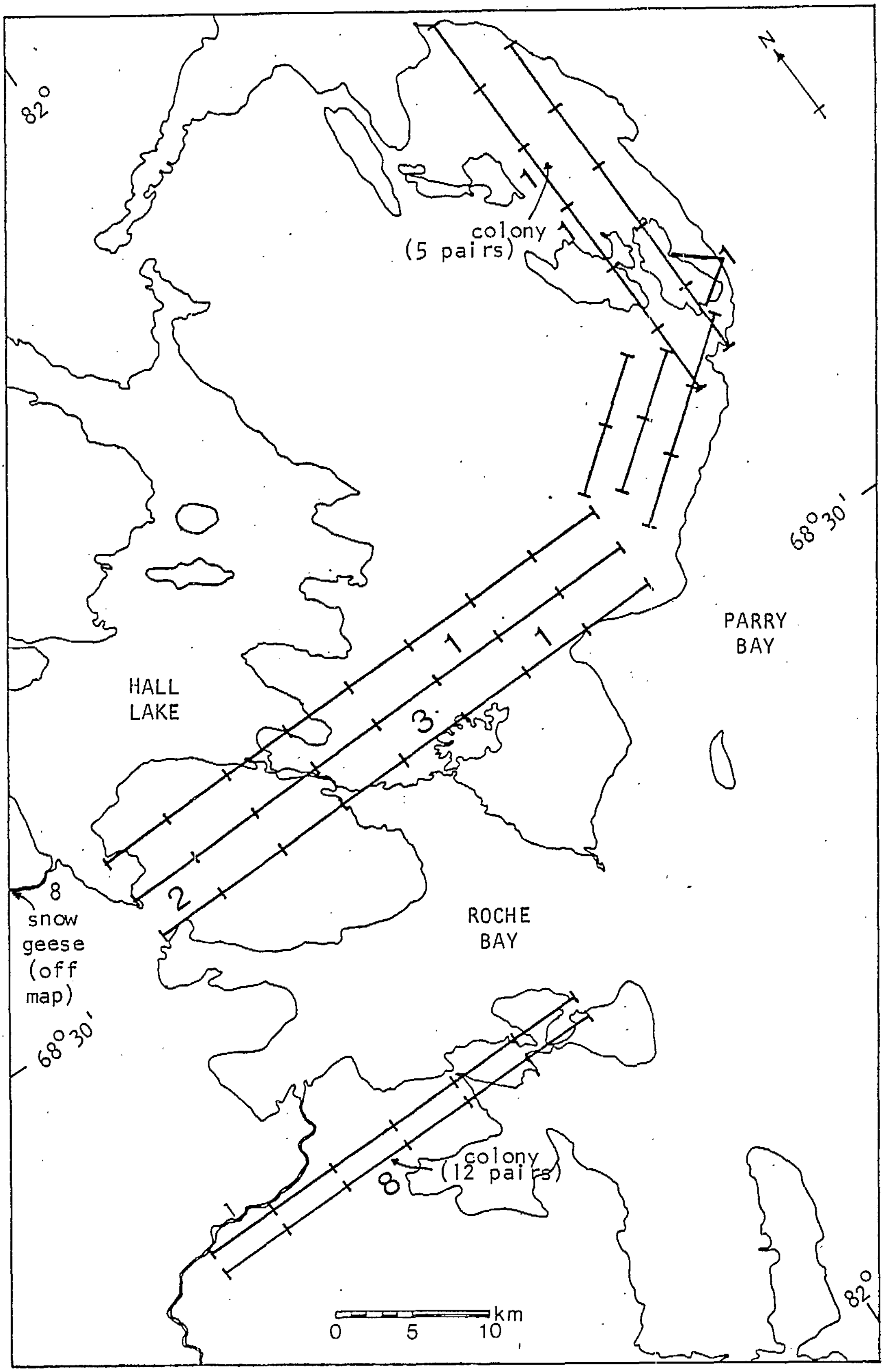

Figure 22 . Snow goose pairs observed on transects in the Parry Bay area, July 9-11, 1981.

through a narrow gorge or chute, approximately eight kilometres upstream from Hall Lake (Figure 22). The reasons for the occurrence of the geese at this unlikely spot are not known. However, it is possible that the geese are attracted to the location for similar reasons that they are attracted to Kazan Falls near Baker Lake, N.W.T. (63°43'N, 95°46'W). At Kazan Falls, which resembles the Kingora River chute, Miller (1972) found 21 lesser snow goose nests located at the edge of cliffs about 8 to 12 m above the river.

Non-breeding oldsquaw exhibited a strong preference for coastal regions of the study area, such as Ignertok Peninsula. Breeders were distributed in small numbers throughout the study area (Figure 23). Coastal regions were also favoured by king eiders (Figure 24). Unidentified non-breeding eiders were all observed on Ignertok Peninsula (Figure 25). Only two pairs of common eiders were seen during the transect surveys (Figure 26).

To summarize , coastal (marine-influenced) regions of the study area were most attractive to loons and waterfowl (Figure 27). Habitat on Ignertok Peninsula, in the area east of the Ikerasak River, and south of Hall Beach was favoured.

5.3.3.2 Other Birds

This section describes the distribution of those birds, other than loons and waterfowl, that were most frequently observed during the transect surveys.

Sandpipers were most abundant in the heavily-ponded raised beach area which also appeared to attract snowy owls (Figures 28 and 29). Snowy owls were also quite common on Ignertok Peninsula.

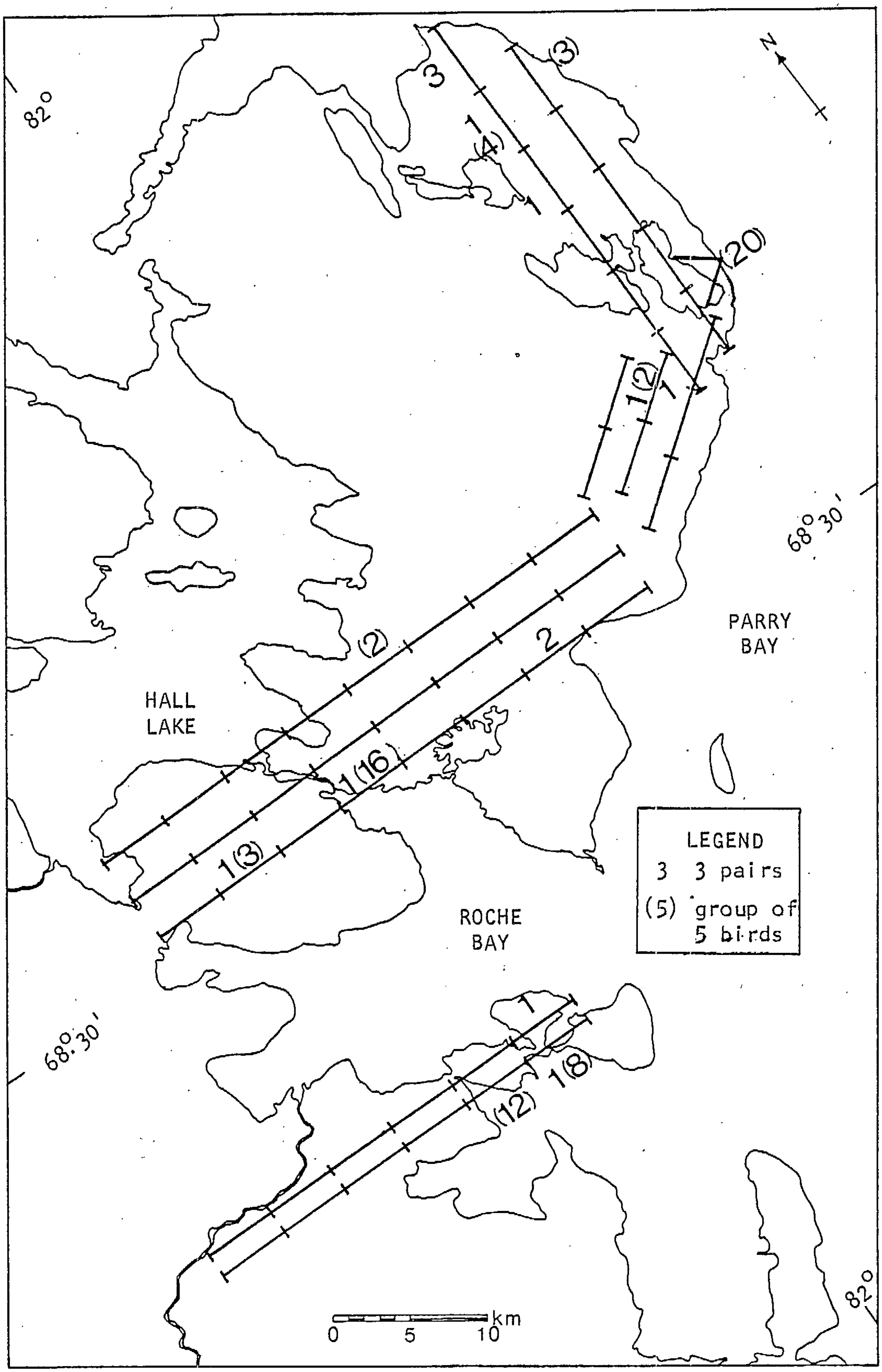

Figure 23 . Oldsquaw pairs and groups observed on transects in the Parry Bay area, July 9-11, 1981.

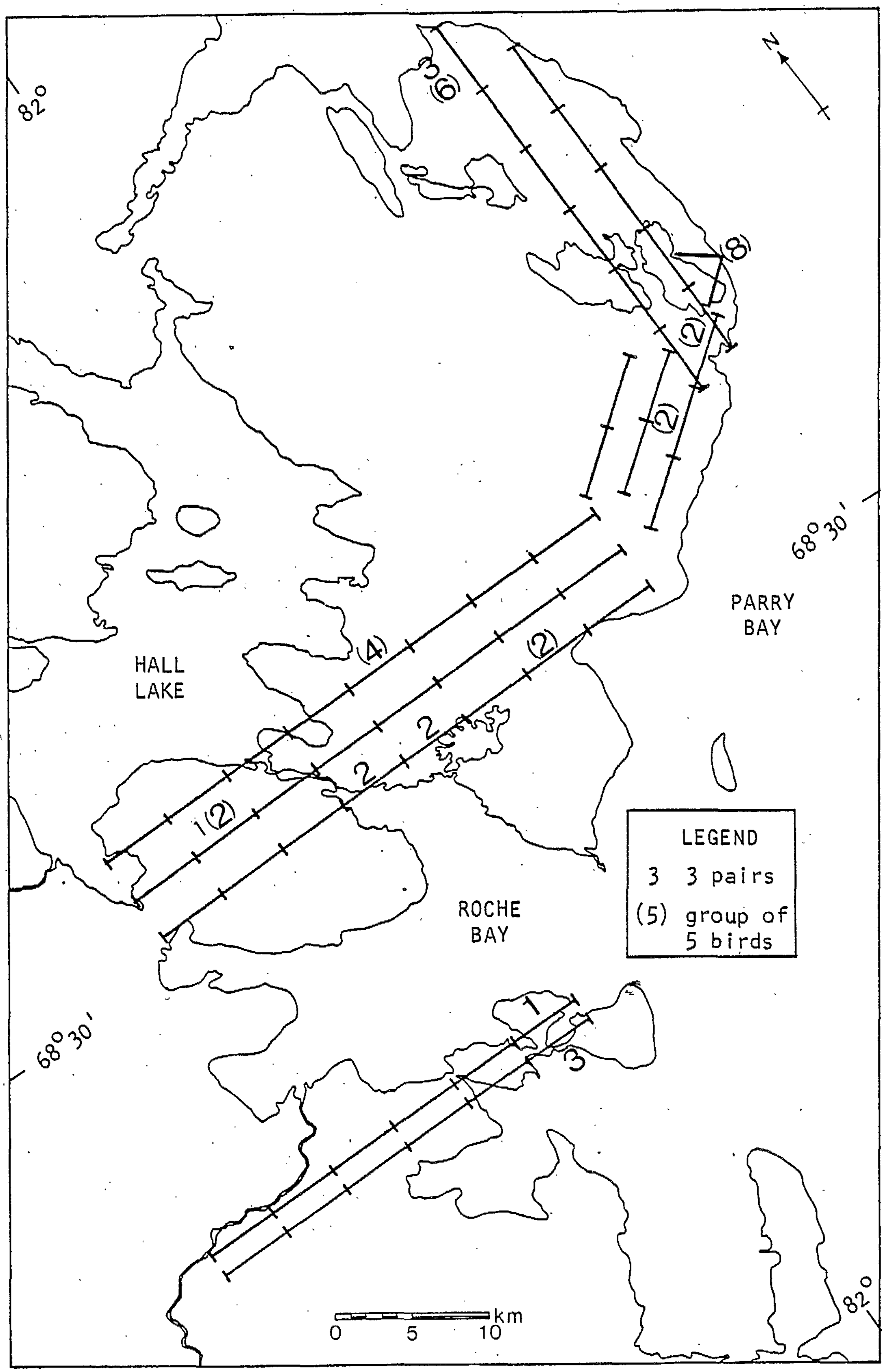

Figure 24. King eider pairs and groups observed on transects in the Parry Bay area, July 9-11, 1981.

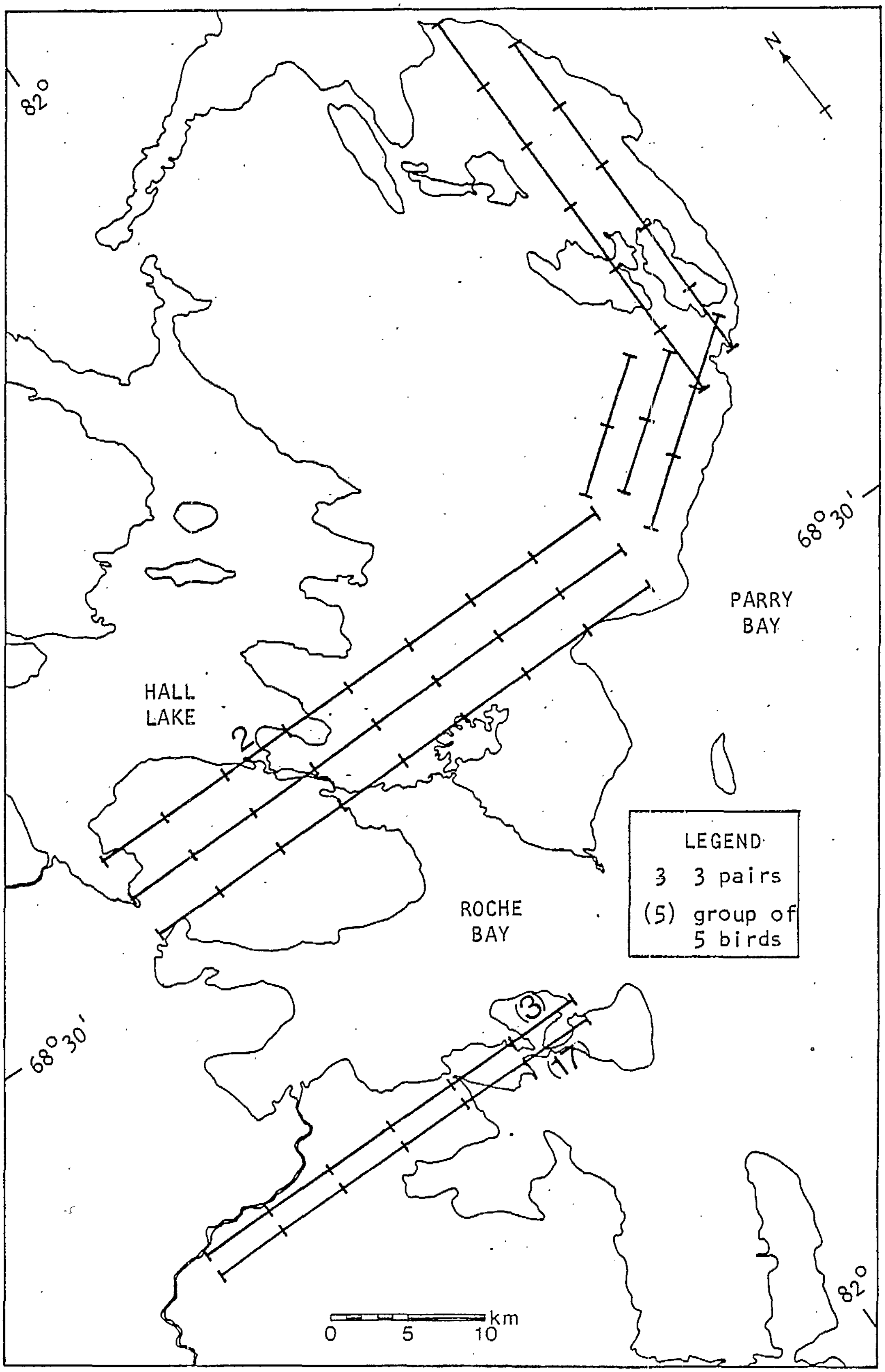

Figure 25 . Unidentified eider pairs and groups observed on transects in the Parry Bay area, July 9-11, 1981.

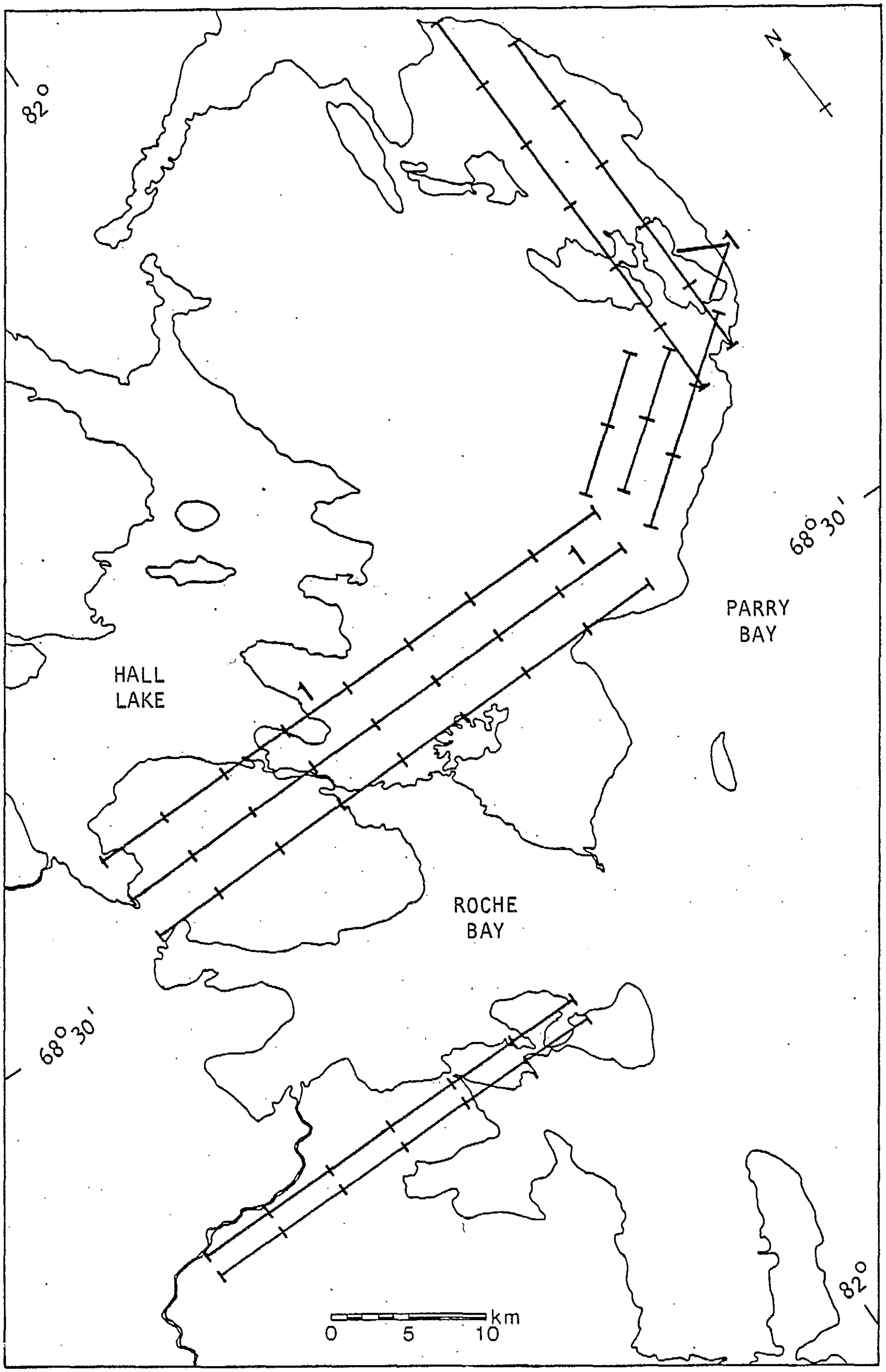

Figure 26 . Common eider pairs observed on transects in the Parry Bay area, July 9-11, 1981.

