ECOLOGICAL LAND CLASSIFICATION IN NORTHERN CANADA

by S.C. Zoltai
Canadian Forestry Service
Edmonton, Alberta

Northern Canada, lying north of the 60th parallel, comprises nearly 40% of the country. This vast area, nearly 4 million km^2 (over 1.5 million mi^2) displays a wide variety of physiography from the highest mountain of Canada to featureless plains. Permafrost is continuous over all but the southwestern part of the area, resulting in unique soil conditions. The harshness of the climate creates nearly barren areas in the far north, varying through treeless, but otherwise well vegetated shrub and grass tundra, to stunted subarctic forests and to closed-canopy boreal forests in the south.

The Arctic and Subarctic areas are alien landscapes to most of us who were reared on the lush forests of more southern latitudes. Nevertheless, a closer examination of these areas will reveal the familiar pattern of interrelationships between the living and non-living environment. The setting is strange and confusing, unless we rid ourselves of some southern biases and accept the facts of the northern environment.

To an outsider, the climate appears to be forbidding in the north. Yet the plants and animals survive, grow and propagate their kind in the Arctic: for them it is <u>HOME</u>. They are adapted to climatic extremes, growing in suitable habitats, or micro-habitats. The forces of the physical environment (soil, moisture, nutrients, local climate, etc.) will determine their success in survival, while competing with other plants for suitable habitats. To the ecologist the tundra is an open book where the importance of the physical environment on plant distribution is very forcefully demonstrated.

The value of northern ecosystems is not always apparent from a man-centered, user oriented viewpoint. A stunted stand of open black spruce of the Subarctic forest, by southern standards, would be written off as worthless waste. A willow thicket, about 30 cm high, would not impress the southern forester, even if it is the tallest vegetation of the region. However, one must recognize the importance of the vegetation in relation to the area where they occur. The willow thicket may provide fuelwood for the camper in an area where there are no alternatives. The stunted black spruce supplied wood for tools, timber for tents, and fuel for campfires of the ancient inhabitants at a time when there were no trading posts or airlifts.

In the north the value of the vegetation is often not readily apparent. In the subarctic areas moss effectively insulates the ground, preserving the permafrost. Disturbance of the living vegetation will result in the summer thawing of the ground, releasing large amounts of water and mud. Vegetation provides food and shelter to wildlife which is often the only harvestable resource in the north.

ECOLOGICAL SETTING

A brief introduction into the ecological setting of northern Canada is provided by the Ecological Region (Land Regions of Lacate 1969; Site Regions of Hills 1960; Biogeoclimatic zones of Krajina 1972). The regions were characterized by examining the undisturbed vegetation on well drained soils, having adequate nutrients on a gentle slope (normal sites, Hills 1960). A provisional map is shown in Figure 1.

ECOLOGICAL LAND SURVEYS

The ecological land surveys conducted in the past were influenced by two main factors. The dominant one was the fact that nearly all were instituted in reaction to proposed developments in the north, mainly pipelines. This meant that because of the urgency and short term nature of the projects, proper planning, development of priorities and methodologies was often not possible. The second factor was the great expenses associated with northern field work imposed by the remoteness from supply points and the total dependence on air transportation.

The result of such pressures was that in most cases the lead agency (controlling the mapping methodology, field operations, and logistics) was in the discipline of Pleistocene geology (Terrain Sciences, Dept. Energy, Mines and Resources). Members of other disciplines such as plant ecologist, botanist, pedologist and wildlife biologist, were attached to the terrain scientists, sometimes as an integral part of the team, but sometimes as an afterthought. Thus the resulting maps sometimes were based entirely on geomorphology, with added ecological characterization.

