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The ecological reference framework for Québec: a useful tool for forest sites evaluation

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Abstract

Quebec ecologists have divised, for more than 25 years, an integrated landform-soil – vegetation approach to landscape typology and mapping. Basic concepts and principles of this approach are briefly described and illustrated. In spite of the huge areas already mapped, attempts to integrate such an information in the forestry practice have thus far proven inconclusive.

Introduction

Unlike Europe, where phytosociological approaches to forest typology have been widely received, Canadian forestry circles have generally favoured pedological and geomorphological approaches. Influenced by both cultures, Québec used to be an exception, as it frequently called on phytosociology. Today, however, it is an accepted fact that ecological classification (typology) and mapping of forest sites must be based on a global approach in which the physical variables of the environment play a decisive role, an approach related to the concept of landscape ecology.

1. Background

The history of forest ecological typology and mapping in Québec falls into three distinct periods.

Pre-1970. Experimentation: phytosociology and geomorphology

Lafond (1969), Dansereau (1959), Linteau (1959) and Grandtner (1966) each proposed partial forest typologies based on phytosociological criteria. Although they were aware of the importance of the physical environment, in their work permanent site conditions were considered only marginally if not excluded altogether (Rousseau 1938).

At the opposite extreme, late in this period an approach related to the concept of landscape ecology was developing in English Canada (Hills 1961; Rowe 1961) and Québec (Jurdant 1968). This approach focused on geomorphology and pedology, while also considering vegetation.

1970-1979. Expansion: surveying the 'capital-nature'

This period was dominated by Québec, in the work of Jurdant and his colleagues, which received special impetus from the hydroelectric development of Northern Québec. Along with other Canadian forest ecologists (Rowe, Damman, Lacate, Zoltai, etc.), Jurdant and his colleagues participated actively in laying the basis for the classification and mapping of forest ecosystems (Fig. 1). More than 700 000 km^2 of Québec's boreal forest and subarctic region were surveyed and mapped (Fig. 2). This work was instrumental in developing an operational methodology (Jurdant *et al.* 1977), training numerous ecologists and bringing about a conceptual consensus among Québec's forest ecologists.

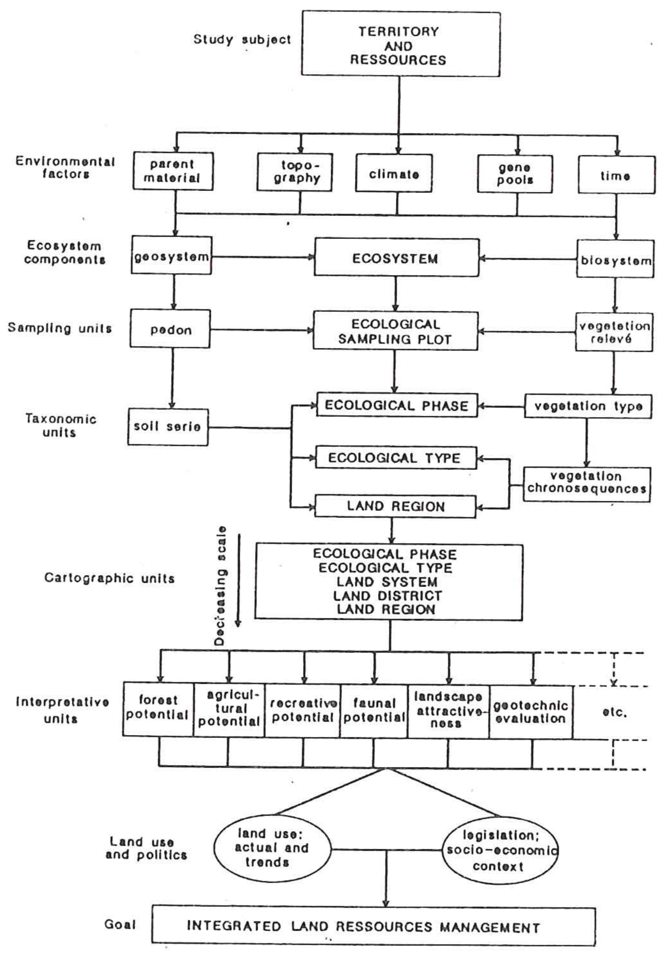


Fig. 1. Landscape mapping and classification: rationale (after Gerardin & Ducruc 1979).