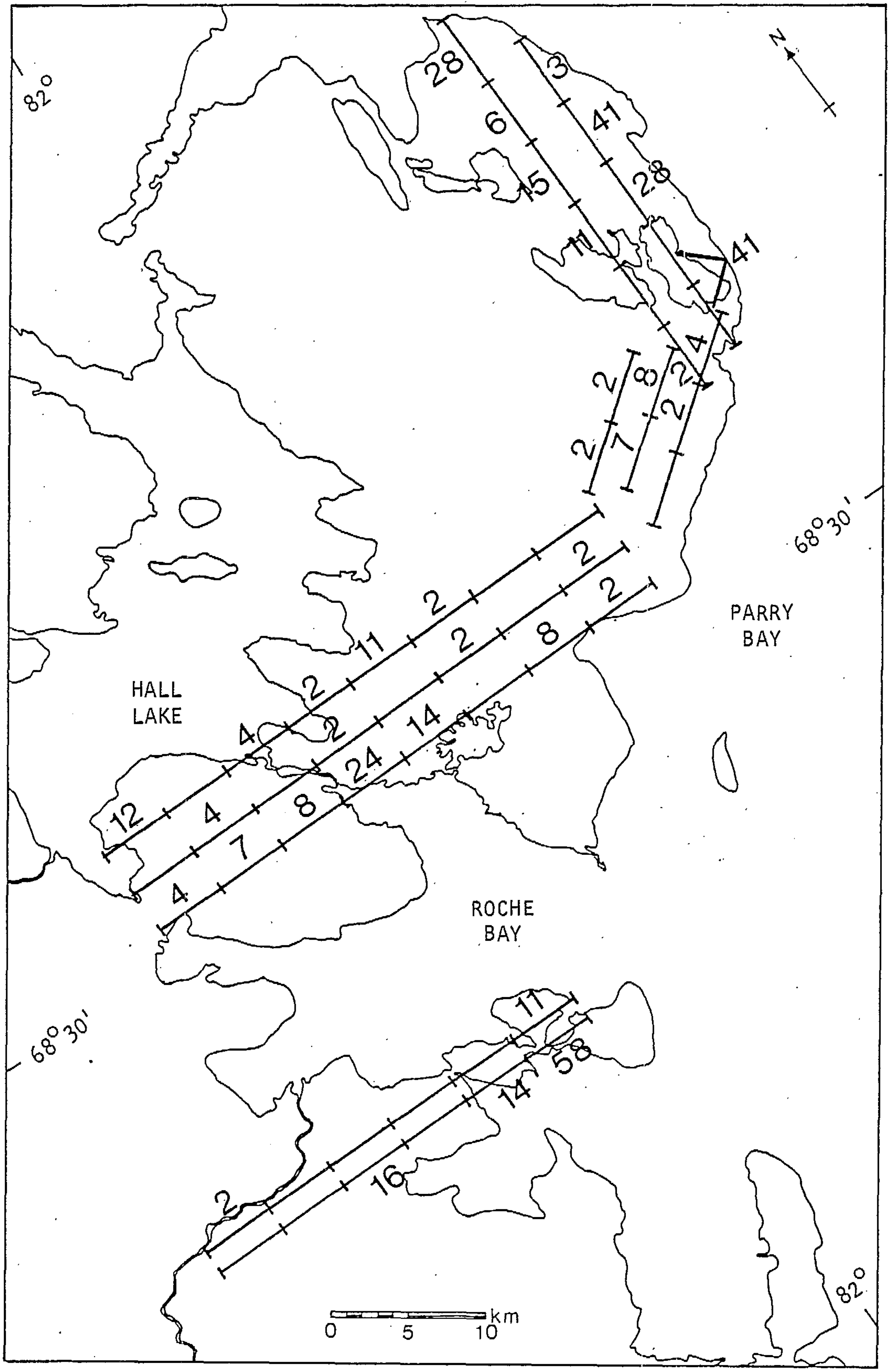

Figure 27 . Loon and waterfowl pairs observed on transects in the Parry Bay area, July 9-11, 1981.

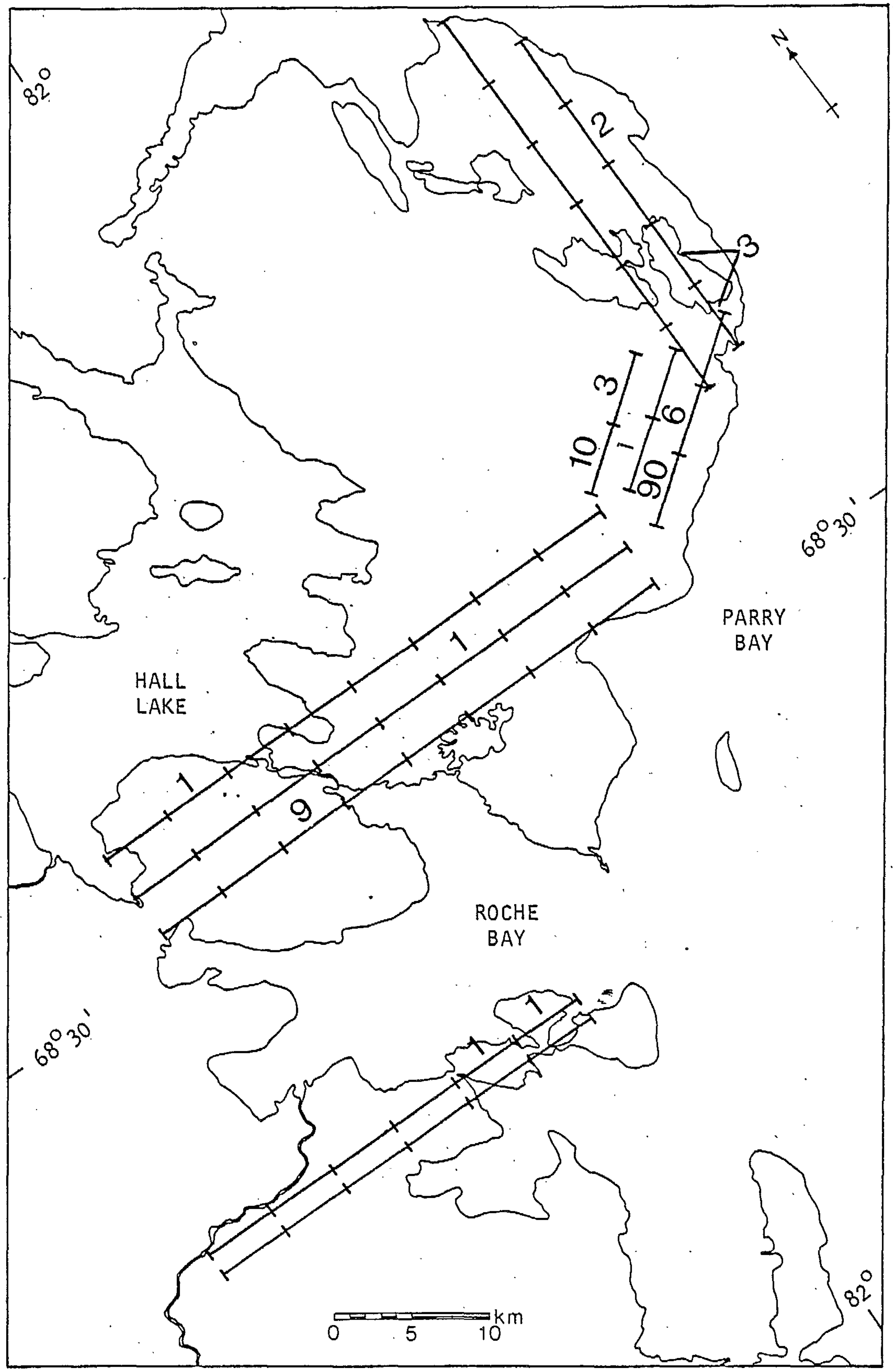

Figure 28. Sandpipers observed on transects in the Parry Bay area, July 9-11, 1981.

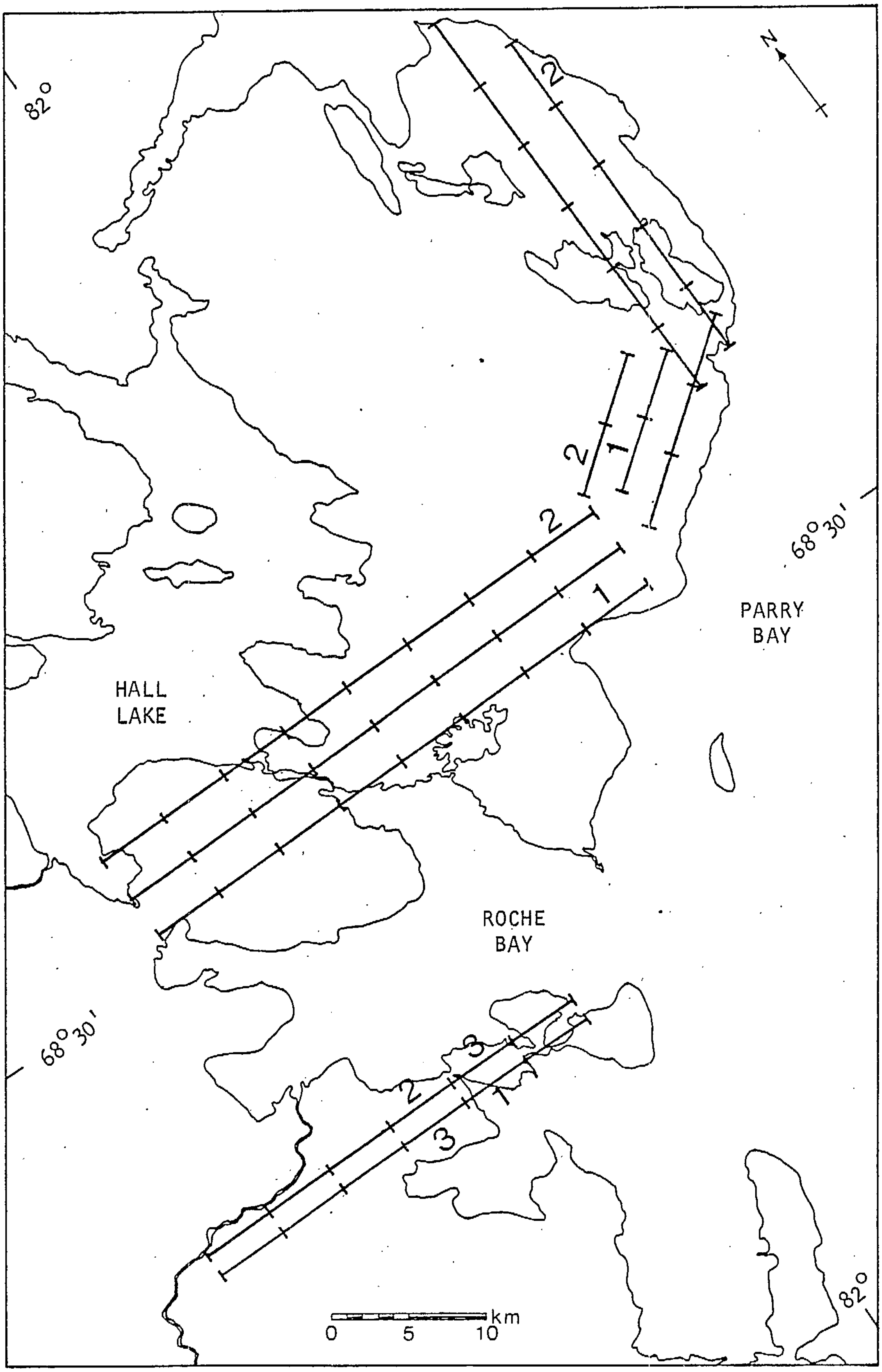

Figure 29. Snowy owls observed on transects in the Parry Bay area, July 9-11, 1981.

Herring/Thayer's gulls showed a preference for the area encompassed by the two large lakes southwest of Hall Beach where they occurred in small colonies. The sedge-moss wetland complex east of the Ikerasak River was also favoured by this species group (Figure 30). During a reconnaissance flight, a colony of 24 herring/Thayer's gulls was discovered on a small island in a lake in the raised beach/pond complex (Figure 30).

Observations of Sabine's gulls were almost totally limited to a colony located near the coast northwest of Hall Beach (Figure 31). An arctic tern colony also existed in the vicinity. The easternmost of the two large lakes southwest of Hall Beach was apparently very attractive to the terns (Figure 32).

In summary, gulls and terns were most abundant in habitat to the north and south of Hall Beach, extending about 10 kilometres inland. Wetland habitat in the vicinity of the Ikerasak River was attractive to a lesser degree. Sandpipers and snowy owls were most common in the raised beach/pond complex southwest of Hall Beach.

5.3.4 Ajaqutalik River

Locations of waterfowl observed during the aerial survey of the Ajaqutalik River are shown in Figure 33. Observations indicated that reaches of the river, where the banks were low-lying and better vegetated, were useful for moulting Canada geese. The degree of importance of these areas is unknown. It is interesting to note that all geese, except one, were observed upstream of the point identified by Borealis as a possible hydroelectric dam site (Borealis 1981a). This is probably because better-vegetated and flatter

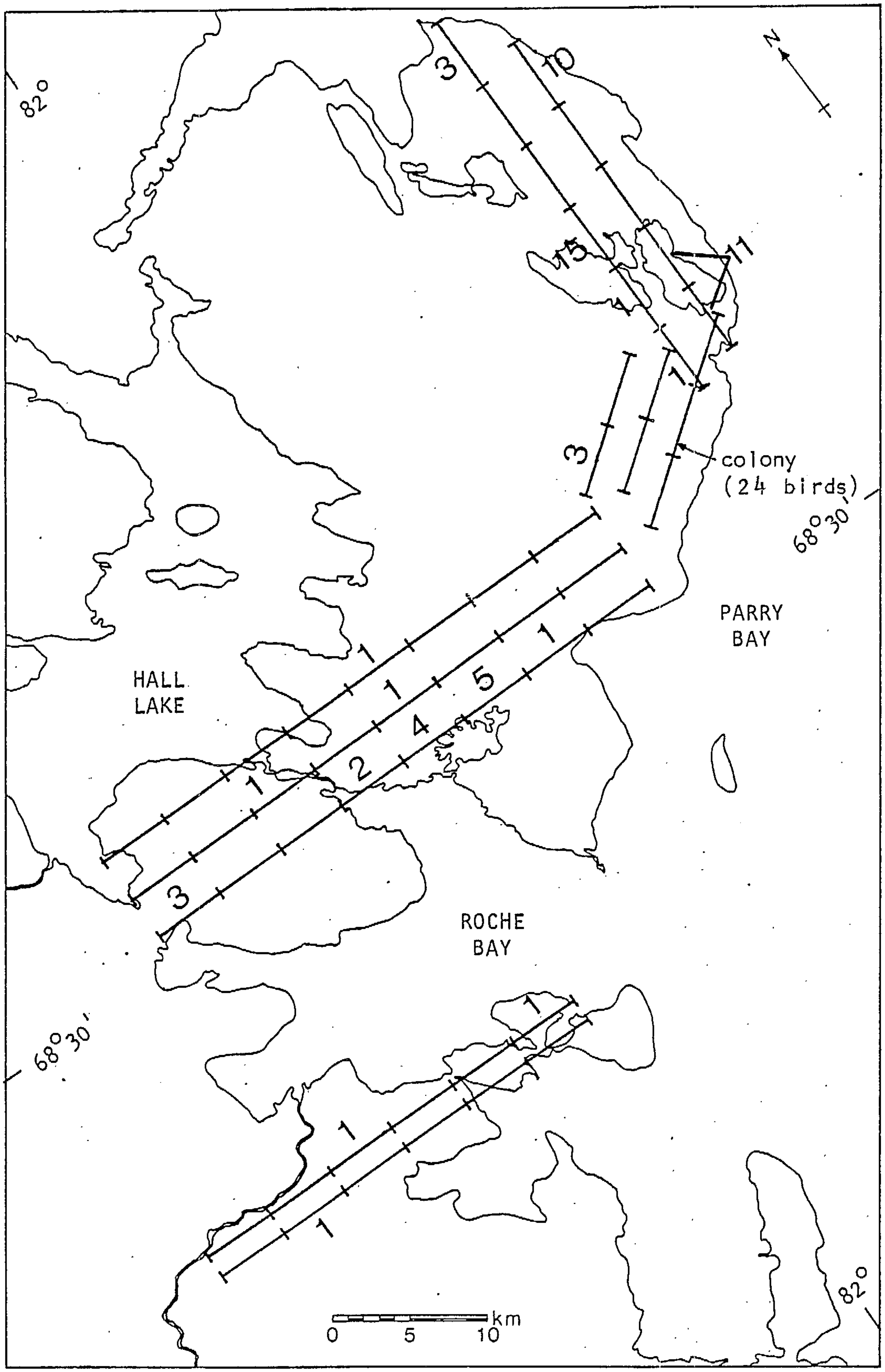

Figure 30. Herring/Thayer's gulls observed on transects in the Parry Bay area, July 9-11, 1981.

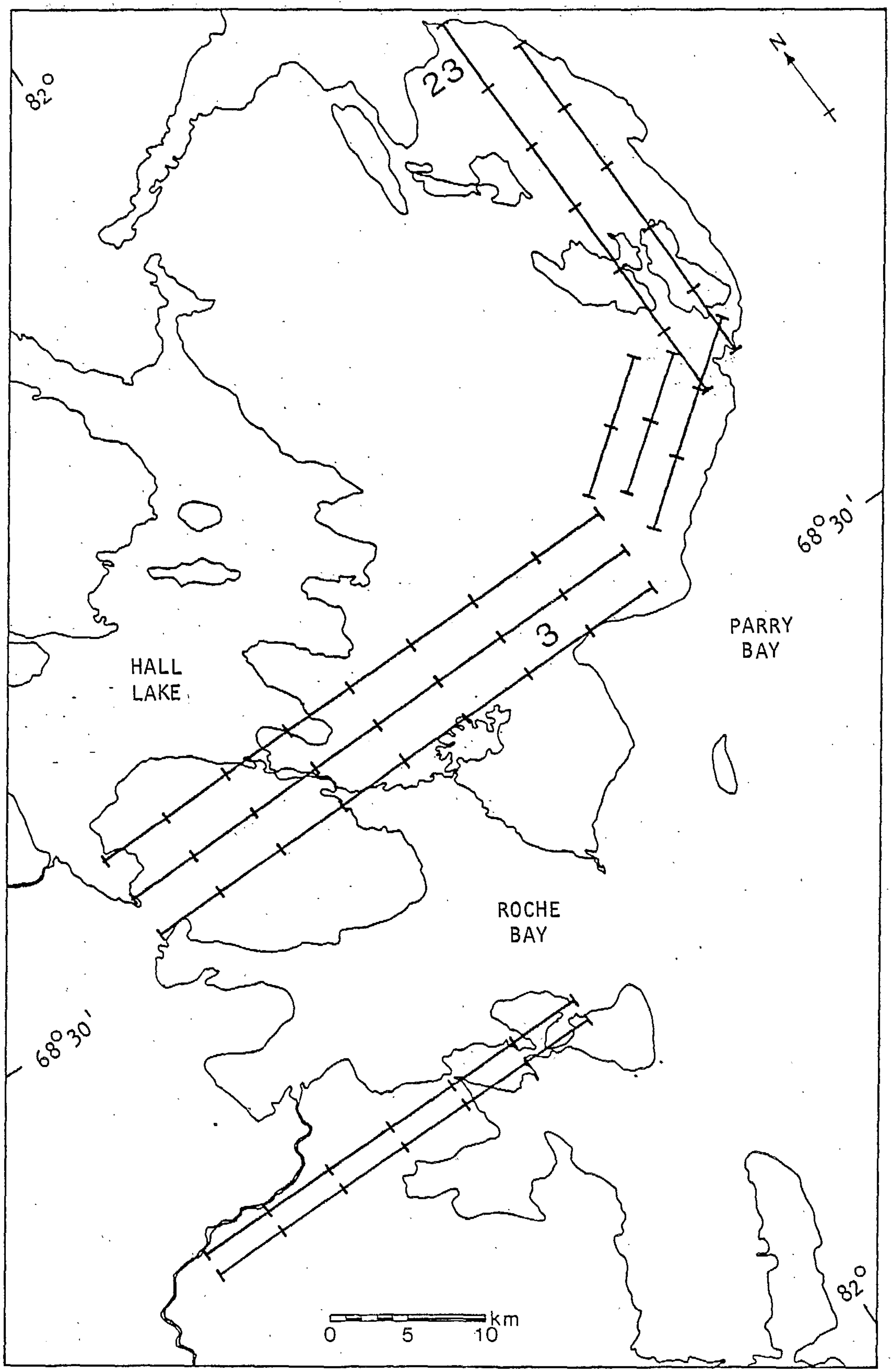

Figure 31. Sabine's gulls observed on transects in the Parry Bay area, July 9-11, 1981.

