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Common Landform Toposequences of Northwestern Ontario

by

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abstract

This report describes six topographic sequences (toposequences) across some commonly encountered landform complexes in northwestern (NW) Ontario. The toposequences comprise groups of sample plots selected from the Northwestern Ontario Forest Ecosystem Classification's (NWO FEC) database. For each toposequence, changes in soil and vegetation characteristics are described and graphically illustrated with reference to a cross-sectional landform profile. Toposequences can be of value to forest managers in NW Ontario as models for illustrating landform / soil / vegetation relationships and as tools for the recognition of site-specific soil and vegetation characteristics.

résumé

Ce rapport décrit six séquences topographiques (toposéquences) dans certains ensembles de relief communs du nord-ouest de l'Ontario. Les toposéquences comprennent des groupes de parcelles-échantillons choisies à partir de la base de données de la Classification des écosystèmes forestiers du nord-ouest de l'Ontario. Pour chaque toposéquence, les changements au niveau des caractéristiques des sols et de la végétation sont décrits et illustrés à l'aide de graphiques par rapport à une coupe de profil du relief. Ces toposéquences peuvent être utiles aux gestionnaires forestiers du nord-ouest de l'Ontario comme modèle illustrant les rapports relief-sol-végétation, et comme outils pour reconnaitre les caractéristiques de sol et de végétation particulières à chaque station.

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The map of NW Ontario was reproduced from *Field Guide to the Forest Ecosystem Classification for Northwestern Ontario* (Sims et al 1989). Photographs were obtained from the NWO FEC photo collection.

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1. introduction

The Northwestern Ontario Forest Ecosystem Classification (NWO FEC) is an ecologically based system of site classification which has recently been completed for northwestern (NW) Ontario (Sims et al 1989). This system provides a basis for the classification of forest soils and vegetation in this part of the province. As such, it forms a useful framework for the effective organization, communication and application of forest management expertise (Towill et al 1988, LeBlanc and Towill 1989, Racey et al 1989, Walsh and Krishka 1990) and constitutes a valuable tool in the development of land management strategies and options.

A number of ancillary benefits have accrued from the large and comprehensive dataset collected during the NWO FEC project. This database, which includes detailed soil, site and vegetation information from approximately 2200 mature forest stands throughout NW Ontario, has contributed to the development of a better understanding of the nature, distribution and relationships of soils and vegetation in NW Ontario (Baldwin and Sims 1989, Wickware et al 1989, Bell 1990, Sims et al 1990).

Of particular interest in this report are the relationships among landform(s) and various soil and vegetation conditions in NW Ontario. By their nature (i.e. processes related to their formation), certain landform and landform complexes exhibit similar soil characteristics regardless of geographic location (Tuttle 1970, Paton 1978, Jenny 1980). In addition, the distribution of vegetation communities is often closely related to soil / site features (Daubenmire 1968, 1974, Jones et al 1983, Klinka et al 1989). When these relationships are understood within a specific area, it is possible to predict trends in certain soil and vegetation characteristics through the recognition of landform features (Van Cleve and Yarie 1986). Mapping the spatial distribution of these soil and vegetation properties can be facilitated by the development of air photo interpretation aids. Thus, the knowledge of landform / soil / vegetation relationships in a management area is essential for mapping purposes, and of value for the planning of land management activities and the prediction of their consequences.

During the NWO FEC sampling program, plots were frequently located in clusters on various landforms and landform complexes. Data were obtained at various topographic positions across these landforms in order to maximize information about landform / soil / vegetation variability. Not surprisingly, similar landforms / landform complexes within the study area exhibited recurring patterns of soil and vegetation properties.

In this report, six groups of NWO FEC sample plots were selected to illustrate some frequently encountered topographic sequences (toposequences or slope sequences) in NW Ontario. For each toposequence, changes in soil and vegetation characteristics are illustrated and described across a cross-sectional landform profile.

2. study area

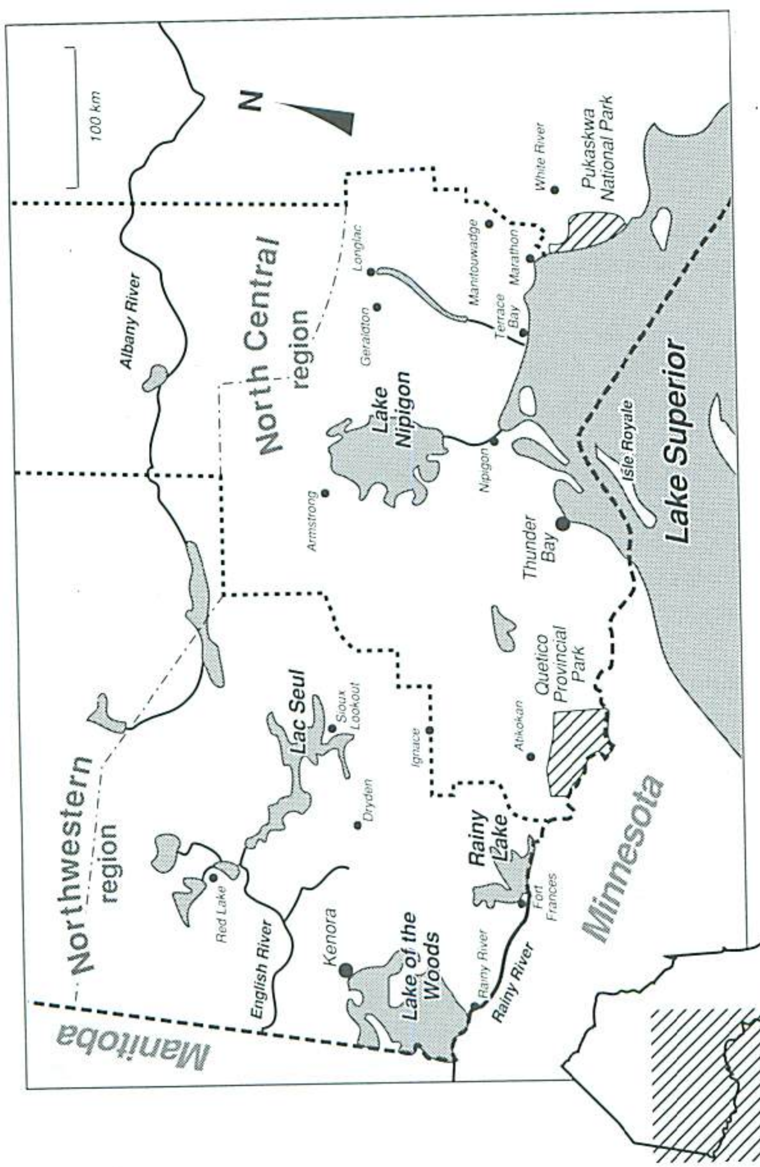
The NWO FEC study area encompasses the southern portions of two Ontario Ministry of Natural Resources administrative regions in NW Ontario: the North Central (NC) and Northwestern (NW) Regions. Geographically the study area extends from Manitouwadge and White River in the east to the Ontario - Manitoba border in the west. In north - south orientation, it extends from the Ontario - Minnesota border in the south to just north of the physiographic limit of the Canadian Precambrian Shield.

With the exception of a zone of strongly broken topography along the Lake Superior coast, NW Ontario is characterized by an undulating, bedrock dominated terrain. Surficial landform features generally reflect the effects of four major glaciations (Zoltai 1961, 1965a, 1967), the last ending approximately 10,000 years ago.

The most commonly occurring glacial deposit is a shallow, bouldery, sandy or coarse loamy till (Sado and Carswell 1987) which typically reveals the topographic character of the underlying Shield bedrock. A finer-textured till, derived from the carbonate bedrock of the Hudson Bay Lowland and spread southward onto the Shield by moving ice, occurs within discrete dispersion trains and locally thin smears. Ice-contact and outwash glaciofluvial deposits, consisting of sorted sands and gravels, are found throughout the area. These deposits, including features such as eskers, kames, kame moraines and deltas, are among the most prominent landforms in NW Ontario. Numerous glacial lakes (including Lake Agassiz), which historically inundated much of NW Ontario, deposited a range of materials including beach and near-shore sand deposits as well as deeper basin silts and clays. These glaciolacustrine deposits are frequently in close proximity to glaciofluvial landforms.

Aeolian deposits occur throughout NW Ontario, although with restricted spatial distribution. Typically sandy in nature, these materials tend to be associated with both glaciofluvial and glaciolacustrine landforms. Organic deposits are generally of limited areal extent in the study area, usually occupying poorly drained bedrock depressions and lower landscape positions. Occasionally, organic materials extensively overlie fine-textured (silt and clay), low relief glaciolacustrine basins.

The forests of NW Ontario consist predominantly of elements of the Boreal Forest Region (Rowe 1972). These include pure or mixed stands of jack pine (*Pinus banksiana* Lamb.), trembling aspen (*Populus tremuloides* Michx.), white birch (*Betula papyrifera* Marsh.), balsam fir (*Abies balsamea* [L.] Mill.), white and black spruce (*Picea glauca* [Moench] Voss and *Picea mariana* [Mill.] B.S.P.). To the west of L. Superior, along the U.S. border, the forests constitute part of the Great Lakes - St. Lawrence Forest Region. At one time, extensive communities of red pine (*Pinus resinosa* Ait.) and eastern white pine (*Pinus strobus* L.) dominated the landscape of this portion of NW Ontario. Logging and recent fires, however, have changed the character of these stands to reflect a somewhat more boreal nature. Nevertheless, there continues to be a scattering of red and white pine stands throughout the area. In addition, occasional occurrences of yellow birch (*Betula lutea* Michx. f.), basswood (*Tilia americana* L.), Manitoba maple (*Acer negundo* L.), bur oak (*Q. macrocarpa* Michx.), red maple (*Acer rubrum* L.), white elm (*Ulmus americana* L.), black and red ash (*Fraxinus nigra* Marsh. and *Fraxinus pennsylvanica* Marsh.) reflect the mixed nature of forests of the Great Lakes - St. Lawrence Forest Region.



