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Occasional Paper
Number 70
Canadian Wildlife Service



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Disponible également en français sous le titre
*Les habitats côtiers du nord-est de la baie James*





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## Abstract

This study describes the coastal habitats of northeastern James Bay and provides a preliminary description of their potential use by waterfowl. The interpretation of colour aerial photographs at a scale of 1:10 000 led to a preliminary classification of the coastal habitats and served as a basis for field verification, which was done by helicopter at low speed and altitude, with about 80 stops along the coast.

From offshore to mainland, the principal habitats were open water, eelgrass beds, mud/sand or boulder-strewn tidal flats, boulder-strewn shores fringed with vegetation, rocky tidal flats, salt marshes, heaths, shrubs, and forests. Their distribution pattern between the Au Castor River and Point Louis-XIV was mapped at a scale of 1:125 000.

Eelgrass beds are located mainly south of Point Attikuan and are absent from the mouths of the main rivers. Vast mudflats are common between the Au Castor River and Point Kakassituq; northward from there, the coast is more exposed, and boulder-strewn tidal flats are more common. The vegetation and structure of marshes change from south to north, with the disappearance or strong variation in the importance of certain communities, reduced diversity of species, and the appearance of bare areas in the upper marsh.

Heaths dominated by lichens and having few or no rocky outcrops are found south of Dead Duck Bay and north of Point Kakassituq. Between these two locations, rocky heaths, characterized by *Empetrum* cover, dominate the insular and coastal landscapes. Areas of shrub and forests tend to decrease in northward and seaward directions.

The eastern shore of James Bay represents a vital staging and feeding area for migrating waterfowl — mainly Canada Geese *Branta canadensis*, Brant *B. bernicla*, and Lesser Snow Geese *Anser caerulescens caerulescens*. Habitat diversity plays a key role in attracting waterfowl. Most of these habitats are used in spring, summer, or fall for feeding, cover, resting, moulting, nesting, and brood rearing. Salt marshes, heaths, and eelgrass beds show the highest potential for utilization by waterfowl.

Multidisciplinary studies aimed at improving our knowledge of the habitats of the eastern James Bay coast and their use by waterfowl should be undertaken in the near future.

# 1.0 Introduction

Because of its geographic location and the diversity of its coastal habitats, James Bay is of vital importance to several species of migratory birds, particularly waterfowl (geese and ducks) and shorebirds (sandpipers, plovers, etc.) (Manning and Macpherson 1952; Todd 1963; Curtis and Allen 1976; Prevett et al. 1979; Thomas and Prevett 1982; Morrison and Gaston 1986). The shores of this region are an important staging area for several long-distance migrants; for others, the region is a final destination, a nesting site, and a place to raise young.

Since the early part of this century, the eastern shore of James Bay has interested the scientific community. The pioneering work of Low (1909), Hustich (1950), Dutilly and Lepage (1948), Baldwin (1949, 1953), and Dutilly et al. (1958) described the major characteristics of the physiography and flora of this remote area.

Interest in this coastline was revived in the early 1970s with the opening of the La Grande hydroelectric complex. Since then, several studies have been undertaken to identify the coast's various biophysical components. Lamoureux and de Repentigny (1972), Lamoureux and Zarnovican (1972), and Lacoursière and Maire (1976) contributed significantly to our knowledge of the vegetation along the shore of Rupert Bay. In 1974, the vegetation of the coastal marsh of Des Oies Bay was studied in detail by Lamoureux and Zarnovican (1974), and Curtis (1974-75) produced a map of eelgrass beds at a scale of 1:125 000 for the Canadian Wildlife Service.

Other important contributions include those of the Regional Ecological Studies Service (Gérardin 1980), geomorphological work by Dionne (1976, 1978, 1980), and studies conducted by the James Bay Energy Corporation, which are summarized in the paper titled "Connaissance du milieu des territoires de la baie James et du Nouveau-Québec" (James Bay Energy Corporation 1978).

Between 1982 and 1989, the eelgrass beds in this region were studied extensively by Roche Associés Ltée. (1982, 1985), Lalumière (1986a, 1987a, 1987b, 1988a), and Lalumière and Belzile (1989). Since 1986, the James Bay Energy Corporation has studied certain coastal marshes (Lalumière 1986b, 1988b).

A review of this literature provides only an incomplete view of the coastal habitats, however, and often only for specific sections of the shore. To date, no single report has described the diversity and distribution of habitats on the eastern shore of James Bay and their use by waterfowl in spring, summer, and fall.

The aim of this publication is to fill this gap, at least partially. The coastal habitats are described briefly, especially in terms of their vegetation, and are mapped at a scale of 1:125 000. A final section discusses potential use of those habitats by waterfowl.



# 2.0 Methods and terminology

The habitats described and mapped are located in the coastal area of James Bay between the Au Castor River and Point Louis-XIV. For the purposes of this report, the coastal area is considered to extend from the offshore islands to 5 km inland from the mainland coast.

The methods were dictated largely by the availability of basic information (aerial photographs 1:10 000, topographical maps 1:50 000), by the scale chosen for mapping (1:125 000), by the short period available for ground verification (10 days), and by the need to produce a concise overview.

Preliminary interpretation was based on colour aerial photographs at a scale of 1:10 000, taken at low tide in August and September 1986. The habitats were identified on the basis of our previous experience and observations on the eastern shore of James Bay. Habitat types were chosen and defined in relation to features likely to influence their selection by waterfowl for feeding, resting, nesting, brood rearing, and moulting. The information was transferred to topographical maps at a scale of 1:50 000 to give a preliminary view of the distribution of habitats along the coast and to help us plan the field verification.

Field verification was carried out from 21 to 31 July 1989 by helicopter, while flying slowly at low altitude. Two observers transferred the information onto the aerial photographs and onto topographical maps at a scale of 1:50 000. About 80 landings were made, mostly on coastal islands and the intertidal zone, including salt marshes. Because emphasis was placed on open habitats preferred by waterfowl, ground checks were not made in forested areas; these were, nevertheless, mapped. The vast region of heathland north of Point Attikuan was not surveyed in detail, but several stops were made to document its principal features.

At each stop, the dominant plant species were recorded. Those that could not be identified in the field were collected for further examination. The nomenclature used was that of Taylor (1957), Scoggan (1978-79), Crum and Anderson (1981), Arnell (1979), and Hale and Culberson (1970). Most of the specimens collected were deposited at the Herbier du Québec (QUE); a few were deposited at the herbaria of Agriculture Canada (DAO) and the Canadian Museum of Nature (CANM) in Ottawa. Appendix 1 contains the complete list of plants collected by us in 1988-89 on the northeast coast of James Bay.

The entire coast of our study area, including all the islands, was systematically overflown, and all waterfowl observations (broods, moulting birds, etc.) were recorded on topographical maps at a scale of 1:50 000.

**Table 1**
Coastal habitat terminology

| Habitat | Map designation |
|---|---|
| **Aquatic milieu** | |
| Open water | Open water |
| Eelgrass beds | Eelgrass beds |
| **Shoreline milieu** | |
| Mud/sand tidal flat | Mud/sand tidal flat |
| Boulder-strewn tidal flat<br>Boulder-strewn shore fringed with vegetation | Boulder-strewn shore fringed with vegetation |
| Rocky tidal flat | Rocky outcrop |
| Salt marsh | Salt marsh |
| **Terrestrial milieu** | |
| Freshwater marsh | Not mapped |
| Lichen heath | Heath |
| Rocky heath (*Empetrum*) | Rocky heath |
| Shrub formations | Shrub |
| Forest formations | Forest |

The final interpretation of photographs was conducted in parallel by two observers using a twin stereoscope; the information was transferred to topographical maps at a scale of 1:50 000 and later to 1:125 000, with some loss of information with each reduction in scale. The results are, nevertheless, available at all three scales.

The eelgrass beds were also mapped using the distribution maps (1:125 000) produced by Lalumière (1987b) and Curtis (1974-75).

Habitat descriptions were based on data recorded during the 1989 ground check and on knowledge acquired during earlier studies. Salt marsh descriptions, in particular, benefited from our past experience with more than 200 vegetation surveys in 10 marshes during 1988 (Lalumière 1988b).

The habitats were grouped in three milieus: aquatic, shoreline, and terrestrial (Table 1). This report does not describe the vegetation of bogs and coastal lakes. Our terminology is not intended to replace earlier, more classical classifications (Gauthier 1982; Jacques and Hamel 1982; Couillard and Grondin 1986); it was chosen for the practical purpose of designating areas with distinct features that are readily identifiable from the ground or from the air and that would likely be selected differentially by waterfowl. Information on the use of coastal habitats by waterfowl is drawn mainly from the following sources:

- Canadian Wildlife Service (Curtis and Allen 1976),
- observations of waterfowl made in August 1989 (this study),
- signs of use noted during earlier fieldwork (1986-89),
- information obtained during visits accompanied by Cree during the spring hunts in 1986 and 1989, and
- a review of the literature.

In the absence of recent survey data, our waterfowl information remains incomplete. As a result, some of our conclusions regarding waterfowl use are speculative and require further research for validation.

Finally, the map (1:125 000) that accompanies this report (pocket on inside back cover) illustrates the distribution of the various habitats along the coast of the study area.

# 3.0 Physical characteristics of the coast

The study area is part of the James Bay lowland and extends from the mouth of the Au Castor River (53°24′N, 78°58′W) to Point Louis-XIV (54°38′N, 79°45′W) (Fig. 1). The distance between those points is approximately 160 km, but the coastline that connects them and surrounds the adjacent islands, because of its extreme irregularities, exceeds 1500 km. There are hundreds of islands, shoals, and reefs within 10-15 km of the coast, which itself is punctuated by a multitude of peninsulas and bays.

Rock formations are composed mainly of granites, gneiss, and granodiorites of the Canadian Shield, which has been eroded and partially covered by quaternary deposits (Eade 1966). Through isostatic rebound, the coastline is currently rising at a rate of 0.9-1.2 m per century (Hunter 1970).

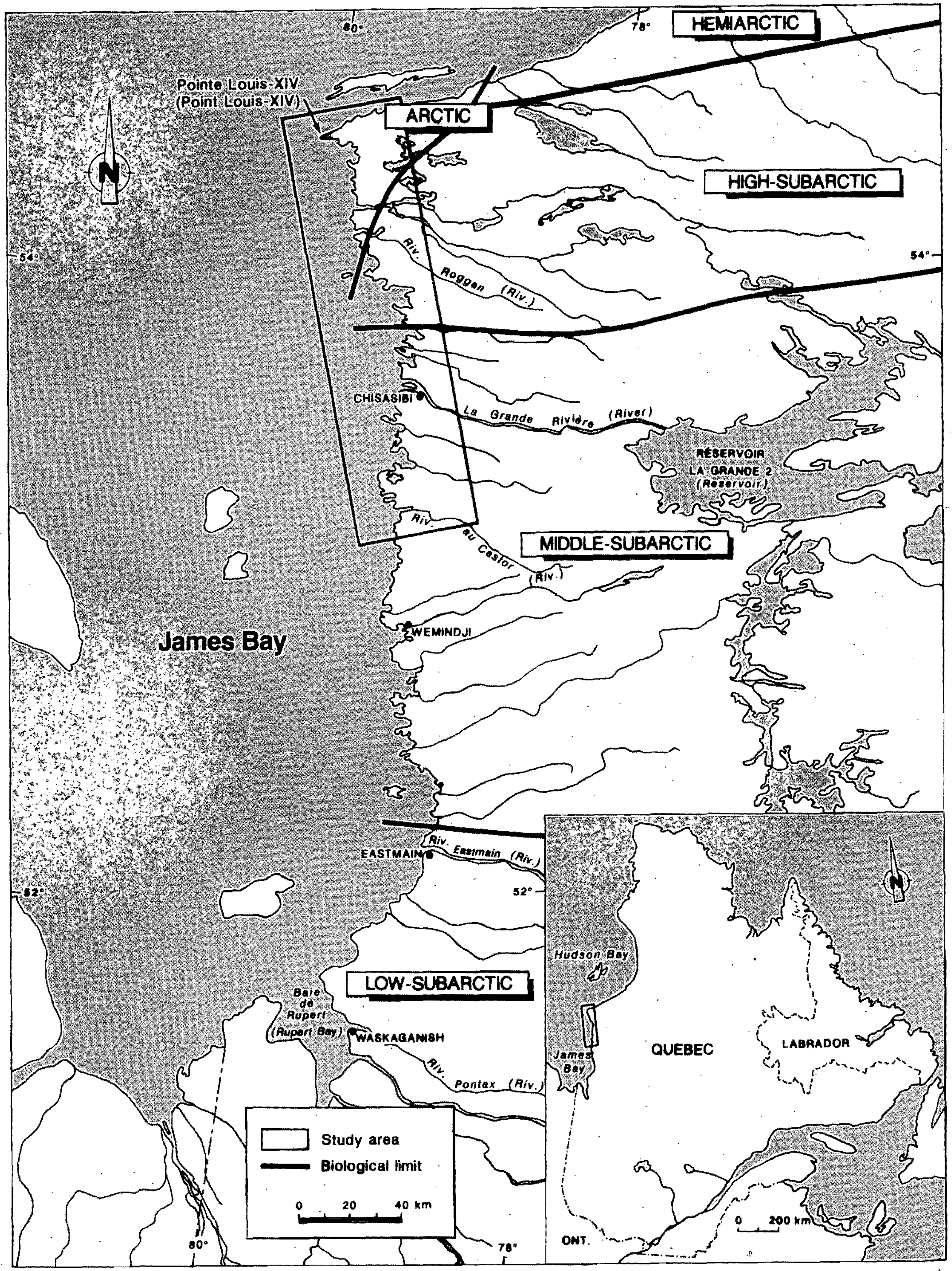
The area is low, with little relief. Only a few rocky hills exceed 25 m in height, and few islands are higher than 10 m. The La Grande River is the only important river that empties into the study area, but there are several minor ones: Au Castor, Caillet, Guillaume, Piagochioui, Kapsaouis, Roggan, and Au Phoque rivers. All contribute to reduced salinity in the littoral zone and to the transport of sediments to James Bay.