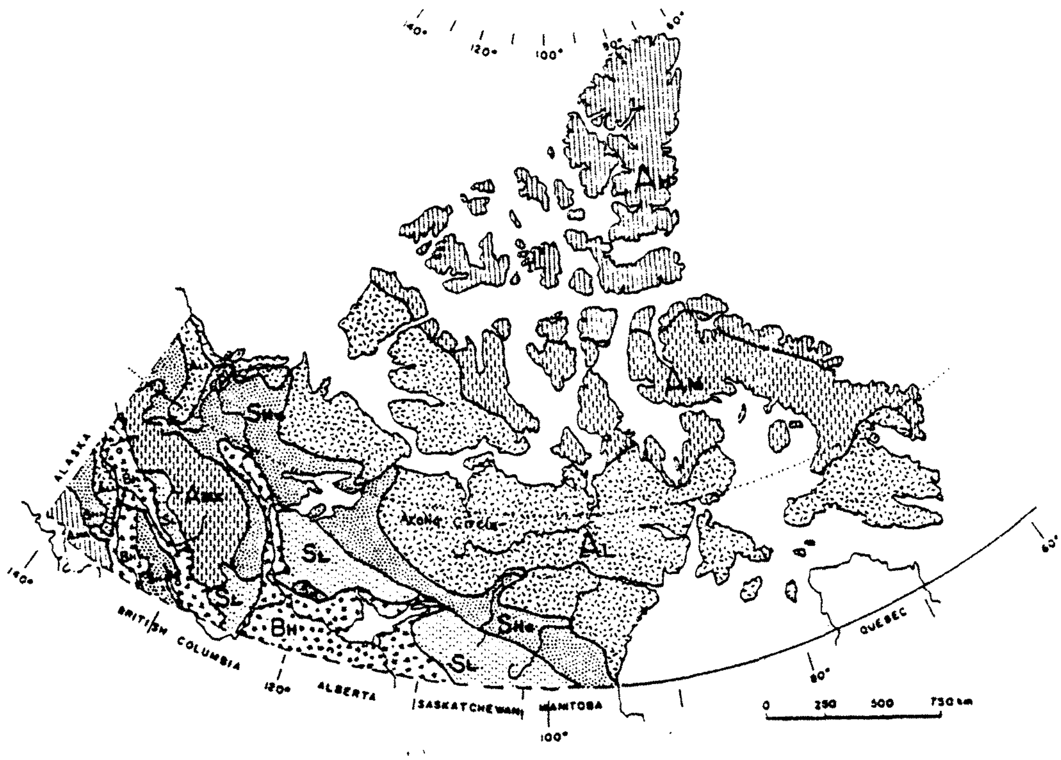

Figure 1 - Provisional map of Ecological Regions of northern Canada.

LEGEND

AH - High Arctic
AM - Mid-Arctic
AL - Low Arctic

SHw - High Subarctic, west
SHe - High Subarctic, east
SL - Low Subarctic

BH - High Boreal
BHd - High Boreal, dry

AHx - High Alpine Complex
AMx - Mid-Alpine Complex
ALx - Low Alpine Complex

There were seven studies related to various pipeline proposals (Figure 2): Mackenzie (Hughes et al. 1972a. b; Hanley et al. 1975; Rutter et al. 1972; Tarnocai 1973; Zoltai and Pettapiece 1973), Mackenzie South (Crampton 1973), Boothia Peninsula (Tarnocai and Boydell 1975; Tarnocai et al. 1976; Tarnocai and Netterville 1976), Central Keewatin (Tarnocai 1977), Melville Island (Barnett et al. 1975, 1976a; Barnett 1976), Bathurst and Cornwallis Islands (Barnett et al. 1976b; Tarnocai 1976), Somerset Island (Zoltai and Woo 1976). Two studies were made of potential National Park sites (Kelsall et al. 1970; Scotter et al. 1971). One project is underway in the Great Slave area, but no reports are available. Another project, covering the entire Yukon Territory, was reported to this conference elsewhere.

The purpose of all but one study was to provide baseline information on terrain and environmental characteristics for the assessment of pipeline development proposals. Consequently those aspects which affect the engineering performance of the terrain or which supply granular materials for construction were stressed. However, as the role of vegetation in preventing thermal erosion became clear, and as ecologically sensitive areas were encountered biological studies became part of the mapping projects. Thus, biological information was present only as additional characterization of the mapping units in the early studies (Mackenzie). Later, however, vegetation and soils aspects also became mapping criteria, along with the geomorphological features.

The only projects not prepared for pipeline impact assessment were oriented toward providing information on the natural environment of potential National Parks. In these studies the large scale of mapping permitted (1:50,000) the production of separate terrain and vegetation maps.

METHODOLOGY

As the projects were initiated at different times, different locations and by different organizations, there was no opportunity for applying any one classification system. In spite of this, it is interesting to note the similarities in the classification approaches (Table 2).

All but two studies divided their area into broad regions on the basis of climate. The two which did not, occurred on areas which were all in the same climatic region. The main criterion for this broad regionalization was climate as reflected by the distribution, growth and successional trends of vegetation communities. Some studies included such climatically controlled factors as the occurrence of dominant Great Soil Groups and the distribution pattern of permafrost.