Northwestern Ontario

important centres, geographic features, regional boundaries (·······) and northern extent of NWO FEC (-·-·-)

3. approach and methodology

The ecological character of any site is a function of the interaction of a number of biophysical conditions. Climate, soil parent materials (and depositional history), biological communities, topographic influence and elapsed developmental time all make important contributions to the ecological uniqueness of a particular site (Jenny 1941, 1980, Major 1951, Brady 1984, Paton 1978). Within a local area, such as a management unit, these major biophysical conditions will either be relatively similar among specific sites or vary within a limited (and predictable) range of expression. Thus, discrimination of ecological character among individual sites at the local level requires an examination of site-specific factors.

Characterizing the expression of specific site-related factors is not always easy, often requiring complex and elaborate procedures. However, many important site conditions can be assessed, either directly or indirectly, from simple ground and aerial observations. For example, topographic features are readily described either by ground surveys or by interpretation of aerial photographs. Since local topography influences the expression of numerous other site factors, its description provides a convenient basis by which these factors can be predicted. If a preliminary impression of a site's ecological character can be developed through such inference in the management planning process, the results of forest management practices can be postulated.

There are several site factors which are subject to predictable influence by topographic considerations like slope position and degree of slope. Air and soil temperatures tend to decrease with lower topographic position, an effect especially pronounced on steeper, north and east facing slopes (Oke 1978, Brady 1984, van Groenewoud 1986). Soil drainage and, consequently, soil aeration are generally greater at higher topographic positions (Brady 1984, van Groenewoud 1986). Lateral movement of water (seepage and surface runoff) increases with a larger slope angle. Due mainly to lateral water movement, higher concentrations of soil moisture and many nutrients tend to be found at lower slope positions (Klinka et al 1980, Brady 1984, Hausenbuiller 1985, Roberts 1986).

Site factors which act independently of topographic influences are also important (Brady 1984, Hausenbuiller 1985). These factors may alter the expression of a site's ecological character from that which would be predicted based solely on, for example, its topographic position. Soil texture, soil depth, coarse fragment content, organic matter form and thickness, vegetation cover and microtopography are such considerations. Many of these properties can be broadly anticipated from a knowledge of landform characteristics within a specific geographic area, and their mitigating effects along a slope gradient predicted.

Development of toposequence models across selected landform types requires familiarity with basic characteristics of each landform type as well as an understanding of the relationships among topographic position, degree of slope and topographically dependent site factors. Once developed, however, these models can be employed within a particular management area to help interpret local landscape features. In turn, a series of schematic toposequences encompassing common landform / soil / vegetation conditions may be formulated. Subsequently, these toposequences can be consulted in the management planning process (Klinka et al 1980, Meidinger et al 1984, Viereck et al 1984, Corns and Annas 1986, Houseknecht et al 1986).

Toposequences developed for this report include some of the more commonly encountered landform complexes in NW Ontario. These toposequences occur throughout NW Ontario and, although actual conditions may vary locally, they can be of considerable value as interpretive tools. They also serve as examples of a procedure which can be followed by practitioners in their efforts to better understand the landform / soil / vegetation relationships in their management areas.

When referring to these toposequences, it is important to recognize that, although landform development processes were similar throughout NW Ontario, local geographic conditions have created a degree of variability in some site factors. Consequently, landform / soil / vegetation relationships will differ somewhat from one locality to another. For example, vegetation development and certain soil characteristics (e.g. soil moisture regime or drainage) observed on an end moraine constructed from sandy, bouldery till might be different from conditions exhibited by an end moraine constructed from a fine-textured till. Toposequences, therefore, require testing in order to determine their applicability within a particular management area.

3.1 identification and selection of toposequences

Toposequences can be formulated in two ways. In one method, composite or schematic toposequences are developed based on broad geographic sampling. Samples are then pooled and a schematic toposequence based on these samples is developed. The toposequence, as an entity, does not necessarily exist in "reality" although the constituent parts do. In the second approach, adopted by this study, a toposequence is described by actual plots sampled over a representative example of a particular landform or landform complex within a geographic area.

NWO FEC soil / site and vegetation datasets (see Appendix A), as well as plot location files, were initially inspected for clusters of sample plots located along topographic gradients. Approximately 50 such plot clusters were extracted for further examination and six toposequences were selected for final development. Each selected toposequence represents a range of topographic expression, floristic characteristics and surficial geology found commonly in NW Ontario.

Site, soil and vegetation data for each candidate NWO FEC plot were compiled, sorted and summarized using computerized data handling techniques. In the selection process, summarized data were manually inspected to determine which plot clusters provided the most suitable representation of common toposequences in NW Ontario. NWO FEC sample plots included in the six selected toposequences are listed in Appendix B; plot information used in developing the toposequences is presented in Appendix C.

3.2 presentation of selected toposequences

Cross-sectional profiles illustrating general relationships among the sample plots are presented figuratively for each of the selected toposequences. Brief interpretive descriptions, as well as some representative site photographs, are provided on facing pages. Schematic diagrams, as well as tabular summaries, relate specific trends in vegetation and soil / site conditions to individual plot locations along the toposequence profiles. This information can be readily obtained by reading vertically above and below each plot location on the cross-sectional diagrams. Terminology is defined in Appendix D.

For each toposequence, the cross-sectional diagram establishes basic reference positions for the sample plots. It visually depicts slope position, degree of slope, relative overstory abundance, soil depth and parent material class for each plot. Each plot is assigned equal horizontal space in the diagram but is separated from its neighbours since relative, rather than absolute, relationships are portrayed.

Aligned below each plot on the cross-sectional diagram are summaries of soil and site properties. Soil profile diagrams display the mineral and organic soil horizons for each sample plot. Tabular descriptions of other important soil / site factors are provided at the bottom of the page.

Above the cross-sectional diagram, species coenoclines (Whittaker 1975) illustrate stand structure along the toposequences. Abundance trends of tree species as well as major understory species groups are portrayed. Above the coenoclines, listings of common understory species in each plot are provided (nomenclature follows Baldwin and Sims 1989).

4. selected toposequences

Deep, Sandy Lacustrine - Beach Deposit

Bedrock Knob - Shallow Soil

Deep, Sandy Ablation Till

Deep, Coarse Loamy Ground Moraine

Deep, Sandy Glaciofluvial - Outwash

Deep, Coarse Loamy Ablation Till

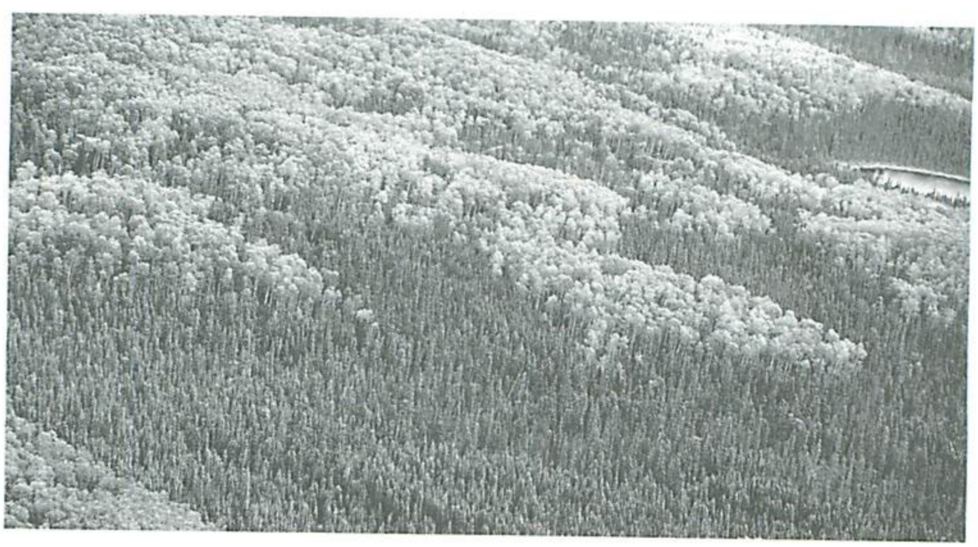
deep, sandy, lacustrine - beach deposit

This toposequence exhibits a well-defined association between soil moisture and topographic position. In the mineral soils of the sequence, moisture ranges from a fresh, rapidly drained crest / upper / mid slope (**S2**) to a moist, imperfectly drained lower slope position (**S7**). Wet, very poorly drained, organic soils (Sphagnum peat) occur at the toe of the slope (**S12F**) and in the landscape depression (**S12S**).

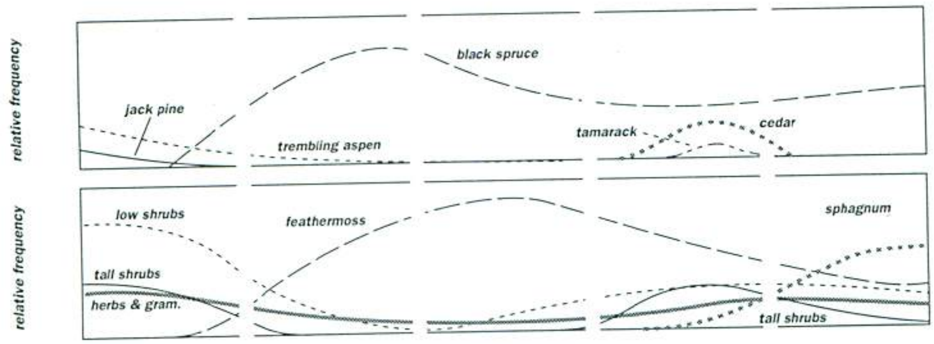
Forest overstory conditions at the crest position are dominated by trembling aspen (**V10**) while black spruce is the main overstory species throughout the rest of the toposequence (**V33**, **V34**, **V35**). Herb and shrub layers are well developed at both the crest (*Diervilla lonicera*, *Aralia nudicaulis*, *Aster macrophyllus*, *Alnus crispa* and black spruce) and toe slope (*Alnus rugosa* and cedar) positions. Continuous feathermoss ground cover with a shrub and herb poor understory are characteristic at the mid and lower slope positions (**V33**). Sphagnum species, present in low abundance at the toe of the slope (**V34**), dominate ground cover in the depression (**V35**).