The islands, points, and peninsulas represent bedrock outcrops, glacial deposits, especially drumlins (Lee et al. 1960), and spits (Dionne 1976). Bays represent bedrock depressions that have been partially filled by glacial and glaciomarine sediments, covered by recent deposits of clay, silt, or fine sand. The slope of the tidal flats is gradual, 0.5-3 degrees (Dionne 1976), and their lower portions are strewn with glacial boulders originating from drumlins, spits, and boulder piles surrounding the islands. In large bays, the intertidal zone is more than 2 km wide. During mean and strong tides, the tidal amplitude is in the order of 1.5 m and 2.4 m, respectively (Anonymous 1973; CSSA Inc. 1987). This amplitude varies considerably in response to wind speed and direction (Godin 1975).

Surface salinity in the littoral zone is subject to seasonal variations and to the effects of freshwater input from rivers. In summer, the salinity is approximately 25‰ near Point Louis-XIV and 20‰ south of the La Grande River (Dionne 1976); it decreases to 5‰ at the mouths of the principal rivers (Messier et al. 1989).

The regional climate is rigorous and subject to marked fluctuations in temperature. The mean monthly temperatures for July and January are greater than 10°C and less than -25°C, respectively. The annual mean temperature is -2.5°C, and precipitation averages approximately 650 mm per year (Wilson 1971). Extreme temperatures registered at Fort George (former village located near the

Figure 1
Location of the study area, showing biological zones proposed by Ducruc et al. (1976)




present site of Chisasibi) were 34.4°C and -40.3°C (Villeneuve 1967); north of Point Attikuan, extreme temperatures were lower. The bay is covered with ice from December to May. Shore ice 75-150 cm thick covers the tidal flats and part of the lower salt marshes and extends 15-25 km seaward (Messier et al. 1989), reducing the buffering influence of the large water mass of the bay and allowing penetration of polar-like conditions. In summer, cold currents and floating ice in James and Hudson bays delay the arrival of warm weather and prolong the period of frost (James Bay Energy Corporation 1978). Dominant westerly winds also keep the temperature cool and contribute to the formation of thick fog when atmospheric humidity is high.

Figure 1 illustrates the location of our study area in relation to biological zones described by Ducruc et al. (1976). From south to north, three zones are involved, distinguished principally by the number of degree-days of growth: the middle-subarctic zone, ending at Paul Bay; the high-subarctic zone, from Paul Bay to the Roggan River; and, northward, the arctic zone. This area of arctic zone, which extends beyond Point Louis-XIV to Point Vauquelin, represents the most southerly extension of the arctic zone in the world. Its limits coincide with the isolines of 600 mm annual precipitation and -4°C mean annual temperature. They also coincide with two marked changes in vegetative structure: the first is physiognomic and related to the northern limit of tree growth; the second is floristic and related to the southern limit of the range of several species of arctic plants. The presence of permafrost, palsen, and, in certain marshes, ice-lifted boulders attests to the arctic affinities of this coastal area (Dionne 1978). Most of the outer islands south of this boundary that are dominated by heath could also be included in the arctic zone.

Although, over the long term, isostatic rebound has been the prime force determining the configuration of the coastline, other factors are also important. Waves and currents are the most important, even if their action is felt over only six months of the year. Much of the high energy they carry as they arrive near the coast is, however, dissipated as they encounter shallow waters (<20 m) of the coastal shelf, shoals, reefs, islands, and a highly convoluted shoreline (Dionne 1976).

Currents transport sediments from the coast towards offshore areas. They also influence the movement of ice and patterns of erosion and sedimentation. Tides do not play a major role except in areas where they create strong currents (Dionne 1980). The main influence of ice along the coastline is one of scouring and deposition, although in some areas it serves to protect against other erosive factors. The presence of numerous ponds created by ice rafting and scouring, which has been reported for southern James Bay marshes (Dionne 1976), is much less evident north of latitude 53°N. The most visible sign of ice action is the occurrence of stones and boulders strewn over the tidal flats.

# 4.0 Coastal habitats

## 4.1 Aquatic milieu

### 4.1.1 Open water

This category covers the largest surface area of all habitats in our study area. By early June, the temperature of these waters may, in certain protected bays, reach 7-10°C and, by the end of July, 18°C. By the end of October, water temperature has decreased to 1°C (Lalumière 1990). The open water area extending from the outer islands to the mainland coast is as broad as 20 km at some locations, but the water is shallow throughout. Beyond the outer islands, the sea bottom drops off quickly. Between the numerous islands, there are many reefs and shoals that are evident at low tide.

### 4.1.2 Eelgrass beds

The coastline offers excellent conditions for the development of vast subtidal meadows of eelgrass (*Zostera marina* L.): protection provided by the many islands, numerous bays with gently sloping floors, substrate of proper texture, low tidal amplitude, salinity that remains within the optimal range (10-30‰) during the growing season (Phillips and Watson 1984), and summer water temperatures that reach almost 20°C in protected bays.

The eelgrass beds colonize fine sediments in areas sheltered from the direct action of wind and waves at depths between 0.5 and 4.0 m below average low water. Towards the open sea, they generally give way to a zone colonized by *Fucus distichus* and *Ascophyllum nodosum*. In shallow water, where hydrodynamic conditions are weak, *Enteromorpha* sp., *Cladophora* sp., *Rhizoclonium riparium*, *Chorda filum*, *Potamogeton pectinatus*, and, more rarely, *Ruppia maritima* are associated with the eelgrass. In deeper waters, the subtidal bed is generally monospecific (Lalumière 1988a).

Depending on conditions, *Zostera marina* grows at a density ranging from 50 to 1500 shoots/m² and produces a dry biomass in the order of 30-675 g/m² (Lalumière and Belzile 1989). The blades of the most vigorous plants reach 5 mm in width and 2.5 m in length.

These eelgrass meadows are concentrated mainly in Dead Duck Bay, Aquatuc Bay, and Bay of Many Islands, and along the shore between Point Kakassituq and Point Attikuan; they are absent from the mouths of the main rivers because of the instability of the substrate and the low water salinity.

### 4.2 Shoreline milieu

The shoreline area generally coincides with the intertidal zone and is here defined as extending from the lower limit of weak tides to the upper limit of spring tides (see Couillard and Grondin [1986] for tidal range definition). Three general types of shoreline habitat are recognized: tidal flats, salt marshes, and boulder-strewn shores fringed with vegetation. We have used the term tidal flat to describe that portion of the intertidal area that occurs below the lower limit of terrestrial or salt-marsh vegetation.

#### 4.2.1 Tidal flats

Three types of tidal flats are recognized, based on physical features and the degree of exposure to wave and current action: mud/sand tidal flat, boulder-strewn tidal flat, and rocky tidal flat. Although based on physiography rather than geomorphology, this breakdown appears meaningful in terms of habitat selection by waterfowl.

Mud/sand tidal flats occur in large bays with gentle slopes and are often broader than 1 km (Fig. 2). Boulders are generally rare in the upper portion but may be abundant near the lower tidal limit where ice action is greater. These are areas of sedimentation and are fully exposed at low tide. Towards the north, they tend to be narrower and to have steeper slopes and higher densities of boulders (Fig. 3). Portions of these flats are sometimes colonized by *Fucus distichus, Ascophyllum nodosum, Potamogeton pectinatus,* and, more rarely, *Ruppia maritima.*

Boulder-strewn tidal flats occur along shores exposed to more active erosion and are narrower and have steeper slopes than mud/sand tidal flats. Substrate material may vary from boulders and gravels, as is often the case north of the Roggan River (Fig. 4), to boulders on finer sediments (Fig. 5). Because of difficulties in displaying the narrow tracts of boulder-strewn tidal flats at the chosen map scale, this habitat, along with small islands of unvegetated boulders, has been mapped with the same colour symbol as "boulder-strewn shores fringed with vegetation."

Rocky tidal flats (Fig. 6) are generally characterized by bedrock that, except for a few algae, is barren. For mapping purposes, they have been grouped with barren rocky islands and rocky outcrops and displayed under the colour code for "rocky outcrops."

#### 4.2.2 Salt marshes

Salt marshes develop in protected areas where there is active sedimentation. Tarnocai (1980) recognized two zones: the lower marsh, which extends from the upper limit of the tidal flat to the mean high-tide level, and the upper marsh, which extends farther towards dry land, as far as the upper level of spring tides. Of the 264 salt marshes mapped, fewer than 10 were greater than 1 km² in extent; these are located principally in the Bay of Many Islands and Dead Duck, Aquatuc, Des Oies, and Paul bays, all within the subarctic zone. North of Point Attikuan, the coast is more exposed, has fewer bays, and has few large marshes. The transition from subarctic to arctic salt marsh occurs between Point Kakassituq and the Roggan River.

In general, the plant communities are well defined. The size of the communities and their relative position along the slope depend on the time they are submerged, the texture and salinity of the substrate, the microrelief caused by ice action, the drainage network of the particular marsh, and the amount of freshwater inflow.

##### *4.2.2.1 Subarctic zone*

The lower marsh (Fig. 7) is colonized by *Eleocharis kamtchatica, Triglochin palustris,* and *Hippuris tetraphylla,* which sometimes forms extensive colonies in depressions that retain water at low tide and at the outlets of streams where salinity is reduced by freshwater runoff. *Puccinellia phryganodes, Spergularia canadensis, Ranunculus cymbalaria,* and *Plantago maritima* occupy firmer sediments and form low herbaceous meadows, which become continuous near the high-tide line (Fig. 8).

*Puccinellia phryganodes* extends farther inland to the lower portion of the upper marsh, where it is replaced by a low herbaceous meadow of *Carex subspathacea* and *Potentilla egedii,* with *Triglochin maritima* as a minor component. These two herbaceous meadows sometimes cover several hectares in the larger marshes.

Farther inland, on the upper marsh, *Carex paleacea* takes over (Fig. 9). It usually forms such a thick canopy that only a few other species can become established: *Puccinellia langeana, Carex salina, C. subspathacea, Ranunculus cymbalaria, Galium trifidum, Potentilla egedii,* and *Stellaria longifolia. Carex paleacea* meadows are closely associated with areas of freshwater inflow (Grandtner 1975; Martini and Glooschenko 1983–84). *Carex mackenziei* is found in wet depressions, whereas *Hippuris tetraphylla* colonizes ponds and stream edges (Fig. 10). This latter species tends to be gradually replaced by *Eleocharis smallii* towards the inland limit of the upper marsh.

*Festuca rubra, Rhinanthus borealis, Triglochin maritima, Euphrasia arctica, Chrysanthemum arcticum, Potentilla egedii, Hierochloe odorata, Parnassia palustris, Primula egaliksensis,* and *Lomatogonium rotatum* replace *Carex paleacea* farther inland in the upper marsh. *Juncus balticus* and *Scirpus rufus* occasionally form small colonies in depressions at the base of the willow thickets that border the marsh (Fig. 11). Dominated by *Salix candida* and *S. brachycarpa,* the thickets mark the upper limit of the marsh and the maximal reach of the high tides (Payette and Lepage 1977). *Castilleja pallida, Pedicularis groenlandica, Polygonum viviparium, Aster borealis, Lathyrus palustris, Drepanocladus uncinatus,* and *Aulacomnium palustre* are nearly always present.

##### *4.2.2.2 Arctic zone*

The structure and vegetation of the arctic salt marshes are somewhat different from those of the subarctic zone. They are more exposed, have a steeper slope, and have a less developed drainage network. Greater intensity of ice action has moulded the marsh surface into a mosaic pattern of mounds and depressions. Different plant communities are present in an intricate pattern that mirrors that of the marsh surface (Fig. 12). Zones devoid of vegetation often occupy areas of appreciable size.

Immediately above the tidal flat, the lower marsh is colonized by patches of *Puccinellia phryganodes; Stellaria humifusa, Triglochin palustris, Eleocharis kamtchatica,* and *Ranunculus cymbalaria* are found near the inner edge of the lower marsh, which is usually narrow. They are replaced by *Carex subspathacea, C. salina, Potentilla egedii,* and *Triglochin maritima* in the upper marsh; these, in turn, give way to *Calamagrostis deschampsioides, Festuca rubra, Dupontia fisheri, Potentilla egedii, Chrysanthemum arcticum, Primula stricta,* and *Parnassia palustris* towards the inland limit of the marsh.

*Salix candida* and *S. brachycarpa,* which marked the upper reaches of the subarctic marshes, are absent in the arctic marshes that merge abruptly with heaths or narrow *Carex aquatilis* fens. In this narrow transition zone, upper marsh, heath, and fen species intermingle: *Empetrum nigrum, Salix reticulata, S. uva-ursi, Carex microglochin, C. aquatilis, C. scirpoidea, C. bigelowii, Drepanocladus uncinatus, Paludella squarrosa, Helodium blandowii,* and *Scorpidium scorpioides.* Stream edges are colonized by *Eleocharis smallii* and *Senecio congestus,* whereas ponds support little, if any, aquatic vegetation.

#### 4.2.3 Boulder-strewn shores fringed with vegetation

Along sections of the coast exposed to erosion, shoreline vegetation occurs in a narrow band that marks the point of contact between the upper part of the boulder-strewn shore and terrestrial habitats. The vegetation is usually dominated by *Elymus mollis* or *Carex paleacea.*

*Elymus mollis* usually occurs on coarse sands fringing the outer shores of the bay or islands, where it is accompanied by *Ligusticum scothicum, Lathyrus japonicus, Chrysanthemum arcticum, Arenaria peploides,* and, more rarely, *Poa eminens* (Fig. 13). On points or sand spits, *Elymus mollis* and *Epilobium angustifolium* often form meadows.

*Carex paleacea* forms similar belts in finer substrates along sheltered shores of Dead Duck Bay, around certain islands, along narrow inlets, and on the edges of some coastal lakes that connect with the sea. It generally backs onto willow thickets of the same type as those bordering subarctic salt marshes (Fig. 14).