TABLE 2 - ECOLOGICAL LAND CLASSIFICATION IN NORTHERN CANADA

STUDY	DISCIPLINES (lead)	LEVEL 1		LEVEL 2		LEVEL 3 (MAPPING)		ADDED INFORMATION
		NAME	CRITERIA	NAME	CRITERIA	NAME	CRITERIA	
1. Mackenzie	Pleistocene geology soils vegetation	Land Zone Ecological Zone	bioclimate permafrost			Map Unit	material thickness topography drainage pattern	soil texture permafrost drainage vegetation assn.
2. Mackenzie (S)	Geography	Land Region	bioclimate soil genesis permafrost	Land District	soil texture	Land System	relief material vegetation permafrost	
3. E. Melville Isl. 4. Bathurst and Cornwallis Isl.	Pleistocene geology vegetation mammals soils			Landscape Type	bedrock formation marine limit	Terrain Unit	morphology relief drainage materials weathering products	vegetation communities mammals birds
5. Boothia Peninsula 6. Central Keewatin	Pleistocene geology soils vegetation	Ecoregion	bioclimate soil genesis	Ecodistrict	pattern of physiography & materials	Ecoarea	material origin relief soil vegetation	
7. Somerset Isl.	Pleistocene geology soils vegetation	Ecoregion	bioclimate soil genesis	Ecodistrict	pattern of physiography & materials	Soil Assoc.	material relief soil drainage vegetation	
8. South Nahanni 9. Gt. Slave-Artillery Lake	Wildlife vegetation Pleistocene geology	Vegetation Zone	bioclimate			Vegetation Type Terrain Unit	vegetation communities material relief origin	

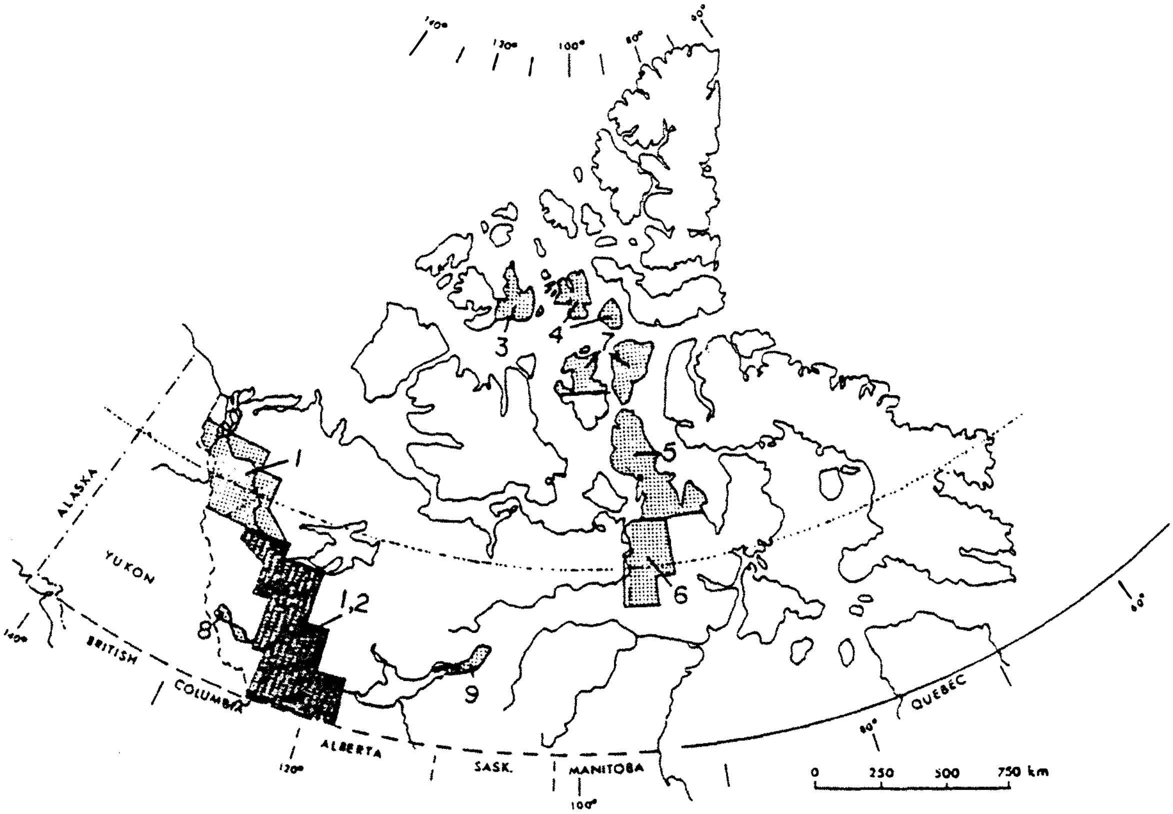

Figure 2 - Ecological land classification projects in northern Canada.