The shift from a hardwood dominated stand condition (**V10**) at the crest to a conifer forest type (**V33**) downslope is a recurring pattern observed in the NWO FEC dataset. In addition to the slope-related soil moisture gradient, microclimatic trends along the toposequence may influence this distribution of species. For example, while air and soil humidity tend to increase downslope, air and soil temperatures tend to decrease. Such trends may favour the development of conifer dominated stands at lower slope positions.

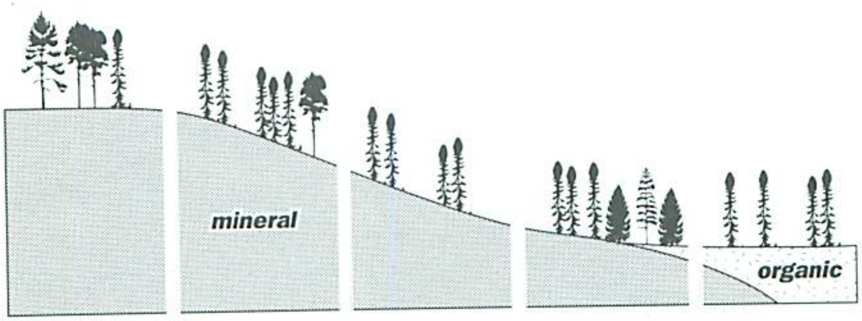
The presence of cedar, tamarack, *Alnus rugosa* and a diversity of herb species at the toe slope (**V34**) and depressional (**V35**) positions indicates nutrient enrichment and enhanced soil aeration on these wet, poorly drained sites. Such enrichments typically result from downslope transport of nutrients and dissolved oxygen by groundwater seepage.



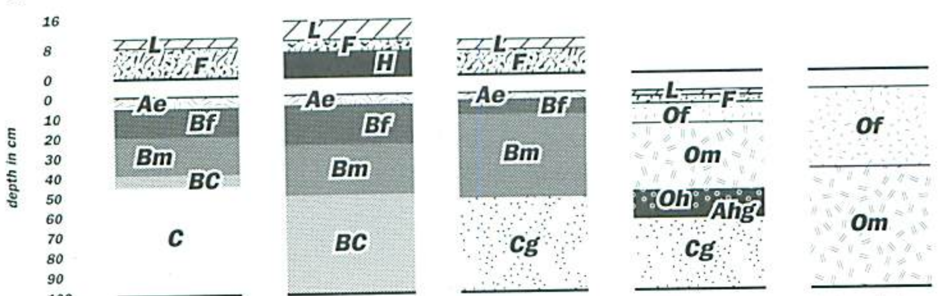
Shrubs	Diervilla lonicera 25 Picea mariana 24 Aralia nudicaulis 15 Alnus crispa 10 Cornus stolonifera 2 Abies balsamea 1 Populus tremuloides 1 Rubus pubescens 1	Gaultheria hispidula 3 Picea mariana 1 Vaccinium myrtilloides 1	Ledum groenlandicum 4 Gaultheria hispidula 2 Picea mariana 2 Abies balsamea 1 Vaccinium angustifolium 1 Vaccinium myrtilloides 1	Thuja occidentalis 35 Alnus rugosa 2 Gaultheria hispidula 1 Ledum groenlandicum 1 Linnaea borealis 1 Picea mariana 1 Rubus pubescens 1 Vaccinium myrtilloides 1	Alnus rugosa 15 Gaultheria hispidula 2 Ledum groenlandicum 2 Linnaea borealis 2 Picea mariana 2 Oxycoccus microcarpus 1 Rubus pubescens 1 Vaccinium angustifolium 1 Vaccinium myrtilloides 1
Herbs & Graminoids	Aster macrophyllus 10 Clintonia borealis 4 Coptis trifolia 1 Lycopodium clavatum 1 Streptopus roseus 1 Trientalis borealis 1	Cornus canadensis 2 Maianthemum canadense 2	Cornus canadensis 3 Maianthemum canadense 3	Coptis trifolia 1 Cornus canadensis 1 Maianthemum canadense 1	Carex vaginata 3 Coptis trifolia 1 Equisetum sylvaticum 1 Petasites palmatus 1 Mitella nuda 1 Smilacina trifolia 1 Trientalis borealis 1



NWO FEC Vegetation Type	**V10**	**V33**	**V33**	**V34**	**V35**



NWO FEC Soil Type	**S2**	**S2**	**S7**	**S12F**	**S12S**



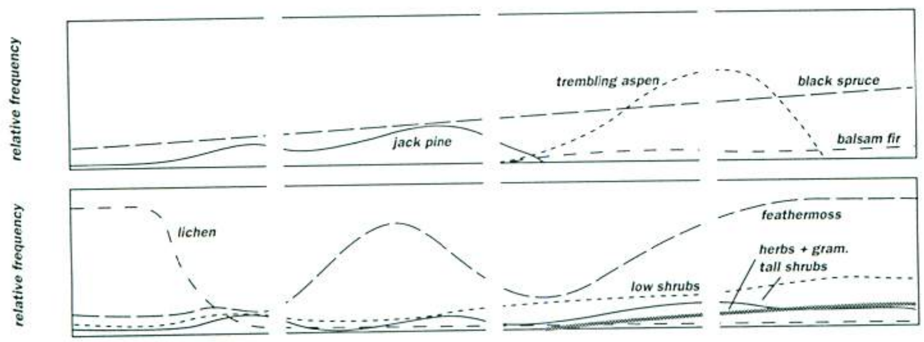
	orthic humo - ferric podzol	duric dystric brunisol	orthic eutric brunisol	terric mesisol	typic mesisol
% exposed bedrock	0	0	0	0	0
humus type	fibrimor	fibrimor	fibrimor	mesic peatymor	mesic peatymor
dominant surf. text.	fSL	SiL	LfS	mesic	fibric
dominant sub-surf. text.	fS	vfS	LfS	humic	mesic
drainage	R	W	I	vP	vP
moisture regime	mF	F	mM	mW	W
% coarse fragments	5-20	5-20	5-20	<5	<5
size of crs. fragments	gc	s	gcs	-	-
% slope	0	18	10	6	0
slope position	crest	mid	lower	toe	depression

bedrock knob - shallow soil

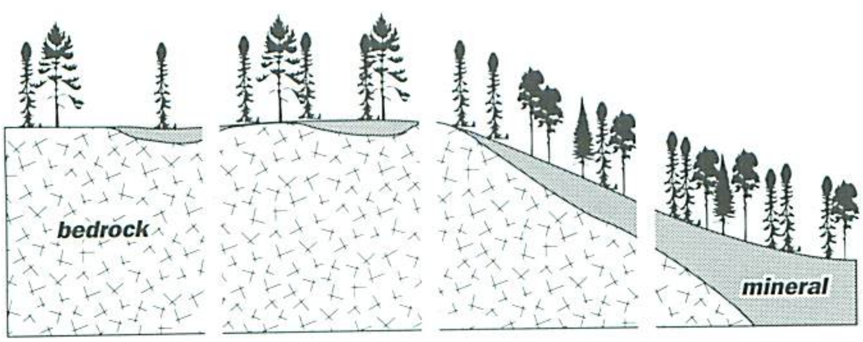
Bedrock controlled topography, with exposed bedrock and an often shallow, discontinuous mantle of mineral soil, is very common throughout NW Ontario. This landform type is a result of scouring by glacial ice and wave washing during the post-glacial lake period. Soil volume increases downslope as a result of the downward creep of soil and organic matter through constant erosion and colluviation of upper slope materials. On this landform type, availability of rooting matrix, soil nutrients and soil moisture is limited primarily by soil volume (depth).

With the exception of lichen (**V30**) and feathermoss (**V32**) ground cover, vegetation abundance is low on the crest (**SS1**) and upper slope (**SS2**) portions of this toposequence. These sites support poorly stocked jack pine / black spruce stands. Species diversity and cover values increase downslope, especially in the tree and low shrub layers, where soil volume is greater (**SS7**, **S9**). Trembling aspen / black spruce mixedwood stands (**V11**, **V19**) occupy the lower and toe slope positions, with the proportion of black spruce increasing downslope.

