Sensitivity of Surface Materials and Vegetation to Disturbance in the Queen Elizabeth Islands: an Approach and Commentary

INTRODUCTION

Concern about potential and actual disturbance of surface materials, vegetation and wildlife of the Queen Elizabeth Islands has risen sharply in the last few years. The purpose of this paper is to outline an approach to the problem, based on terrain studies, and to offer a commentary on the recent paper by T. A. Babb and L. C. Bliss in *Arctic*.[1]

Activities which may initiate disturbance include the construction of airstrips, staging areas, drillsites, townsites, seismic survey lines, winter and all-year roads, and pipelines. Of these the first four are restricted-area, or 'point' activities; the remainder are usually far more extensive and require detailed terrain studies, as extensive activities can cause locally-intensive disturbance.

What constitutes disturbance, what is "acceptable" disturbance, and what "normal precautions" mean, are formidable questions which unfortunately can not be resolved here. They involve aesthetics and politics and the natural sciences. However, after tackling the problem of mapping terrain and studying its sensitivity to the activities of man in two areas of the Queen Elizabeth Islands,[2,3,4] the present writers feel it appropriate to make some commentary on the factors involved.

A GEOBOTANICAL APPROACH TO TERRAIN ANALYSIS

For a rational assessment of the problem, information is required on: (a) surface materials — ice content, texture, engineering properties; (b) topography and landforms; (c) geomorphic processes; (d) drainage — seasonal change and single events; (e) vegetation — percentage cover and composition by species; (f) summer temperatures, and moisture balance in soil; (g) wildlife.

The obtaining of such information involves several disciplines and calls for either integrated studies[5] or complementary projects. These require the extensive use of aerial photography and ground reconnaissance, supplemented where possible by shallow drill cores for the evaluation of ice content and changes in materials with depth.

Surface materials are very significant elements of the terrain, especially when potential for disturbance is being considered. Hence, surface materials are used by the present writers as a nucleus around which other elements of the terrain are grouped.

Data are displayed on maps and presented in written form as a legend with optional detailed text. Selection of scale for a map is influenced by the available topographic and photographic bases. A balance must be struck between complexity of terrain and time and money available. However, a minimum working scale of 1:250,000 is necessary to depict the information pertinent to the planning of activities mentioned above. Two of the present writers undertook in 1972 an exercise in the mapping of sensitivity at a scale of 1:500,000 of the Queen Elizabeth Islands, based primarily on bedrock maps and extensive personal communications, but found it unsatisfactory because the degree of detail was insufficient to reflect the variability in the sensitivity of the terrain. An example of complexity of terrain from Ellesmere Island has been published which is illustrative of the problem.[6]

Maps require a substantial legend to display adequately the range of information which has been synthesized into their units. Textual amplification of legend may be desirable. Ideally the user should be presented with all the facts used in the compilation of a map so that he may assess what information will be of value to him.

AN EVALUATION OF THE PAPER BY BABB AND BLISS

The overall objective of these authors in emphasizing the 'susceptibility of the soils and vegetation to surface disturbance' is good. However the methods used to achieve this objective are inconsistent, and in several cases the results are inaccurate. A serious deficiency is that the criteria for determining categories of 'susceptibility' are obscure. Only after careful study of the relevant section can the reader perceive that they consist of a combination of plant cover, relief, soil moisture, ground ice and possibly surface materials; but there is no indication of how it was decided what relative significances should be attached to these individual factors in determining the categories, or just why an area may be especially critical in terms of susceptibility to surface disturbance. An expansion of the legend of the map would have been an aid to clarity.

The four categories of susceptibility are inconsistent in headings and in content. The fourth is primarily botanical in nature, though it concerns other disciplines. In one case, percentage cover of vascular plants is singled out; in others, lichens and mosses are included in the percentage plant cover. Consistency is desirable, and vascular to nonvascular plant ratios are important in the determination of wildlife habitat — the ultimate concern of the paper.

The 'Polar Desert' category is described as an area with 10%-or-less plant cover, low susceptibility to disturbance and low ground ice content. One interpretation of this seems to be that poorly-vegetated areas are less susceptible to disturbance of vegetation than are more densely vegetated areas. Only in so far as a low plant density lessens the probability of direct impact of vehicles on plants is this interpretation obviously true. A sparsely vegetated area may be an important, or even critical, range for ungulates; therefore the effect of disturbance of it could be great. The type of vegetation — such as willow, sedge, saxifrage, grass or bryophyte — is a vital consideration. An alternative interpretation is that unvegetated areas (90% of the Polar Desert category, classed as 'soils') have a low sensitivity to surface disturbance. This is not true for some major areas of both eastern Melville Island and Western Ellesmere Island where highly sensitive surfaces, almost devoid of vegetation, are subject to extensive slope failure or thermokarst development, even without disturbance.

Where the authors have left their major field of expertise and have commented on geology and geomorphology, weaknesses are evident. They appear to draw a direct relationship between active-layer soil moisture and 'susceptibility'. For overland travel this is generally true, but if excavation penetrates the shallow active layer and the frost table, then the relationship certainly no longer holds. Furthermore, the implication of a relationship between susceptibility, ice content and vegetation cover is simplistic and can be misleading. The assertion that "10%-or-more vegetation cover indicates the existence of sufficient moisture for the segregation of horizontal ice layers" is without basis. The present writers have drilled over 300 shallow (1-6 m) holes in eastern Melville Island[7] and western Ellesmere Island[8] to evaluate ice content and have found the relationship between vegetation, ground ice and materials to be complex.