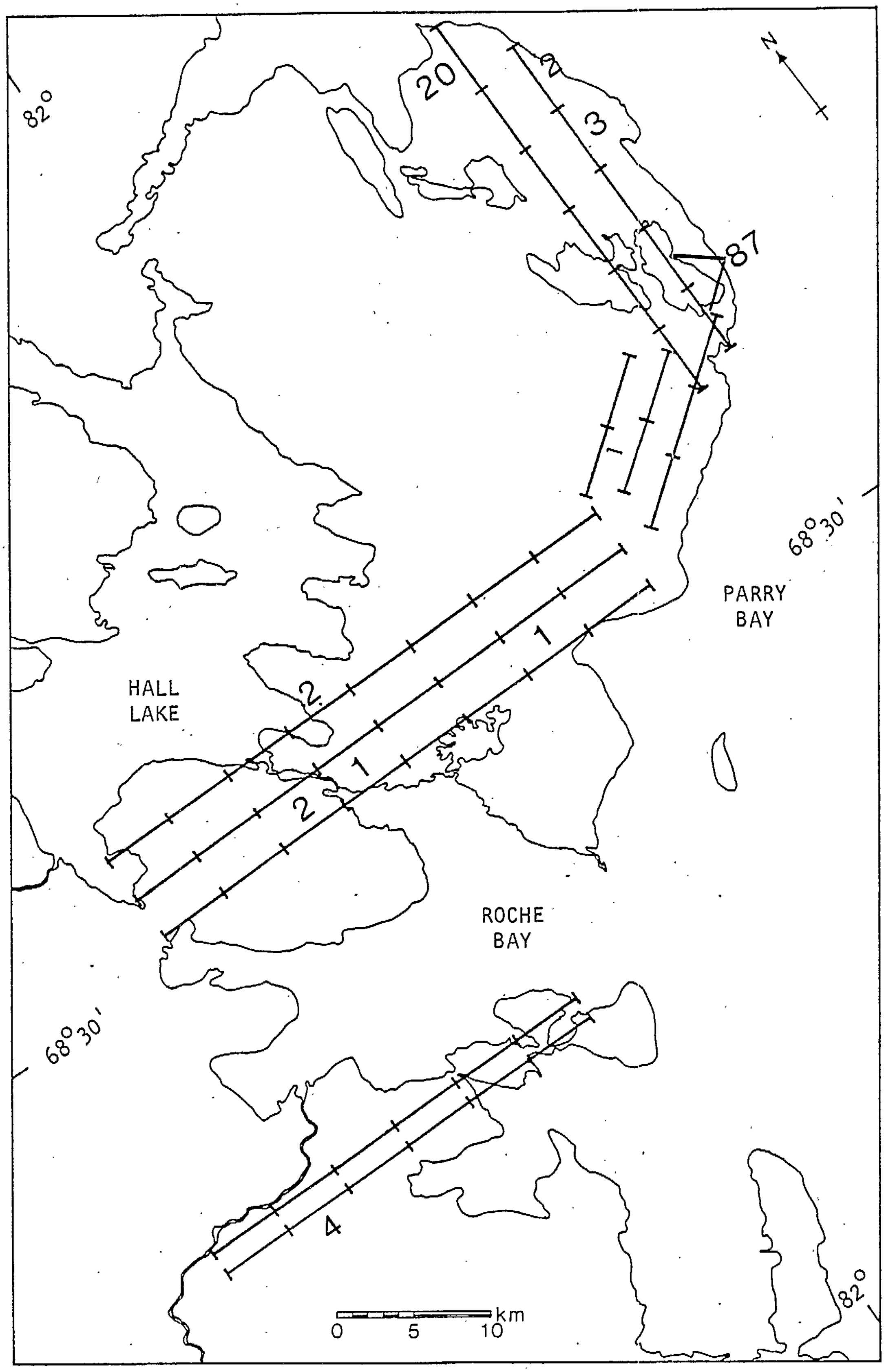

Figure 32. Arctic terns observed on transects in the Parry Bay area, July 9-11, 1981.

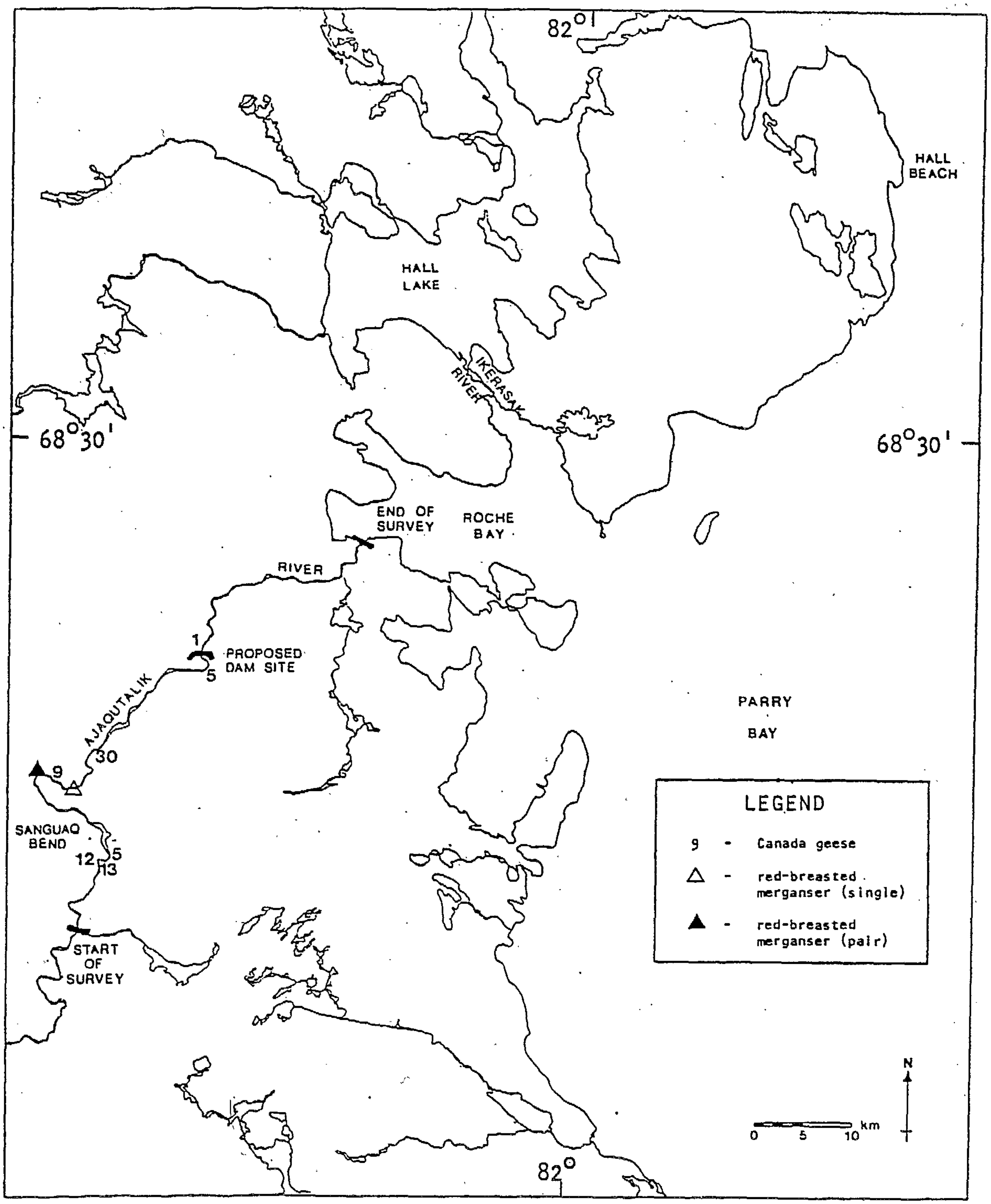

Figure 33. Waterfowl observed during an aerial survey of the Ajaqutalik River, July 10, 1981.

areas, such as Sanguaq Bend (Figure 33) are more numerous and extensive upstream of the dam site.

One single and one pair of red-breasted mergansers were seen at Sanguaq Bend. Occurrence of these birds in the study area is significant since the northern limits of the known breeding range are more than 500 km to the south in the Chesterfield Inlet area (Godfrey 1966). However, Montgomerie et al. (1983) observed single birds at Sarcpa Lake approximately 35 km north of Sanguaq Bend. These birds were apparently behaving in a manner suggesting that there may have been young nearby. Breeding has been recorded on southern Baffin Island to the east (Godfrey 1966) and southeastern Victoria Island to the west (Parmelee et al. 1967).

5.3.5 Biogeographic Affinity of Bird Fauna

Appendix 1 is a preliminary checklist of birds inhabiting the Roche Bay area. Breeding status in the Roche Bay area has been documented for 16 species; another 9 species almost certainly breed there also. If we consider the total number of breeding species as 25, this is comparable to the 22 species documented as breeding by Montgomerie et al. (1983) for Sarcpa Lake due west of Roche Bay. Montgomerie noted that the breeding bird community at Sarcpa Lake is more similar to those of arctic island sites than to other mainland sites. Bliss (1977) characterized Melville Peninsula as High Arctic on the basis of climatic and vegetation characteristics. Consequently, avifauna of the study is typically high Arctic: depauperate in both number of species and numbers of birds in each species.

6. ENVIRONMENTAL IMPACT ASSESSMENT - BIOPHYSICAL LANDSAT TECHNIQUE

The application of biophysical land classification to the field of environmental impact assessment has been recognized (Environmental Conservation Service Task Force 1981). One of the objectives of the study conducted by Jaques (1982) was to determine whether LANDSAT imagery could be used in assessing the potential environmental impacts of proposed developments on migratory birds. The purpose of this section is to introduce and describe an impact assessment procedure which incorporates the technique of biophysical land classification using LANDSAT data. The procedure is called the Biophysical LANDSAT Technique for Environmental Impact Assessment.

6.1 Description of the Technique

A flow diagram showing the components of the "technique" and examples of output products that could be obtained is given in Figure 34. One of the main advantages of the technique is the capability for predicting potential environmental impacts in a relatively short time period (two years) and, consequently, at a relatively low cost.

Biophysical land classification is completed during the first year. Available information on the study area (geological maps, LANDSAT photos, known wildlife uses, etc.) is assembled to enable a preliminary biophysical classification to be performed prior to the field surveys. LANDSAT digital data is selected, corrected geometrically and radiometrically, and analyzed using the computer, together with field data on vegetation communities, to produce a final biophysical classification. The classification results can be used to generate detailed maps of the study area showing, for example, vegetation distribution and sensitivity of the various terrain types to development activities.

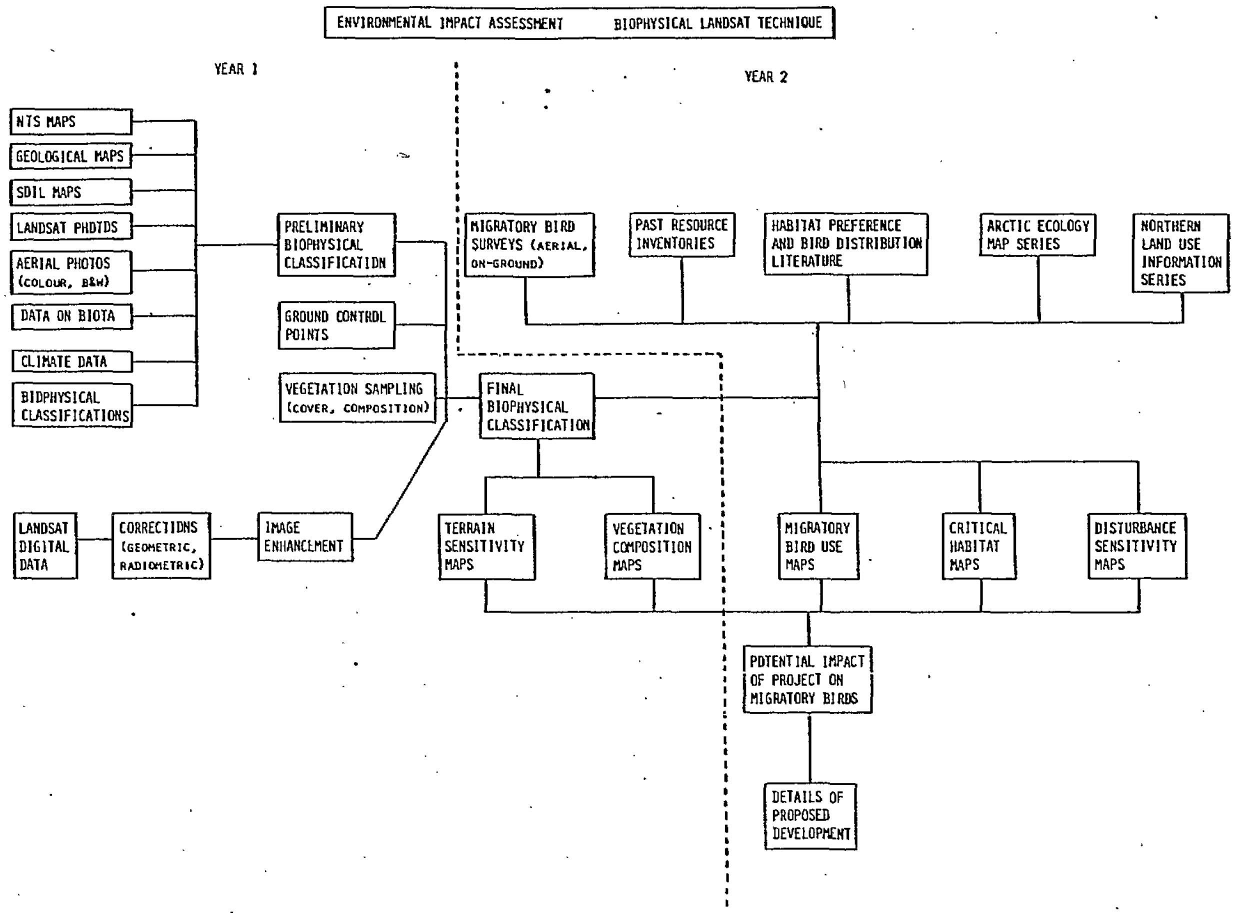

Figure 34 . Flow diagram of the biophysical LANDSAT technique of environmental impact assessment.

Over the winter, between year 1 and year 2, data on known migratory bird use of the study area are obtained from past resource inventory studies, maps in the Arctic Ecology Map Series and Northern Land Use Information Series[a/], and through personal communication with researchers familiar with the area. In addition, a thorough review would be carried out of literature dealing with bird species distribution in the region and habitat preferences. With this information, and with the aid of the biophysical classification completed previously, aerial and on-ground migratory bird surveys may be designed to fill knowledge gaps and provide current bird use data. These surveys are conducted during the field season of year 2. Following analysis of the data, it should then be possible to generate maps of the study area which depict such things as migratory bird use, distribution of critical habitat and relative sensitivity to man-induced disturbance.

Consideration of the resource distribution and disturbance sensitivity maps, and details of the proposed development, permits a preliminary assessment to be made of the potential impact of the development project on migratory birds. At this point, it may be decided that further surveys are required to allow for better definition of the impacts and possible measures for their mitigation.

6.2 Application of the Technique: Roche Bay, Melville Peninsula

As was indicated in the methods section of this report, the field work required to provide ground-truthing for the biophysical classification work at Roche Bay was carried out concurrently with the aerial migratory bird

[a/] the technique assumes a development proposal in an arctic area but could equally be applied to projects in southern Canada.

surveys. This arrangement differs, of course, from the approach outlined in the previous section in which the habitat work precedes the population studies. The reason for this discrepancy is the fact that the possibility for including the biophysical work along with the bird surveys arose late in the organization of the project. Nonetheless, the potential value of the biophysical approach was recognized and the work reported by Jaques (1982) proceeded in conjunction with the bird work. Consequently, the biophysical classification was not available as a basis for designing the bird surveys as envisioned in the proposed biophysical LANDSAT technique.

With this departure from the technique having been recognized, the following sections apply the various steps of the technique (Figure 34) to the Roche Bay case.

6.2.1 Species List and Habitat Preferences

A provisional checklist of the birds of the Roche Bay area was developed from previous observations made by other researchers in the area and a review of the literature (Appendix 1). The list numbers 42 species of which 30 have been observed in the study area itself. Breeding status in the Roche Bay area has been documented for 16 species. Another 9 species almost certainly breed there also, and future observations of birds in the area will likely increase the number of documented breeders further.

Bird habitat at Roche Bay can be separated into eight habitat types (Figure 35). Six of these habitat types correspond to vegetation types defined by Jaques (1982) and described in section 2.3.2 of this report. The "grass-moss meadow" habitat type was described briefly by Jaques as a

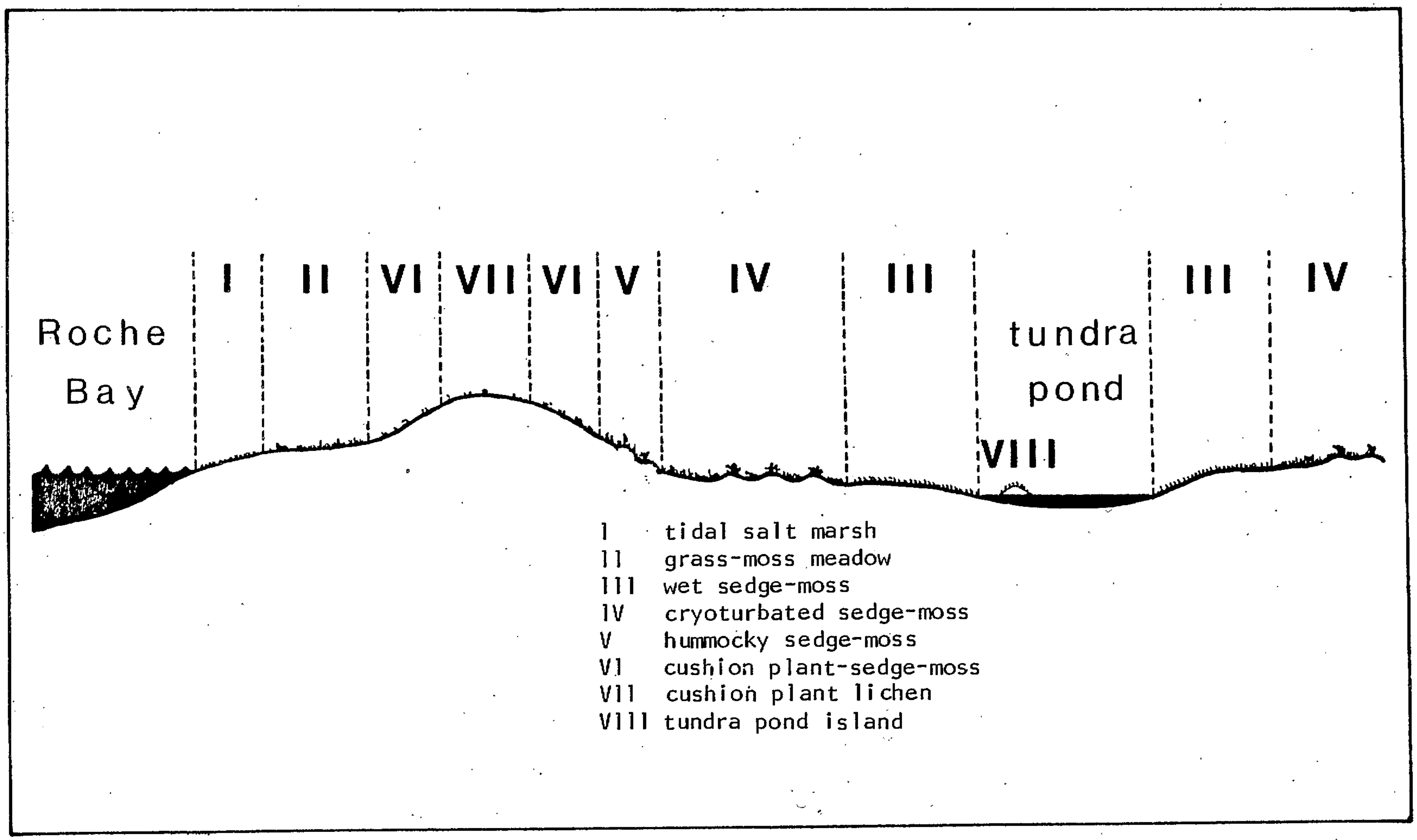

Figure 35. Bird habitat types in the Roche Bay area.

variant of the "tidal salt marsh" type but was not defined as a unique vegetation type. The "tundra pond island" habitat type was considered to be unique because of its selection for nest sites by many species.

From the literature, and previous bird work conducted in the study area, nesting habitat preferences of the 25 documented and "likely" breeders (hereafter referred to collectively as "breeders") can be identified (Table 10). Ground observations made during this study in 1981 were also useful in identifying habitat preferences.

Loons and waterfowl of the study area show a marked preference for the tundra pond island (VIII) and wet sedge moss (III) habitat types for nesting (Tables 10 and 11). The better-drained cryoturbated and hummocky sedge-moss habitat types (IV and V) are also favoured but to a much lesser degree. Marine-influenced habitat (types I and II) are preferred by brant and lesser snow geese.

Well-vegetated, sedge-moss habitat types (III and IV) are also attractive to birds other than loons and waterfowl (Tables 10 and 11). Affinity for islands in freshwater ponds is significantly less for this species group. Gulls and arctic terns, which do make use of these islands for nesting, are also attracted to marine-influenced habitat (types I and II). Of greater significance is the preference exhibited by many of the non-loon and waterfowl species for the drier, better-drained habitat types (V and particularly VI and VII) associated with raised beaches.

Considering all birds listed in Table 10, habitat associated with tundra ponds (cryoturbated and wet sedge moss types and islands) in the study area

Table 10. Nesting habitat preferences of documented and likely breeders at Roche Bay.