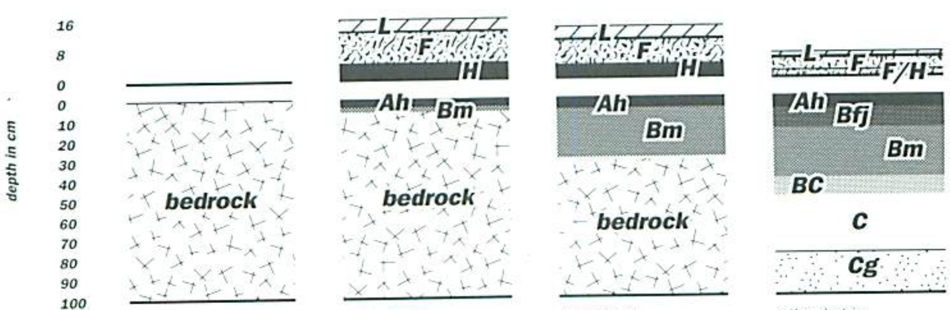
	V30	V32	V11	V19
Shrubs	Picea mariana 6	Ledum groenlandicum 2 Gaultheria hispidula 1 Linnaea borealis 1 Vaccinium angustifolium 1	Abies balsamea 4 Betula papyrifera 4 Aralia nudicaulis 3 Viburnum edule 3 Amelanchier spp. 2 Diervilla lonicera 1 Gaultheria hispidula 1 Ledum groenlandicum 1 Vaccinium myrtilloides 1	Abies balsamea 8 Ledum groenlandicum 8 Alnus crispa 5 Picea mariana 5 Linnaea borealis 3 Gaultheria hispidula 2 Rosa acicularis 1 Vaccinium angustifolium 1
Herbs & Graminoids		Maianthemum canadense 5 Clintonia borealis 1	Aralia nudicaulis 2 Maianthemum canadense 2 Lycopodium annotinum 1 Trientalis borealis 1	Cornus canadensis 2 Aster macrophyllus 1 Calamagrostis canadensis 1 Maianthemum canadense 1 Petasites palmatus 1



NWO FEC Vegetation Type **V30** **V32** **V11** **V19**



NWO FEC Soil Type **SS1** **SS2** **SS7** **S9**



	SS1	SS2	SS7	S9
	rock (non soil)	orthic dystric brunisol	typic folisol	orthic dystric brunisol
% exposed bedrock	2	0	0	0
humus type	fibrimor	humifibrimor	raw moder	fibrimor
dominant surf. text.	-	-	SiL	LfS
dominant sub-surf. text.	-	-	-	SiL
drainage	-	-	I	I
moisture regime	D	D	F	mM
% coarse fragments	<5	<5	5-20	<5
size of crs. fragments	-	-	cs	-
% slope	0	38	1	14
slope position	crest	upper	mid	toe

deep, sandy ablation till

Site-specific factors which are independent of topographic position can modify the expression of toposequence gradients. In this toposequence, the crest, upper and lower slope positions are characterized by deep, coarse-textured, till deposits (**S2**, **S3**) containing a high volume of coarse fragments. These soils are so well-drained that even the lower slope position shows no evidence of significant moisture retention. Moisture accumulates at the base of the slope in low-lying, depressional positions (**S11**, **S12S**).

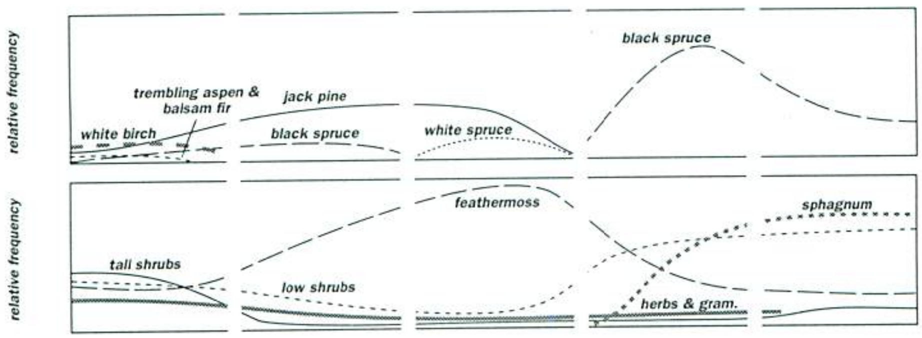
Forest cover on this toposequence contrasts jack pine dominated stand conditions upslope (**V18**, **V32**) with a wetland black spruce community at the slope base (**V37**). The understory at the crest position (**V18**) is shrub and herb rich with an abundance of balsam fir, black spruce, *Acer spicatum* and *Cornus canadensis*. Dense shrub cover on the wet, low-lying positions (**V37**) consists primarily of *Ledum groenlandicum*. Ground cover dominance changes abruptly from feathermoss to Sphagnum between the lower slope position (**V32**) and the depressional (level) wetland (**V37**).

Shrubs

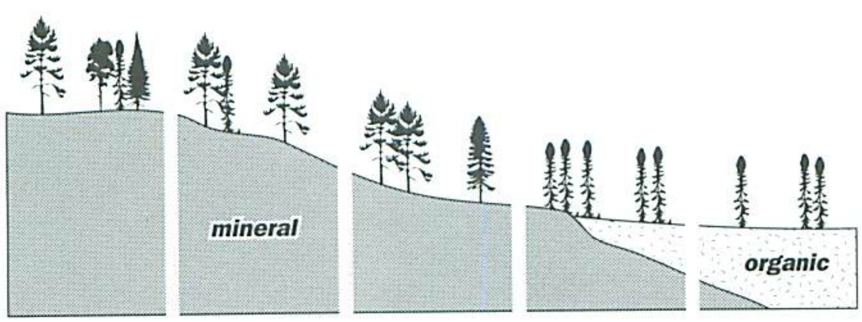
Abies balsamea 46 Picea mariana 7 Acer spicatum 6 Populus tremuloides 3 Vaccinium angustifolium 2 Gaultheria hispidula 1 Linnaea borealis 1 Vaccinium myrtilloides 1	Gaultheria hispidula 3 Aralia nudicaulis 2 Ledum groenlandicum 1 Linnaea borealis 1 Picea mariana 1 Vaccinium angustifolium 1 Vaccinium myrtilloides 1	Picea glauca 3 Abies balsamea 2 Gaultheria hispidula 1 Linnaea borealis 1	Ledum groenlandicum 55 Gaultheria hispidula 1 Kalmia polifolia 1 Oxycoccus microcarpus 1 Vaccinium angustifolium 1 Vaccinium myrtilloides 1	Ledum groenlandicum 55 Picea mariana 10 Alnus rugosa 5 Abies balsamea 3 Oxycoccus microcarpus 1 Vaccinium angustifolium 1 Vaccinium myrtilloides 1

Herbs & Graminoids

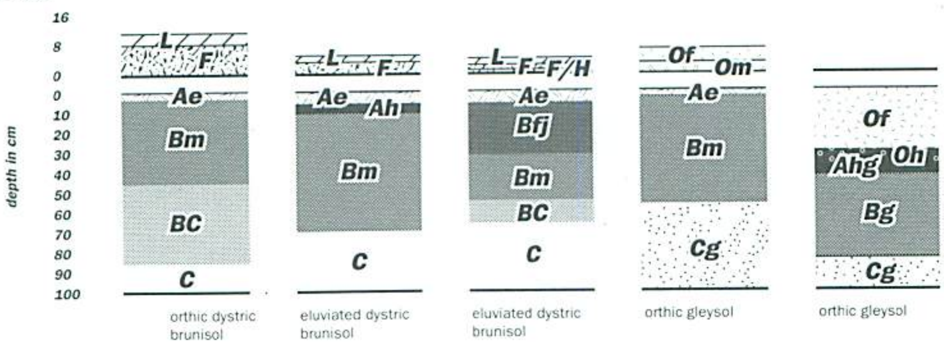
Cornus canadensis 7 Clintonia borealis 3 Lycopodium annotinum 3 Maianthemum canadense 3 Coptis trifolia 2 Trientalis borealis 1	Maianthemum canadense 4 Cornus canadensis 2 Clintonia borealis 1	Maianthemum canadense 2 Clintonia borealis 1 Cornus canadensis 1	Smilacina trifolia 2 Equisetum sylvaticum 1	Carex vaginata 4 Carex trisperma 1 Equisetum sylvaticum 1 Smilacina trifolia 1



NWO FEC Vegetation Type	V18	V32	V32	V37	V37



NWO FEC Soil Type	S3	S3	S2	S11	S12S

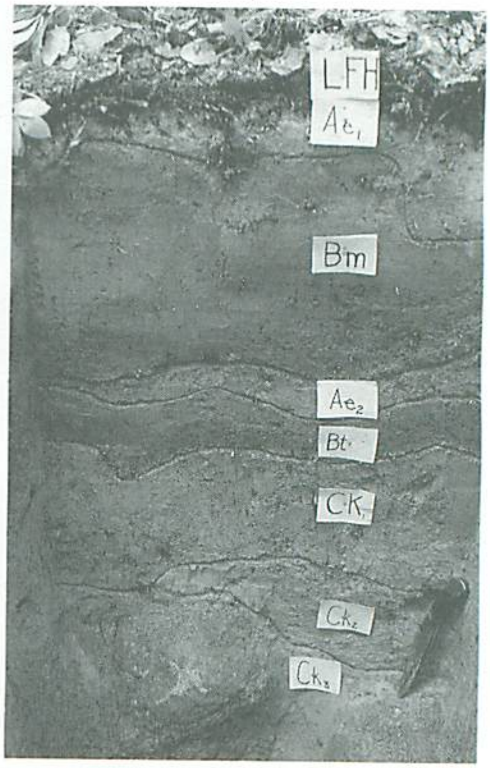


	orthic dystric brunisol	eluviated dystric brunisol	eluviated dystric brunisol	orthic gleysol	orthic gleysol
% exposed bedrock	0	0	0	0	0
humus type	fibrimor	raw moder	fibrimor	fibric peatymor	fibric peatymor
dominant surf. text.	SiL	fSL	SifS	fS	vfS
dominant sub-surf. text.	fS	fS	LfS	fS	vfS
drainage	R	R	vR	I	vP
moisture regime	mF	mF	mF	mM	mW
% coarse fragments	5-20	>50	35-50	<5	<5
size of crs. fragments	gc	cs	gcs	-	-
% slope	0	32	12	0	0
slope position	crest	upper	lower	level	depression

deep, coarse loamy ground moraine

In this toposequence, the association between soil moisture and topographic position is generally apparent. However, dry soil conditions at the upper and mid slope positions are somewhat enhanced. Lack of soil volume (**SS5**) reduces moisture retention capacity on the upper slope. At the mid slope position (**S1**), enhanced soil drainage due to a high proportion of coarse fragments results in a drier moisture regime than expected. At both of these positions stratified soils could alter the soil moisture regimes, with fine-textured surface soils tending to ameliorate excessive drainage but also potentially increasing surface runoff.

