Susceptibility to Environmental Impact in the Queen Elizabeth Islands*

INTRODUCTION

Exploration for oil and gas is proceeding on a rapidly increasing scale in the Queen Elizabeth Islands, and the region needs therefore to be assessed comprehensively in terms of susceptibility of habitat to physical disturbance. Important animal habitats in the region have been delimited in a series of booklets issued by the Canadian Wildlife Service[1], but the vegetation still requires detailed analysis. Susceptibility of the soils and vegetation to surface disturbance is emphasized in this paper and its accompanying map, which are in the main intended to complement the wildlife series. The evaluation is however necessarily provisional, since only a small part of the total land area has so far been the subject of detailed biological description. Areas likely to be ecologically critical are delimited with the object of assisting governmental and industrial planning. The appended list of references pertains both to the text of this report and to sites indicated on the map. Where one small area is discussed in a number of publications, usually only one key reference is listed.

CATEGORIES OF SUSCEPTIBILITY AND METHODS OF ASSESSMENT

Land areas were subdivided into four broad categories based largely on observations made by the present authors[2,3]. Supplementary information was obtained from the literature or from personal communications. Areas remote from well-described sites were subdivided on the basis of a scrutiny of topographical maps of scale 1:50,000[4] and of a geological map of the region[5], which indirectly provided information on suitability of substrate for plant growth and on topographical diversity. The relative importance of each broad category was estimated by planimetry of the final map. Within the delimited areas the predominant or most critical of the categories is indicated, though all can occur within a particular area on a smaller scale. The categories are as follows:

1) *Polar Desert* (31% of land area): susceptibility low; dry uplands, felsenmeer, saline coastal plains, etc., with very little if any plant cover (0-10%) and low ground ice contents. With normal precautions the deleterious effects of vehicle travel, construction of airstrip, and similar activities would be minimal. It should be emphasized, however, that areas falling within this and the second category may contain small, isolated pockets of considerably greater biological importance than the remainder of the landscape. Industrial activity in the vicinity of these sites should be avoided in the same manner as in large areas of category 4. An additional 20% of the land area in the region is ice cap.

2) *Polar Semi-desert* (25% of land area): susceptibility moderate; moister upland areas with 5-20% cover by vascular plants — *Luzula confusa, L. nivalis, Alopecurus alpinus, Phippsia algida, Papaver radicatum* and species of *Saxifraga* and *Draba* (nomenclature according to Porsild[6]) — and with lichens and mosses bringing total cover to as high as 80%[7]. On fine-grained substrates ice contents directly below the active layer can be high. Frost- or soil-boils may be extensive. Minor disturbance, regardless of plant cover, can result in deeply rutted surfaces. Wet areas on runways, often unusable in summer, result from capillary rise of water freed during the thaw of ice-rich layers[3,8]. The sloping banks of streams may be especially unstable, as are many upland areas where the lack of iron oxides and a resultant lack of cohesion of soil particles leads to sheet erosion. In many of the western islands where soils are often silty clays developed from shales, mass wasting, occurring due to sheet and gully erosion after the spring melt, can be accelerated following snow accumulation on surfaces modified by earth-moving activities.

3) *Diverse terrain* (22% of land area): susceptibility high in many sites. This category includes a more mesic gradation of polar semi-desert vegetation interspersed with numerous patches of 100% cover. While much of the upland area includes steep slopes with little plant cover, in depressional sites where there is adequate moisture in summer and protection from wind in winter, mats of woody species (*Cassiope tetragona, Dryas integrifolia,* and *Salix arctica*) sometimes develop. In the moistest areas small moss-graminoid meadows occur. In the severe climate, reestablishment of cover following disturbance takes place extremely slowly. Areas within this category usually have enough topographic diversity, however, for selection of sites resistant to degradation of terrain to be possible.