LEGEND

1. Mackenzie Valley
2. Southern Mackenzie Valley
3. Eastern Melville Island
4. Bathurst and Cornwallis Islands
5. Boothia Peninsula & northern Keewatin
6. Central Keewatin
7. Somerset Island
8. South Nahanni
9. Great Slave Lake - Artillery Lake

The next lower level of detail was handled differently by the investigators. Most studies used the Land District concept of the Biophysical Classification (Lacate 1969), where the districts were recognized as areas of broadly similar patterns of geomorphological and geological features, and soil parent material and permafrost conditions. Vegetation distribution would also follow a recognizable pattern within the climatic region. On some of the Arctic islands the bedrock formations were taken as the corresponding level of subdivision. This was prompted by the virtual absence of glacially transported materials: the surface materials reflected the underlying bedrock. In the southern Mackenzie study the parent material was used to distinguish areas at this level of detail.

At the mapping level all studies used parent materials and relief as criteria. In some biophysically oriented studies vegetation, soils and internal drainage were included in the mapping criteria. In some studies additional criteria were the geological origin of the surficial material and permafrost conditions.

Under Arctic conditions where catastrophic disruptions of the vegetation (fire, clearing, etc.) are rare, the existing vegetation reflects the vegetation communities best adapted to each kind of land surface. The physiographic conditions, such as parent material, nutrient status, soil moisture, active layer depth, slope, aspect, etc. will result in distinctive vegetation and soil conditions within climatic zones. The understanding of such interrelationships between the terrain and vegetation allows the plant ecologist to make use of physiographic information for an ecological land classification.

REFERENCES

Barnett, D.M. 1970. Eastern Melville Island: Biophysical aspects of a geological survey reconnaissance program. In: Ecological (Biophysical) Land Classification in Canada, J. Thie and G. Ironside, eds. 153-158.

Barnett, D.M., S.A. Edlund, L.A. Dredge, D.C. Thomas and L.S. Prevett. 1975. Terrain classification and evaluation, Eastern Melville Island, N.W.T. Geol. Surv. Can. Open File #252.

Barnett, D.M., S.A. Edlund and L.A. Dredge. 1976a. Terrain characterization and evaluation: an example from Eastern Melville Island. Geol. Surv. Can. Paper 76-23.

Barnett, D.M. L.A. Dredge and S.A. Edlund. 1976b. Terrain Inventory: Bathurst, Cornwallis and adjacent islands, Northwest Territories. Geol. Surv. Can., Paper 76-1, Pt. A, 201-204.

Crampton, C.B. 1973. Landscape survey in the upper and central Mackenzie Valley. Envir. -- Soc. Comm., North. Pipelines, Task Force North. Oil Devl., Rept. No. 73-8, 67 p.

Hanley, P.T., S.C. Chatwin, O.L. Hughes, and J. Pilon. 1975. Surficial geology, District of Mackenzie, N.W.T. (Mapsheets 96 E, F, 106 P). Geol. Surv. Can. Open File No. 294.

Hills, G.A. 1961. The ecological basis for land-use planning. Ont. Dept. Lands & For., Res. Rep. No 46, 204 p.

Hughes, O.L., D.A. Hodgson and J. Pilon. 1972a. Terrain maps, Mackenzie Valley (Mapsheets 106 I, M, and N). Geol. Surv. Can. Open File No. 97.

Hughes, O.L., D.A. Hodgson and J. Pilon. 1972b. Surficial geology maps, Mackenzie Valley (Mapsheets 106 J, K, and O). Geol. Surv. Can. Open File No. 109.

Kelsall, J.P., E. Kuyt and S.C. Zoltai. 1970. Ecology of the Fort Reliance-Artillery Lake area. Can. Wildlife Serv., File Rept., 99 p.

Krajina, V.J. 1972. Ecosystem perspectives in forestry. The H.R. MacMillan Lectureship in Forestry, Univ. B.C., 31 p.