North of Point Attikuan, the vegetative fringes associated with boulder-strewn shores gradually disappear and are replaced by the occasional patch of *Elymus mollis* and *Arenaria peploides.*

### 4.3 Terrestrial milieu

#### 4.3.1 Freshwater marshes

In the subarctic zone, the salt marsh will often be succeeded by a freshwater marsh. These marshes are beyond the reach of the highest tides and usually have an important inflow of fresh water. With the buildup of organic material, they become fens that can spread several kilometres inland. The freshwater marsh is characterized by *Menyanthes trifoliata, Potentilla palustris, Carex limosa, C. rariflora, Caltha palustris, Sium suave, Calamagrostis neglecta, Eriophorum angustifolium, E. russeolum, Calliergon* spp., and *Drepanocladus* spp. *Carex aquatilis,* which characterizes the lower portion of the fen, is also an important freshwater marsh species. Ponds and streams are colonized by *Eleocharis smallii* or *Hippuris vulgaris.* Dutilly et al. (1958) reported a number of taxa in coastal fens, including *Carex × subsalina* Lepage *(C. aquatilis × salina),* that indicate past contact with the sea. Majcen (1973) and Gagnon (1976) provided further descriptions of the wetlands of the interior.

#### 4.3.2 Heaths

The vegetation of the heaths consists of lichens or low shrubs with subarctic/arctic affinities. The presence of heaths is governed primarily by climatic variables: in the subarctic zone, heaths occur on islands and points exposed to winds from the sea; in the arctic zone, where the climate prevents tree growth and limits the presence of shrubs to protected areas, heaths occupy a strip — which widens to 20 km at Point Louis-XIV — along the entire coast.

Two types of heath can be distinguished: those that have developed on rocky outcrops, and those on deposits of glacial and glaciomarine origin. Those on rocky outcrops (rocky heaths) are characterized by a distinct dominance of *Empetrum nigrum* over lichens and bryophytes (Fig. 15) and occur between the Au Castor River and the Bay of Many Islands. Those on nonconsolidated glacial/glaciomarine deposits are characterized by lichens (lichen heaths) (Fig. 16). Both types contain similar plant species, but there is a net dominance of *Empetrum nigrum* and ericaceous shrubs in the former, and lichens dominate in the latter. The most characteristic species are *Empetrum nigrum, Vaccinium uliginosum, V. vitis-idaea, Betula glandulosa, Shepherdia canadensis, Arctostaphylos rubra, Cetraria nivalis, Cladina stellaris, C. rangiferina, C. mitis, Alectoria ochroleuca, Bryoria nitidula, Ptilidium ciliare, Dicranum elongatum,* and *Rhacomitrium lanuginosum.* This recognition of two types of heath is further justified by a marked difference in attractiveness to certain migratory birds that feed extensively on the berries of shrubs.

In northward and seaward directions, the heaths develop a more arctic character due to increasingly rigorous climatic conditions. Additional species are added: *Saxifraga tricuspidata, Salix arctica, S. uva-ursi, S. reticulata, Dryas integrifolia, Ledum palustre, Rhododendron lapponicum, Poa alpina, Festuca brachyphylla, Carex bigelowii,* and *Silene acaulis.* The inland heaths north of the Roggan River are similar to those of the coast and are dominated largely by these same species (Gérardin 1980).

The two types of heath are generally dotted with ponds or small lakes, and their edges are often occupied by *Carex aquatilis, C. rariflora, Scirpus caespitosus, S. hudsonianus, Myrica gale, Alnus rugosa, Eriophorum angustifolium,* and *Aulacomnium palustre. Eleocharis smallii, Potamogeton perfoliatus* ssp. *richardsonii, Ranunculus aquatilis,* and *R. gmelinii* often form distinct communities in those wetlands, especially in the southern part of the study area. This aquatic vegetation is poorly developed or absent north of the Roggan River.

#### 4.3.3 Shrub formations

Shrub communities are most often found along the forest edges (Fig. 17) and around ponds in the southern part of the area and, farther north, in depressions and sheltered slopes where protection from snow cover is greater (Fig. 18). Their density varies considerably, attaining a maximum on moist soils. They are composed mainly of *Salix glauca, S. arctophila, Alnus crispa,* or *Betula glandulosa,* with an undercover of *Calamagrostis canadensis, Rubus acaulis, Carex* spp., *Maianthemum canadense, Lycopodium annotinum, Coptis trifolia, Solidago macrophylla, Pleurozium schreberi, Hylocomium splendens,* and *Ptilidium ciliare.* Shrub formations are particularly extensive between Point Kakachischuan and Point Kakassituq. They disappear almost completely north of the Au Phoque River.

#### 4.3.4 Forest formations

White spruce *Picea glauca* has become the dominant species of the coastal forest (Fig. 19), apparently as a result of the intensity and frequency of fog rolling off James and Hudson bays (Ducruc et al. 1976). It is the principal element of both forest types recognized by Gérardin (1980). The open white spruce-lichen forest colonizes coarse or thin deposits on rock and supports *Empetrum nigrum, Ledum groenlandicum, Betula glandulosa, Solidago macrophylla, Cladina stellaris, C. rangiferina,* and *Pleurozium schreberi.* The white spruce-moss forest is

**Figure 2**
Mud/sand tidal flat below a salt marsh a few kilometres north of the La Grande River

**Figure 3**
Mud/sand tidal flat with numerous glacial boulders near the Kapsaouis River

**Figure 4**
Narrow boulder-strewn tidal flat north of the Roggan River

**Figure 5**
Boulder-strewn tidal flat on fine sediments south of Dead Duck Bay

**Figure 6**
Rocky tidal flat near Paul Bay

**Figure 7**
Lower salt marsh colonized by *Hippuris tetraphylla*



**Figure 8**
Lower salt marsh dominated by *Puccinellia phryganodes*

**Figure 9**
*Carex paleacea* meadow in the upper salt marsh south of the La Grande River

**Figure 10**
Stream colonized by *Hippuris tetraphylla* in a salt marsh south of Point Attikuan

**Figure 11**
Willow thicket marking the inner limit of a *Festuca rubra* meadow in the upper marsh

**Figure 12**
Typical salt marsh of the arctic zone north of the Roggan River

**Figure 13**
Strip of *Elymus mollis* bordering an island

Figure 14
Strip of *Carex paleacea* near Dead Duck Bay

Figure 15
Rocky heath dominated by *Empetrum nigrum* near Point Walrus

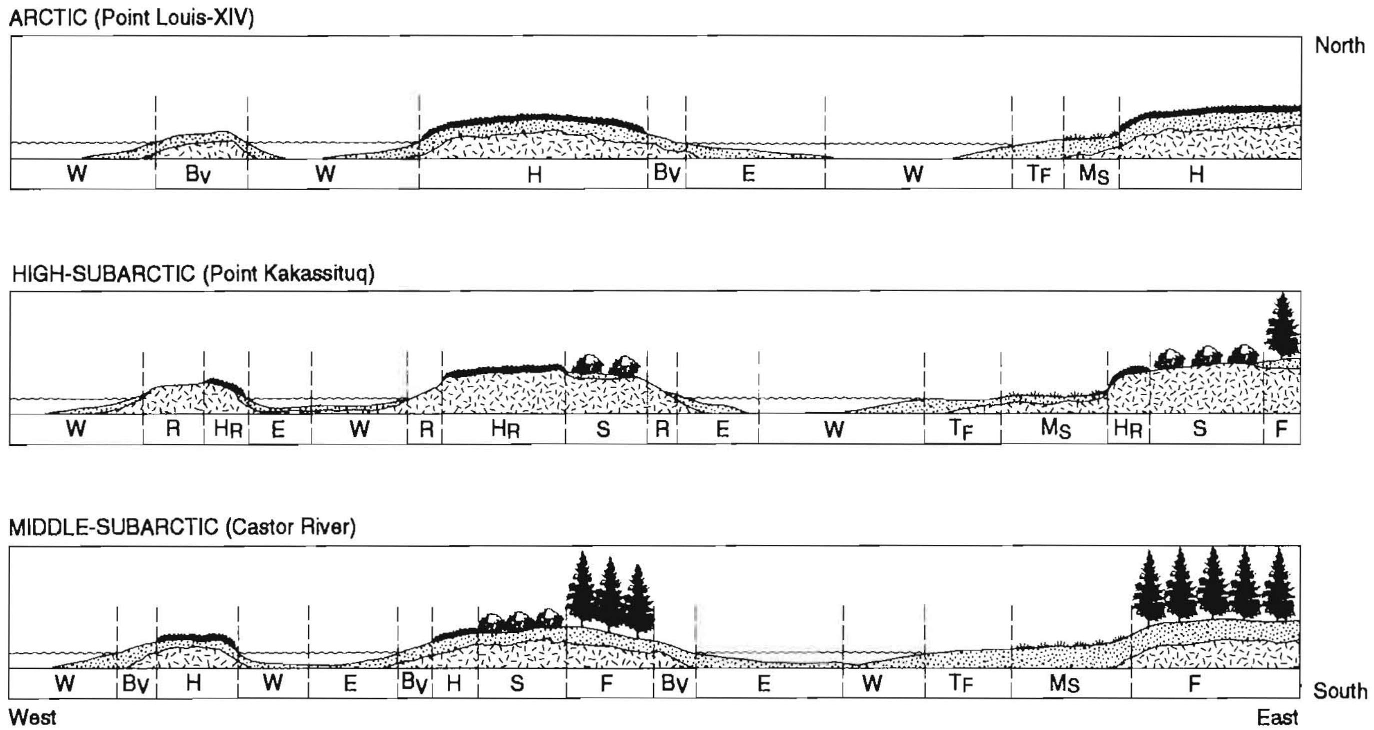
Figure 16
Lichen heath near Point Attikuan

Figure 17
Shrub formation bordering the coastal forest

Figure 18
Shrub formations typical of the coastal landscape near Point Attikuan

Figure 19
White spruce coastal forest

Figure 20
Schematic transects of the coastal habitats of the three biological zones of northeastern James Bay (S: shrub; $B_V$: boulder-strewn shore fringed with vegetation; W: open water; $T_F$: mud/sand tidal flat; F: forest; H: heath; $H_R$: rocky heath; R: rocky outcrop; E: eelgrass bed; $M_S$: salt marsh)




found on finer, poorly drained deposits and has an undercover dominated by ericaceous shrubs and the mosses *Pleurozium schreberi* and *Hylocomium splendens*. Other common species are *Cornus canadensis*, *Trientalis borealis*, *Carex disperma*, *Petasites palmatus*, and *Calamagrostis canadensis*. Beyond the limit of maritime fogs, black spruce *Picea mariana* gradually replaces white spruce to become the dominant species of the immense interior forests.

*Picea glauca* forests occupy the entire coast northward to Point Kakassituq; beyond that point, they retreat progressively inland, separated from the coast by a widening band of heath. They also cover most of the inner islands in the southern portion of the study area. On the outer islands south of Point Attikuan, they occur as isolated groves. In the study area, white spruce rarely attain full size, but they do not develop the distorted growth forms that occur in exposed individuals of *Picea mariana* (Payette 1974).

### 4.4 Overview

Northeastern James Bay is characterized principally by its irregular coastline, the presence of hundreds of islands, reefs, and shoals, and shallow, subtidal waters. Overall, it is considered a low-energy coastline (Dionne 1980). The waters are brackish and covered by ice through six months of the year. Isostatic rebound, waves, ice action, currents, and tides have been the active forces behind the shaping of the coast.

At the regional level, the distribution of the broad plant communities (Fig. 20) is the result of climatic variables (temperature and precipitation); at the local level, the texture and physicochemical properties of the surface deposits have been most influential. On a north-south axis, there are marked changes in coastal vegetation, which correspond with the biological zones and subzones proposed by Ducruc et al. (1976); within each, the plant communities show strong structural and floristic homogeneity.

The presence of vast subtidal eelgrass meadows is explained by the abundance of well-protected bays, low tidal amplitude, optimal salinity during the growing period, and relatively warm water temperatures during summer.

There are many salt marshes, the most developed of which are found in the large bays. Notable changes take place in their structure and vegetation from south to north, especially in the upper marsh. *Carex paleacea* and *C. mackenziei*, which often cover large areas, and *Salix candida* and *S. brachycarpa*, which mark the upper limit of the same subarctic marshes, are rare or absent in the arctic zone. Similarly, *Festuca rubra* is gradually replaced by *Calamagrostis deschampsioides*. These changes are attributable to lower temperatures, as shown by the reappearance of these species in the hemiarctic (Payette and Lepage 1977; Deshaye and Cayouette 1988), where climatic conditions are less severe, and disappearance again in the arctic zone (Blondeau 1986, 1989). The mosaic pattern of mounds and depressions in the upper marsh of the arctic zone could be the result of former more intense ice action along this exposed portion of the coast. The presence of bare patches in the upper marsh of the arctic zone is more difficult to explain but could be due to the absence of such plants as *Carex paleacea* and *C. mackenziei*, which occupy that niche in subarctic marshes.

Because of the shape of the coastline of northeastern James Bay, vast expanses of marshy flats cannot develop as they have done on the west coast of James and Hudson bays, where they cover 85-90% of the shore (Glooschenko 1980). At equal latitudes, however, the vegetation and zonation of the salt marshes are similar on both sides of James Bay. In southern James Bay, the coastal marshes are dominated by *Scirpus americanus* and *S. validus* where salinity is very low or nil, or by *Hippuris tetraphylla* and *Scirpus maritimus* in brackish areas (Lacoursière and Maire 1976; Glooschenko 1983). According to Lacoursière and Maire (1976), the first halophytes appear just south of the estuary of the Pontax River (51°35′N).

The marshes between the Eastmain and Au Castor rivers have not been studied. In general, the vegetation of the salt marshes of the arctic and subarctic zones of James Bay is similar to those of the same zones elsewhere in the northern hemisphere (Glooschenko 1980), except that their species diversity is greater. Only the marshes of southern James Bay show floristic similarities with those of the St. Lawrence estuary and certain regions along the Atlantic coast.