4) *Large meadows* (<2% of land area): susceptibility high; lake margins and poorly drained lowlands are normally dominated by a continuous layer of mosses and sedges or

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grasses. Deep accumulations of peat are relatively rare, the organic layer usually being no more than 10-20 cm. thick. Removal of moss and peat during the passage of wheeled and tracked vehicles in summer months can have long-lasting detrimental effects[2,9,10]. While massive ice appears less common in the High Arctic[11], meltout and erosion can occur in some ice-rich areas[2]. As elsewhere, severe environmental conditions limit revegetation rates on disturbed sites. Few, if any, instances of natural recovery comparable to those reported in the Low Arctic are known. Several researchers have advised that activities in these areas be restricted to the winter months of October-June when the soil is frozen. Special precautions are necessary to avoid disturbing muskox in the few but important areas where they are present, especially in winter. These relatively rich areas of only minor extent provide the basis for such biological diversity and productivity as does occur at this latitude[7].

General descriptions of some of these sites have been given by Barnett and Forbes[12], Beschel[18], Bliss[7], Brassard[14], Brassard and Longton[15], Bruggemann and Calder[16], Kevan[9], Kuc[10], MacDonald[17], Polunin[18], Powell[19], Savile [20, 21], Tedrow *et al.*[22], and Thornsteinsson[23].

GENERAL DESCRIPTION OF THE REGION

Northwestern islands: Prince Patrick, Borden, Mackenzie King, King Christian, Ellef Ringnes, Amund Ringnes, Meighen and Lougheed.

Topographical relief within this region is insignificant. The low degree of variability of habitat is matched by a correspondingly small diversity of plant species and communities. The islands offer little resistance to the movement of cold air from the ice-covered Beaufort Sea during summer months, and growing conditions are therefore poor. The Beaufort Formation, a late Tertiary deposit of coarse-grained material exposed along the northwest margin of the region, is extremely barren. Where substrate is more favourable to growth (fine-textured soils derived from shale), especially on level sites with adequate moisture, moderately-vegetated, mesic meadows dominated by grasses (*Dupontia fisheri, Alopecurus alpinus,* and *Phippsia algida*) and mosses may occur. The Mould Bay area is illustrative of this type. Much of the landscape, however, is transitional between Polar Desert and Polar Semi-desert occupied by *Alopecurus alpinus, Puccinellia vaginata, Luzula confusa, Papaver radicatum, Saxifraga* spp., *Draba* spp., lichens and mosses.

The most widespread environmental problem is the summer softening of slightly modified surfaces on fine-grained substrates. If a significant amount of vegetation is present (i.e. a cover 10% or more), it indicates the existence of sufficient moisture for the segregation of horizontal ice layers; investigation of subsurface ice conditions is needed at sites where summer activity is anticipated.

Peary's caribou are found throughout the region, and Lougheed Island is considered to be of critical importance for a large population of this species.

Southern and central islands: Melville, Bathurst, Cornwallis and Somerset.

Slight continental effects produced by the islands themselves, more favourable substrates, greater relief, protection from the direct influence of a broad expanse of sea ice, and less extreme latitude together contribute to generally better conditions for plants and wildlife here than in the northwestern islands.

While much of western Melville Island is a sparsely vegetated highland, lush meadows and mesic slopes are common in the vicinity of the coast. Most of eastern Melville is Polar Semi-desert and Polar Desert, though generally more heavily vegetated than the Semi-desert areas of Ellef Ringnes and Amund Ringnes Islands. There are well-vegetated lowlands in the Sherard Bay — Drake Point region of the Sabine Peninsula. Coastal and interior lowlands are an important habitat for muskoxen, and some of the better-vegetated south coastal uplands support numerous Peary's caribou.

The landscape of Bathurst Island is similar to that of eastern Melville Island, with Polar Desert or moderately-productive uplands predominating. The island is traversed by a number of relatively well-vegetated lowlands running from west to east, the most important being that between Bracebridge and Goodsir Inlets (D. Gray, personal communication). These meadows, as well as adjacent uplands dominated by *Salix, Dryas,* and *Saxifraga oppositifolia,* are an important habitat of muskoxen and caribou.

Much of Cornwallis Island is an upland with few sites where sufficient moisture for plant growth remains on the surface in the summer. This, combined with limestone soils and a foggy summer climate, results in a sparse plant cover. The main exception to this occurs along the northwest coast where some muskoxen occupy small lowland meadows.