Species	Habitat type							
	I[a]	II	III	IV	V	VI	VII	VIII
Arctic loon			+					+
Red-throated loon			+					+
Whistling swan				+	+			+
Canada goose			+					+
Brant	+		+					+
Lesser snow goose		+	+					+
Greater snow goose			+	+				+
Oldsquaw			+	+				+
Common eider			+		+	+		+
King eider			+	+	+			+
Rock ptarmigan						+	+	
Semipalmated plover	+						+	+
Black-bellied plover							+	
Ruddy turnstone				+	+	+		
Baird's sandpiper						+	+	
Semipalmated sandpiper		+	+	+	+			
Sanderling						+	+	
Red phalarope			+	+				
Parasitic jaeger			+	+				
Long-tailed jaeger			+	+	+			
Herring/Thayer's gull	+	+		+				+
Sabine's gull	+	+	+	+				+
Arctic tern	+	+	+				+	+
Snowy owl				+	+	+	+	
Lapland longspur			+	+	+			

[a] see Figure 35 for illustration of habitat types.

Table 11. Numbers of loon, waterfowl and other bird species favouring each habitat type.

Species group	Habitat type							
	I[a]	II	III	IV	V	VI	VII	VIII
Loons & waterfowl	1 (4)[b]	1 (4)	9 (36)	4 (16)	3 (12)	1 (4)	0	10 (40)
Other birds	4 (16)	4 (4)	7 (28)	9 (36)	5 (20)	6 (24)	7 (28)	3 (12)
All birds	5 (20)	5 (20)	16 (64)	13 (52)	8 (32)	7 (28)	7 (28)	13 (52)

[a] see Figure 35 for illustration of habitat types

[b] percentage of birds in species group selecting habitat type; percentages do not add up to 100 because each species selects more than one habitat type (Table 10).

is of most importance to birds occurring in the study area (Table 11).

6.2.2 Past Resource Inventories

On July 7-9, 1979, an aerial survey of the Parry Bay coastline was flown by Reed et al. (1980). The emphasis of the survey was on breeding geese, although observations of other birds were also recorded. Results of the survey are described below.

Low-lying shorelines preferred by brant are sparsely distributed in Parry Bay, being restricted to protected bays. Tidal flats bordering these shorelines are therefore not as extensive as in other areas of the Foxe Basin (Reed et al. 1980). Consequently, brant were not found to be common in Parry Bay, observations being restricted to Quarman Point (Figure 36). Concentrations of breeding greater snow geese were noted in Parry Bay, particularly on Ignertok Peninsula and on the northern shoreline of Roche Bay (Figure 36). Many moulting waterfowl, and eider and oldsquaw creches, were present in the lakes near Hall Beach (P. Dupuis, pers. comm.).

On August 11, 1980, Reed and Dupuis (1980) counted 822 adult snow geese and 351 goslings (mostly in large creches) during another aerial survey of the Parry Bay area. Locations of the geese are shown in Figure 37. The reader should note that the formal survey route did not include Ignertok Peninsula and therefore no goose observations were made there. However, P. Dupuis (pers. comm.) noted that geese did appear to use that peninsula to a lesser extent in 1980 than in 1979. The survey results do indicate that, in 1980, the well-vegetated and ponded areas east and west of the Ikerasak River were very important for snow geese. A few days earlier,

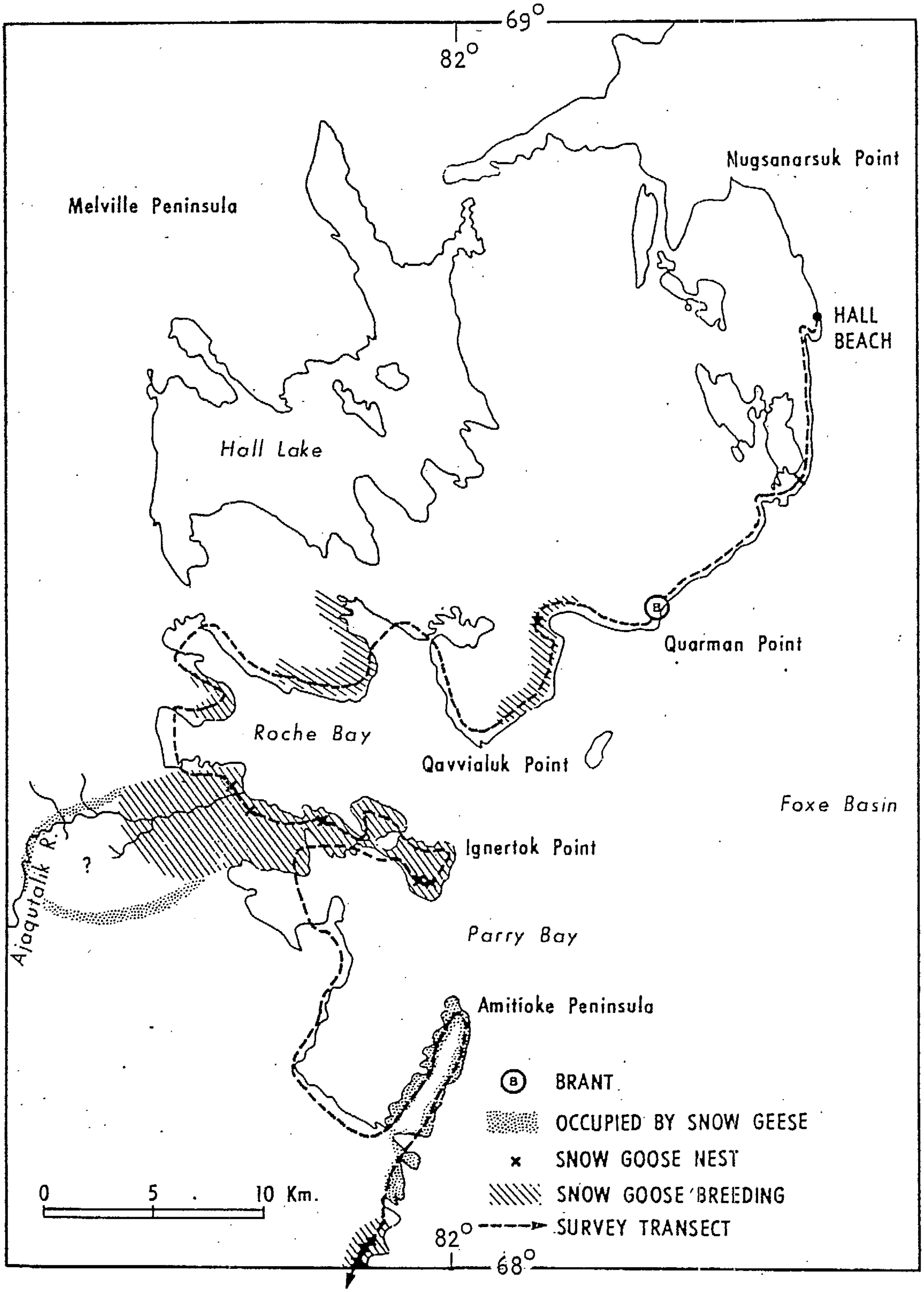

Figure 36 . Areas occupied by greater snow geese and brant in Parry Bay, July 7-9, 1979.

Source: Reed et al. (1980)

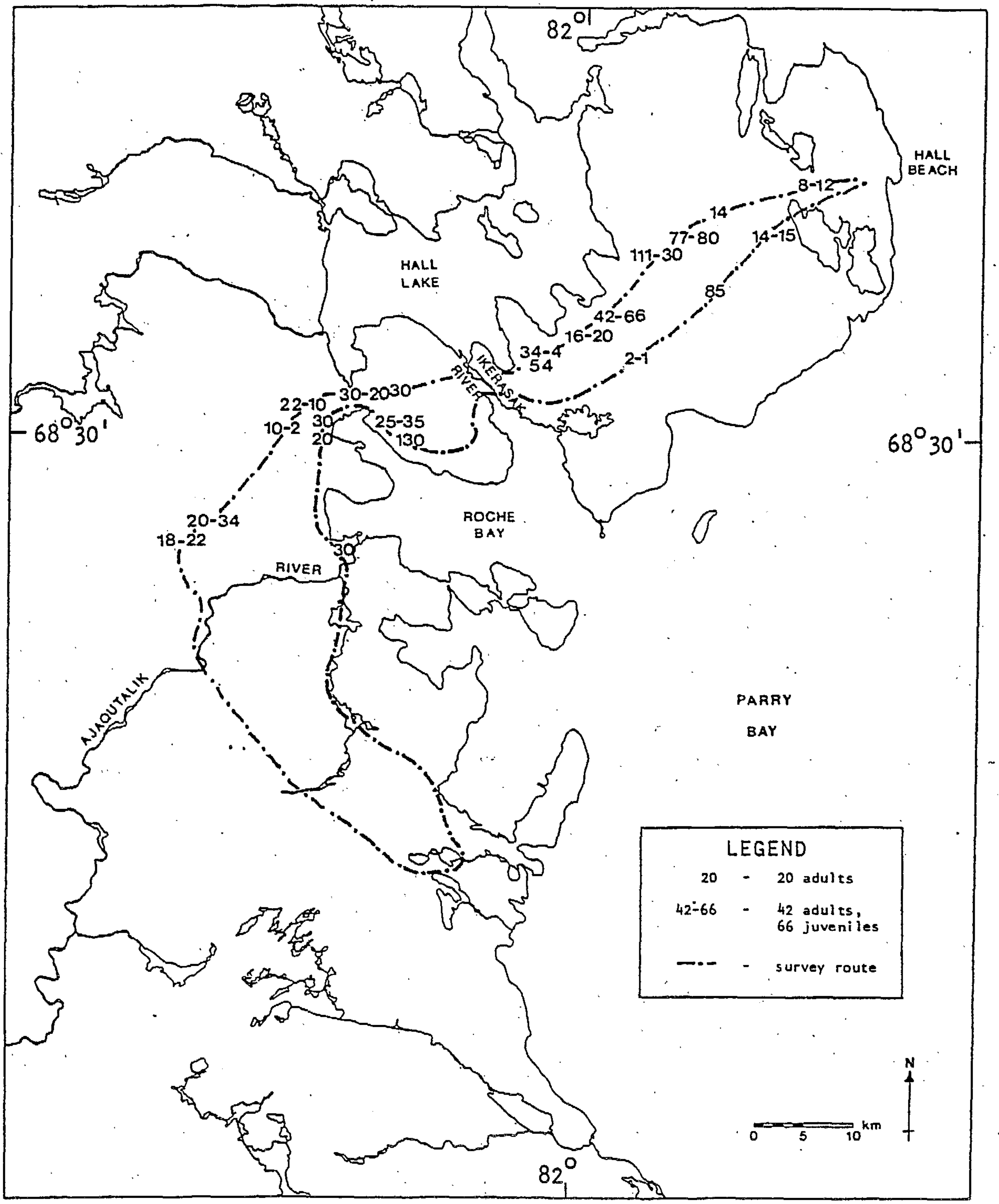

Figure 37 . Locations of adult and juvenile snow geese, August 11, 1980. Source: P. Dupuis (pers. comm.)

Elliott and Elliott (pers. comm.) counted 70 snow geese east and west of the Ikerasak River. Some groups were with young. Another 41 snow geese with young were observed further east. A pair of swans (no young) were present at each of the three locations. A fourth pair (no young) was seen in the vicinity of the large lakes southwest of Hall Beach.

Figure 38 shows distribution of adult snow geese in July, 1981 for comparison with earlier surveys.

6.2.3 Wildlife Resource Maps

The study area falls within area 12 ("Melville Peninsula - Southampton Island") in the Northern Land Use Information Series. Maps for this area have not yet been published. The relevant map sheet in the Arctic Ecology Map Series does not provide any information on migratory birds in the study area. The Northern Conservation Lands Inventory Steering Committee included all except the most interior region of Melville Peninsula in its list of "Canada's Special Places in the North" (Environment Canada 1982). The area was considered important for barren-ground caribou, raptors, walrus and avifauna.

6.2.4 Bird Use, Critical Habitat and Disturbance Sensitivity Maps

6.2.4.1 Bird Use Maps

From the results of all aerial and ground bird surveys that have been conducted in the study area and knowledge of habitat preferences, maps can be prepared which summarize bird use of the study area. Such maps are of course somewhat subjective, depending on the extent and detail of the data available. For example, the use of the study area by snow geese,

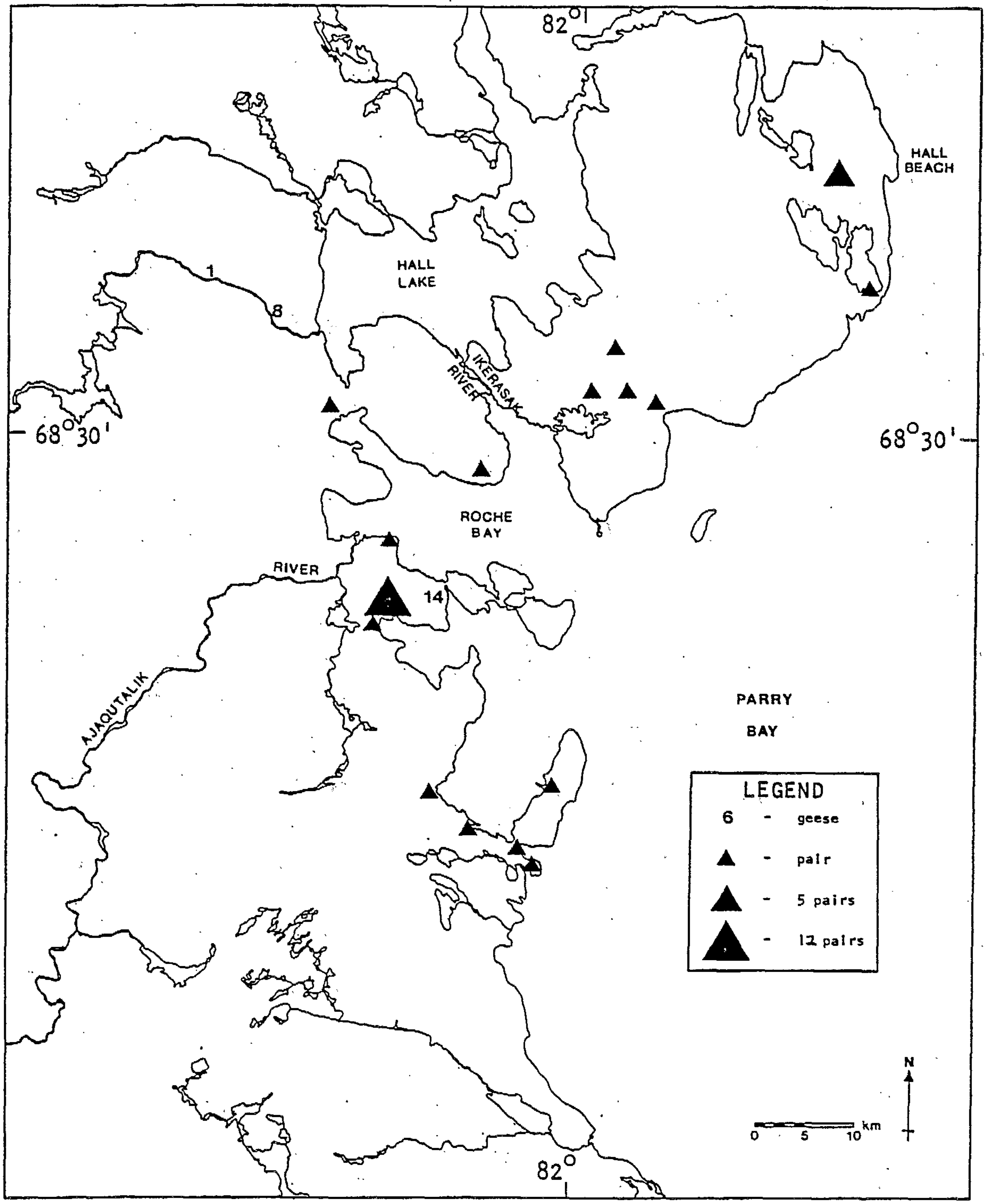

Figure 38 . Locations of adult snow geese, July 5-11, 1981.

described by the results of surveys conducted in 1979, 1980 and 1981, is not consistent from year to year. Many factors influence the use made by snow geese (and other bird species) of habitat on northern Melville Peninsula in a given year. These would include: mortality experienced by the Foxe Basin snow goose population on the wintering grounds; snow cover distribution on the peninsula at time of arrival of the geese; timing of snow melt and ice breakup; and weather conditions.

Figure 39 is an example of the kind of map that could be prepared to illustrate bird use of the study area.

6.2.4.2 Critical Habitat and Disturbance Sensitivity Maps

Critical habitat maps can be prepared by incorporating the vegetation maps produced from the LANDSAT analysis, bird distribution data and knowledge of habitat preferences. These maps would show distribution of habitat of greatest importance to selected species or species groups. They could be prepared quite easily by requesting the computer to map only those vegetation classes identified as being important to the species or species group in question, using the vegetation classification data already on file.

Disturbance sensitivity maps would take into account both habitat type and bird use, and the sensitivity of both the birds and habitat to human disturbance (e.g. use of all-terrain vehicles, construction activities, aircraft overflights). Maps could be prepared either for single species or species groups. In both cases, each vegetation class could be assigned one of several colours, each colour representing a degree of sensitivity.

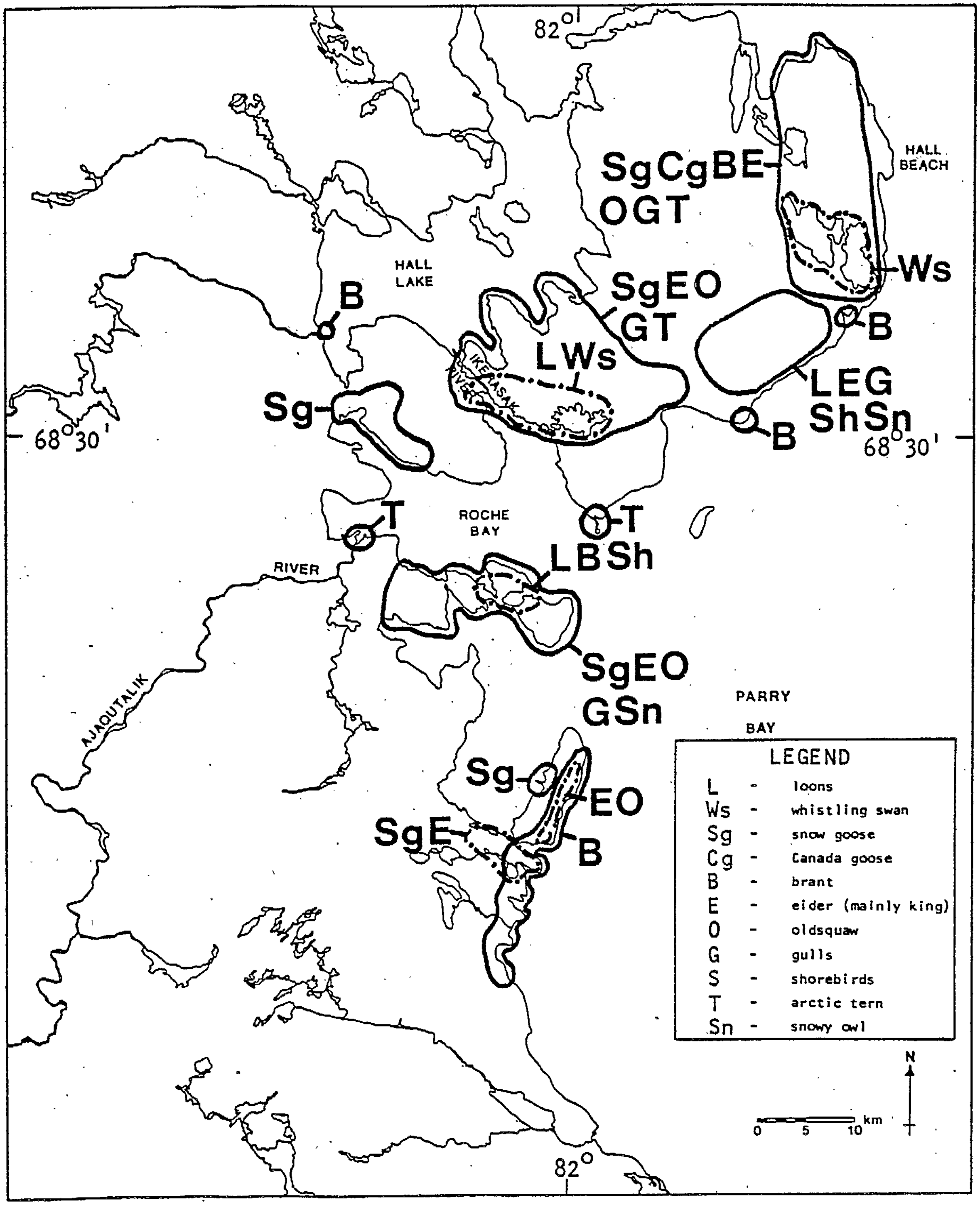

Figure 39. Areas important for birds in the Parry Bay area.

The sensitivity "rating" assigned to each vegetation class would depend on the species or species group in question.

6.2.5 Potential Impacts of the Borealis Proposal on Birds

Potential impacts of the Borealis iron ore development proposal on birds of the Parry Bay area are discussed in the following sections in order of decreasing magnitude.

6.2.5.1 Ore Carrier Traffic

Borealis has claimed that transportation of the ore to market using ore carriers can be accomplished during a maximum 102 day season between roughly August 1 and November 10 (Borealis 1982). Roche Bay should be largely, if not completely, free of ice by the beginning of the season. Detailed information on type and number of ore carrying ships to be employed, and scheduling is not presently available. Therefore, any concerns about possible hazards of shipping on birds can only be speculative at this stage.