Heaths cover some or all of the outer islands north of 53°N, as well as a narrow band along the coast in the upper subarctic zone. A progressive increase in the number of arctic species, from south to north and from the coast seaward, reflects increasing severity of climate. The arctic zone is devoid of trees and is dominated by heaths.

White spruce forests are limited to the subarctic coast and extend inland to the limit of penetration by sea fog. These forests are dense in the middle subarctic and open in the high subarctic. Increasing climatic severity limits their development and allows the establishment of shrub formations only in protected areas. They disappear progressively in the arctic zone.



# 5.0 Use by waterfowl

James Bay's chief attraction for migratory birds is the abundance of food, both animal and plant, in the diverse and relatively productive habitats along the coast. The western shore of James Bay has been studied in some detail, and its use by aquatic birds has received considerable attention. The same is not true of the eastern shore of the bay.

This section makes a preliminary assessment of waterfowl use of the coastal habitats of northeastern James Bay. This assessment is, by necessity, based mainly on our general knowledge of waterfowl ecology and on information gleaned from the literature. Presented as a basis for future detailed studies, it draws heavily from earlier reports on bird distribution by Manning and Macpherson (1952), Todd (1963), Bourget (1973), and Curtis and Allen (1976) for the east coast, and, for James Bay in general, by Manning (1952, 1981), Manning and Coates (1952), and Morrison and Gaston (1986). The ecological studies by Prevett et al. (1979), Wypkema and Ankney (1979), Thomas and Prevett (1982), and Ross (1982, 1983, 1984) along the west coast of James Bay were also consulted.

## 5.1 Species diversity

James Bay is generally characterized by a great diversity of species, especially waterfowl. The Tundra Swan *Cygnus columbianus*, Lesser Snow Goose *Anser caerulescens caerulescens* (both white and blue colour phases), Canada Goose *Branta canadensis*, Brant *B. bernicla*, and about 24 duck species are found there. All but six of the duck species have been recorded within the mapped area (Table 2). Canada Geese and at least eight species of duck nest in the study area.

Approximately 23 species of shorebirds have been observed along the northeast shore of James Bay (Table 2), about eight of which nest there (Todd 1963; Bourget 1973). Herring Gulls *Larus argentatus*, Glaucous Gulls *L. hyperboreus*, Arctic Terns *Sterna paradisaea*, and Black Guillemots *Cepphus grylle* are also present. Common Loons *Gavia immer* and Red-throated Loons *G. stellata* can be observed in spring and fall, but no nesting has been reported (Todd 1963). American Bitterns *Botaurus lentiginosus* nest there, and migrating Sandhill Cranes *Grus canadensis* have been seen occasionally (Ouellet and Bourget 1975). In addition, several species of passerines and raptors occur in the study area, but these are not discussed in this report.

**Table 2**
Ducks and shorebirds reported from the northeast coast of James Bay[a]

| Species | Presence of birds | Presence of nests |
|---|---|---|
| **Ducks** | | |
| Mallard *Anas platyrhynchos* | X | X |
| American Black Duck *A. rubripes* | X | X |
| Northern Pintail *A. acuta* | X | X |
| Green-winged Teal *A. crecca* | X | X |
| American Wigeon *A. americana* | X | X |
| Greater Scaup *Aythya marila* | X | ? |
| Lesser Scaup *A. affinis* | X | ? |
| Ring-necked Duck *A. collaris* | X | |
| Common Goldeneye *Bucephala clangula* | X | |
| Common Eider *Somateria mollissima* | X | X |
| Common Merganser *Mergus merganser* | X | ? |
| Red-breasted Merganser *M. serrator* | X | ? |
| Hooded Merganser *Lophodytes cucullatus* | X | |
| Black Scoter *Melanitta nigra* | X | |
| Surf Scoter *M. perspicillata* | X | X |
| White-winged Scoter *M. fusca* | X | |
| Oldsquaw *Clangula hyemalis* | X | X |
| Harlequin Duck *Histrionicus histrionicus* | X | ? |
| **Shorebirds** | | |
| Lesser Golden-Plover *Pluvialis dominica* | X | |
| Black-bellied Plover *P. squatarola* | X | |
| Semipalmated Plover *Charadrius semipalmatus* | X | X |
| Killdeer *C. vociferus* | X | X |
| Greater Yellowlegs *Tringa melanoleuca* | X | |
| Lesser Yellowlegs *T. flavipes* | X | ? |
| Solitary Sandpiper *T. solitaria* | X | X |
| Spotted Sandpiper *Actitis macularia* | X | X |
| Whimbrel *Numenius phaeopus* | X | |
| Hudsonian Godwit *Limosa haemastica* | X | |
| Ruddy Turnstone *Arenaria interpres* | X | |
| Red Knot *Calidris canutus* | ? | |
| Sanderling *C. alba* | X | |
| Semipalmated Sandpiper *C. pusilla* | X | X |
| Least Sandpiper *C. minutilla* | X | X |
| White-rumped Sandpiper *C. fuscicollis* | X | |
| Baird's Sandpiper *C. bairdii* | ? | |
| Pectoral Sandpiper *C. melanotos* | X | |
| Purple Sandpiper *C. maritima* | X | |
| Dunlin *C. alpina* | ? | |
| Short-billed Dowitcher *Limnodromus griseus* | ? | |
| Common Snipe *Gallinago gallinago* | X | X |
| Red-necked Phalarope *Phalaropus lobatus* | X | X |

[a]Principal references: Manning and Macpherson 1952; Todd 1963.

## 5.2 Synthesis of current knowledge

Table 3 summarizes current knowledge of the potential use of coastal habitats by waterfowl in spring, summer, and fall, and the following paragraphs provide further details.

### 5.2.1 Aquatic milieu

#### *5.2.1.1 Open water*

Large areas of coastal water gradually become free of ice through the spring migration period, providing resting areas for most aquatic birds (geese, ducks, loons, gulls, terns, guillemots).

Diving ducks (scaups, goldeneyes, scoters, mergansers, eiders, oldsquaws) and seabirds (gulls, terns, guillemots) feed there throughout the ice-free season. Many of the same diving ducks moult in these open water areas, but only the Common Eider *Somateria mollissima* is likely to raise its young there.

#### *5.2.1.2 Eelgrass beds*

These subtidal meadows are a source of food for several species of waterfowl. Although water depth poses certain limits, the leaves, seeds, and rhizomes of eelgrass are grazed. The invertebrates and fish associated with eelgrass beds are also an important food source.

In early spring, the eelgrass beds are covered with shorefast ice and unavailable to the birds. With the thaw, openings in the ice gradually expose the beds. Brant, which migrate later than Canada Geese and Lesser Snow Geese, use these openings to graze on eelgrass, their favourite food. Canada Geese and American Wigeon *Anas americana* probably exploit this food source as well.

There is no specific information available on the use of eelgrass beds in summer, but moulting diving ducks probably use them, feeding mainly on molluscs, crustaceans, and fish found there.

In fall, migrating birds have full access to the eelgrass beds. Brant and Canada Geese frequent them in large numbers (Curtis and Allen 1976). American Wigeon probably eat the blades of eelgrass and other underwater plants, whereas American Black Duck *Anas rubripes* and Northern Pintail *A. acuta* probably eat eelgrass seeds. As in summer, several species of diving duck feed on invertebrates and crustaceans.

### 5.2.2 Shoreline milieu

#### *5.2.2.1 Tidal flats and boulder-strewn shores fringed with vegetation*

With the spring thaw, the tidal flats become available for use by Canada Geese, American Black Ducks, and Northern Pintail. Use of these habitats in summer is not well documented, but several groups of diving ducks were seen on mud/sand tidal flats during the summer of 1989. Moulting scoters, goldeneyes, and mergansers feed there. In fall, they are used extensively by Canada Geese and dabbling ducks for feeding.

Generally, the mud/sand tidal flats are potentially more attractive to feeding waterfowl than the narrower, boulder-strewn tidal flats. Boulder-strewn shores with fringes of vegetation offer a certain amount of food and cover for broods and moulting ducks travelling along the coast. Finally, the blades of eelgrass that accumulate in windrows along the shore, as well as the associated invertebrates, are consumed by several species of duck and, probably, geese.

Rocky tidal flats appear to hold little attraction for waterfowl. Eiders and mergansers may rest on rocky points during low tide and, along with other diving ducks, feed on molluscs, amphipods, and fish when the tide is high. Only Common Eiders are likely to frequent this habitat during brood rearing.

Certain rocky islets could serve as nest sites for Herring Gulls, Arctic Terns, and Black Guillemots.

#### *5.2.2.2 Salt marshes*

Salt marshes provide an abundant and varied source of food for several species of dabbling duck throughout the ice-free season, for Canada Geese during the two migration periods, and for Lesser Snow Geese, particularly in autumn.

In spring, the marshes are used by Canada Geese, which feed on *Triglochin palustris* bulbs and the seeds of *Carex* spp. (Reed et al. 1990). American Black Duck, Mallard *Anas platyrhynchos*, Northern Pintail, and Green-winged Teal *A. crecca* also frequent the marshes in spring, probably feeding on seeds and invertebrates. During spring, the timing of the thaw has a strong influence on the availability of food. While the marshes are still mostly covered with snow, meltponds attract many migratory birds. Seeds, bulbs, and other plant material are abundant then. As the thaw progresses, increasingly larger areas of

Table 3
Potential use of coastal habitats by waterfowl

| Habitats | Spring | Summer | Fall |
|---|---|---|---|
| **Aquatic milieu** | | | |
| Open water | Feeding and resting by diving ducks and seabirds; resting by geese and other ducks | Feeding, resting, and moulting by diving ducks and seabirds; brood rearing by Common Eiders | Feeding and resting by diving ducks and seabirds |
| Eelgrass bed | Feeding at openings in ice: Brant, Canada Geese, and American Wigeon | Feeding by diving ducks in moulting season | Feeding by Canada Geese, Brant, American Wigeon, American Black Duck, Northern Pintail, diving ducks |
| **Shoreline milieu** | | | |
| Mud/sand tidal flats | Variable use depending on thaw; feeding and resting by Canada Geese, American Black Duck, and Northern Pintail | Feeding by diving ducks in moulting season | Feeding and resting by Canada Geese and dabbling ducks |
| Boulder-strewn tidal flat | Similar to mud/sand tidal flats, but not used to the same extent | Similar to mud/sand tidal flats, but not used to the same extent | Similar to mud/sand tidal flats, but not used to the same extent |
| Rocky tidal flat (rocky outcrop) | Limited attraction for resting and feeding by some diving ducks; brood rearing by Common Eiders | Limited attraction for resting and feeding by some diving ducks; brood rearing by Common Eiders | Limited attraction for resting and feeding by some diving ducks; brood rearing by Common Eiders |
| Salt marsh | Variable use depending on thaw; feeding by geese and dabbling ducks | Raising broods and moulting by ducks | Feeding by Canada Geese and dabbling ducks |
| Boulder-strewn shore fringed with vegetation | Same as marsh, but not nearly as attractive | Escape cover and feeding by broods and moulting ducks travelling along the coast | Same as marsh, but not nearly as attractive |
| **Terrestrial milieu** | | | |
| Freshwater marsh | Unknown, probably used for feeding | Unknown, probably used for feeding | Unknown, probably used for feeding |
| Heath | Feeding by Canada Geese | Nesting by ducks; moulting by geese and ducks | Feeding by Canada Geese and American Black Duck |
| Shrub | Not used | Nesting, moulting, escape cover, and feeding by ducks if along the edge of marsh or pond | Not used |
| Forest | Not used | Nesting along edges by ducks | Not used |

the marsh become available. In summer, some dabbling ducks (American Black Duck, Northern Pintail, American Wigeon, Green-winged Teal) probably raise their broods in the marshes, benefiting from the abundant food supply (both animal and plant) and good escape cover provided by the vast expanses of *Carex paleacea* and/or the adjacent fringe of willows. These same features also undoubtedly attract dabbling ducks during the moulting period. In fall, Canada Geese frequent the marshes to graze the foliage and to glean the seeds of sedges and grasses to supplement their main diet, which consists chiefly of the berries of *Empetrum* and *Vaccinium* and the foliage of eelgrass. Dabbling ducks also use this habitat to feed on seeds and invertebrates.

5.2.3 Terrestrial milieu

*5.2.3.1 Freshwater marshes*

Little information is available on the use of freshwater marshes, but they are probably used for feeding.

*5.2.3.2 Heaths*

At present, it is not possible to distinguish between bird use of *Empetrum* heaths and bird use of lichen heaths. Both types of heath appear to play an important role in the life cycle of several species of aquatic birds.

In spring, berries (*Empetrum nigrum*, *Vaccinium* spp.) that have remained under the snow all winter represent an important food source for Canada Geese (Reed et al. 1990); because snow cover on the islands is not deep, the berries become available early. In summer, several species of duck probably nest in the dense cover provided by ericaceous shrubs or in *Elymus* meadows, especially near the numerous ponds on the islands. Moulting ducks and geese also use these ponds. In fall, the heaths provide an enormous quantity of food for Canada Geese and American Black Ducks in the form of *Empetrum* and *Vaccinium* berries.

The vast expanse of coastal heath north of Point Attikuan is frequented by Lesser Snow Geese, but little is known about their diet in this area.

*5.2.3.3 Shrub and forest formations*

During migration, shrub habitat is not used by waterfowl. In summer, shrub thickets are probably used for cover by some nesting, brood-rearing, and moulting ducks. Shrubs are particularly attractive as escape cover when they are located adjacent to feeding sites, such as ponds or marshes. Similarly, forest habitats are not used by aquatic birds during migration; in summer, however, some ducks (especially dabbling ducks) nest under trees (particularly conifers) on the edge of the forest or in groves of trees found on islands.

### 5.3 Key habitats for waterfowl

It is undoubtedly the diversity of habitats that makes the east coast of James Bay so attractive to aquatic birds, particularly waterfowl. Of the various types of habitat, it is the salt marshes, eelgrass beds, and heaths that seem to be the most important feeding and resting areas. During an overflight in the summer of 1989, it became evident that the shallow coastal lakes that are directly linked to the sea are also used by ducks for nesting and raising their young.