The forest overstory at the upper and mid slope positions is dominated by white spruce (**V25**). Black spruce is the main tree species downslope (**V31**, **V34**) and in the landscape depression (**V35**). Shrub layers at all positions are characterized by scattered occurrences of balsam fir. Dense shrub cover in the depression (*Alnus rugosa*, *Ledum groenlandicum*, balsam fir, black spruce) suggests nutrient and oxygen enrichment from downslope groundwater seepage.

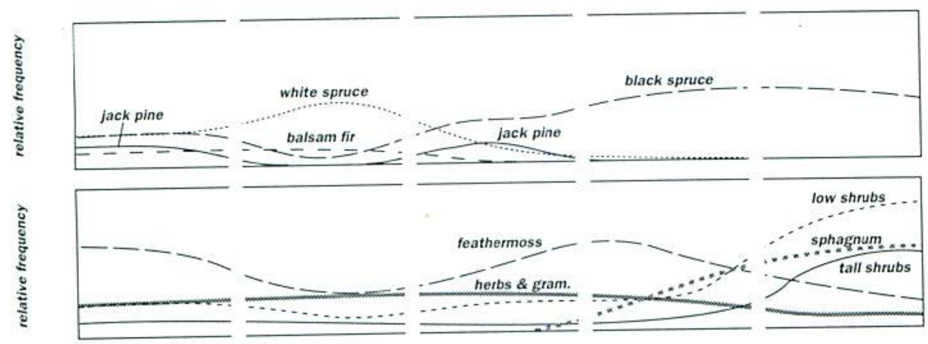


Shrubs

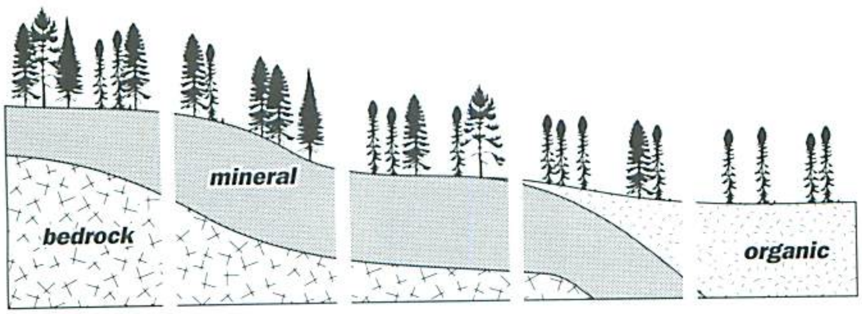
Abies balsamea 15	Abies balsamea 4	Abies balsamea 7	Abies balsamea 14	Ledum groenlandicum 50
Rubus pubescens 2	Corylus cornuta 1	Diervilla lonicera 2	Gaultheria hispidula 4	Abies balsamea 27
Diervilla lonicera 1	Diervilla lonicera 1	Gaultheria hispidula 2	Alnus rugosa 1	Alnus rugosa 25
Linnaea borealis 1	Linnaea borealis 1	Linnaea borealis 1	Ledum groenlandicum 1	Picea mariana 15
Ribes triste 1	Ribes triste 1	Rubus pubescens 1	Linnaea borealis 1	Gaultheria hispidula 5
Rosa acicularis 1	Rubus pubescens 1	Vaccinium myrtilloides 1	Rubus pubescens 1	Linnaea borealis 2
Sorbus decora 1			Vaccinium myrtilloides 1	Kalmia polifolia 1
				Oxycoccus microcarpus 1

Herbs & Graminoids

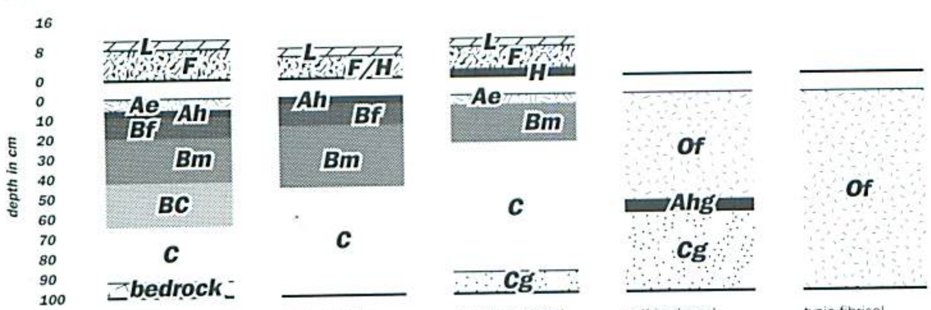
Aster macrophyllus 3	Aster macrophyllus 3	Clintonia borealis 3	Maianthemum canadense 2	Equisetum sylvaticum 1
Clintonia borealis 2	Clintonia borealis 2	Aster macrophyllus 1	Coptis trifolia 1	Mitella nuda 1
Cornus canadensis 1	Cornus canadensis 1	Coptis trifolia 1	Cornus canadensis 1	Petasites palmatus 1
Mitella nuda 1	Mitella nuda 1	Cornus canadensis 1		Smilacina trifolia 1
Streptopus roseus 1	Streptopus roseus 1	Maianthemum canadense 1		
Trientalis borealis 1	Trientalis borealis 1	Trientalis borealis 1		



NWO FEC Vegetation Type	V25	V25	V31	V34	V35



NWO FEC Soil Type	SS5	S1	S4	S12S	S12S

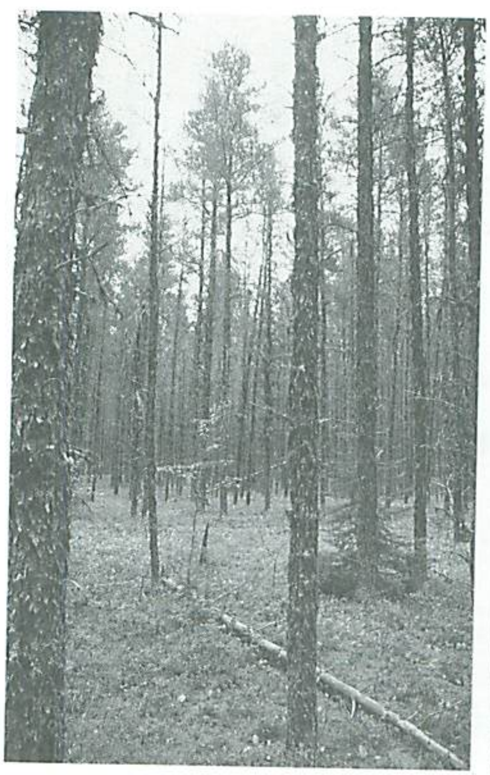


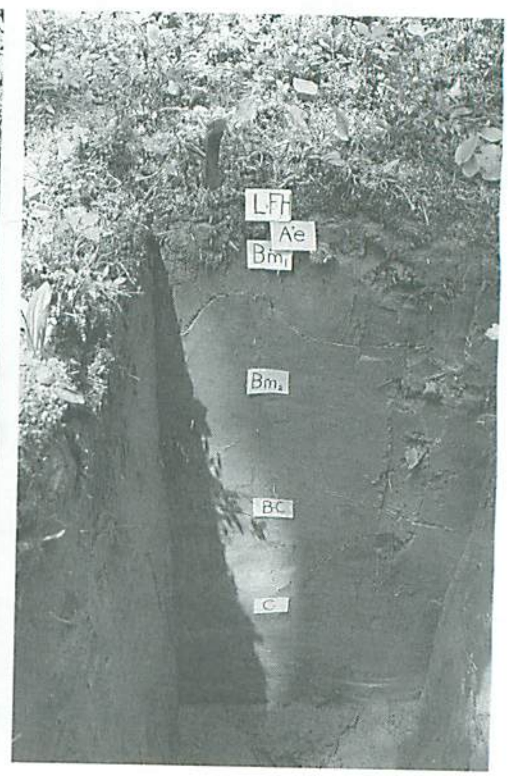
	orthic dystric brunisol	orthic dystric brunisol	gleyed eluviated brunisol	orthic gleysol	typic fibrisol
% exposed bedrock	0	0	0	0	0
humus type	fibrimor	fibrimor	humifibrimor	fibric peatymor	fibric peatymor
dominant surf. text.	SiL	CL	vfSL	fibric	fibric
dominant sub-surf. text.	LvfS	mS	Si	mSL	fibric
drainage	W	vR	I	vP	vP
moisture regime	mD	mD	vF	vM	W
% coarse fragments	<5	35-50	<5	>50	<5
size of crs. fragments	-	g	-	gcs	-
% slope	0	4	0	5	1
slope position	upper	mid	level	toe	depression

deep, sandy glaciofluvial - outwash

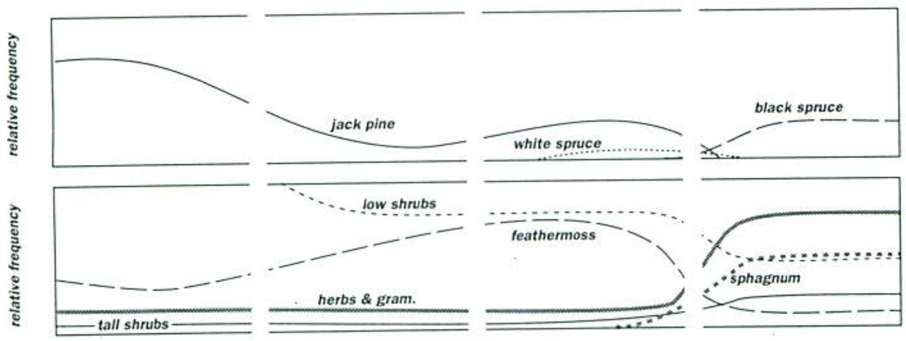
The association between soil moisture and topographic position is, perhaps, most clearly illustrated in NW Ontario in non-fragmental, coarse-textured soils. In this toposequence, moisture regime grades from moderately dry in coarse sand (**S1**) at the crest to a moderately fresh, fine sandy soil (**S2**) at mid slope and fresh, fine sand (**S2**) at the lower slope position. The depressional position is occupied by a wet, Sphagnum peat deposit (**S12S**). Of particular interest is the abrupt discontinuity in the soil moisture gradient between the moderately well-drained lower slope position (**S2**) and the very poorly drained depressional position (**S12S**).