Roche Bay is deep and is therefore attractive from a ship navigation point of view. However, the grounding and subsequent rupture of the vessel Edgar Jourdain 300 m from the shore at Hall Beach in September 1980 demonstrated that accidents can happen. An ore carrier could run aground in bad weather at Qavvialuk Point or along Ignertok Peninsula, for example, in its approach to the dock facility. Rupture of the vessel could result in the release of oil into Roche Bay. Oil could also be released as a result of a collision of an ore carrier with another vessel or during fueling operations at the dock facility. The source of oil pollution notwithstanding, the impact of possible oil releases on bird use and bird habitat of Roche Bay needs to be assessed.

Before the severity of potential oil pollution hazards can be determined, data on feeding, moulting, and staging seaduck use of Roche Bay and near-shore Parry Bay is required. Hundreds of oldsquaw and eiders were observed in the vicinity of the entrance to Roche Bay during the July 5 ice edge survey (Table 5, Figure 9). However, no data is available on seaduck populations using this area later in the season. The sensitivity of Roche Bay shorelines to oil pollution and capability for protection and clean-up also needs to be assessed. Shallow areas bordering gently-sloping land, and areas adjacent to salt marshes that receive greatest use by birds in Roche Bay, are the most vulnerable to oil spills. These shoreline areas need to be identified.

Because of the lack of data on bird use of Roche Bay itself and absence of details relating to shipping, the potential impact of shipping on birds cannot yet be assessed.

Although this study focusses on bird resources and development implications in the Parry Bay area, the potential consequences of an oil spill in the southeastern Foxe Basin and Hudson Strait areas are several orders of magnitude greater than in the Parry Bay area. Lesser snow geese nesting in the Dewey Soper Migratory Bird Sanctuary, located on the Great Plain of the Koukdjuak in west central Baffin Island, (Figure 40), constitute the world's largest goose colony (Nettleship and Smith 1975). In 1973, Kerbes (1975) estimated approximately 223 000 lesser snow goose nests in

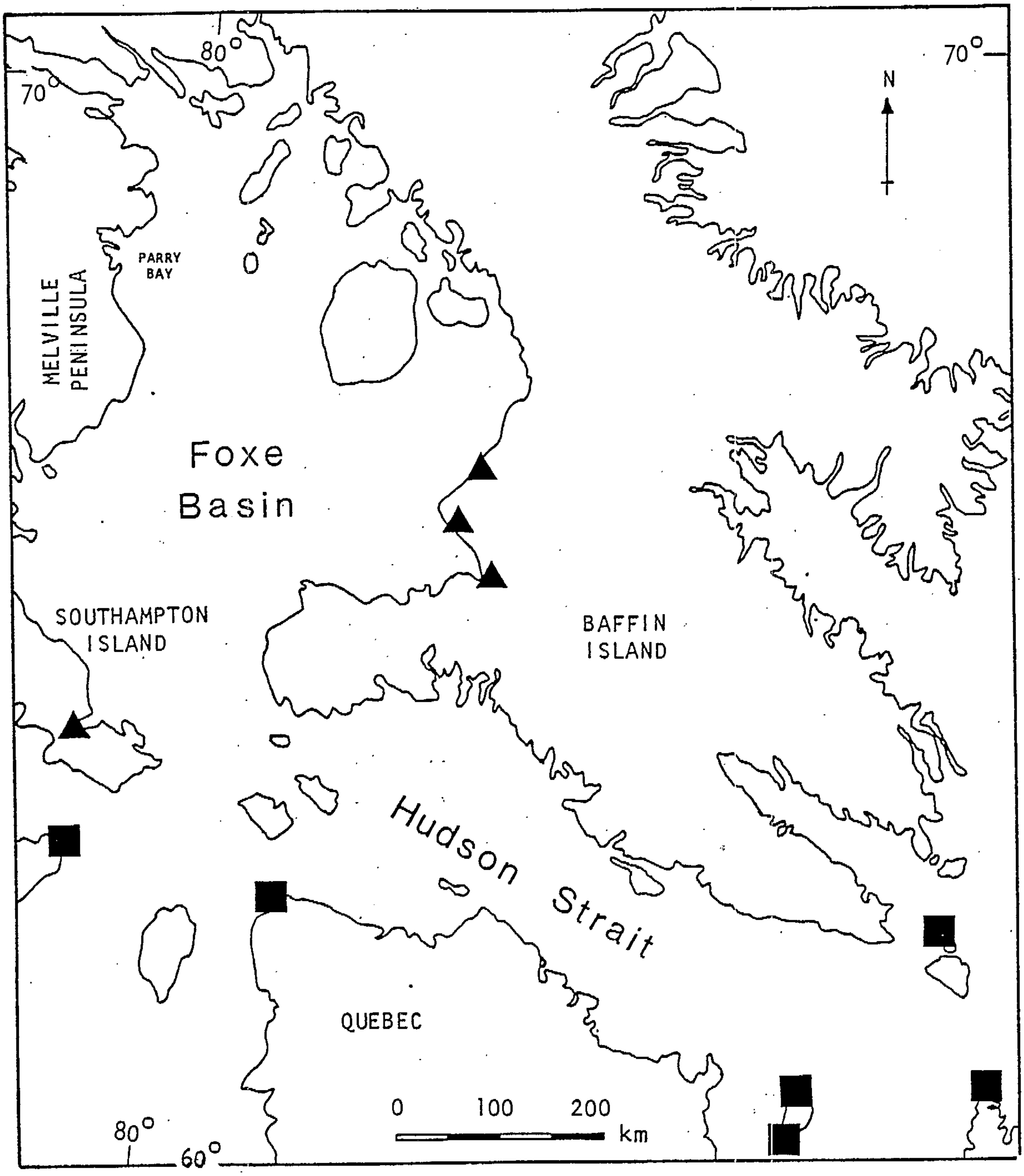

Figure 40 . Location of lesser snow goose colonies (▲) and seabird colonies (■) in south Foxe Basin and Hudson Strait.
Source: Gaston (1982), Boyd <u>et al</u>. (1982)

this area. An oil spill occurring along the ore carrier route through Foxe Basin could result in contamination of the saline and freshwater marshes adjacent to the marine shoreline where the geese breed. Such contamination could have a disastrous effect on the colony. Similarly such a spill could have a harmful effect on the East Bay lesser snow goose colony on the northern coast of Southampton Island. There were roughly 7 500 nests there in 1973 (Kerbes 1975).

Some 367,000 seabirds, including 300 000 thick-billed murres, are found in eastern Hudson Strait (Gaston 1982); the thick-billed murre colony at Digges Sound is the largest in the Canadian Arctic (Gaston 1980). Another 328 000 seabirds, including 315 000 thick-billed murres, occur in western Hudson Strait (Figure 40). While disturbance of the colonies themselves would probably not occur, feeding murres and migrating flightless murres could be adversely affected by ship traffic or by oil discharged from the ships. Brown et al. (1975) show areas in Hudson Strait where seabird concentrations are vulnerable to oil spills from July to October.

Without knowledge of the possible routes for ore carriers through Foxe Basin and Hudson Strait and oil spill contingency plans for this region, the potential impacts of shipping on birds cannot yet be assessed. However, they could be severe.

6.2.5.2 Road Construction and Use

As stated in section 4, an all-weather road connecting the iron ore mill and associated infrastructure (dock, town site, air strip, etc.) to Hall Beach would almost certainly be built, should the project go ahead.

Although candidate routes have not been selected (or have not been publicized), the routing would most likely run south of Hall Lake, across the Ikerasak River and on to Hall Beach, using raised gravel beaches wherever possible.

The most significant impacts would likely occur in the well-vegetated, heavily ponded areas located west and east of the Ikerasak River. This area is important to snow geese for feeding and brood rearing, and probably nesting. The area is also used to a lesser degree by loons, eiders, oldsquaws, gulls and arctic terns. Habitat, east of the river, was the only area that whistling swans were observed in 1981.

Except for snow geese, construction and use of a road through this habitat would have only a minor effect on bird species since actual numbers of birds using the area are very low. However, the impact of the road on snow geese would be at least moderate and could approach severe. In July 1979, Parry Bay had the largest numbers of breeders of all locations surveyed in the Foxe Basin by Reed et al. (1980) (Table 12). However, in 1980 Reed and Dupuis (1980) found large numbers of breeding snow geese on Jens Munk Island in north Foxe Basin (not surveyed in 1979) and much sparser distribution between Parry Bay and Fury and Hecla Strait. Results of the present study show that numbers of breeding snow geese were much reduced at Parry Bay in 1981. Reports of other observers in the area in 1982 indicate a similar low use of the area that year (P. Dupuis, pers. comm.).

The dynamics of the Foxe Basin and northern Baffin Island snow goose

Table 12. Numbers of greater snow geese observed in Foxe Basin, July 7-9, 1979.

Area	Breeders	Total birds seen
West Foxe Basin		
Parry Bay	211	369
East Foxe Basin		
Taverner Bay	0	20
North Foxe Basin		
Longstaff Bluff, Straits and Piling bays, Piling Lake	33	489
Tikerarsuk Point	6	41
Grant - Sutlie Bay	18	107
Steensby Inlet (north)	19	372
Steensby Inlet (south)	46	546
Murray Maxwell Bay	25	735
	147	2 290
Islands in Foxe Basin		
Foley Island	6	6
Air Force Island	13	24
Prince Charles Island	8	8
Bray Island	1	1
Koch Island	15	18
Rowley Island	7	16
	50	73

Source: Reed *et al*. (1980)

populations is not understood. Reed and Dupuis (1980) estimate that the Parry Bay area supports several hundred pairs of snow geese (see Table 12). Breeding use of this location in a particular year, compared to use of habitat elsewhere in Foxe Basin or northern Baffin, however, would be influenced by spring conditions. Compared to lesser snow geese, greater snow geese are more "nomadic" by nature. Consequently, in a given year they tend to home to a general region, such as northern Foxe Basin, and then select breeding habitat according to what is available that spring (A. Dzubin, pers. comm.). Further work on the interrelationships between habitat areas in Foxe Basin is needed before impacts of road construction and operation on snow geese can be properly assessed.

Further east, the road would be located predominantly on beach ridges. Birds, such as loons and eiders, using ponds bounded by these ridges would experience disturbance from both construction and traffic activity. However, due to the low numbers of birds in the area, the overall impact would likely be very slight. Birds preferring the sparsely-vegetated crowns and slopes of the ridges, such as semipalmated and black-bellied plovers and Baird's sandpipers, would experience a small loss in available nesting habitat. However, because numbers of these species inhabiting northeastern Melville Peninsula are small, only a slight impact would be experienced. Although, routing of the road has not been finalized, the road would most likely use the beach ridges running south from Hall Beach approximately 20 kilometres, adjacent to the Parry Bay coastline. This series of beach ridges, in fact, follows the shore to Qavvialuk Point and beyond. Inuit from Hall Beach take advantage of this "ready-made" roadway using all-terrain vehicles to obtain access to, for example, the Ikerasak

River for fishing. This route would, of course, be also attractive to Borealis for its proposed road.

Species that could be affected by use of a road along the shoreline include brant, arctic terns, and gulls (particularly Sabine's gulls). Results of the coastline survey flown in 1981 showed that the section of coastline between Hall Beach and Qavvialuk Point was favoured most by sandpipers, gulls and terns (section 5.3.2.2). In addition, brant have been observed at various locations along this coastline. Some disturbance of these populations would likely result from road traffic. The impact would probably be slight to moderate, depending on the species. There may have been some habituation by birds to the current Inuit traffic. The extent to which this has occurred is, however, not known and requires further study.

Road traffic along the coastline could reduce seaduck use of the lead which occurs along the Parry Bay shoreline in early spring. Distribution and numbers of birds, such as eiders and oldsquaw, using this lead is not known and therefore the magnitude of this impact is difficult to assess. However, any disturbance that might occur would probably be slight and of short duration and would probably not be significant. Development of the Parry Bay shoreline lead system and its use by waterfowl in the spring needs to be documented to resolve this question.

6.2.6.3 Aircraft Traffic

Although a need for an air strip has been stated by Borealis, siting of the air strip has not been finalized, to the author's knowledge. One possibility that has been considered is the peninsula at the western end of Roche Bay which has been identified for dock and ore storage facilities (Figure 7).

Operation of the air strip could result in disturbance of spring staging waterfowl using the open water area created by the outflow of the Ajaqutalik River (Figure 3). As stated in the previous section, data oh bird use of the bay itself is lacking. Therefore it is not possible to assess the potential impact of air strip operation on these birds. Without knowing the orientation of the air strip, type of aircraft to be used and aircraft traffic projections, the effect of aircraft activity on terrestrial bird use in the Roche Bay area cannot be assessed. Mitigation of adverse effects may be possible through restrictions on air strip approach and departure routing and altitude.

6.2.5.4 Hydroelectric Development of the Ajaqutalik River

Hydroelectric development of the Ajaqutalik River to supply power for the mining operation and associated facilities was initially considered by Borealis. However, it now appears that hydroelectric power development would not be part of the initial start-up of the mine. Hydroelectric facilities do not have to be in place before ore extraction begins.

Because plans for hydroelectric development are only conceptual, assessment of possible impacts of a dam on the Ajaqutalik River can only be speculative. From the limited observations made during the Ajaqutalik River survey, and other ground reconnaissance, the river appears to be of some importance to waterfowl, particularly Canada geese. Relatively well-vegetated areas, such as Sanguaq Bend, are distributed discontinuously upstream of the proposed dam location. Should plans for the dam become more serious, data should be collected to document bird use of the river and to delineate important riparian habitat.

Modification of the Ajaqutalik River flow regime would likely alter ice formation and break-up patterns in Roche Bay. Possible impacts of flow modification on birds would need to be studied should further attention be given to the feasibility of hydroelectric development.

7. SUMMARY AND CONCLUSIONS

The Parry Bay area was divided into two ecoregions by Jaques (1982): the Melville Uplands and Igloolik Lowlands. Seven ecodistricts were recognized in the Igloolik Lowlands ecoregion, each characterized by a unique assemblage of landform units, vegetation associations, soils and large-order microclimate conditions.

Computer analysis of LANDSAT digital data produced 17 classes, each corresponding to specific groupings of land, vegetation and water features. Using ground data on vegetation communities, the final biophysical classification comprised 10 classes. Each class was assigned a colour and colour-coded biophysical maps were produced at a scale of 1:70 000 (Jaques 1982). From these maps, a derivative map was created which showed the distribution of shallow marine areas, wetland areas and areas of possible nitrogen enrichment, in the Roche Bay area, which would be most attractive to water-oriented birds.

A total of 3 366 seaducks were observed during an aerial survey of the shorefast ice edge in Parry Bay. The flocks consisted of oldsquaws, king eiders and common eiders. Highest density of seaducks occurred along the eastern shoreline of Ignertok Peninsula.

During an aerial survey of the Parry Bay and Roche Bay shorelines, from Hall Beach to Cape Jermain, Ignertok and Amitioke peninsulas were found to be popular for loons and waterfowl species. The section of shoreline between Hall Beach and Qavvialuk Point was attractive to some species, particularly brant, oldsquaw, sandpipers, gulls and terns. Roche Bay itself received less use by loons and waterfowl than the remainder of the shoreline to the north and south. Arctic terns were the most common of the non-loon and waterfowl species in Roche Bay.

Results of the aerial transect surveys showed that coastal (marine-influenced) regions of the study area were the most attractive to loons and waterfowl. Habitat on Ignertok Peninsula, in the area east of the Ikerasak River, and south of Hall Beach was favored. Gulls and terns were most abundant in habitat to the north and south of Hall Beach, extending about 10 kilometres inland. Wetland habitat in the vicinity of the Ikerasak River was attractive to a lesser degree. Sandpipers and snowy owls were most common in the raised beach/pond complex southwest of Hall Beach.

Observations made during an aerial survey of the Ajaqutalik River indicated that reaches of the river, where the banks were low-lying and better-vegetated, were useful for moulting Canada geese. The occurrence of red-breasted mergansers on the river was significant since the northern limits of the known breeding range are more than 500 km to the south.

A technique of environmental impact assessment using visual and computer mapping of LANDSAT imagery and results of a biophysical inventory conducted by Jaques (1982), was demonstrated and applied to the Borealis iron ore development proposal. The procedure, referred to as the Biophysical LANDSAT Technique, incorporates biophysical land classification and inventory using LANDSAT imagery with bird censusing and provides a means for predicting possible environmental impacts on birds in a relatively short, two-year period. Biophysical land classification using LANDSAT data is completed during the first year, culminating in the production of vegetation community and terrain sensitivity maps. These map products can be used, in conjunction with data compiled from previous resource surveys, knowledge of bird habitat preferences, etc., to design the migratory bird surveys to be conducted during the second year. By combining the results of the bird surveys with the vegetation or habitat maps already prepared, other maps illustrating bird use, critical habitat areas, disturbance sensitivity, etc., can be generated.

Using the type of maps described above, and available information on the Borealis iron ore development proposal, the potential impacts of this project on birds were assessed. The most significant impacts in the Roche Bay area would result from construction and operation of a road connecting the mine site with Hall Beach. Routing of the road would necessitate crossing the Ikerasak River and important well-vegetated waterfowl habitat occurring on both sides of the river. Use of the road could adversely affect snow goose brood rearing, and probably nesting, use of this habitat. This potential impact was rated moderate but could approach severe depending on the use of Roche Bay habitat by snow geese in particular years. Some disturbance of brant, sandpipers, gulls and terns could occur should the road follow beach ridges adjacent to the shoreline south of Hall Beach.

Release of oil into Roche Bay could occur as a result of collision of an ore carrier with another vessel, grounding, or during fueling operations at the dock facility. Due to lack of data on seaduck use of Roche Bay waters, the potential effects of such occurrences on birds cannot be properly assessed. Classification of Roche Bay and Parry Bay shorelines, according to their sensitivity to oil spills and potential for clean up, is necessary before the potential of oil spills on bird habitat can be assessed.

Far greater potential threats to birds associated with ore carrier traffic exist outside the Parry Bay study area in the southeastern Foxe Basin and Hudson Strait regions. An oil spill occurring in the southern part of Foxe Basin resulting in contamination of shorelines in the Great Plain of Koukdjuak area of Baffin Island could be disastrous to the world's largest lesser snow goose colony. Similarly, potential oil spills pose a severe threat to hundreds of thousands of thick-billed murres feeding and swimming in Hudson Strait. The murres could also be adversely affected by presence of the ore carriers in the Strait. Knowledge of shipping routes, ore carrier frequency and oil spill contingency plans for the Foxe Basin and Hudson Strait regions is required before potential impacts on birds can be properly evaluated.

Disturbance of spring staging and moulting waterfowl in Roche Bay could result from aircraft traffic using the proposed air strip at the western end of the bay. Because of the lack of data on waterfowl use of Roche Bay waters and aircraft traffic projections, the potential impact of aircraft traffic on birds cannot be properly assessed.

Development of the hydroelectric potential of the Ajaqutalik River could affect its use by moulting Canada geese and other birds. However, further data on bird use are required before impacts of any hydroelectric development could be evaluated.

8. RECOMMENDATIONS

(1) Should a decision be made to construct a road from the mine development area to Hall Beach, studies should be conducted to:

(a) identify important habitat for nesting and brood-rearing snow geese along the preferred and alternate routes, and

(b) determine the importance of habitat in the Parry Bay area to snow geese relative to other habitat in the Foxe Basin area.

(2) Before ore carriers commence operations,

(a) seaduck use of Roche Bay and Parry Bay waters during the shipping season should be documented,

(b) the coastline extending from Hall Beach to Cape Jermain, including Roche Bay, should be classified according to its sensitivity to oil spills and potential for cleanup.

(c) oil spill contingency plans should be developed which detail responses to be made in the event of an oil spill occurring in Roche Bay, Parry Bay, Foxe Basin and Hudson Strait; these should include designation of areas of highest priority for protection,

(d) oil spill contingency plans should receive approval by the appropriate government agencies.

(3) Before aircraft activity commences at the proposed air strip, specific aircraft approach and departure routes and expected flight path altitudes should be reviewed by the appropriate government agencies to ensure that disturbance to bird

populations is minimized.

(4) Should development of the hydroelectric potential of the Ajaqutalik River be reconsidered, studies should be conducted:

(a) to determine loon and waterfowl use of reaches of the river upstream and downstream of proposed dam site(s),

(b) to identify important riparian bird habitat which would be adversely affected by such development, and

(c) to determine the effects of altered Ajaqutalik River flow regimes on ice breakup patterns and chronology in Roche Bay and spring bird use.

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Appendix 1. Provisional checklist of the birds of the Roche Bay area, Melville Peninsula.

This appendix summarizes published information on avifauna of the Roche Bay area and incorporates observations made during the 1981 field work. The main sources of information are: M = Montgomerie et al. (1983); R = Reed et al. (1980); E & E - Ellis and Evans (1960); B = this study.

The assignment of common (C), uncommon (U) or rare (R) status is subjective. "Rare" status applies to those species for which: (a) there are no known observation records in the study area itself but the species has been recorded in adjacent areas and/or (b) Godfrey (1966) or Snyder (1957) indicates the breeding range includes the study area. Species are "common" if they are more abundant in the study area than other (uncommon) species. "Common" status does not infer abundance relative to other areas of the Canadian Arctic. The prefix "P" indicates that breeding of the species in the study area is probable but not definite. Species for which breeding has been documented in the study area by one or more observations of nests or juveniles have been assigned the "B" prefix. The "B?" prefix applies to species for which no nests or juveniles have been observed but other evidence indicates that the species likely breeds in the study area.