## 6.0 Conclusion

As was pointed out by the National Wetlands Working Group (1988), there is a paucity of information on the wetlands of the east coast of James Bay. Knowledge on their use by waterfowl is also inadequate, given the evident importance of the area as a major staging area for many species. This report has described the characteristic plant life, extent, and diversity of coastal habitats on the northeast coast of James Bay; we hope it will serve as a basis for future, more detailed, studies.

## Literature cited


**Anonymous. 1973.** Table des marées et des courants du Canada. Vol. 4. L'Arctique et la baie d'Hudson. Hydrographic Service of Canada, Energy, Mines and Resources Canada, Ottawa. 58 pp.

**Arnell, S. 1979.** Illustrated moss flora of Fennoscandia. I. Hepaticae. Swedish Natural Science Research Council, Kungalv. 314 pp.

**Baldwin, W.K.W. 1949.** Botanical investigations on the coast of Hudson and James bays. Natl. Mus. Can. Bull. 113:31–32.

**Baldwin, W.K.W. 1953.** Plants of two small island habitats in James Bay. Annual report of the National Museums of Canada. Reprinted from Natl. Mus. Can. Bull. 128:1–14.

**Blondeau, M. 1986.** La flore vasculaire d'Inukjuak, Nouveau-Québec. Provancheria 19, Memoires de l'Herbier Louis-Marie, Université Laval. 68 pp.

**Blondeau, M. 1989.** La flore vasculaire des environs d'Akulivik, Nouveau-Québec. Provancheria 23, Memoires de l'Herbier Louis-Marie, Université Laval. 80 pp.

**Bourget, A. 1973.** Études à la baie James, Québec 1972. Internal report, Canadian Wildlife Service, Ste. Foy. 92 pp.

**Couillard, L.; Grondin, P. 1986.** La végétation des milieux humides du Québec. Les Publications du Québec, Ministère de l'Environnement, Gouvernement du Québec. 400 pp.

**Crum, H.; Anderson, L.E. 1981.** Mosses of Eastern North America. 2 vols. Columbia University Press, New York. 1328 pp.

**CSSA Inc. 1987.** Études océanographiques physiques et physico-chimiques dans la baie James en 1987. Report for the Engineering and Environment Department of the James Bay Energy Corporation, Montreal. 89 pp.

**Curtis, S. 1974–75.** Distribution of eelgrass: East coast, James Bay. Map at a scale of 1:125 000. Canadian Wildlife Service.

**Curtis, S.; Allen, L. 1976.** The waterfowl ecology of the Quebec coast of James Bay. Internal report, Canadian Wildlife Service, Ottawa. 72 pp.

**Deshaye, J.; Cayouette, J. 1988.** La flore vasculaire des îles et de la presqu'île de Manitounuk, baie d'Hudson: structure phytogéographique et interprétation bioclimatique. Provancheria 21, Memoires de l'Herbier Louis-Marie, Université Laval. 74 pp.

**Dionne, J.-C. 1976.** L'action glacielle dans les schorres du littoral oriental de la baie James. Cah. Geogr. Que. 20(50):303–326.

**Dionne, J.-C. 1978.** Formes et phénomènes périglaciaires en Jamésie, Québec subarctique. Geogr. Phys. Quat. 32(3):187–246.

**Dionne, J.-C. 1980.** An outline of the eastern James Bay coastal environment. Pages 311–338 *in* S.B. McCann (ed.), The coastline of Canada. Geological Survey of Canada.

**Ducruc, J.-P.; Zarnovican, R.; Gérardin, V.; Jurdant, M. 1976.** Les régions écologiques du territoire de la baie James: caractéristiques dominantes de leur couverture végétale. Cah. Geogr. Que. 20(50):365–392.

**Dutilly, A.; Lepage, E. 1948.** Coup d'oeil sur la flore subarctique du Québec. Contrib. Arct. Inst. Cath. Univ. Am. 1F, Washington, D.C. 170 pp.

**Dutilly, A.; Lepage, E.; Duman, M. 1958.** Contribution à la flore des îles (T.N.O.) et du versant oriental (Qué.) de la baie James. Contrib. Arct. Inst. Cath. Univ. Am. 9F, Washington, D.C. 199 pp.

**Eade, R.E. 1966.** Fort George River and Kaniapiskau (west half) map-areas, New Quebec. Geol. Surv. Can. Mem. 339. 84 pp.

**Gagnon, R. 1976.** Flore aquatique et riveraine d'eau douce d'une partie du versant est de la Baie James. Ecology Laboratory of the James Bay Energy Corporation. Université de Montréal, Research Report 37. 44 pp.

**Gauthier, B. 1982.** L'étagement des plantes vasculaires en milieu saumâtre, estuaire du Saint-Laurent. Naturaliste can. 109(2):189–203.

**Gérardin, V. 1980.** L'inventaire du capital-nature du territoire de la baie James: Les régions écologiques et la végétation des sols minéraux. Vol. I. Quebec. Regional Ecological Studies Service, Lands Directorate, Environment Canada. 398 pp.

**Glooschenko, W.A. 1980.** Coastal ecosystems of the James/Hudson Bay area of Ontario, Canada. Z. Geomorphol., Suppl. 34:214–224.

**Glooschenko, W.A. 1983.** Salt marsh vegetation of the Ontario coast of Hudson and James Bay. Part I. Transects descriptions. Natl. Water Res. Inst. Rep. No. 83-23, Inland Waters Directorate, Environment Canada. 55 pp.

**Godin, G. 1975.** Les vagues de tempête dans la baie de James. Naturaliste can. 102(2):219-228.

**Grandtner, M.M. 1975.** Les marais salés du parc national Forillon. Colloq. phytosociol. 4:171-179.

**Hale, M.E.; Culberson, W.L. 1970.** A fourth checklist of the lichens of the continental United States of Canada. Bryologist 73:499-543.

**Hunter, G.T. 1970.** Postglacial uplift at Fort Albany, James Bay. Can. J. Earth Sci. 7:547-548.

**Hustich, I. 1950.** Notes on the forests on the east coast of Hudson Bay and James Bay. Acta Geogr. 11(1):1-83.

**Jacques, D.; Hamel, C. 1982.** Système de classification des terres humides du Québec. Dép. sci. biol., Université du Québec à Montréal. Direction générale de la faune, Ministère du Loisir, de la Chasse et de la Pêche, Québec. 131 pp.

**James Bay Energy Corporation. 1978.** Connaissance du milieu des territoires de la baie James et du Nouveau-Québec. Montreal. 297 pp.

**Lacoursière, E.; Maire, A. 1976.** Étude écologique et cartographie de la végétation du littoral de la Baie de Rupert. Report for the Environment Department of the James Bay Energy Corporation, Montreal. 76 pp.

**Lalumière, R. 1986a.** Étude de la zostère marine (*Zostera marina* L.) sur la côte est de la baie James — été 1986. Report by Gilles Shooner et Associés for the Engineering and Environment Department of the James Bay Energy Corporation, Montreal. 80 pp. plus appendices.

**Lalumière, R. 1986b.** Caractérisation phyto-écologique de deux marais de la côte est de la baie James. Report by Gilles Shooner et Associés for the Engineering and Environment Department of the James Bay Energy Corporation, Montreal. 47 pp. plus appendices.

**Lalumière, R. 1987a.** Caractérisation bio-écologique de quelques zostéraies de la côte est de la baie James. Report by Gilles Shooner et Associés for the Engineering and Environment Department of the James Bay Energy Corporation, Montreal. 82 pp. plus appendices.

**Lalumière, R. 1987b.** Répartition de la zostère marine (*Zostera marina* L.) sur la côte est de la baie James — été 1987. Report by Gilles Shooner et Associés for the Engineering and Environment Department of the James Bay Energy Corporation, Montreal. 30 pp. plus map (1:125 000).

**Lalumière, R. 1988a.** Suivi des stations permanentes d'étude de la zostère marine sur la côte est de la baie James. Report by Gilles Shooner et Associés for the Engineering and Environment Department of the James Bay Energy Corporation, Montreal. 30 pp. plus appendices.

**Lalumière, R. 1988b.** Caractérisation écologique de dix marais de la côte est de la baie James. Report by Gilles Shooner et Associés for the Engineering and Environment Department of the James Bay Energy Corporation, Montreal. 48 pp. plus appendices.

**Lalumière, R. 1990.** Étude des herbiers de zostère marine de la côte est de la baie James. Étude complémentaire physico-chimique. Unpublished technical note by the Groupe Environnement Shooner, prepared for the James Bay Energy Corporation, Montreal.

**Lalumière, R.; Belzile, L. 1989.** Suivi des stations permanentes d'études de la zostère marine sur la côte est de la baie James — été 1989. Report by Gilles Shooner et Associés for the Engineering and Environment Department of the James Bay Energy Corporation, Montreal.

**Lamoureux, J.-P.; de Repentigny, L.G. 1972.** Contribution à la flore des marécages intertidaux de la baie de Rupert (Québec). Internal report, Canadian Wildlife Service, Valleyfield, Que. 14 pp.

**Lamoureux, J.-P.; Zarnovican, R. 1972.** Approximation relative à la végétation riparienne de la Baie de Rupert (Québec). Internal report, Canadian Wildlife Service, Valleyfield, Que. 126 pp.

**Lamoureux, J.-P.; Zarnovican, R. 1974.** Les marécages côtiers de la Baie aux Oies, Québec. Impact du projet hydroélectrique. James Bay Report Series No. 13, Canadian Wildlife Service. 99 pp.

**Lee, H.A.; Eade, K.E.; Heywood, W.W. 1960.** Superficial geology, Sakami Lake (Fort George - Great Whale River area), New Quebec. Geological Survey of Canada, map 52-1959.

**Low, A.P. 1909.** Rapport d'une exploration de la côte orientale de la Baie d'Hudson, du Cap Wolstenholme à l'extrémité méridionale de la baie James. Geological Survey of Canada Report No. 1069.

**Majcen, Z. 1973.** Classification des terrains organiques et des forêts humides du territoire de la baie James. Regional Ecological Studies Service, Lands Directorate, Environment Canada. 46 pp.

**Manning, T.H. 1952.** Birds of the west James Bay and southern Hudson Bay coasts. Natl. Mus. Can. Bull. 125. 114 pp.

**Manning, T.H. 1981.** Birds of the Twin Islands, James Bay, N.W.T. Natl. Mus. Nat. Sci. (Ottawa) Syllogeus 30. 50 pp.

**Manning, T.H.; Coates, D.F. 1952.** Notes on the birds of some James Bay islands. Natl. Mus. Can. Bull. 126:195-207.

**Manning, T.H.; Macpherson, A.H. 1952.** Birds of the east James Bay coast between Long Point and Cape Jones. Can. Field-Nat. 66:1-35.

**Martini, I.P.; Glooschenko, W.A. 1983-84.** Emergent coast of Akimiski Island, James Bay, Northwest Territories, Canada: geology, geomorphology and vegetation. Sediment. Geol. 37:229-250.

**Messier, D.; Lepage, S.; de Margerie, S. 1989.** Influence du couvert de glace sur l'étendue du panache de La Grande Rivière (baie James). Arctic 42(3):278-284.

**Morrison, R.I.G.; Gaston, A.J. 1986.** Marine and coastal birds of James Bay, Hudson Bay and Foxe Basin. Pages 355-386 *in* I.P. Martini (ed.), Canadian inland seas. Oceanography Series No. 44. Elsevier, New York.

**National Wetlands Working Group. 1988.** Wetlands of Canada. Ecological Land Classification Series No. 24. Sustainable Development Branch, Environment Canada, Ottawa, and Polyscience Publications, Montreal. 452 pp.

**Ouellet, H.; Bourget, A. 1975.** The Sandhill Crane in Quebec. Can. Field-Nat. 89:73-74.

**Payette, S. 1974.** Classification écologique de formes de croissance *Picea glauca* (Moench) Voss et de *Picea mariana* (Mill.) BSP. en milieux subarctiques et subalpins. Naturaliste can. 101(6):893-903.

**Payette, S.; Lepage, E. 1977.** La flore vasculaire du golfe de Richmond, baie d'Hudson, Nouveau-Québec. Provancheria 7, Memoires de l'Herbier Louis-Marie, Université Laval. 68 pp.

**Phillips, R.C.; Watson, J.F. 1984.** The ecology of eelgrass meadows in the Pacific Northwest: a community profile. U.S. Fish and Wildlife Service FWS/DBS-84/24. 85 pp.

**Prevett, J.P.; Marshall, I.F.; Thomas, V.G. 1979.** Fall foods of Lesser Snow Geese in the James Bay region. J. Wildl. Manage. 43:736-742.

**Reed, A.; Goyette, D.; Lameboy, G. 1990.** Preliminary observations on the spring diet of Canada Geese on the east coast of James Bay. Can. Wildl. Serv. Prog. Note No. 191. 5 pp.

**Riley, J.L.; McKay, S.M. 1980.** The vegetation and phytogeography of coastal southwestern James Bay. Life Sci. Contrib. R. Ont. Mus. No. 124. 81 pp.

**Roche Associés Ltée. 1982.** Études océanographiques de la côte est de la baie James. Vol. III. La végétation littorale. Report for the Engineering and Environment Department of the James Bay Energy Corporation, Montreal. 105 pp. plus appendices.

**Roche Associés Ltée. 1985.** Étude de la végétation aquatique de l'estuaire de La Grande Rivière et de la côte est de la baie James. Report for the Engineering and Environment Department of the James Bay Energy Corporation, Montreal.

**Ross, R.K. 1982.** Duck distribution along the James Bay and Hudson Bay coasts of Ontario. Naturaliste can. 109:927-932.

**Ross, R.K. 1983.** An estimate of the Black Scoter, *Melanitta nigra*, population moulting in James and Hudson bays. Can. Field-Nat. 97:147-150.