Lacate, D.S. 1969. Guidelines for Bio-physical land classification. Dep. Fish. & For., Can. For. Serv., Publ. No. 1264, 61 p.

Rutter, N.W., G.V. Minning and J. Netterville. 1972. Terrain maps, Mackenzie Valley (Mapsheets 85 E, 95 A, J, and H). Geol. Surv. Can., Open File No. 93.

Scotter, G.W., N.M. Simmons, H.L. Simmons and S.C. Zoltai. 1971. Ecology of the South Nahanni and Flat River areas. Can. Wildlife Serv., File Rep., 186 p.

Tarnocai, C. 1973. Soils of the Mackenzie River area. Envir.-Soc. Comm., North. Pipelines, Task Force North. Oil Dev., Rep. No. 73-26, 136 p.

Tarnocai, C. and Boydell, A.N. 1975. Biophysical study of the Boothia Peninsula and Northern Keewatin. Geol. Surv. Can., Paper 75-1, Pt. A, 423-424.

Tarnocai, C., A.N. Boydell, J.A. Netterville, and K.A. Drabinsky. 1976. Biophysical land classification maps of Boothia Peninsula and Northeast Keewatin, N.W.T. Geol. Surv. Can., Open File #.

Tarnocai, C. and Netterville, J.A. 1976. Biophysical land classification in Boothia Peninsula and northeast Keewatin, N.W.T. In: Ecological (Biophysical) Land Classification in Canada, J. Thie and G. Ironside, eds., 159-171.

Tarnocai, C. 1976. Soils of Bathurst, Cornwallis, and adjacent islands, District of Franklin. Geol. Surv. Can., Paper 76-1, Pt. B, 137-141.

Tarnocai, C. 1977. Soils of North-central Keewatin. Geol. Surv. Can., Paper 77-1, Pt. A, 61-64.

Zoltai, S.C. and W.W. Pettapiece. 1973. Terrain, vegetation and Permafrost relationships in the northern part of the Mackenzie Valley and northern Yukon. Environ.-Soc. Comm., North. Pipelines, Task Force North. Oil Dev., Rep. No. 73-4, 105 p.

Zoltai, S.C. and V. Woo. 1976. Soils and vegetation of Somerset and Prince of Wales Islands, District of Franklin. Geol. Surv. Can., Paper 76, Pt. B, 143-145.

Table 1 - Brief characteristics of the Ecological Regions of Northwest Territories and Yukon.

AH High Arctic	- Scattered vegetation (less than 50% ground cover) of perennial herbs, dwarf shrubs and lichens. Continuous permafrost.
AM Mid-Arctic	- Discontinuous vegetation (50 - 90% ground cover) of low shrubs, perennial herbs, mosses and lichens. Continuous permafrost.
AL Low Arctic	- Complete ground cover of shrubby lichen-heath tundra. Continuous permafrost.
SH High Subarctic	- W Open canopied, stunted black spruce-shrub-lichen forest (white spruce near tree line). Continuous permafrost in mineral soils, discontinuous in peatlands. E As in W, but with large expanses of Low Arctic tundra.
SL Low Subarctic	- Open canopied black spruce-lichen forests. Permafrost widespread, but discontinuous in mineral soils and in peatlands.
BH High Boreal	- Closed canopy forests of aspen-spruce-feathermoss. Sporadic permafrost in imperfectly drained mineral soils and in peatlands. d - Low rainfall area with open stands of white spruce and lodgepole pine. Sporadic permafrost in peatlands.

<u>MOUNTAIN COMPLEXES</u>

AHX High Alpine Complex	- Dominantly resembles High Arctic regions, but lower slopes and valleys resemble Mid- and Low Arctic regions.
AMX Mid-Alpine Complex	- Dominantly resembles Mid-Arctic regions, but with higher peaks resembling Low Arctic and High Subarctic regions.
ALX Low Alpine Complex	- Dominantly resembles Low Arctic regions, but some higher peaks resembling Mid-Arctic regions, and some valleys resembling High Subarctic regions.
SHX High Subalpine Complex	- Dominantly resembling High Subarctic regions, but with peaks resembling Low Arctic regions, and valleys resembling Low Subarctic regions.

Ecological Classification of Forest Land in Canada and Northwestern U.S.A.

September 30 - October 2, 1977

Vancouver, B.C.

Sponsored by

Forest Ecology Working Group of the
Canadian Institute of Forestry
and Centre for Continuing Education,
The University of British Columbia