Where identification of a species in the study area by one of the four observation record sources was tentative only, a "?" appears in the "occurrence records" column.

Appendix 1. Provisional checklist of the birds of the Roche Bay area, Melville Peninsula.

Species	Provisional status in study area	Preferred habitat	Occurrence records M	R	E&E	B	Remarks
Yellow-billed loon Gavia adamsii	P - uncommon	moist tundra					Melville Peninsula included in breeding range by Godfrey (1966)
Arctic loon Gavia arctica	B?- uncommon	moist tundra	+	+		+	pairs observed; no nests or juveniles recorded
Red-throated loon Gavia stellata	B - uncommon	moist tundra	+			+	
Whistling swan Olor columbianus	B - uncommon	moist tundra		+		+	
Canada goose Branta canadensis	B - uncommon	moist tundra		+		+	pairs observed; no nestsor juveniles recorded
Brant Branta bernicla	B - common	wet tundra		+	+	+	
Lesser snow goose Chen caerulescens caerulescens	B?- uncommon	wet tundra		+			pairs observed by Reed et al.(1980); no nests located
Greater snow goose Chen caerulescens atlanticus	B - common	wet tundra	+	+		+	
Oldsquaw Clangula hyemalis	B common	moist tundra	+	+	+	+	juveniles observed near Hall Beach (P.Dupuis, pers. comm.)
Common eider Somateria mollissima	B?- uncommon	moist tundra		+		+	territorial female observed (this study); breeders common on S. Coglit Island (Bray 1943)
King eider Somateria spectabilis	B - common	moist tundra	+	+	?		

Appendix 1 (contd.).

Species	Provisional status in study area	Preferred habitat	Occurrence records M	R	E&E	B.	Remarks
Rough-legged hawk Buteo lagopus	P - uncommon	cliffs, ravines	+			+	territorial bird seen near Ignertok Peninsula snow goose colony (this study)
Gyrfalcon Falco rusticolis	P - rare	cliffs					breeding range includes Melville Peninsula (Godfrey 1966); bird seen at Sarcpa Lake, west of study area (Montgomerie et al. (1983)
Peregrine falcon Falco peregrinus	U - rare	cliffs					breeding recorded on extreme northern Melville Peninsula (Snyder 1957)
Willow ptarmigan Lagopus lagopus	P - uncommon	moist-heath tundra					breeding range includes Melville Peninsula (Godfrey 1966)
Rock ptarmigan Lagopus mutus	B?- common	dry sparsely-vegetated tundra					nest and broods seen at Sarcpa Lake (Montgomerie et al. (1983)
Sandhill crane Grus canadensis	U - uncommon	wet tundra				+	Melville Peninsula is within summer range of species (Snyder 1957)
Semipalmated plover Charadrius semipalmatus	B - common	barren raised beaches, gravel ridges			+	+	juveniles observed near Hall Beach (P. Dupuis, pers. comm.)
American golden plover Pluvialis dominica	P - common	dry vegetated slopes	+		?	+	breeding range includes Melville Peninsula (Godfrey 1966)
Black-bellied plover Pluvialis squatarola	B - common	sparsely-vegetated gravel ridges	+		?	+	
Ruddy turnstone Arenaria interpres	B - common	wet tundra			+	+	
Red knot Calidris canutus	U - rare	diverse					Godfrey (1966) indicates possible breeding on Melville Peninsula

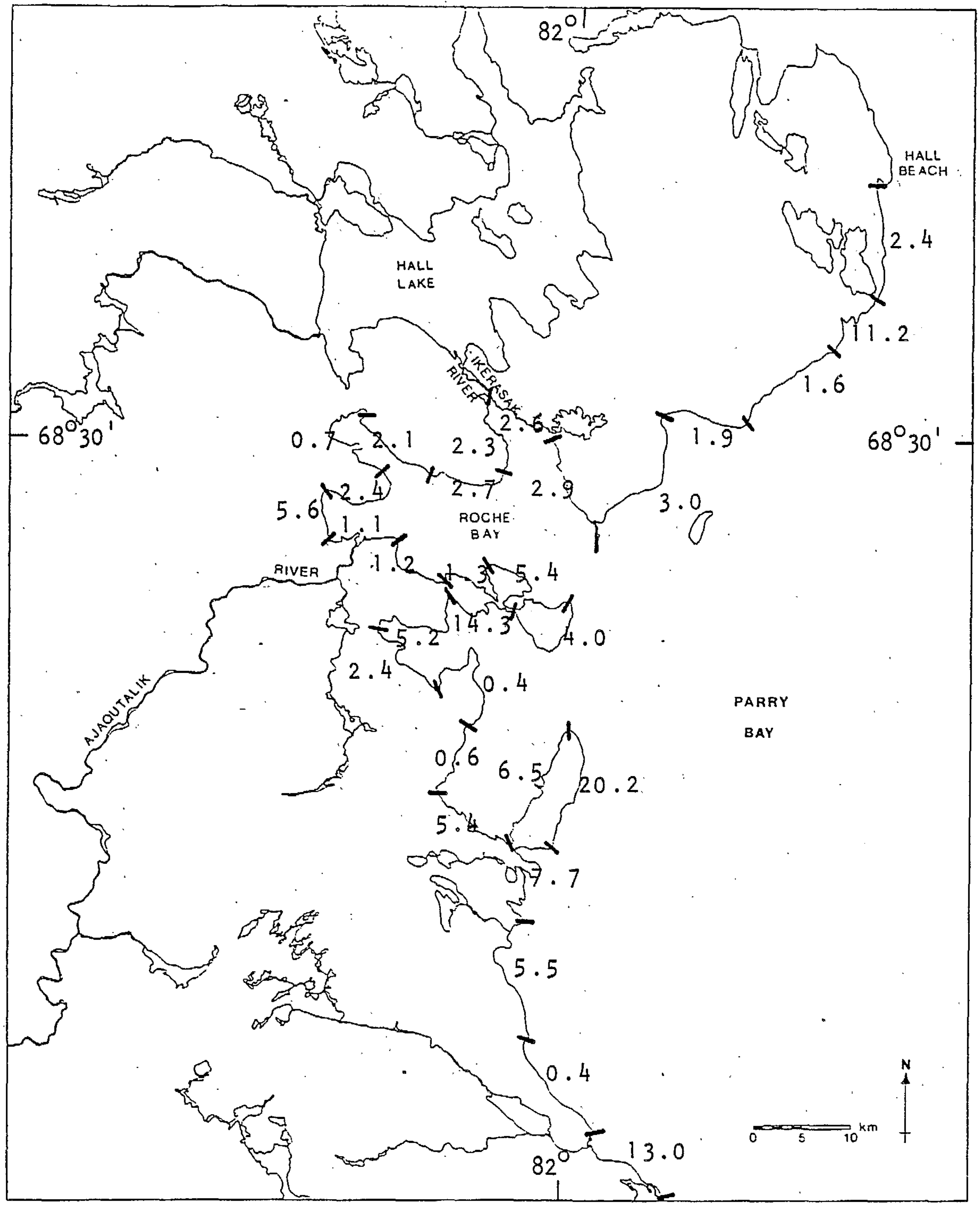
Appendix 1 (contd.).

Species	Provisional status in study area	Preferred habitat	Occurrence records H	R	E&E	B	Remarks
White-rumped sandpiper Calidris fuscicollis	P - common	wet tundra	+		+	+	breeding range includes coastal Melville Peninsula (Godfrey 1966)
Baird's sandpiper Calidris bairdii	B?- common	barren raised beaches, gravel ridges	+		+	+	pairs observed during this study, nesting observed north of study area by Bray (1943)
Dunlin Calidris alpina	P - uncommon	moist-wet tundra	+			+	breeding range includes Melville Peninsula (Godfrey 1966)
Semipalmated sandpiper Calidris pusilla	B - uncommon	moist-wet tundra					juveniles observed near Hall Beach (P.Dupuis, pers. comm.)
Sanderling Calidris alba	B - uncommon	sparsely-vegetated gravel ridges					juveniles observed near Hall Beach (P. Dupuis, pers. comm.)
Red phalarope Phalaropus fulicarius	B?- common	wet tundra	+		+	+	breeding pairs observed (this study)
Parasitic jaeger Stercorarius parasiticus	B - uncommon	wet tundra	+		+	+	
Pomarine jaeger Stercorarius pomarinus	U - uncommon	wet tundra			+	+	Melville Peninsula not included in breeding range indicated by Godfrey (1966)
Long-tailed jaeger Stercorarius longicaudus	B - uncommon	moist-wet tundra	+		+	+	
Herring/Thayer's gull Larus argentatus &. L. thayeri	B - uncommon	gravel ridges and sparse tundra	+	+	+	+	
Iceland gull Larus glaucoides	U - uncommon	coastal or near-coastal cliffs, rocky islands					observed near Hall Beach (P. Dupuis, pers. comm.); breeds on southern Baffin Island (Godfrey 1966)

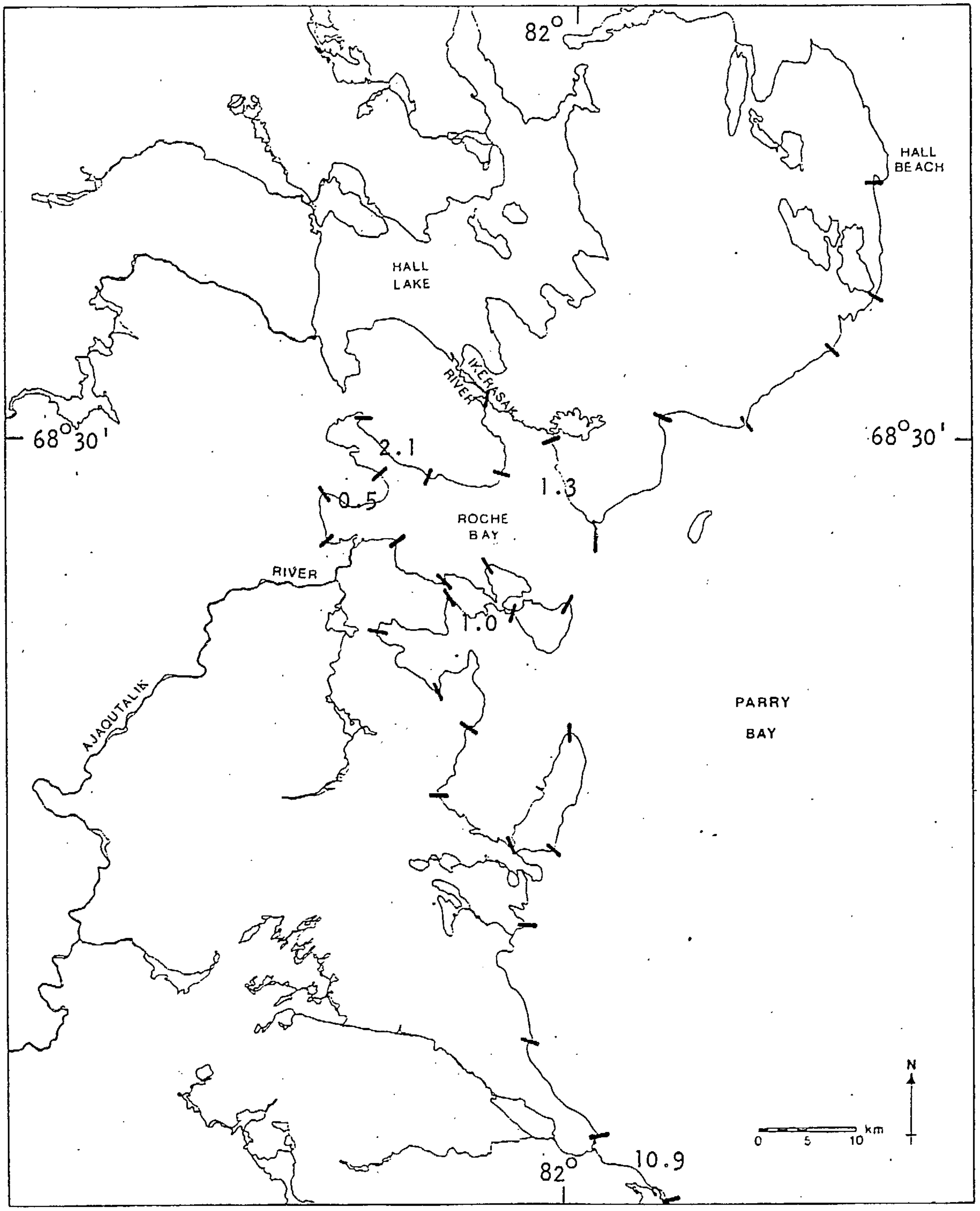
Appendix 1 (contd.).

Species	Provisional status in study area	Preferred habitat	Occurrence records M	R	E&E	B	Remarks
Glaucous gull <u>Larus</u> <u>hyperboreus</u>	U - uncommon	coastal tundra, freshwater islands and lakeshores		+	+	+	possible breeding on Melville Peninsula (Godfrey 1966)
Sabine's gull <u>Xema</u> <u>sabini</u>	B?- uncommon	tundra ponds, coastal wet tundra		+	+	+	colony observed (this study)
Arctic tern <u>Sterna</u> <u>paradisaea</u>	B - uncommon	freshwater islands and lakeshores, coastal sand and gravel bars	+			+	juveniles observed near Hall Beach (P. Dupuis, pers. comm.)
Black guillemot <u>Cepphus</u> <u>grylle</u>	P - rare	flat rocky islands					breeding range includes coastal Melville Peninsula (Godfrey 1966)
Snowy owl <u>Nyctea</u> <u>scandiaca</u>	B?- rare	flat rocky islands		+		+	nesting pair observed north of study area (Bray 1943)
Horned lark <u>Eremofila</u> <u>alpestris</u>	P - uncommon	raised beaches, gravel ridges			+		breeding observed at Sarcpa Lake (Montgomerie <u>et</u> <u>al</u>. (1983)
Common raven <u>Corvus</u> <u>corax</u>	P - rare	cliffs					nesting observed north of study area (Bray 1943)
Water pipit <u>Anthus</u> <u>spinoletta</u>	P - rare	sparsely-vegetated slopes					juveniles observed with adult at Sarcpa Lake (Montgomerie <u>et</u> <u>al</u>. (1983)
Lapland longspur <u>Calcarius</u> <u>lapponicus</u>	B?- common	moist hummocky tundra	+		+	+	breeding pairs observed (this study)
Snow bunting <u>Plectrophenax</u> <u>nivalis</u>	P - uncommon	rocky outcrops, talus slopes	+		+	+	breeding range includes Melville Peninsula (Godfrey 1966)

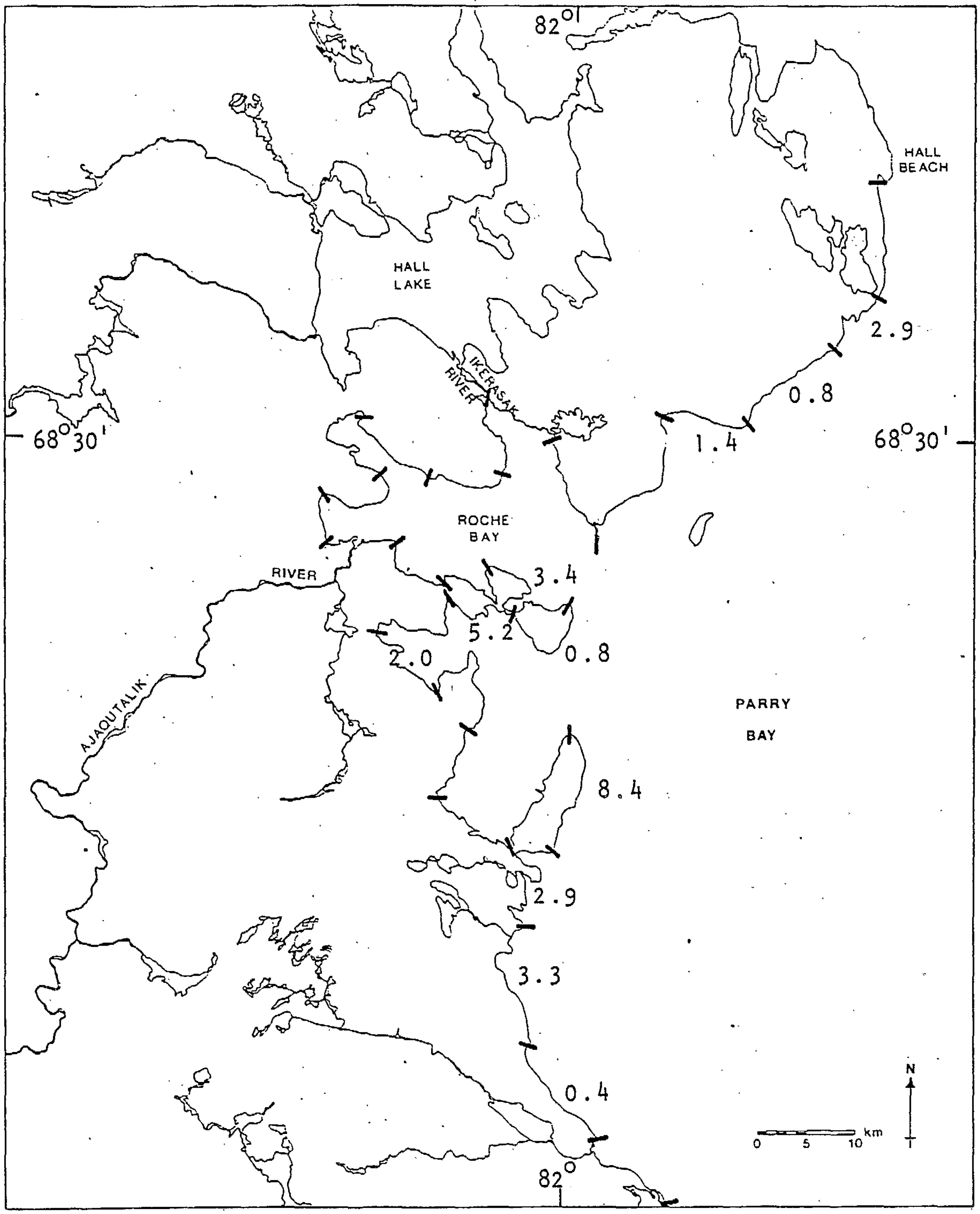
APPENDIX II



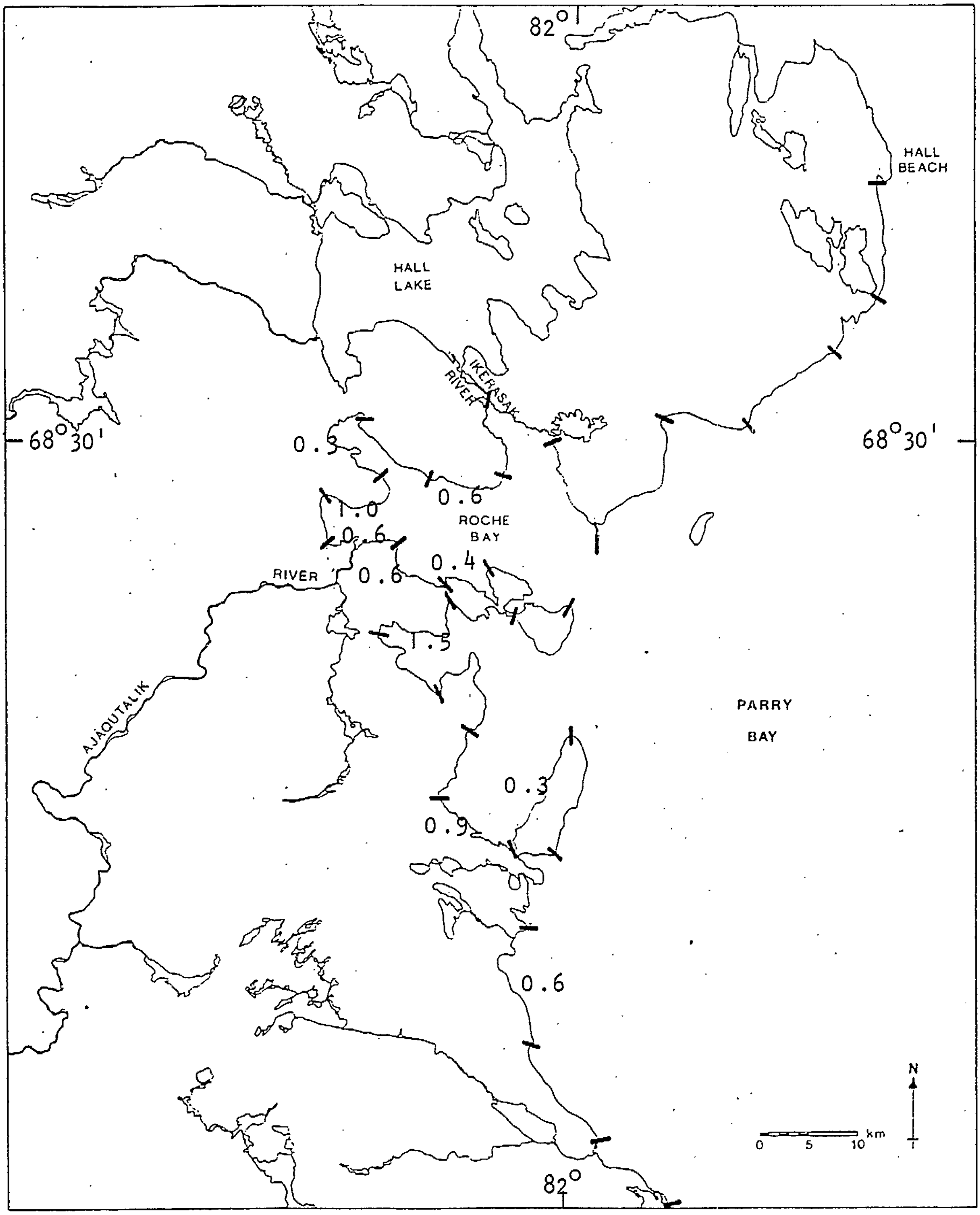
(a) Densities (birds/km^2) of loons and waterfowl in coastal segments of the Parry Bay shoreline, July 9-10, 1981.