**Ross, R.K. 1984.** Use of the James Bay and Hudson Bay coasts of Ontario by dabbling ducks. Pages 63-69 *in* S.G. Curtis, D.G. Dennis, and H. Boyd (eds.), Waterfowl studies in Ontario, 1973-1981. Can. Wildl. Serv. Occas. Pap. 54.

**Scoggan, H.J. 1978-79.** The flora of Canada. 4 vols. National Museum of Natural Sciences, National Museums of Canada, Ottawa. 1711 pp.

**Tarnocai, C. 1980.** Canadian wetland registry. Pages 9-39 *in* Proc. Workshop on Wetlands of Canada. Ecological Land Classification Series No. 12, Lands Directorate, Environment Canada.

**Taylor, W.R. 1957.** Marine algae of the northeastern coast of North America. 2nd ed. University of Michigan Press, Ann Arbor, Mich. 509 p.

**Thomas, V.G.; Prevett, J.P. 1982.** The roles of the James Bay and Hudson Bay lowland in the annual cycle of geese. Naturaliste can. 109:913-925.

**Todd, W.E.C. 1963.** The birds of the Labrador Peninsula and adjacent areas. University of Toronto Press, Toronto. 819 pp.

**Villeneuve, G.O. 1967.** Sommaire climatique du Québec. Min. Rich. nat. du Québec, Serv. météorol. rapp. 24. 18 pp.

**Wilson, C. 1971.** Le climat du Québec, Première partie: atlas climatique. Climate Studies No. 11, Meteorological Services of Canada, Information Canada, Ottawa.

**Wypkema, R.C.P.; Ankney, C.D. 1979.** Nutrient reserve dynamics of Lesser Snow Geese staging at James Bay, Ontario. Can. J. Zool. 57:213-219.




**Appendix 1**

List of plant species collected or observed in different habitats along the northeast coast of James Bay

Aquatic milieu: eelgrass bed (E)
Shoreline milieu: tidal flat ($T_F$), boulder-strewn shore fringed with vegetation ($B_V$), salt marsh ($M_S$)
Terrestrial milieu: freshwater marsh ($M_F$), heath (H), shrub (S), forest (F)

| 1) Algae | E | $T_F$ | $B_V$ | $M_S$ | $M_F$ | H | S | F |
|---|---|---|---|---|---|---|---|---|
| **ULVACEAE** | | | | | | | | |
| *Enteromorpha* sp. | X | | | | | | | |
| **CLADOPHORACEAE** | | | | | | | | |
| *Cladophora* sp. | X | | | | | | | |
| *Rhizoclonium riparium* (Roth) Harvey | X | | | | | | | |
| **CHORDARIACEAE** | | | | | | | | |
| *Chordaria flagelliformis* (Müll.) C. Ag. | X | | | | | | | |
| **LAMINARIACEAE** | | | | | | | | |
| *Chorda filum* (L.) Lamour. | X | | | | | | | |
| **FUCACEAE** | | | | | | | | |
| *Ascophyllum nodosum* (L.) Le Jol. | X | X | | | | | | |
| *Fucus distichus* L. | X | X | | | | | | |

| 2) Vascular | E | $T_F$ | $B_V$ | $M_S$ | $M_F$ | H | S | F |
|---|---|---|---|---|---|---|---|---|
| **LYCOPODIACEAE** | | | | | | | | |
| *Lycopodium annotinum* L. *sensu lato* | | | | | | X | X | X |
| *Lycopodium selago* L. | | | | | | X | | |
| **OPHIOGLOSSACEAE** | | | | | | | | |
| *Botrychium lunaria* (L.) Sw. | | | X | | | | | |
| **PINACEAE** | | | | | | | | |
| *Juniperus communis* L. var. *depressa* Pursh | | | | | | X | X | X |
| *Larix laricina* (Du Roi) Koch | | | | | | X | | X |
| *Picea glauca* (Moench) Voss | | | | | | X | X | X |
| *Picea mariana* (Mill.) BSP. | | | | | | | | X |
| **SPARGANIACEAE** | | | | | | | | |
| *Sparganium chlorocarpum* Rydb. | | | | X | X | | | |
| **ZOSTERACEAE** | | | | | | | | |
| *Potamogeton filiformis* Pers. var. *borealis* (Raf.) St. John | | X | | X | | | | |
| *Potamogeton perfoliatus* L. ssp. *richardsonii* (Benn.) Hult. | | | | X | | | | |
| *Potamogeton pectinatus* L. | X | X | | X | | | | |
| *Zostera marina* L. | X | | | | | | | |
| **RUPPIACEAE** | | | | | | | | |
| *Ruppia maritima* L. | X | X | | | | | | |
| **JUNCAGINACEAE** | | | | | | | | |
| *Triglochin maritima* L. | | | | X | X | | | |
| *Triglochin palustris* L. | | | | X | | | | |
| **POACEAE** | | | | | | | | |
| *Agropyron trachycaulum* (Link) Malte var. *novae-angliae* (Scribn.) Fern. | | | X | | | X | | |
| *Agrostis hyemalis* (Walt.) BSP. f. *tuckermanii* (Fern.) Scoggan | | | | X | | | | |
| *Calamagrostis canadensis* (Michx.) Nutt. var. *canadensis* | | | X | | X | X | X | X |
| *Calamagrostis deschampsioides* Trin. | | | | X | | | | |
| *Calamagrostis inexpansa* Gray | | | | X | | | | |
| *Calamagrostis neglecta* (Ehrh.) Gaertn., Mey. & Scherb. | | | | X | X | | | |
| *Catabrosa aquatica* (L.) Beauv. var. *laurentiana* Fern. | | | | | X | | | |
| *Dupontia fisheri* R. Br. ssp. *psilosantha* (Rupr.) Hult. | | | | X | | | | |
| *Elymus mollis* Trin. | | | X | X | | X | | |
| *Festuca brachyphylla* Schult. & Schult. f. ssp. *brachyphylla* | | | | | | X | | |
| *Festuca rubra* L. | | | | X | X | | | |
| *Festuca richardsonii* Hook. | | | | X | | | | |
| *Hierochloë odorata* (L.) Beauv. | | | X | X | | | | |
| *Hordeum jubatum* L. | | | X | X | | | | |
| *Poa alpina* L. | | | | | | X | | |
| *Poa arctica* R. Br. | | | | | | X | | |
| *Poa eminens* Presl | | | X | X | | | | |
| *Poa pratensis* L. *sensu lato* | | | | X | | | | |
| *Puccinellia langeana* (Berl.) Soer. | | | | X | | | | |
| *Puccinellia lucida* Fern. & Weath. | | | | X | | | | |
| *Puccinellia phryganodes* (Trin.) Scribn. & Merr. | | | | X | | | | |
| *Trisetum spicatum* (L.) Richter var. *molle* (Michx.) Beal | | | X | | | X | | |
| *Trisetum spicatum* (L.) Richter var. *pilosiglume* Fern. | | | | | | X | | |
| **CYPERACEAE** | | | | | | | | |
| *Carex aquatilis* Wahl. ssp. *aquatilis* | | | | X | X | X | | |
| *Carex aquatilis* Wahl. var. *stans* (Drej.) Boott | | | | X | X | X | | |
| *Carex aurea* Nutt. | | | | | X | | | |
| *Carex bicolor* All. | | | | X | | | | |
| *Carex bigelowii* Torr. | | | | | | X | X | |
| *Carex canescens* L. | | | | | X | | X | X |
| *Carex capitata* L. var. *capitata* | | | | | | X | | |
| *Carex diandra* Schrank | | | | X | X | | | |
| *Carex disperma* Dewey | | | | | | | X | X |
| *Carex glareosa* Wahl. var. *amphigena* Fern. | | | X | | | | | |
| *Carex gynocrates* Wormsk. | | | X | | | X | | |
| *Carex limosa* L. | | | | X | X | X | X | |
| *Carex mackenziei* Krecz. | | | | X | | | | |
| *Carex maritima* Gunn. | | | X | | | X | | |
| *Carex microglochin* Wahl. | | | | | X | | | |
| *Carex norvegica* Retz. | | | | | | X | | |
| *Carex paleacea* Wahl. | | | X | X | | | | |
| *Carex rariflora* (Wahl.) Sm. | | | | X | X | X | X | |

| 2) Vascular | E | $T_F$ | $B_V$ | $M_S$ | $M_F$ | H | S | F |
|---|---|---|---|---|---|---|---|---|
| *Carex salina* Wahl. | | | | X | | | | |
| *Carex saxatilis* L. var. *miliaris* (Michx.) Bailey | | | | | | X | | |
| *Carex scirpoidea* Michx. | | | | X | X | X | | |
| *Carex subspathacea* Wormsk. | | | | X | | | | |
| *Eleocharis acicularis* (L.) R. & S. | | | | X | | | | |
| *Eleocharis kamtschatica* (Mey.) Komarov | | | | X | | | | |
| *Eleocharis smallii* Britt. | | | | X | X | | | |
| *Eriophorum angustifolium* Honckeny | | | | X | X | X | | |
| *Eriophorum russeolum* Fries *sensu lato* | | | | X | X | | | |
| *Eriophorum viridicarinatum* (Engelm.) Fern. | | | | | X | | | |
| *Scirpus caespitosus* L. var. *callosus* Bigel. | | | | | X | X | | |
| *Scirpus hudsonianus* (Michx.) Fern. | | | | | X | X | | |
| *Scirpus maritimus* L. var. *paludosus* (Nels.) Kük. | | | | X | | | | |
| *Scirpus rufus* (Huds.) Schrad. var. *neogaeus* Fern. | | | X | X | | | | |
| **LEMNACEAE** | | | | | | | | |
| *Lemna minor* L. | | | | | X | | | |
| *Lemna trisulca* L. | | | | | X | | | |
| **JUNCACEAE** | | | | | | | | |
| *Juncus albescens* Lange | | | | X | | X | | |
| *Juncus alpinus* Vill. | | | | X | | | | |
| *Juncus balticus* Willd. var. *littoralis* Engelm. | | | X | X | | | | |
| *Juncus bufonius* L. *sensu lato* | | | | X | | | | |
| *Luzula confusa* Lindeberg | | | | | | X | | |
| **LILIACEAE** | | | | | | | | |
| *Maianthemum canadense* Desf. | | | | | | | X | X |
| *Tofieldia pusilla* (Michx.) Pers. | | | | | X | X | X | |
| **ORCHIDACEAE** | | | | | | | | |
| *Habenaria dilatata* (Pursh) Hook. | | | | X | X | | | |
| *Habenaria hyperborea* (L.) R. Br. | | | | X | | | | |
| *Habenaria obtusata* (Pursh) Richards. | | | | X | | X | | |
| *Spiranthes romanzoffiana* Cham. | | | | X | | X | X | |
| **SALICACEAE** | | | | | | | | |
| *Salix arctica* Pallas | | | | | | X | | |
| *Salix arctophila* Cockerell ex A.A. Heller | | | | | X | X | X | |
| *Salix brachycarpa* Nutt. | | | | X | | | | |
| *Salix candida* Fluegge | | | | X | | | | |
| *Salix glauca* L. ssp. *callicarpaea* (Trautv.) Böcher | | | | | | X | X | |
| *Salix lanata* L. ssp. *calcicola* (Fern. & Wieg.) Hult. | | | | | | X | | |
| *Salix planifolia* Pursh | | | | | | | X | X |
| *Salix reticulata* L. ssp. *reticulata* | | | | X | | X | | |
| *Salix serissima* (Bailey) Fern. | | | | X | X | | | |
| *Salix uva-ursi* Pursh | | | | | | X | | |
| **MYRICACEAE** | | | | | | | | |
| *Myrica gale* L. | | | | | X | | X | |
| **BETULACEAE** | | | | | | | | |
| *Alnus crispa* (Ait.) Pursh var. *mollis* Fern. | | | | | | X | X | X |
| *Alnus rugosa* (Du Roi) Spreng. | | | | | | | | |
| *Betula glandulosa* Michx. | | | | | | X | X | X |
| **POLYGONACEAE** | | | | | | | | |
| *Polygonum viviparum* L. | | | | X | | X | | |
| *Rumex occidentalis* Wats. | | | | X | X | | | |
| **PORTULACACEAE** | | | | | | | | |
| *Montia fontana* L. | | | | X | | | | |
| **CHENOPODIACEAE** | | | | | | | | |
| *Atriplex cf. glabriuscula* Edmonston | | | X | X | | | | |
| *Salicornia europaea* L. var. *prostrata* (Pall.) Fern. | | | | X | | | | |
| **CARYOPHYLLACEAE** | | | | | | | | |
| *Arenaria peploides* L. var. *diffusa* Hornem. | | | X | | | | | |
| *Cerastium alpinum* L. ssp. *lanatum* (Lam.) Aschers. & Graebn. | | | | | | X | | |
| *Lychnis alpina* L. | | | X | | | X | | |
| *Sagina nodosa* (L.) Frenzl. var. *pubescens* Mert. & Koch | | | | X | | | | |
| *Silene acaulis* L. var. *exscapa* (All.) DC. | | | | | | X | | |
| *Spergularia canadensis* (Pers.) Don | | | | X | | | | |
| *Stellaria crassifolia* Ehrh. | | | | X | | | | |
| *Stellaria humifusa* Rottb. | | | | X | | | | |
| *Stellaria longifolia* Muhl. | | | | X | X | | | |
| **RANUNCULACEAE** | | | | | | | | |
| *Anemone parviflora* Michx. | | | X | | | X | | |
| *Caltha palustris* L. | | | | | X | | | |
| *Coptis trifolia* (L.) Salisb. ssp. *groenlandica* (Oeder) Hult. | | | | | | | X | X |
| *Ranunculus aquatilis* L. var. *eradicatus* Laest. | | | | X | X | | | |
| *Ranunculus cymbalaria* Pursh | | | | X | | | | |
| *Ranunculus gmelinii* DC. var. *hookeri* (Don) Benson | | | | X | X | | | |
| *Ranunculus pedatifidus* Sm. ssp. *affinis* (R. Br.) Hult | | | X | | | X | | |
| **BRASSICACEAE** | | | | | | | | |
| *Cardamine pratensis* L. var. *angustifolia* Hook. | | | | X | X | | | |
| *Cardamine pratensis* L. var. *palustris* Wimm. & Grab. | | | | X | X | | | |
| *Draba glabella* Pursh | | | X | | | X | | |
| **DROSERACEAE** | | | | | | | | |
| *Drosera anglica* Huds. | | | | | X | | | |
| *Drosera rotundifolia* L. | | | | | X | | | |
| **SARRACENIACEAE** | | | | | | | | |
| *Sarracenia purpurea* L. | | | | | | | | X |
| **SAXIFRAGACEAE** | | | | | | | | |
| *Parnassia kotzebuei* Cham. | | | | | | X | X | |
| *Parnassia palustris* L. ssp. *neogaea* (Fern.) Hult. | | | X | X | | | | |
| *Saxifraga aizoides* L. | | | | | | X | | |
| *Saxifraga aizoön* Jacq. var. *neogaea* Butters | | | | | | X | | |