Although Somerset Island is not strictly part of the same geographical region, it is ecologically quite similar to Cornwallis Island. It is mainly Polar Desert, with only limited areas qualifying as Semi-desert terrain. These are situated adjacent to four lowland meadow complexes at the mouths of rivers.

Wildlife is scarce except in the vicinities of larger river deltas, which support terrestrial mammals and are also calving grounds for beluga whales.

Eastern islands: Devon, Ellesmere, Axel Heiberg.

Although much of this region is mountainous, glaciated and therefore mainly barren, the large land masses and mountainous topography result in mild summer conditions at low elevations. The Hazen Lake and Fosheim Peninsula regions on Ellesmere Island are biologically exceptionally productive for this latitude, supporting 1000 or more muskoxen, several thousand arctic hare, and some caribou.

Sedge and moss meadows occupy limited lowland areas in the vicinity of Cape Sparbo on Devon Island, as well as several areas along the southern coast. The remainder of the island is a high-elevation plateau — Polar Desert and ice cap. Approximately 300 muskoxen are found on the lowlands in the Cape Sparbo region; these same wet lowlands are utilized by numerous waterfowl during the warm season. Northern Devon Island and southern Ellesmere Island are within the hunting range of Eskimos from Grise Fiord[24]. Careful consideration should be made of the effects of air traffic, surface activity, deposition of industrial material, etc., on the movement of caribou, muskoxen and other game, especially in the few oases of biological diversity.

CONCLUSIONS

While biological diversity and plant cover are far less in the High Arctic than in the warmer mainland Arctic, there are numerous areas where the land is susceptible to disturbance. The most common forms of degradation are sheet and gully erosion in areas of sparse plant cover, and the softening in summer of slightly disturbed surfaces on moist, fine-grained substrates. This situation contrasts with that in the Low Arctic where removal of vegetation and potential thermokarst are of great concern.

In relatively small areas of high plant cover, surfaces have a susceptibility similar to the extensive tundra areas farther south. The biological consequences of disturbance can be much greater, however, not because of deleterious effects on the landscape alone, but because these isolated rich sites comprise the bulk of the energy base for the remainder of the terrestrial food web.

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T. A. Babb
L. C. Bliss
Department of Botany
University of Alberta
Edmonton, Alberta, Canada

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The Distribution of *Bryobrittonia pellucida* Williams (Musci)

Bryobrittonia pellucida was first described by R. S. Williams[1] from sterile material collected in April 1899 on a bluff of the Yukon River, just below Dawson City, Yukon Territory. This species, which Williams placed in the monotypic genus *Bryobrittonia*, was considered for several decades to belong in the Pottiaceae. In 1953, Steere[2] described sporophytes from specimens collected in the Brooks Range, Alaska. The presence of large, campanulate calyptrae (Fig. 1A); erect, 8-ribbed capsules; and double peristome are all characters of the Encalyptaceae[3]. As Steere pointed out, *Bryobrittonia* should be placed in this family and retained as a genus separate from *Encalypta. Bryobrittonia* is distinguished by the mammillose upper leaf cells (Fig. 1C) and blunt spatulate-lingulate leaves, while *Encalypta* is characterized by pluripapillose upper leaf cells (Fig. 1D). In the field, the gametophytes are very distinctive in the glistening wide-spreading leaves with erect margins (Fig. 1B). The plants are larger than most *Encalypta* species and often superficially resemble *Dichodontium pellucidum.*

In the summer of 1973, while collecting in the Grande Cache region, north of Jasper National Park, Alberta, Wilbur Peterson and the present author found *Bryobrittonia pellucida* in quantity along a small stream at Sherman Meadows, about 150 km. south of Grande Prairie. Later in the summer they collected the species along small streams in the Yukon Territory in the Whitehorse area, and with sporophytes at Dawson City and in the Mt. Klotz region of west-central Yukon. In 1972, collections were obtained from the Kluane Lake region of southwestern Yukon. All of the collections were from sandy silt banks beside streams. The Alberta collections were from 1220 m. elevation in an area of