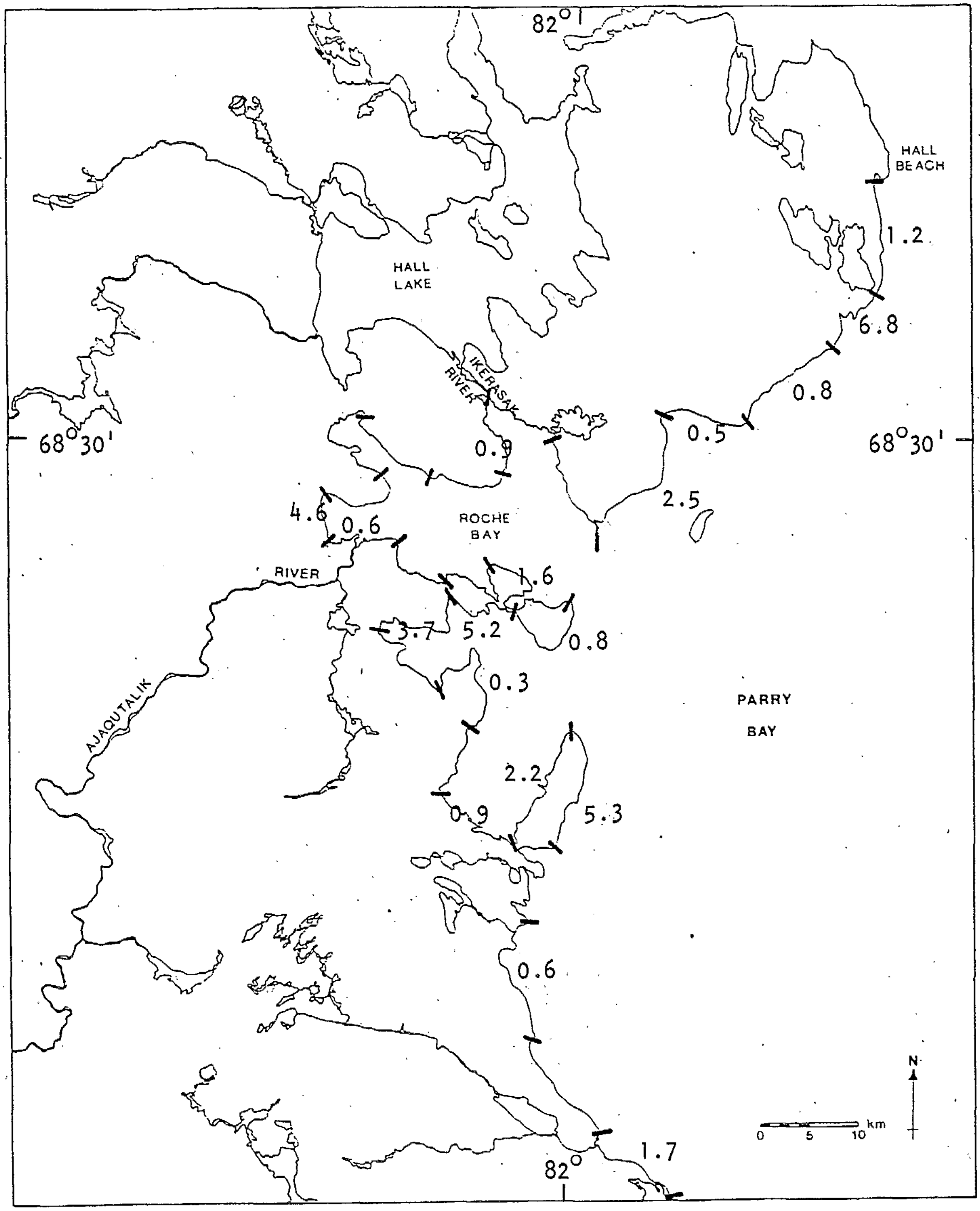
(b) Densities (birds/km^2) of Canada geese in coastal segments of the Parry Bay shoreline, July 9-10, 1981.



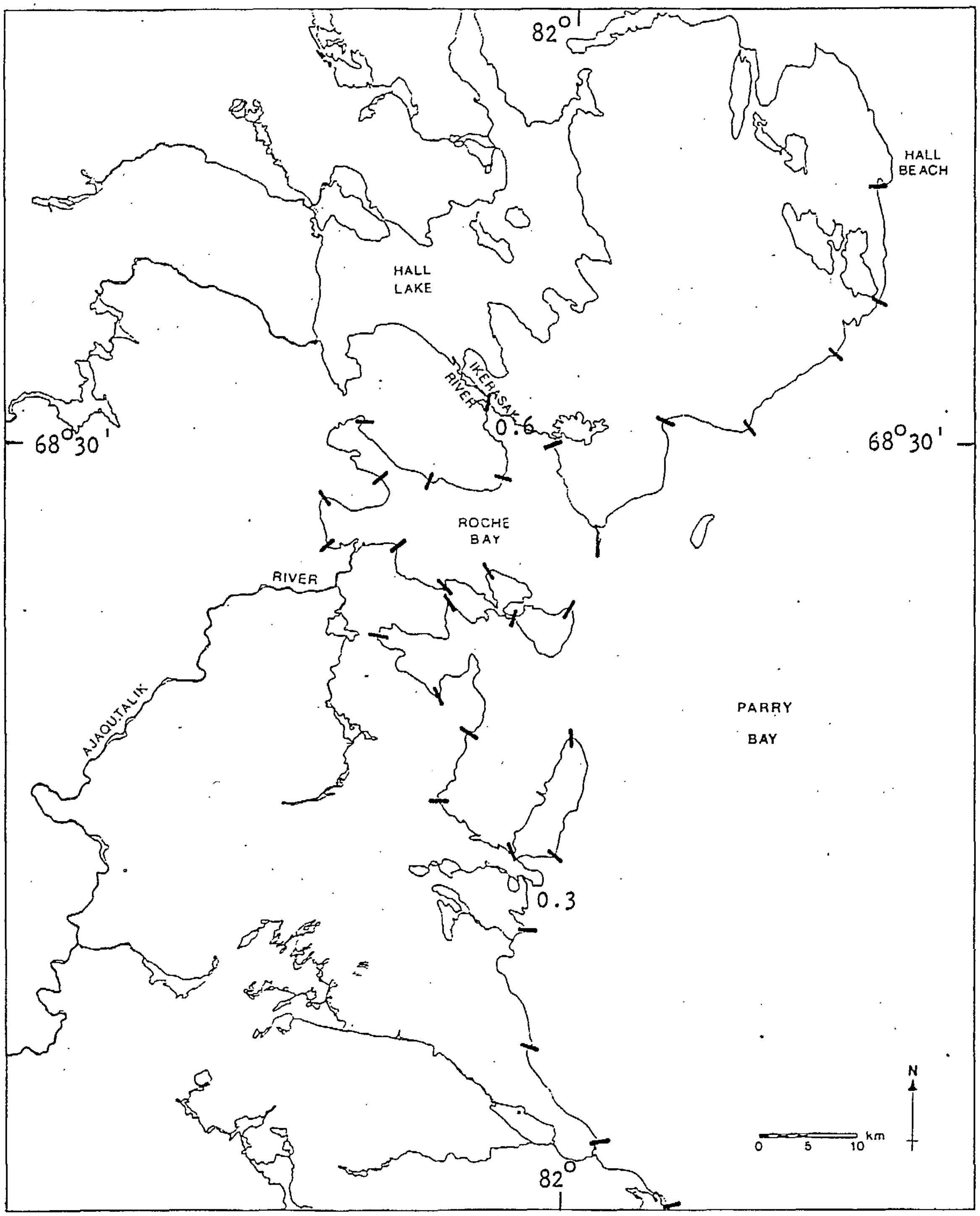
(c) Densities (birds/km^2) of brant in coastal segments of the Parry Bay shoreline, July 9-10, 1981.



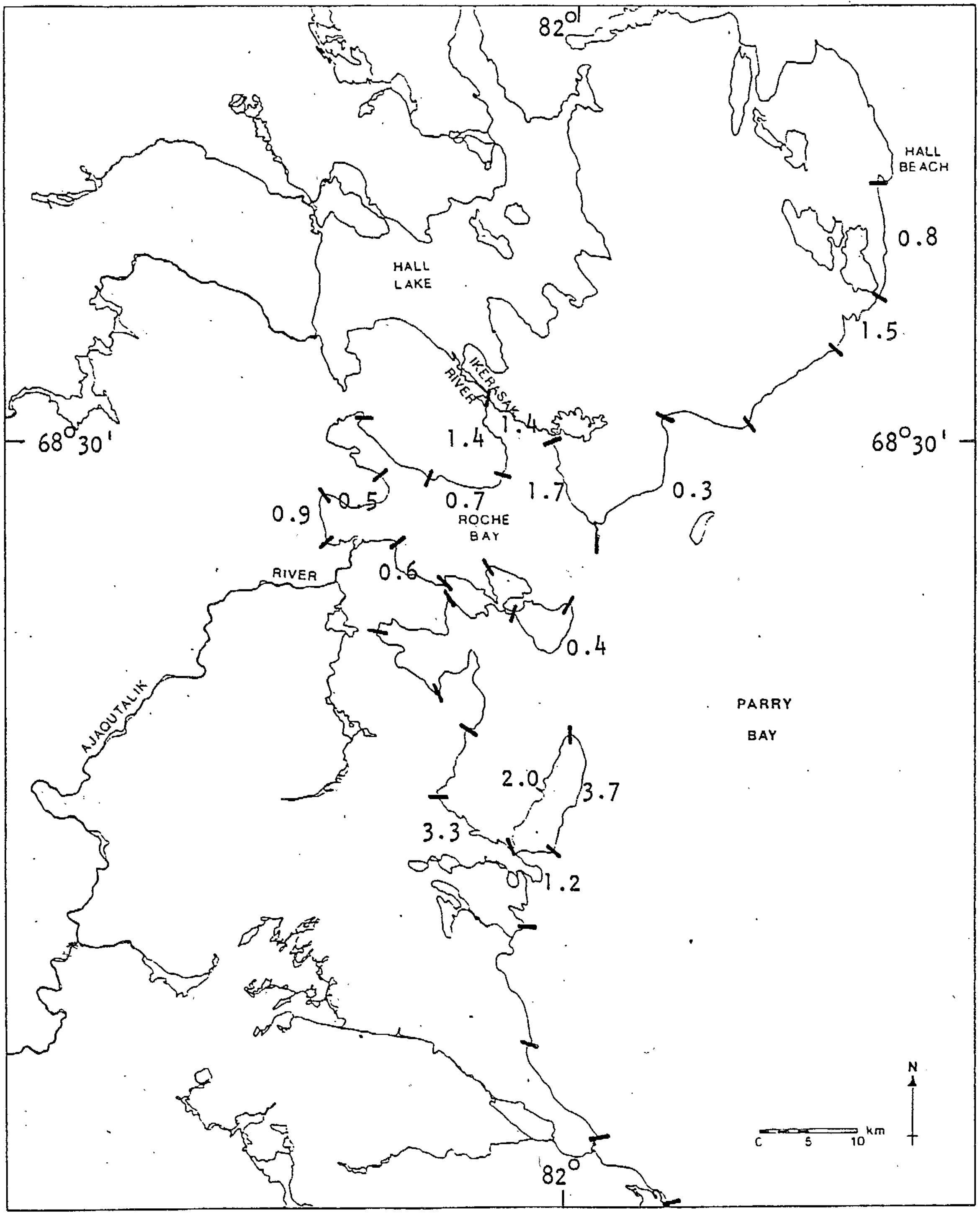
(d) Densities (birds/km^2) of snow geese in coastal segments of the Parry Bay shoreline, July 9-10, 1981.



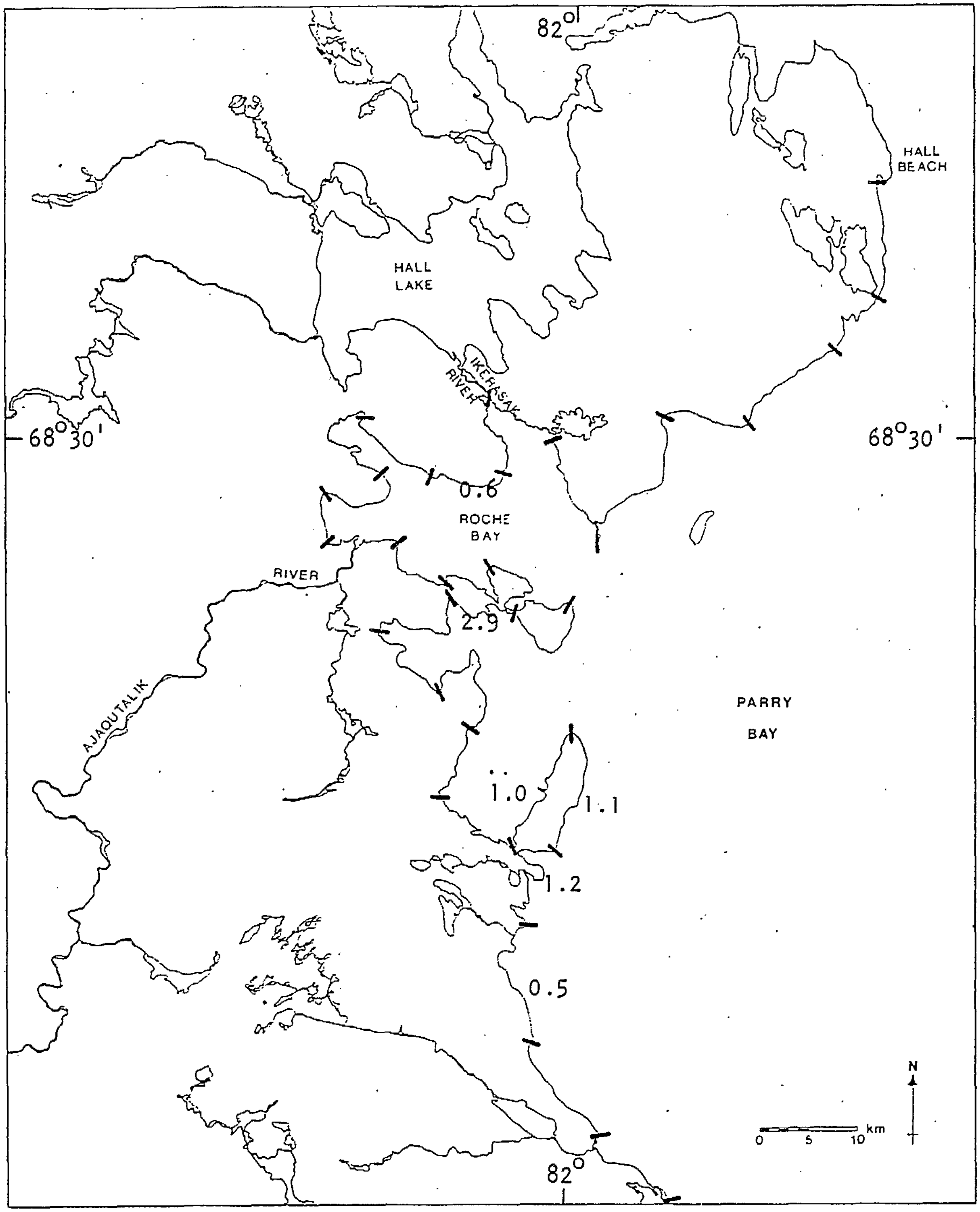
(e) Densities (birds/km^2) of oldsquaw in coastal segments of the Parry Bay shoreline, July 9-10, 1981.



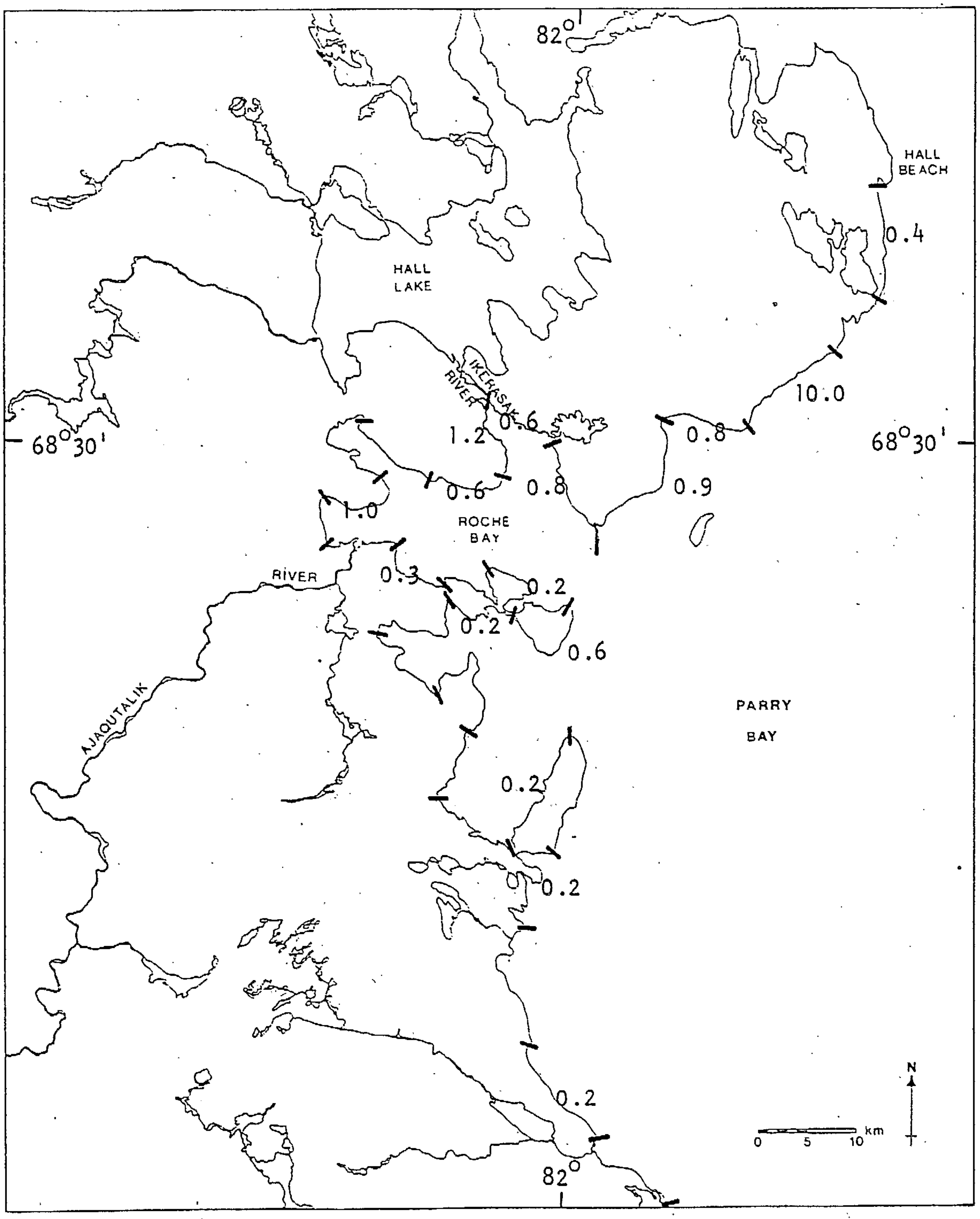
(f) Densities (birds/km^2) of common eiders in coastal segments of the Parry Bay shoreline, July 9-10, 1981.