| 2) Vascular | E | $T_F$ | $B_V$ | $M_S$ | $M_F$ | H | S | F |
|---|---|---|---|---|---|---|---|---|
| *Saxifraga caespitosa* L. ssp. *exaratoides* (Simm.) Englm. & Irmsch. | | | | | | X | | |
| *Saxifraga oppositifolia* L. | | | | | | X | | |
| *Saxifraga tricuspidata* Rottb. | | | X | | | X | | |
| **ROSACEAE** | | | | | | | | |
| *Dryas integrifolia* Vahl | | | X | | | X | | |
| *Potentilla egedii* Wormsk. *sensu lato* | | | | X | | | | |
| *Potentilla nivea* L. *sensu lato* | | | | | | X | | |
| *Potentilla palustris* (L.) Scop. | | | | X | X | | | |
| *Potentilla pulchella* R. Br. | | | | | | X | | |
| *Potentilla tridentata* Ait. | | | X | | | X | | |
| *Rubus acaulis* Michx. | | | | | | X | X | X |
| *Rubus chamaemorus* L. | | | | | | X | X | |
| *Rubus pubescens* Raf. | | | | | | | X | X |
| **FABACEAE** | | | | | | | | |
| *Astragalus alpinus* L. *sensu lato* | | | | | | X | | |
| *Lathyrus japonicus* Willd. var. *aleuticus* (Greene) Fern. | | | X | X | | X | | |
| *Lathyrus palustris* L. var. *linearifolius* Ser. | | | | X | | X | | |
| *Oxytropis viscida* Nutt. var. *hudsonica* (Greene) Barneby | | | | | | X | | |
| **EMPETRACEAE** | | | | | | | | |
| *Empetrum nigrum* L. ssp. *hermaphroditum* (Lange) Böcher | | | | X | | X | X | X |
| **VIOLACEAE** | | | | | | | | |
| *Viola macloskeyi* Lloyd ssp. *pallens* (DC.) S. Baker | | | | | | | X | |
| **ELAEAGNACEAE** | | | | | | | | |
| *Shepherdia canadensis* (L.) Nutt. | | | | | | X | | |
| **ONAGRACEAE** | | | | | | | | |
| *Epilobium angustifolium* L. ssp. *angustifolium* | | | X | | | X | X | X |
| *Epilobium latifolium* L. | | | X | | | X | | |
| *Epilobium palustre* L. var. *lapponicum* Wahl. | | | | X | X | | | |
| *Epilobium palustre* L. var. *longiramerum* Fern. & Wieg. | | | | X | X | | X | |
| **HALORAGACEAE** | | | | | | | | |
| *Myriophyllum spicatum* L. var. *exalbescens* (Fern.) Jeps. | | | | X | X | | | |
| *Myriophyllum verticillatum* L. | | | | X | X | | | |
| **HIPPURIDACEAE** | | | | | | | | |
| *Hippuris tetraphylla* L.f. | | | | X | | | | |
| *Hippuris vulgaris* L. | | | | | X | | | |
| **APIACEAE** | | | | | | | | |
| *Cicuta bulbifera* L. | | | | | X | | | |
| *Heracleum lanatum* Michx. | | | X | | X | | | |
| *Ligusticum scothicum* L. | | | X | X | | | | |
| *Sium suave* Walt. | | | | X | X | | | |
| **CORNACEAE** | | | | | | | | |
| *Cornus canadensis* L. | | | | | | | X | X |
| **PYROLACEAE** | | | | | | | | |
| *Pyrola grandiflora* Radius | | | | | | X | X | |
| *Pyrola secunda* L. var. *obtusata* Turcz. | | | | | | X | X | X |
| **ERICACEAE** | | | | | | | | |
| *Andromeda glaucophylla* Link | | | | | | | X | |
| *Arctostaphylos rubra* (Rehd. & Wils.) Fern. | | | | | | X | | |
| *Kalmia angustifolia* L. | | | | | | | X | X |
| *Kalmia polifolia* Wang. | | | | | | | X | X |
| *Ledum groenlandicum* Oeder | | | | | | X | X | X |
| *Ledum palustre* L. ssp. *decumbens* (Ait.) Hult. | | | | | | X | X | |
| *Rhododendron lapponicum* (L.) Wahl. | | | | | | X | | |
| *Vaccinium angustifolium* Ait. *sensu lato* | | | | | | | X | X |
| *Vaccinium oxycoccus* L. | | | | | | | | X |
| *Vaccinium uliginosum* L. ssp. *gaultherioides* (Bigel.) Young | | | | X | | X | X | |
| *Vaccinium uliginosum* L. ssp. *pubescens* (Wormsk.) Young | | | | X | | X | X | |
| *Vaccinium vitis-idaea* L. ssp. *minus* (Lodd.) Hult. | | | | | | X | X | |
| **PRIMULACEAE** | | | | | | | | |
| *Primula egaliksensis* Wormsk. | | | | X | | | | |
| *Primula stricta* Hornem. | | | | X | | | | |
| *Trientalis borealis* Raf. | | | | | | | X | X |
| **PLUMBAGINACEAE** | | | | | | | | |
| *Armeria maritima* (Mill.) Willd. ssp. *labradorica* (Wallr.) Hult. | | | X | | | X | | |
| **GENTIANACEAE** | | | | | | | | |
| *Gentianella amarella* (L.) Börner *sensu lato* | | | | X | | | | |
| *Lomatogonium rotatum* (L.) Fries | | | | X | | | | |
| *Menyanthes trifoliata* L. var. *minor* Raf. | | | | X | X | | | |
| **SCROPHULARIACEAE** | | | | | | | | |
| *Castilleja pallida* (L.) Spreng. ssp. *septentrionalis* (Lindl.) Scoggan | | | | X | | X | | |
| *Castilleja raupii* Pennell | | | | X | | X | | |
| *Euphrasia arctica* Lange | | | | X | | | | |
| *Pedicularis groenlandica* Retz. | | | | X | | | | |
| *Pedicularis labradorica* Wirsing | | | X | | | X | | |
| *Pedicularis parviflora* Sm. | | | | | X | X | | |
| *Rhinanthus borealis* (Sterneck) Druce | | | | X | | | | |
| **LENTIBULARIACEAE** | | | | | | | | |
| *Pinguicula vulgaris* L. | | | | | | X | X | |
| *Utricularia intermedia* Hayne | | | | | X | | | |
| **PLANTAGINACEAE** | | | | | | | | |
| *Plantago maritima* L. *sensu lato* | | | X | X | | | | |
| **RUBIACEAE** | | | | | | | | |
| *Galium trifidum* L. | | | | X | X | | | |
| *Galium trifidum* L. var. *pusillum* Gray | | | | X | X | | | |
| **CAPRIFOLIACEAE** | | | | | | | | |
| *Linnaea borealis* L. ssp. *americana* (Forbes) Hult. | | | | | | | X | X |
| **CAMPANULACEAE** | | | | | | | | |
| *Campanula rotundifolia* L. | | | | | | X | | |

| 2) Vascular | E | $T_F$ | $B_V$ | $M_S$ | $M_F$ | H | S | F |
|---|---|---|---|---|---|---|---|---|
| **ASTERACEAE** | | | | | | | | |
| *Achillea nigrescens* (Mey.) Rydb. | | | X | | | X | | |
| *Antennaria pulcherrima* (Hook.) Greene | | | | | | X | | |
| *Artemisia campestris* L. ssp. *borealis* (Pall.) Hall & Clements | | | X | | | X | | |
| *Aster borealis* (T. & G.) Provancher | | | | | X | | | |
| *Aster cf. johannensis* Fern.* | | | | | X | | | |
| *Aster lanceolatus* Willd. ssp. *hesperius* (A. Gray) Semple & Chmiel. | | | X | | X | | | |
| *Aster puniceus* L. | | | | X | X | | X | |
| *Chrysanthemum arcticum* L. ssp. *polare* Hult. | | | X | X | | | | |
| *Petasites palmatus* (Ait.) Gray | | | | | | | | X |
| *Petasites sagittatus* (Banks) Gray | | | | X | X | | | |
| *Senecio congestus* (R. Br.) DC. | | | | X | | | | |
| *Solidago macrophylla* Pursh var. *thyrsoidea* (Mey.) Fern. | | | | | | | | |
| *Tanacetum huronense* Nutt. *sensu lato* | | | | | | X | | |
| *Taraxacum cf. lacerum* Greene | | | X | | | | | |
| *Taraxacum cf. umbrinum* Dahlst. | | | X | | | X | | |

| 3) Cryptogams | $M_S$ | $M_F$ | H | S | F |
|---|---|---|---|---|---|
| **Bryophytes** | | | | | |
| **PTILIDIACEAE** | | | | | |
| *Ptilidium ciliare* (L.) Hampe | | | X | X | X |
| **SPHAGNACEAE** | | | | | |
| *Sphagnum capillifolium* (Ehrh.) Hedw. var. *capillifolium* | | | | | X |
| *Sphagnum compactum* DC. ex Lam. & DC. | | | | X | X |
| *Sphagnum fallax* (Klinggr.) Klinggr. | | | | | X |
| *Sphagnum fuscum* (Schimp.) Klinggr. | | | | X | X |
| *Sphagnum lindbergii* Schimp. ex Lindb. | | | | X | X |
| *Sphagnum magellanicum* Brid. | | | | | X |
| *Sphagnum russowii* Warnst. | | | | | X |
| *Sphagnum squarrosum* Crome | | X | | | |
| **ANDREAEACEAE** | | | | | |
| *Andreaea rupestris* Hedw. | | | X | X | X |
| **POLYTRICHACEAE** | | | | | |
| *Polytrichum alpinum* Hedw. | X | | X | X | |
| *Polytrichum commune* Hedw. | | X | X | X | X |
| *Polytrichum hyperboreum* R. Br. | | | X | | |
| *Polytrichum juniperinum* Hedw. | | | X | X | X |
| *Polytrichum longisetum* Brid. | | | X | | |
| *Polytrichum piliferum* Hedw. | | | X | | |
| *Polytrichum strictum* Brid. | | X | X | X | X |
| **FUNARIACEAE** | | | | | |
| *Funaria hygrometrica* Hedw. | | X | | | |
| **ORTHOTRICHACEAE** | | | | | |
| *Orthotrichum speciosum* Nees ex Sturm var. *speciosum* | | | X | | |
| *Ulota hutchinsiae* (Sm.) Hamm. | | | X | X | X |
| **BRYACEAE** | | | | | |
| *Bryum argenteum* Hedw. | X | | | | |
| *Bryum caespiticium* Hedw. | X | | | | |
| *Bryum lisae* var. *cuspidatum* (B.S.G.) Marg. | | | X | | |
| *Bryum stenotrichum* C. Müll. | X | | | | |
| *Leptobryum pyriforme* (Hedw.) Wils. | | | X | | |
| *Pohlia nutans* (Hedw.) Lindb. | | | X | | |
| **MNIACEAE** | | | | | |
| *Cinclidium stygium* Sw. | | X | | | |
| *Plagiomnium ellipticum* (Brid.) Kop. | X | X | | | |
| *Rhizomnium gracile* Kop. | | X | | | |
| **AULACOMNIACEAE** | | | | | |
| *Aulacomnium palustre* (Hedw.) Schwaegr. | X | X | X | X | X |
| *Aulacomnium turgidum* (Wahlenb.) Schwaegr. | X | | X | | |
| **MEESIACEAE** | | | | | |
| *Meesia triquetra* (Richt.) Aongstr. | | X | | | |
| *Meesia uliginosa* Hedw. | | | X | | |
| *Paludella squarrosa* (Hedw.) Brid. | X | X | | | |
| **THUIDIACEAE** | | | | | |
| *Helodium blandowii* (Web. & Mohr) Warnst. | | X | X | | |
| **AMBLYSTEGIACEAE** | | | | | |
| *Calliergon cordifolium* (Hedw.) Kindb. | | X | | | |
| *Calliergon giganteum* (Schimp.) Kindb. | | X | | | |
| *Calliergon richardsonii* (Mitt.) Kindb. ex Warnst. | | X | | | |
| *Calliergon sarmentosum* (Wahlenb.) Kindb. | | | X | | |
| *Calliergon stramineum* (Brid.) Kindb. | | | | X | X |
| *Campylium polygamum* (B.S.G.) C. Jens. | X | X | | | |
| *Campylium stellatum* (Hedw.) C. Jens. | X | | | | |
| *Drepanocladus aduncus* (Hedw.) Warnst. var. *kneiffii* (B.S.G.) Monk. | X | | | | |
| *Drepanocladus exannulatus* (B.S.G.) Warnst. | X | X | X | X | |
| *Drepanocladus fluitans* (Hedw.) Warnst. | | | X | | |
| *Drepanocladus revolvens* (Sw.) Warnst. | | | X | | |
| *Drepanocladus uncinatus* (Hedw.) Warnst. | X | X | X | X | |
| *Scorpidium scorpioides* (Hedw.) Limpr. | X | X | | | |
| **BRACHYTHECIACEAE** | | | | | |
| *Brachythecium salebrosum* (Web. & Mohr) B.S.G. | X | | | | |
| *Tomenthypnum nitens* (Hedw.) Loeske | | X | X | X | |
| **HYPNACEAE** | | | | | |
| *Ptilium crista-castrensis* (Hedw.) De Not. | | | | X | X |