The published map scale of 1:2.85 million would be adequate for initial phases of planning, provided it was based on working maps at a more detailed level. However a map of this scale, based on fragmentary information, is wholly inadequate where the scale of disturbance is measured in metres.

On the map of Babb and Bliss boundaries rarely coincide with any natural boundaries known to the present writers. For example, an area of the western Fosheim Peninsula (including Eureka), on Ellesmere Island is described as Polar Desert (0-10% vegetation, susceptibility low) when 20% of it is in fact well vegetated, and 40% has a sparse-to-moderate vegetation cover. The area also includes extensive networks of ice wedges, and is locally underlain by massive ground ice on which flowslides occur equal in magnitude to those found in the lower Mackenzie valley. By comparison, the 'sedge-moss meadows' unit to the east contains no more meadows than many other areas of the Fosheim Peninsula, and with the exception of the Slidre Valley is less sensitive to disturbance than the Eureka area.

Bjorne Peninsula, Ellesmere Island, is shown as "semi-desert". This category may possibly represent the average condition of approximately thirty units of weathered rock and recent sediment into which the area can be divided, but it certainly does not adequately describe the conditions to be found at most locations. And surely, even at this map scale, the poorly-consolidated shales of the Eids Formation, which run across the waist of the Peninsula in a band up to 40 km wide, should have been identified as a unit more sensitive than the surrounding area. Materials derived from Eids Shale have variable vegetation cover, some of which serves as important range for muskox, and there are numerous ice-wedge polygons.

On the map of Babb and Bliss northern Sabine Peninsula, Melville Island, is divided into two main zones: a peripheral "diverse terrain" and an interior "semi-desert". The shape and size of the semi-desert unit does not reflect the distinct topographic, lithologic and vegetational boundaries which occur and which could be shown at this scale. The "diverse terrain" unit includes an extreme range of topography, lithology, vegetation types and cover, and sensitivities. But a major zone of insensitive sandstone hills (Bjorne Sandstone) almost devoid of plants, and a very sensitive poorly-consolidated shale (Christopher Shale) on which a major well-vegetated lowland has developed, are not distinguished, though they easily could be even at this scale. In the present writers' assessment these two units represent the end members of a sensitivity scale for eastern Melville Island.

The central upland of southeastern Melville Island is divided into three roughly concentric zones. The outer one is "diverse terrain", the middle one "semi-desert" and the inner one "Polar Desert". The basis for this zonation is unclear, although elevation is a possibility. Vegetation cover, and morphological, lithological[9] and sensitivity boundaries, tend to follow narrow east-west bands rather than concentric zonation.

Babb and Bliss have apparently neglected aerial photographs, probably the most important single source of data, and have substituted topographic maps, identified in the text as 1:50,000, a scale which has extremely limited coverage in the Arctic. The A-501 series, listed among their references, is at a scale of 1:250,000 and covers Canada only east of the 96° meridian. Series A-502 covers the area west of 96°. Even a brief glance at an ERTS image or a photomosaic would have shown that the area southeast of Sabine Bay, Melville Island, is quite the opposite to the category shown. The loose sandy surface which is subject to deflation and which is virtually devoid of vegetation is shown as "sedge-moss meadows".

The Geological Map of Canada referred to by Babb and Bliss describes bedrock in terms of time-stratigraphic units, not lithology, and its value in assessing potential disturbance is therefore open to question. There are many more detailed and more pertinent geological reports and maps available.[9,10]

The conclusions reached by Babb and Bliss are a curious mixture of allusions to areas not mentioned in the text, geomorphological inaccuracies, and statements which appear contradictory. Specifically, there are comparisons made between the Queen Elizabeth Islands and the mainland Arctic, which, although desirable, are a topic not touched upon earlier. Perhaps they deserve a more lengthy treatment. In addition, "the softening in summer of slightly disturbed surfaces" as a "common form of degradation" is a concept the present writers have not encountered, and they do not agree that sheet erosion and gullying are the most common forms of erosion; it is currently mass-wasting. The implication that the removal of vegetation and the potential for thermokarst development are not of great concern in the Queen Elizabeth Islands directly conflicts with the final paragraph of Babb and Bliss (one of their best) in which they point out that the botanically rich sites form "the bulk of the energy base for the remainder of the terrestrial food web."

CONCLUSIONS

The present writers have spent several years attempting to achieve similar ends to those sought by Babb and Bliss. They feel a need to refute mistaken generalizations which might gain ready currency because of a sense of urgency and the desire for simple rules-of-thumb. Sampling at sites already disturbed is satisfactory for historical studies, but does not necessarily yield the answer to the pertinent question: "What are the critical variables in sensitivity?"

The map and text of Babb and Bliss do not seem an acceptable accompaniment to the Arctic Ecology Map Series, for the detail that they recognize as necessary is not forthcoming.

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