Predominant jack pine cover (**V28**, **V29**, **V32**) on the mineral soils of this toposequence is indicative of well-drained soil conditions. Presence of white spruce (**V32**) at the lower slope position reflects the fresh moisture regime. Low shrubs are abundant throughout the toposequence but species composition changes along the slope gradient. *Diervilla lonicera* and *Aralia nudicaulis* are abundant as low shrubs at the crest while *Vaccinium angustifolium* and *V. myrtilloides* dominate this layer at the mid and lower slope positions. *Ledum groenlandicum* is the main low shrub species on organic soils (**V36/S12S**) in this sequence. Abundant herb and graminoid cover (*Equisetum sylvaticum, Carex trisperma, C. disperma*) in the depression (**V36**) suggests enhanced oxygen and nutrient status due to inputs from groundwater seepage.

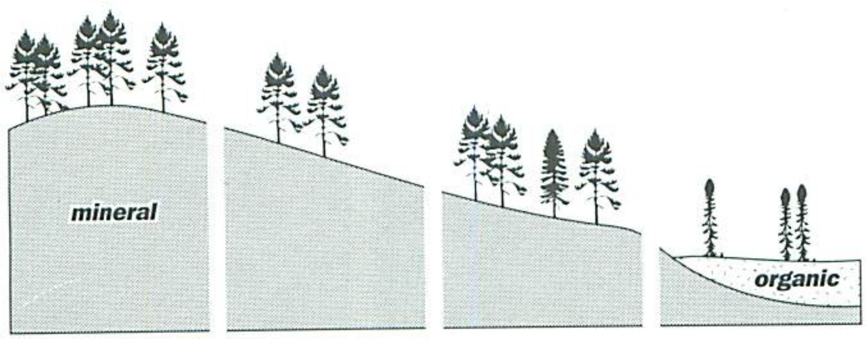




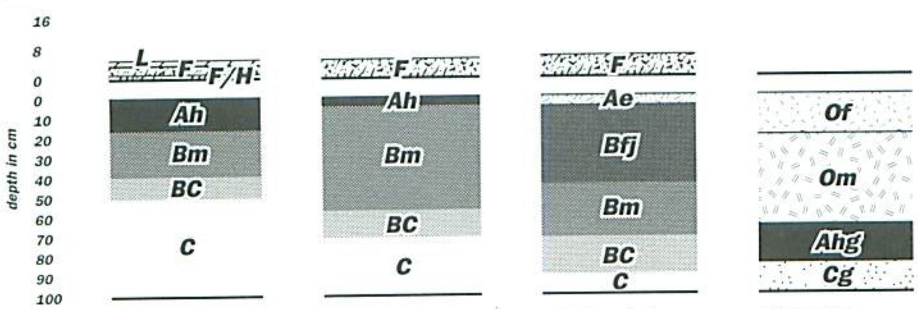
Shrubs	Diervilla lonicera 75 Aralia nudicaulis 70 Alnus crispa 5 Picea mariana 5 Linnaea borealis 1 Rosa acicularis 1 Vaccinium angustifolium 1 Vaccinium myrtilloides 1	Vaccinium myrtilloides 38 Vaccinium angustifolium 15 Pinus banksiana 6 Diervilla lonicera 4 Picea mariana 4 Aralia nudicaulis 1 Linnaea borealis 1	Vaccinium myrtilloides 40 Vaccinium angustifolium 16 Picea mariana 15 Diervilla lonicera 7 Aralia nudicaulis 2 Gaultheria hispidula 1 Linnaea borealis 1	Ledum groenlandicum 26 Picea mariana 11 Alnus rugosa 7 Vaccinium angustifolium 7 Vaccinium myrtilloides 6 Gaultheria hispidula 1
Herbs & Graminoids	Cornus canadensis 4 Aster macrophyllus 1 Clintonia borealis 1 Maianthemum canadense 1	Cornus canadensis 7 Maianthemum canadense 1	Cornus canadensis 6 Maianthemum canadense 1	Carex trisperma 29 Carex disperma 25 Equisetum sylvaticum 10 Cornus canadensis 4 Clintonia borealis 1 Coptis trifolia 1



NWO FEC Vegetation Type	V28	V29	V32	V36



NWO FEC Soil Type	S1	S2	S2	S12S

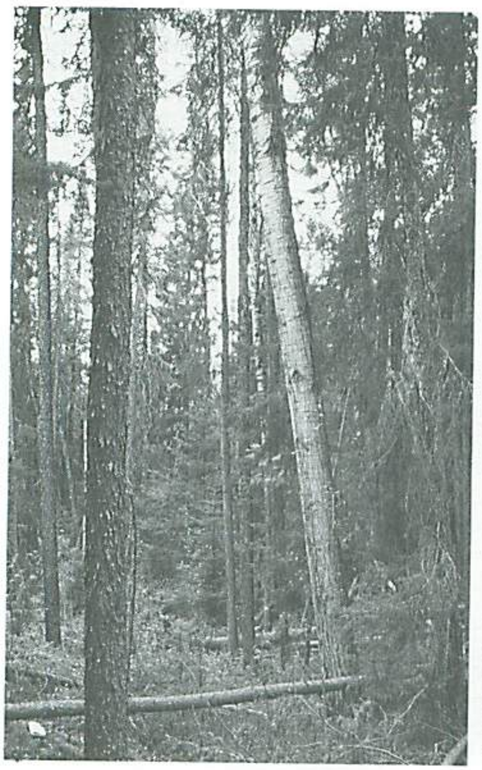


	orthic dystric brunisol	orthic humoferric podzol	orthic humoferric podzol	terric mesisol
% exposed bedrock	0	0	0	0
humus type	fibrimor	fibrimor	fibrimor	fibric peatymor
dominant surf. text.	LvfS	mS	mS	mesic
dominant sub-surf. text.	cS	fS	fS	LmS
drainage	R	R	mW	vP
moisture regime	mD	mF	F	mW
% coarse fragments	<5	<5	<5	<5
size of crs. fragments	g	g	g	-
% slope	0	12	7	0
slope position	crest	mid	lower	depression

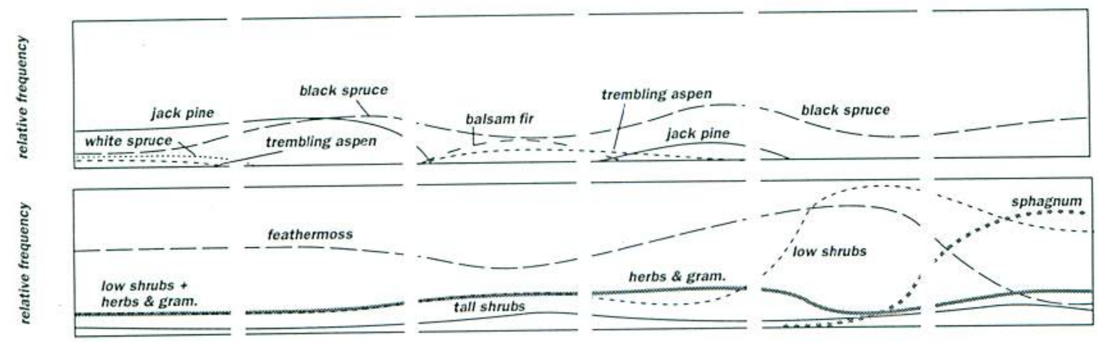
deep, coarse loamy ablation till

On the mineral soils of this toposequence, vegetation conditions range from jack pine dominated stand composition (**V18**, **V31**) at the upper and mid slope positions to balsam fir (**V16**) and black spruce (**V19**) mixedwoods at lower and toe slope positions. These trends are indicative of slope-related soil moisture and microclimatic gradients. Moisture regime at the lower slope position is drier than expected because of decreased moisture retention capacity due to shallow soils (**SS6**).

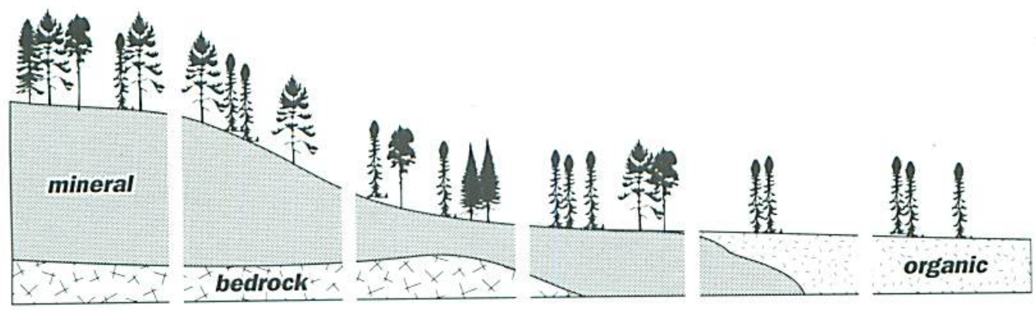
In the understory, a downslope increase in both species diversity and total vegetation cover indicates a slope-controlled nutrient gradient. Abundance of low shrubs (*Ledum groenlandicum*, *Chamaedaphne calyculata*) on wet, organic soils at the slope base (**V34/S12F**, **V36/S12S**) is the result of downslope nutrient and oxygen transport by groundwater seepage. The shift in ground cover dominance from feathermoss to Sphagnum between the **S12F** and **S12S** sites also suggests a nutrient and/or aeration gradient. Similar gradients have been reported by Heikurinen and Pakarinen (1982).