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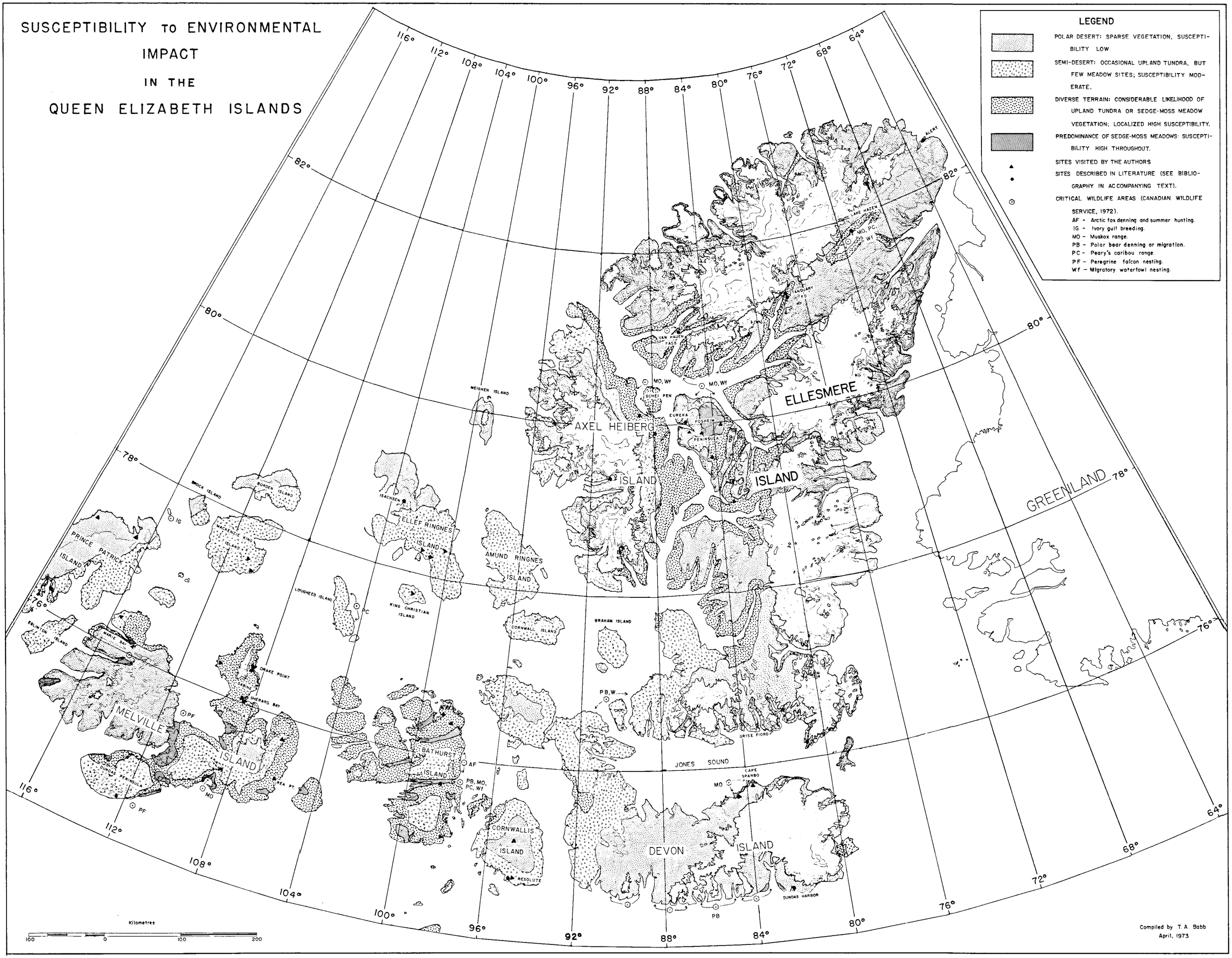

Compiled by T. A. Babb
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