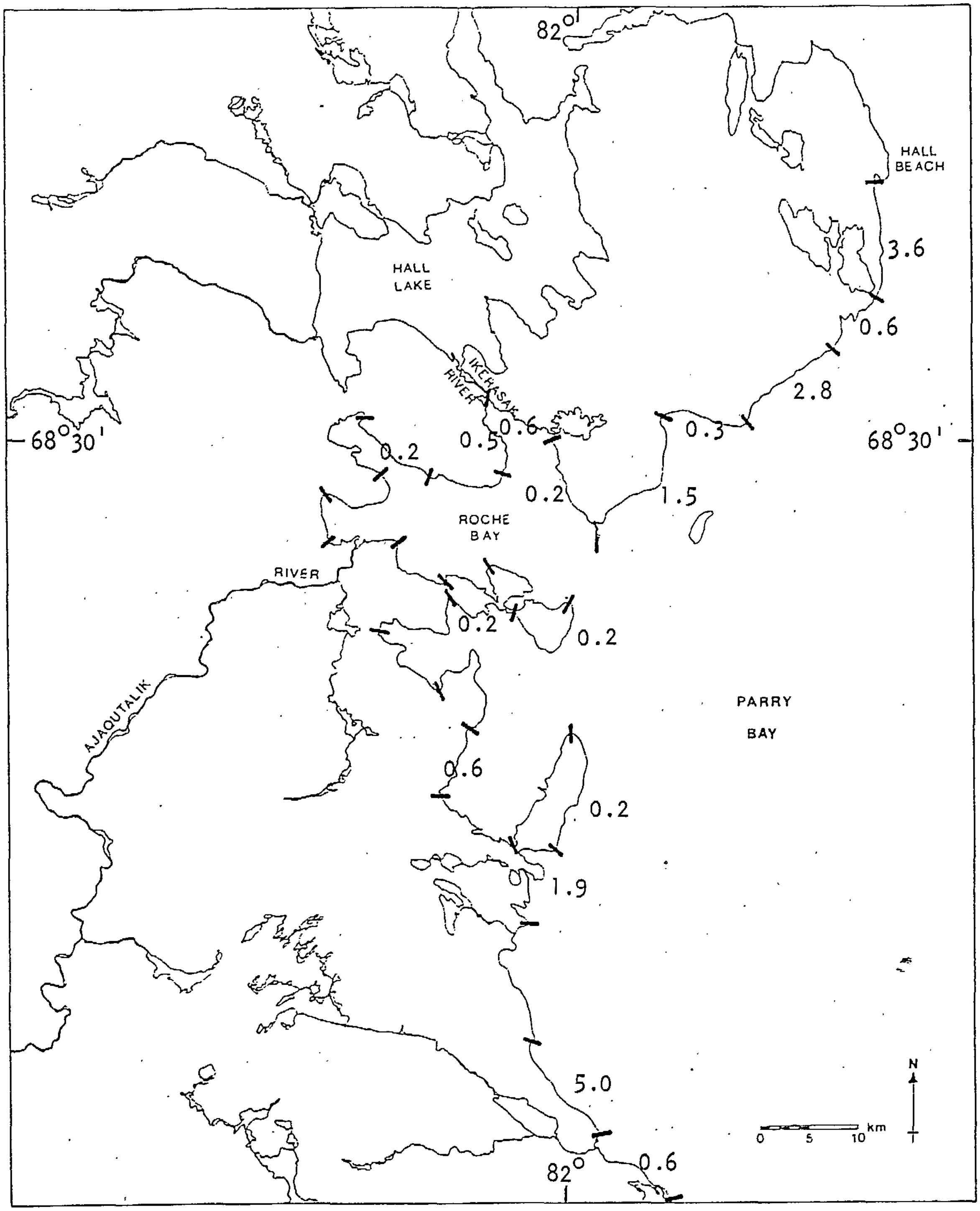
(g) Densities (birds/km^2) of king eiders in coastal segments of the Parry Bay shoreline, July 9-10, 1981.



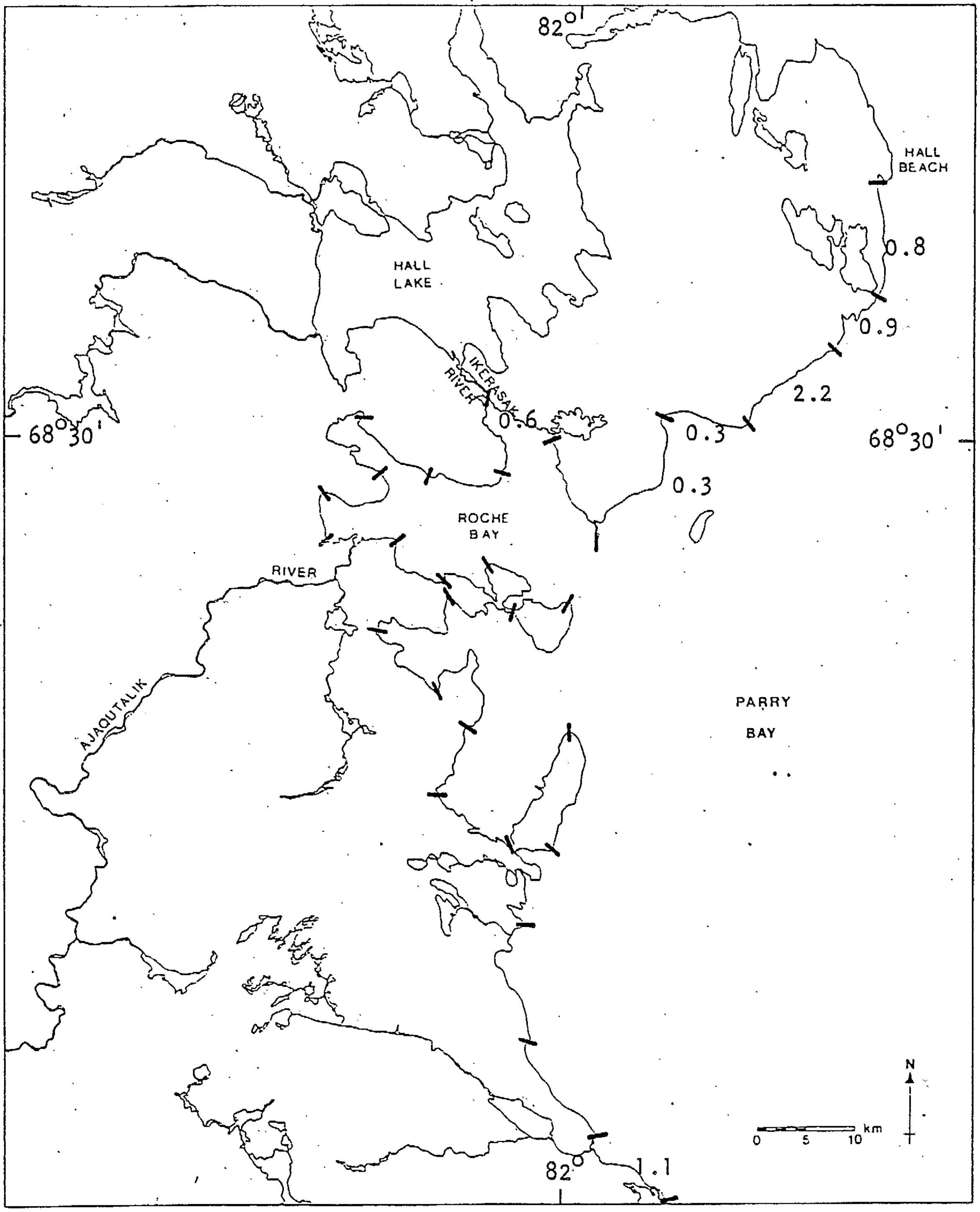
(h) Densities of unidentified eiders (birds/km^2) in coastal segments of the Parry Bay shoreline, July 9-10, 1981.



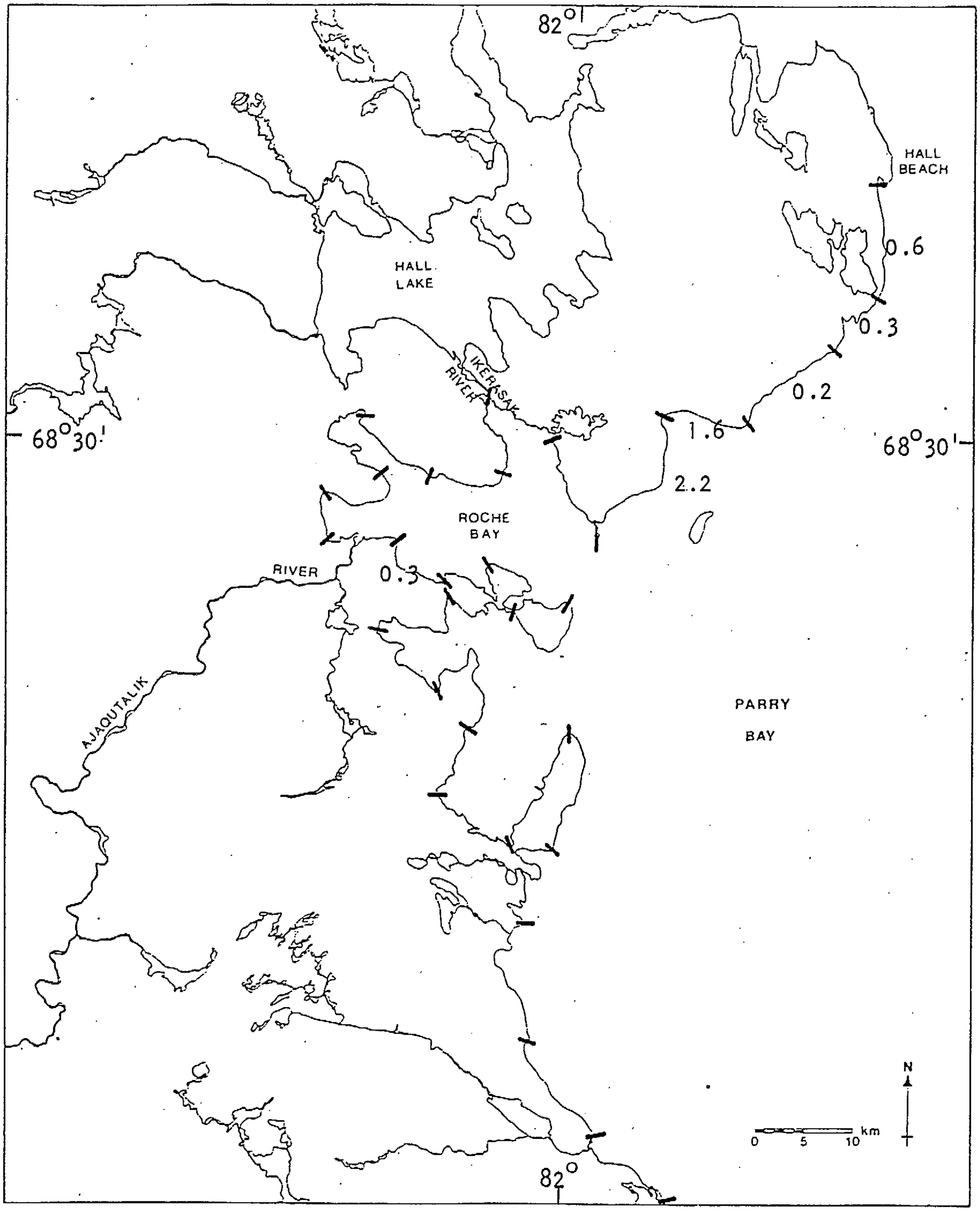
(i) Densities of sandpipers (birds/km^2) in coastal segments of the Parry Bay shoreline, July 9-10, 1981.



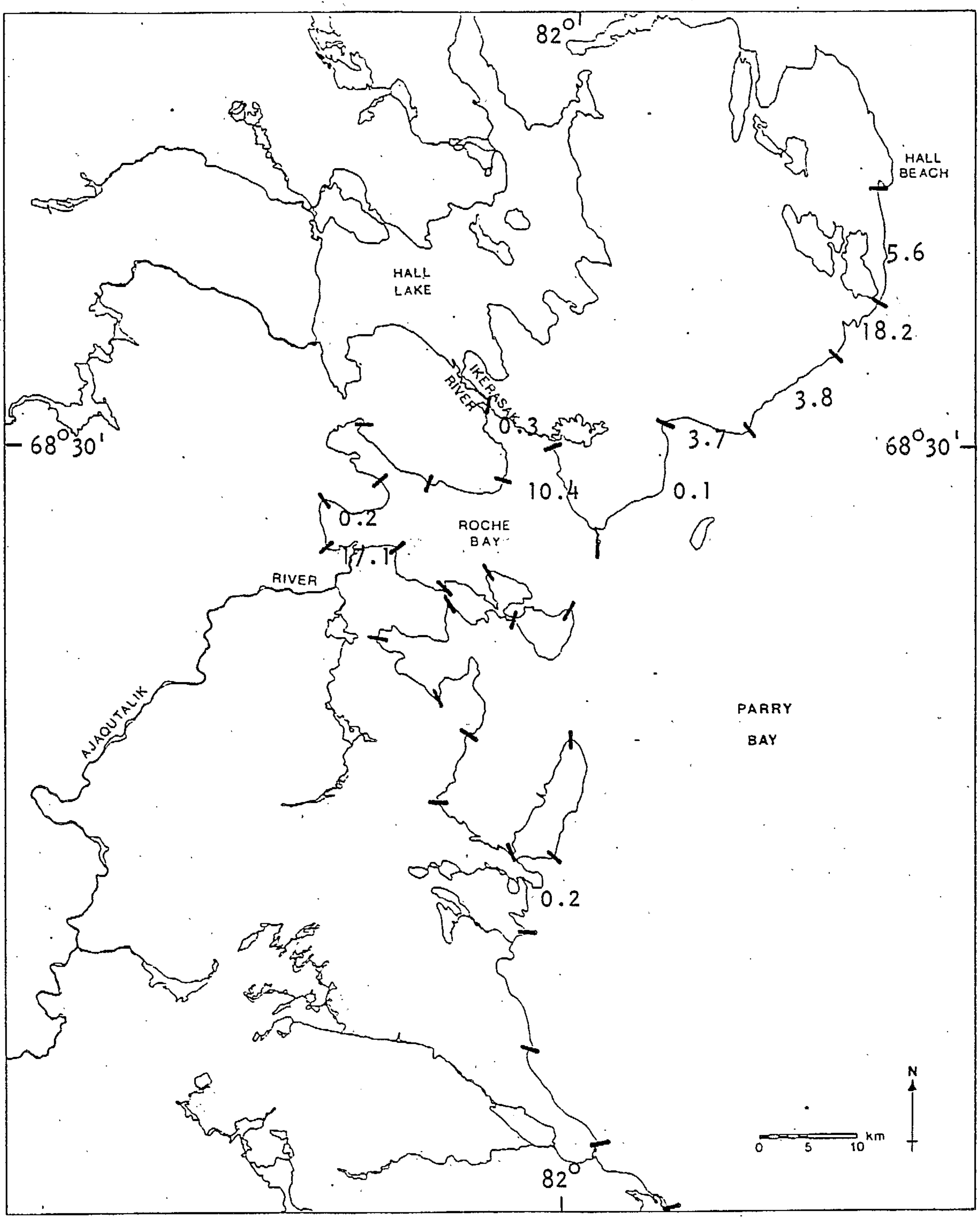
(j) Densities of herring/Thayer's gulls (birds/km^2) in coastal segments of the Parry Bay shoreline, July 9-10, 1981.



(k) Densities of glaucous gulls (birds/km^2) in coastal segments of the Parry Bay shoreline, July 9-10, 1981.



(1) Densities of Sabine's gulls (birds/km^2) in coastal segments of the Parry Bay shoreline, July 9-10, 1981.



(m) Densities of Arctic terns (birds/km^2) in coastal segments of the Parry Bay shoreline, July 9-10, 1981.

APPENDIX III

(a) Loons and waterfowl observed on transect 1, July 9-11, 1981.

	arctic loon	red-throated loon	unidentified loon	whistling swan	Canada goose	brant	snow goose	oldsquaw	common eider	king eider	unidentified eider
Breeding pairs	-	-	2	1	-	-	6	5	-	5	-
(pr/km^2)			(0.1)	(0.1)			(0.4)	(0.3)		(0.3)	
Non-breeders	-	-	-	-	-	4	-	19	-	2	-
($birds/km^2$)						(0.3)		(1.2)		(0.1)	
Total birds	-	-	4	2	-	4	12	29	-	12	
($birds/km^2$)			(0.3)	(0.1)		(0.3)	(0.8)	(1.8)		(0.8)	

(b) Loons and waterfowl observed on transect 2, July 9-11, 1981.

	arctic loon	red-throated loon	unidentified loon	whistling swan	Canada goose	brant	snow goose	oldsquaw	common eider	king eider	unidentified eider
Breeding pairs (pr/km^2)	-	-	-	1 (0.1)	-	-	1 (0.1)	-	1 (0.1)	1 (0.1)	-
Non-breeders ($birds/km^2$)	-	-	-	-	-	-	-	-	-	2 (0.1)	-
Total birds ($birds/km^2$)	-	-	-	2 (0.1)	-	-	2 (0.1)	-	2 (0.1)	4 (0.3)	-

(c) Loons and waterfowl observed on transect 3, July 9-11, 1981.

	arctic loon	red-throated loon	unidentified loon	whistling swan	Canada goose	brant	snow goose	oldsquaw	common eider	king eider	unidentified eider
Breeding pairs	-	-	-	-	-	-	-	1	1	-	2
(pr/km^2)								(0.1)	(0.1)		(0.1)
Non-breeders	-	-	-	-	5	-	-	2	-	4	-
($birds/km^2$)					(0.3)			(0.1)		(0.3)	
Total birds	-	-	-	-	5	-	-	4	2	4	4
($birds/km^2$)					(0.3)			(0.3)	(0.1)	(0.3)	(0.3)

(d) Loons and waterfowl observed on transect 1A, July 9-11, 1981.

	arctic loon	red-throated loon	unidentified loon	whistling swan	Canada goose	brant	snow goose	oldsquaw	common eider	king eider	unidentified eider
Breeding pairs (pr/km^2)	-	-	-	-	-	1 (0.2)	-	-	-	-	-
Non-breeders ($birds/km^2$)	-	-	-	-	-	-	-	-	-	4 (0.7)	-
Total birds ($birds/km^2$)	-	-	-	-	-	2 (0.3)	-	-	-	4 (0.7)	-

(e) Loons and waterfowl observed on transect 2A, July 9-11, 1981.

	arctic loon	red-throated loon	unidentified loon	whistling swan	Canada goose	brant	snow goose	oldsquaw	common eider	king eider	unidentified eider
Breeding pairs	-	-	3	1	-	-	-	1	-	-	-
(pr/km^2)			(0.8)	(0.3)				(0.3)			
Non-breeders	-	-	3	-	-	-	-	2	-	-	-
($birds/km^2$)			(0.8)					(0.5)			
Total birds	-	-	9	2	-	-	-	4	-	-	-
($birds/km^2$)			(2.3)	(0.5)				(1.0)			

(f) Loons and waterfowl observed on transect 3A, July 9-11, 1981.

	arctic loon	red-throated loon	unidentified loon	whistling swan	Canada goose	brant	snow goose	oldsquaw	common eider	king eider	unidentified eider
Breeding pairs (pr/km^2)	-	-	2 (0.5)	-	-	-	-	-	-	-	-
Non-breeders ($birds/km^2$)	-	-	-	-	-	-	-	-	-	-	-
Total birds ($birds/km^2$)	-	-	4 (1.0)	-	-	-	-	-	-	-	-

(g) Loons and waterfowl observed on transect Y, July 9-11, 1981.

	arctic loon	red-throated loon	unidentified loon	whistling swan	Canada goose	brant	snow goose	oldsquaw	common eider	king eider	unidentified eider
Breeding pairs (pr/km^2)	1 (0.1)	-	-	-	-	1 (0.1)	1 (0.1)	1 (0.1)	-	1 (0.1)	-
Non-breeders ($birds/km^2$)	-	-	-	-	-	-	-	-	-	-	3 (0.3)
Total birds ($birds/km^2$)	2 (0.2)	-	-	-	-	2 (0.2)	2 (0.2)	2 (0.2)	-	2 (0.2)	3 (0.3)

(h) Loons and waterfowl observed on transect Z, July 9-11, 1981.

	arctic loon	red-throated loon	unidentified loon	whistling swan	Canada goose	brant	snow goose	oldsquaw	common eider	king eider	unidentified eider
Breeding pairs (pr/km^2)	-	2 (0.2)	-	-	-	3 (0.3)	8[a/] (0.7)	1 (0.1)	-	3 (0.3)	-
Non-breeders (birds/km^2)	-	-	-	-	-	17 (1.4)	-	20 (1.7)	-	-	17 (1.4)
Total birds (birds/km^2)	-	4 (0.3)	-	-	-	23 (1.9)	16 (1.3)	22 (1.8)	-	6 (0.5)	17 (1.4)

(i) Loons and waterfowl observed on transect A, July 9-11, 1981.

	arctic loon	red-throated loon	unidentified loon	whistling swan	Canada goose	brant	snow goose	oldsquaw	common eider	king eider	unidentified eider
Breeding pairs (pr/km^2)	-	-	-	-	2 (0.2)	3 (0.3)	1 (0.1)	-	1 (0.1)	-	-
Non-breeders ($birds/km^2$)	-	-	-	-	22 (2.2)	46 (4.6)	-	23 (2.3)	-	8 (0.8)	-
Total birds ($birds/km^2$)	-	-	-	-	26 (2.6)	52 (5.2)	2 (0.2)	23 (2.3)	2 (0.2)	8 (0.8)	-

(j) Loons and waterfowl observed on transect B, July 9-11, 1981.

	arctic loon	red-throated loon	unidentified loon	whistling swan	Canada goose	brant	snow goose	oldsquaw	common eider	king eider	unidentified eider
Breeding pairs	1	1	1	-	2	2	2	6	-	3	-
(pr/km^2)	(0.1)	(0.1)	(0.1)		(0.2)	(0.2)	(0.2)	(0.6)		(0.3)	
Non-breeders	-	-	-	-	-	16	-	4	-	6	-
($birds/km^2$)						(1.6)		(0.4)		(0.6)	
Total birds	2	2	2	-	4	20	4	16	-	12	-
($birds/km^2$)	(0.2)	(0.2)	(0.2)		(0.4)	(2.0)	(0.4)	(1.6)		(1.2)	