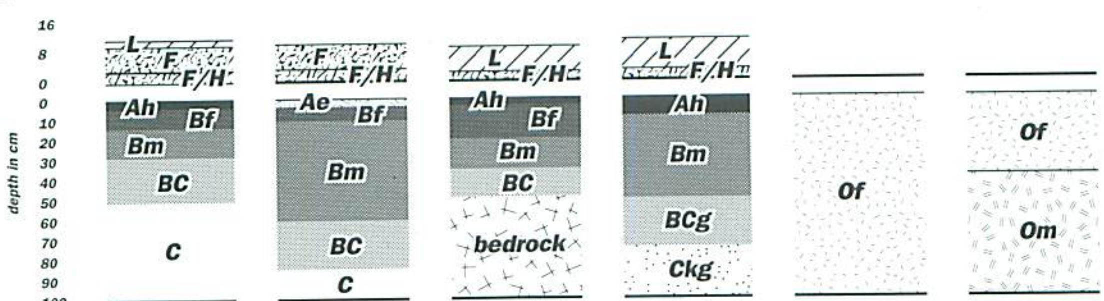
Shrubs	Abies balsamea 10 Linnaea borealis 1 Populus tremuloides 1 Rosa acicularis 1 Vaccinium myrtilloides 1	Abies balsamea 10 Aralia nudicaulis 1 Gaultheria hispidula 1 Linnaea borealis 1 Rubus pubescens 1 Vaccinium myrtilloides 1	Abies balsamea 12 Picea mariana 4 Picea glauca 3 Rosa acicularis 3 Linnaea borealis 1 Rubus pubescens 1	Abies balsamea 11 Diervilla lonicera 2 Gaultheria hispidula 1 Linnaea borealis 1 Rosa acicularis 1 Rubus pubescens 1 Vaccinium myrtilloides 1	Ledum groenlandicum 70 Picea mariana 12 Chamaedaphne calyculata 10 Gaultheria hispidula 2 Kalmia polifolia 1 Linnaea borealis 1 Vaccinium myrtilloides 1	Ledum groenlandicum 45 Picea mariana 12 Abies balsamea 5 Alnus rugosa 3 Gaultheria hispidula 3 Kalmia polifolia 1 Linnaea borealis 1 Oxycoccus microcarpus 1 Vaccinium myrtilloides 1
Herbs & Graminoids	Clintonia borealis 2 Cornus canadensis 1	Cornus canadensis 3 Aster macrophyllus 1 Clintonia borealis 1 Maianthemum canadense 1 Trientalis borealis 1	Cornus canadensis 4 Fragaria virginiana 2 Mitella nuda 2 Clintonia borealis 1 Streptopus roseus 1 Trientalis borealis 1	Cornus canadensis 5 Clintonia borealis 1 Coptis trifolia 1 Trientalis borealis 1 Viola renifolia 1	Calamagrostis canadensis 6 Cornus canadensis 1	Equisetum sylvaticum 6 Cornus canadensis 1 Smilacina trifolia 1



NWO FEC Vegetation Type	V18	V31	V16	V19	V34	V36



NWO FEC Soil Type	S3	S3	SS6	S9	S12F	S12S



	orthic dystric brunisol	orthic humoferric podzol	orthic humoferric podzol	orthic gleysol	typic fibrisol	humic mesisol
% exposed bedrock	0	0	0	0	0	0
humus type	fibrimor	fibrimor	fibrimor	fibrimor	fibric peatymor	mesic peatymor
dominant surf. text.	LfS	SifS	fSL	fSL	fibric	fibric
dominant sub-surf. text.	LfS	LvfS	LfS	Si	fibric	mesic
drainage	R	W	R	mW	vP	vP
moisture regime	mF	F	mF	mM	W	mW
% coarse fragments	20-35	20-35	5-20	5-20	<5	<5
size of crs. fragments	gc	gc	gc	gc	-	-
% slope	10	55	17	4	0	0
slope position	upper	mid	lower	toe	level	level

5. summary and comments

Toposequences are effective models for illustrating landform / soil / vegetation relationships. They succinctly portray common vegetation and soil / site patterns in relation to landscape topography. Toposequence formulation requires a knowledge of the basic vegetation conditions and common soil / landform complexes within a geographic area. Once developed, toposequences are useful tools for the recognition, interpretation and prediction of site-specific soil and vegetation characteristics.

Toposequence modelling can be applied to any land-based planning exercise requiring an understanding of site-related properties. Such diverse management activities as pre-harvest timber surveys, wildlife habitat assessment and integrated management planning can benefit from the preparation of toposequence models.

Since they illustrate the ecologically significant transitions across topographic features, toposequences can be helpful in the development and refinement of air photo interpretation keys. Such keys can be used to identify forest ecosystem attributes, assess site productivity or stand susceptibility to insect damage and to develop harvest and regeneration strategies.

In mapping exercises, toposequences can foster an understanding of the spatial distributions of soil and vegetation conditions. Decisions regarding polygon delineation (and grouping) as well as definition of attribute classes for a map area require this type of familiarity.

6. literature cited

Bell, F.W. 1990. *A Guide to the Critical Silvics of Conifer Crop Species and Selected Competitive Vegetation in Northwestern Ontario*. Ont. Min. Nat. Resources, NW Ont. For. Tech. Develop. Unit, Thunder Bay, Ont. COFRDA report, in preparation.

Baldwin, K.A. and Sims, R.A. 1989. *Field Guide to the Common Forest Plants in Northwestern Ontario*. Ont. Min. Nat. Resources, Toronto, Ont. 344 pp.

Brady, N.C. 1984. *The Nature and Properties of Soils*, 9th edition. MacMillan Publ. Co., Inc., New York, N.Y. 750 pp.

Canada Soil Survey Committee, Subcommittee on Soil Classification. 1978. *The Canadian System of Soil Classification*. Can. Dept. Agric., Publ. 1646. Supply and Services Canada, Ottawa, Ont. 164 pp.

Corns, I.G.W. and Annas, R.M. 1986. *Field Guide to Forest Ecosystems of West-Central Alberta*. Northern For. Centre, Can. For. Serv., Edmonton, Alta. 251 pp.

Daubenmire, R.F. 1968. *Plant Communities: A Textbook of Plant Synecology*. Harper and Row, New York, N.Y. 300 pp.

Daubenmire, R.F. 1974. *Plants and Environment: A Textbook of Plant Autecology*, 3rd edition. John Wiley and Sons, New York, N.Y. 422 pp.

Hausenbuiller, R.L. 1985. *Soil Science: Principles and Practices*. Wm. C. Brown Co., Dubuque, Iowa. 610 pp.

Heikurainen, L. and Pakarinen, P. 1982. Mire Vegetation and Site Types. pp. 14-23, in Laine, J. (ed.). *Peatlands and Their Utilization in Finland*. Finnish Peatland Society. Helsinki.

Houseknecht, S., Haeussler, S., Kokoshke, A., Pojar, J., Holmes, D., Geisler, B.M. and Yole, D. 1986. *A Field Guide for Identification and Interpretation of the Interior Cedar - Hemlock Zone, Northwestern Transitional Subzone (ICHg), in the Prince Rupert Forest Region*. Info. Serv. Br., B.C. Min. of Forests, Victoria, B.C. Land Mgmt. Handbook No. 12, 143 pp.

Jenny, H. 1941. *Factors of Soil Formation*. MacGraw-Hill, New York, N.Y.

Jenny, H. 1980. *The Soil Resource: Origin and Behaviour*. Springer-Verlag, New York, N.Y. 377 pp.

Jones, R.K., Pierpoint, G., Wickware, G.M., Jeglum, J.K., Arnup, R.W. and Bowles, J.M. 1983. *Field Guide to Forest Ecosystem Classification for the Clay Belt, Site Region 3E*. Ont. Min. Nat. Resources, Toronto, Ont. 161 pp.

Klinka, K., van der Horst, W.D., Nuszdorfer, F.C. and Harding, R.G. 1980. *An Ecosystematic Approach to a Subunit Plan - Koprino River Watershed Study.* Info. Serv. Br., B.C. Min. of Forests, Victoria, B.C. Land Mgmt. Handbook No. 5, 118 pp.

Klinka, K., Krajina, V.J., Ceska, A. and Scagel, A.M. 1989. *Indicator Plants of Coastal British Columbia.* Univ. of B.C. Press, Vancouver, B.C. 288 pp.

LeBlanc, P.A and Towill, W.D. 1989. *Key to Jack Pine Site Productivity for North Central Ontario.* NW Ont. For. Tech. Develop. Unit, Ont. Min. Nat. Resources, Thunder Bay, Ont. Tech. Rep. No. 32, 27 pp.

Major, J. 1951. A Functional, Factorial Approach to Plant Ecology. *Ecology* **32**: 392-412.