**Aster johannensis*. Apparently a variant of the complex *Aster simplex* – *Aster hesperius* (Riley and McKay 1980).



| 3) Cryptogams | $M_S$ | $M_F$ | H | S | F |
|---|---|---|---|---|---|
| **HYLOCOMIACEAE** | | | | | |
| *Hylocomium splendens* (Hedw.) B.S.G. | X | | X | X | X |
| *Pleurozium schreberi* (Brid.) Mitt. | | | X | X | X |
| **RHYTIDIACEAE** | | | | | |
| *Rhytidium rugosum* (Hedw.) Kindb. | | | X | | |
| **DICRANACEAE** | | | | | |
| *Cynodontium strumiferum* (Hedw.) Lindb. | | | X | | |
| *Dicranum elongatum* Schleich. ex Schwaegr. | | | X | | |
| *Dicranum fuscescens* Sm. | | | X | X | X |
| *Dicranum groenlandicum* Brid. | | | X | | |
| *Dicranum leioneuron* Kindb. | | | X | | |
| *Dicranum majus* Sm. | | | X | | |
| *Dicranum polysetum* Sw. | | | | | X |
| *Dicranum scoparium* Hedw. | | | X | X | X |
| *Dicranum spadiceum* Zett. | | | X | X | |
| *Dicranum undulatum* Brid. | | | X | X | |
| *Oncophorus virens* (Hedw.) Brid. | | | X | X | X |
| *Oncophorus wahlenbergii* Brid. | | | X | X | |
| *Paraleucobryum longifolium* (Hedw.) Loeske | | | | X | X |
| **DITRICHACEAE** | | | | | |
| *Ceratodon purpureus* (Hedw.) Brid. | | | X | X | |
| *Distichum inclinatum* (Hedw.) B.S.G. | X | | X | | |
| **GRIMMIACEAE** | | | | | |
| *Grimmia affinis* Hoppe & Hornsch. ex Hornsch. | | | X | X | |
| *Rhacomitrium canescens* (Hedw.) Brid. | | | X | X | |
| *Rhacomitrium heterostichum* (Hedw.) Brid. var. *microcarpon* (Hedw.) Boul. | | | X | | |
| *Rhacomitrium lanuginosum* (Hedw.) Brid. | | | X | | |
| *Schistidium rivulare* (Brid.) Podp. | | | X | X | |
| **Lichens** | | | | | |
| **PELTIGERACEAE** | | | | | |
| *Peltigera aphthosa* (L.) Willd. | X | | | X | X |
| **NEPHROMACEAE** | | | | | |
| *Nephroma arcticum* (L.) Torss. | | | | X | X |
| **LECIDEACEAE** | | | | | |
| *Rhizocarpon geographicum* (L.) DC. | | | X | | |
| **CLADONIACEAE** | | | | | |
| *Cladina mitis* (Sandst.) Hale & W. Culb. | | | X | X | X |
| *Cladina rangiferina* (L.) Harm. | X | | X | X | X |
| *Cladina stellaris* (Opiz) Brodo | | | X | X | X |
| *Cladonia amaurocraea* (Flörke) Schaer. | | | X | | |
| *Cladonia ecmocyna* (Ach.) Nyl. | | | X | | |
| *Cladonia gracilis* (L.) Willd. ssp. *gracilis* | | | X | X | X |
| *Cladonia metacorallifera* Asah. | | | X | | |
| *Cladonia uncialis* (L.) Wigg. | | | X | X | X |
| **UMBILICARIACEAE** | | | | | |
| *Umbilicaria cylindrica* (L.) Del. | | | X | | |
| **LECANORACEAE** | | | | | |
| *Ochrolechia frigida* (Sw.) Lynge | | | X | | |
| *Ochrolechia cf. inaequatula* (Nyl.) Zahlbr. | | | X | | |
| **PARMELIACEAE** | | | | | |
| *Cetraria cucullata* (Bell.) Ach. | | | X | X | |
| *Cetraria ericetorum* Opiz | | | X | | |
| *Cetraria laevigata* Rass. | | | X | X | |
| *Cetraria nivalis* (L.) Ach. | | | X | X | X |
| **USNEACEAE** | | | | | |
| *Alectoria nidulifera* Norrl. | | | X | X | |
| *Alectoria ochroleuca* (Hoffm.) Mass. | | | X | | |
| *Bryoria nitidula* (Th. Fr.) Brodo & D. Hawksw. | | | X | | |
| *Cornicularia divergens* Ach. | | | X | X | |
| *Thamnolia vermicularis* (Sw.) Ach. ex Schaer. | | | X | | |
| **SPHAEROPHORACEAE** | | | | | |
| *Sphaerophorus globosus* (Huds.) Vain. | | | X | | |

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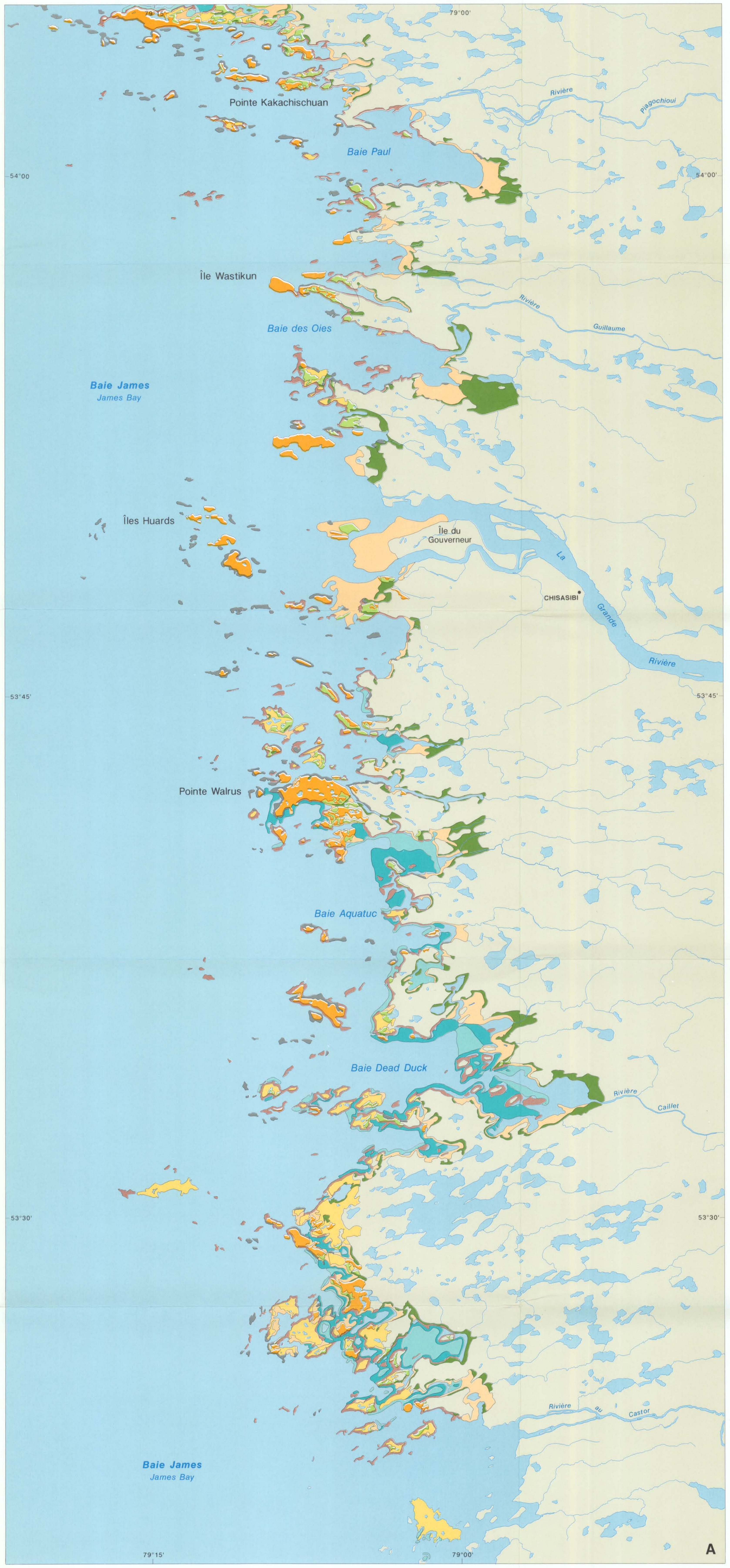
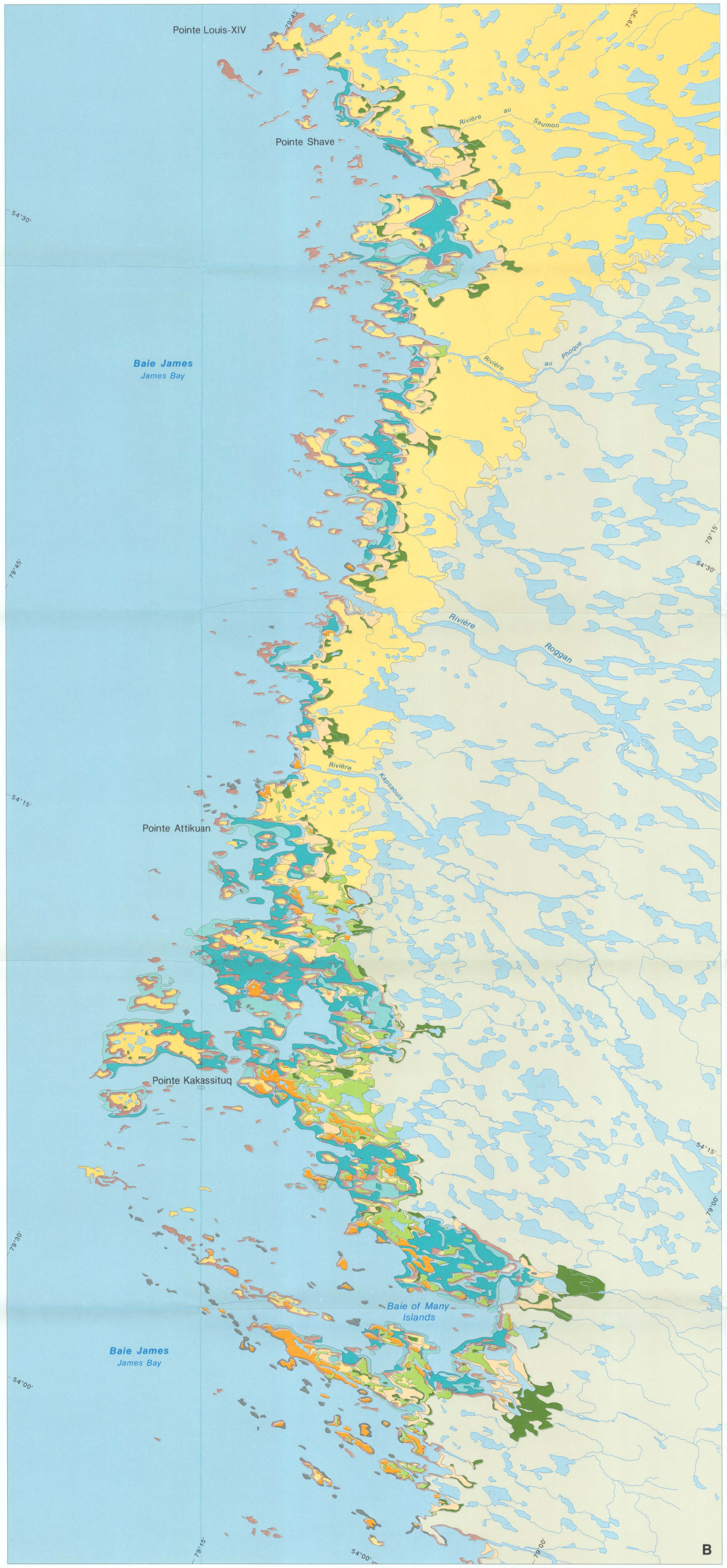
# LES HABITATS CÔTIERS DU NORD-EST DE LA BAIE JAMES

# COASTAL HABITATS OF NORTHEAST JAMES BAY



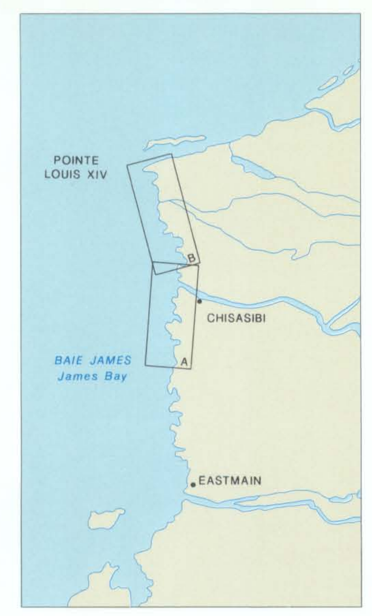

## LÉGENDE
## LEGEND

- Eau libre / Open water
- Herbier de zostère (densité élevée) / Eelgrass bed (high density)
- Herbier de zostère (densité faible) / Eelgrass bed (low density)
- Estran vaseux/sableux / Mud/sand tidal flat
- Littoral caillouteux avec frange de végétation / Boulder strewn shore fringed with vegetation
- Affleurement rocheux / Rocky outcrop
- Marais salé / Salt marsh
- Lande / Heath
- Lande rocheuse / Rocky heath
- Arbustaie / Shrub
- Forêt / Forest

Échelle 1:125 000 Scale

Kilomètres 1 0 1 2 3 4 5 6 7 Kilometres

## ORIENTATION




## RÉGION ÉTUDIÉE
## STUDY AREA



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Service canadien de la faune / Canadian Wildlife Service

Société d'énergie de la Baie James

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