Meidinger, D.V., Hope. G.D. and McLeod, A.J. 1984. *Classification and Interpretation of some Ecosystems of the Rocky Mountain Trench, Prince George Forest Region, British Columbia.* Info. Serv. Br., B.C. Min. of Forests, Victoria, B.C. Land Mgmt. Handbook No. 22, 294 pp.

Oke, T.R., 1978. *Boundary Layer Climates.* Methuen and Co., Ltd., London, England. 372 pp.

Ontario Institute of Pedology, 1985. *Field Manual for Describing Soils*, 3rd edition. Ont. Inst. Ped. & Univ. Guelph, Guelph, Ont. O.I.P. Publ. No. 85-3. 42 pp.

Paton, T.R. 1978. *The Formation of Soil Material.* George Allen and Unwin, London. 143 pp.

Roberts, B.A. 1986. *The Importance of Soil Drainage and Soil Seepage Factors in Assessing Forest Site Capacity in Central Newfoundland.* pp. 89-100 in van Groenewoud, H. (ed.). Proceedings of the IUFRO Workshop on Forest Site Classification and Evaluation. Maritimes Forestry Centre, Can. For. Serv., Fredericton, N.B. 182 pp.

Racey, G.D., Whitfield, T.S. and Sims, R.A. 1989. *Northwestern Ontario Forest Ecosystem Interpretations.* NW Ont. For. Tech. Develop. Unit, Ont. Min. Nat. Resources, Thunder Bay, Ont. Tech. Rep. No. 46, 90 pp.

Rowe, J.S. 1972. *Forest Regions of Canada.* Dept. Environ., Can. For. Serv., Ottawa, Ont. Publ. No. 1300. 172 p.

Sado, E.V., and Carswell, B.F. 1987. *Surficial Geology of Northern Ontario.* Ont. Geol. Surv., Toronto, Ont. Map 2518, scale 1:1,200,000.

Sims, R.A., Kershaw, H.M. and Wickware, G.M. 1990. *The Autecology of Major Tree Species in the North Central Region of Ontario.* Forestry Canada, Ontario Region, Sault Ste. Marie, Ont. COFRDA Report No. 3302, 134 pp.

Sims, R.A., Towill, W.D., Baldwin K.A. and Wickware, G.M. 1989. *Field Guide to the Forest Ecosystem Classification for Northwestern Ontario.* Ont. Min. Nat. Resources, Toronto, Ont. 191 pp.

Towill, W.D., Barauskas, A. and Johnston, R. 1988. *A Pre-Cut Survey Method Incorporating the Northwestern Ontario Forest Ecosystem Classification.* NW Ont. For. Tech. Develop. Unit, Ont. Min. Nat. Resources, Thunder Bay, Ont. Tech. Rep. No. 2, 25 pp.

Tuttle, S.D. 1970. *Landforms and Landscapes.* Foundation of Earth Science Series, W.C. Brown Co., Dubuque, Iowa. 135 pp.

Van Cleve, K. and Yarie, J. 1986. Interaction of Temperature, Moisture and Soil Chemistry in Controlling Nutrient Cycling and Ecosystem Development in the Taiga of Alaska. pp. 160-189 in Van Cleve, K., Chapin III, F.S., Flanagan, P.W., Viereck, L.A. and Dyrness, C.T. (eds.). *Forest Ecosystems in the Alaskan Taiga - A Synthesis of Structure and Function.* Springer-Verlag, New York, N.Y. 230 pp.

van Groenewoud, H. 1986. *Forest Site Classification in New Brunswick and its Use in Forest Management.* p.171-180 in van Groenewoud, H. (ed.). Proceedings of the IUFRO Workshop on Forest Site Classification and Evaluation. Maritimes Forestry Centre, Can. For. Serv., Fredericton, N.B. 182 pp.

Viereck, L.A.,, Dyrness, C.T. and Van Cleve K. 1984. Potential Use of the Alaska Vegetation System as an Indicator of Forest Site Productivity in Interior Alaska. pp. 25-34. in Murray, M. (ed.). *Forest Classification at High Latitudes as an Aid to Regeneration.* Pacific NW Range and Experiment Sta. and Univ. of Alaska, Fairbanks, Alaska. 56 pp.

Walsh, S.A. and Krishka, C.S. 1990. *Vegetation Dynamics in the First Five Years after Timber Harvesting on Sites of Some NWO FEC Treatment Units.* Ont. Min. of Nat. Resources, S.S.Marie, Ont. in prep.

Whittaker, R.H. 1975. *Communities and Ecosystems*, 2nd edition. MacMillan Publ. Co., Inc., New York, N.Y. 387 pp.

Wickware, G.M., Towill, W.D. and Sims, R.A. 1989. *Site and Stand Conditions Associated with the Occurrence and Abundance of Black Spruce Advance Growth in North Central Ontario.* Proc. IUFRO N. For. Silvic. and Mgmt. Sympos. (Working Party S1.05-12), Gander Nfld., Aug. 12-17, 1989. For. Can., Nfld. Region. in press.

Working Group on Soil Survey Data. 1978. *The Canadian Soil Information System (CanSIS) Manual for Describing Soils in the Field.* Soil Res. Inst., Can. Dept. Agric., Ottawa, Ont. 170 pp.

Zoltai, S.C. 1961. Glacial History of Part of Northwestern Ontario. *Proceed. Geol. Assoc. Canada.* **13**: 61-83.

Zoltai, S.C. 1965a. Glacial Features of the Quetico-Nipigon Area, Ontario. *Can. J. Earth Sci.* **2**: 247-269.

Zoltai, S.C. 1967. Glacial Features of the North-Central Lake Superior Region, Ontario. *Can. J. Earth Sci.* **4**: 515-528.

appendix a

The following data and procedure files were accessed on the VAX/VMS 8530 system at the Great Lakes Forestry Centre, Sault Ste. Marie, Ontario. These files form part of the NWO FEC dataset.

NWOSOIL	main soil/site data file
NCTHICK	soil profile data file
NCNWVEG	cover values for all trees, shrubs, herbs, graminoids, mosses and lichens for each plot
NCNWPHYS	physiognomic summaries for each plot
VSRUN	V-Type and S-Type attributes for each plot
SITELOC	plot location information

appendix b

The following NWO FEC plots were included, in left-to-right order, in each toposequence:

Deep, Sandy Lacustrine - Beach Deposit:
Plot #'s R0008 R0003 R0005 R0006 R0014

Bedrock Knob - Shallow Soil:
Plot #'s R0016 R0017 R0015 R0018

Deep, Sandy Ablation Till:
Plot #'s R0108 R0127 R0109 R0117 R0128

Deep, Coarse Loamy Ground Moraine:
Plot #'s R0033 R0032 R0034 R0035 R0036

Deep, Sandy Glaciofluvial - Outwash:
Plot #'s W0217 W0195 W0196 W0194

Deep, Coarse Loamy Ablation Till:
Plot #'s R0076 R0086 R0075 R0085 R0093 R0092

appendix c

The following information was assessed when evaluating and developing the toposequences:

Vegetation Factors

- NWO FEC V-Type (Sims et al 1989)
- percent covers of individual tree species (see Sims et al 1989)
- percent covers of common understory species
- combined percent cover of all tall shrubs
- combined percent cover of all low shrubs
- combined percent cover of all herbs and graminoids
- combined percent cover of all mosses and lichens
- combined percent cover of all feathermoss species
- combined percent cover of all Sphagnum species

Site Factors

- geographic location
- slope angle
- topographic position (Ont. Inst. Pedology 1985)
- landform type (Can. Soil Survey Comm., Subcomm. on Soil Class. 1978)

Soil Factors

- NWO FEC S-Type (Sims et al 1989)
- percent exposed bedrock
- soil depth over bedrock
- forest humus type (Can. Soil Survey Comm., Subcomm. on Soil Class. 1978)
- litter type (Can. Soil Survey Comm., Subcomm. on Soil Class. 1978)
- soil profile (Can. Soil Survey Comm., Subcomm. on Soil Class. 1978)
- soil drainage (Ont. Inst. Pedology 1985)
- soil seepage
- soil moisture regime (Ont. Inst. Pedology 1985)
- dominant surface texture (0-25 cm) (Ont. Inst. Pedology 1985)
- dominant subsurface texture (26-100 cm) (Ont. Inst. Pedology 1985)
- percent coarse fragment content (Sims et al 1989)
- coarse fragment size class (Working Group on Soil Survey Data 1978)

appendix d

Abbreviations and coded notation were used in the soil/site summaries on the toposequence description pages. Terminology follows the definitions outlined by *The Canadian System of Soil Classification* (Canada Soil Survey Committee [CSSC], Subcommittee on Soil Classification 1978) and *Field Manual for Describing Soils* (Ontario Institute of Pedology [OIP] 1985). Most of the variables summarized in the toposequence descriptions are briefly defined in Section 5 of *Field Guide to the Forest Ecosystem Classification for Northwestern Ontario* (Sims et al 1989).

Soil Textures

S	sand
vfS	very fine sand
fS	fine sand
mS	medium sand
cS	coarse sand
vcS	very coarse sand
Si	silt
SiL	silt loam
SifS	silty fine sand
L	loam
vfSL	very fine sandy loam
fSL	fine sandy loam
mSL	medium sandy loam
LvfS	loamy very fine sand
LfS	loamy fine sand
LmS	loamy medium sand
C	clay
CL	clay loam

Soil Drainage (OIP 1985)

vR	very rapid
R	rapid
W	well
mW	moderately well
I	imperfect
P	poor
vP	very poor

Moisture Regime (OIP 1985)

D	dry
mD	moderately dry
mF	moderately fresh
F	fresh
vF	very fresh
mM	moderately moist
M	moist
vM	very moist
mW	moderately wet
W	wet
vW	very wet

Coarse Fragment Size

g	gravel
c	cobbles
s	stones