1980 to Present: recession

During this period, the ecological classification of Québec territory slowed down considerably. The activities and areas studied no longer had the scope of previous projects, despite the passage of major legislation governing the development of municipal territory and forest lands. Although there was an obvious desire to act as regards to forest land, this period was dominated by research focusing on map scales, level of perception and data transfer (Domon *et al.* 1989).

2. A simple, permanent working tool

The work of Jurdant and his team throughout the 1970s and that of his successors led to the concept of the *ecological reference framework* (Veillette & Ducruc 1984).

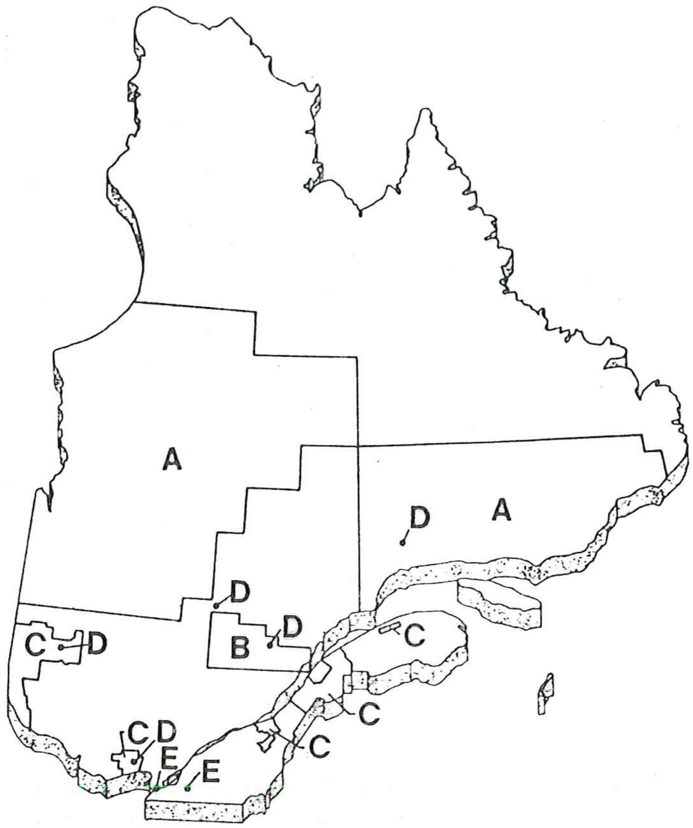
Although the notion of 'forest station' includes two distinct but indissociable elements of forest ecosystem and forest management, the supporting *environment* and the *stand*, the ecological reference framework is directed more at defining the supporting environment than at what is growing in it. The ecological reference framework can be defined as all structured data on ecological parameters which are essential to productivity and forest management. This information is generally sent to users in various forms.

2.1. Typology

Classification of land types (deposit-drainage combination, which constitutes the permanent basis of site definition), associated vegetation types and vegetation chronosequences are the backbone of forest typology (Fig. 3), as well as the basic elements of landscape mapping, regardless of the level of perception or scale used (Fig. 4).

2.2. Mapping

Although the methodology clearly recognizes and promotes different levels of perception (Fig. 4)



	Area (km²)	Scale	Land Cover; Land Use	Map Users
A	700 000	1:1 000 000 1:250 000 1:125 000	Boreal forest and taïga; aboriginal life, hydro-electrical installations, coastal fishing communities, forest harvesting and mining.	Hydro-energy planners, forest and wildlife managers, environmental impact assessors...
B	35 000	1:1 000 000 1:125 000	Boreal forest, agricultural lands and urban areas; forest harvesting, dairy production, grains, industries.	Foresters, urban planners, hydro-energy planners, environmental impact assessors...
C	25 000	1:50 000	Deciduous to boreal forest, agricultural lands and urban areas; forest harvesting, dairy production, grains, mining and industries.	Municipalities and regional planners and managers, foresters, wildlife managers...
D	500	1:20 000	Deciduous to boreal forest, agricultural lands; forest recreation and harvesting, dairy production, grains.	Field foresters, municipalities planners, agronomists...
E	1	≥1:2 500	Hackberry forest and open Pitch Pine forest; conservation.	Ecological reserves administrators, researchers...

Fig. 2. Achievements since 1967.

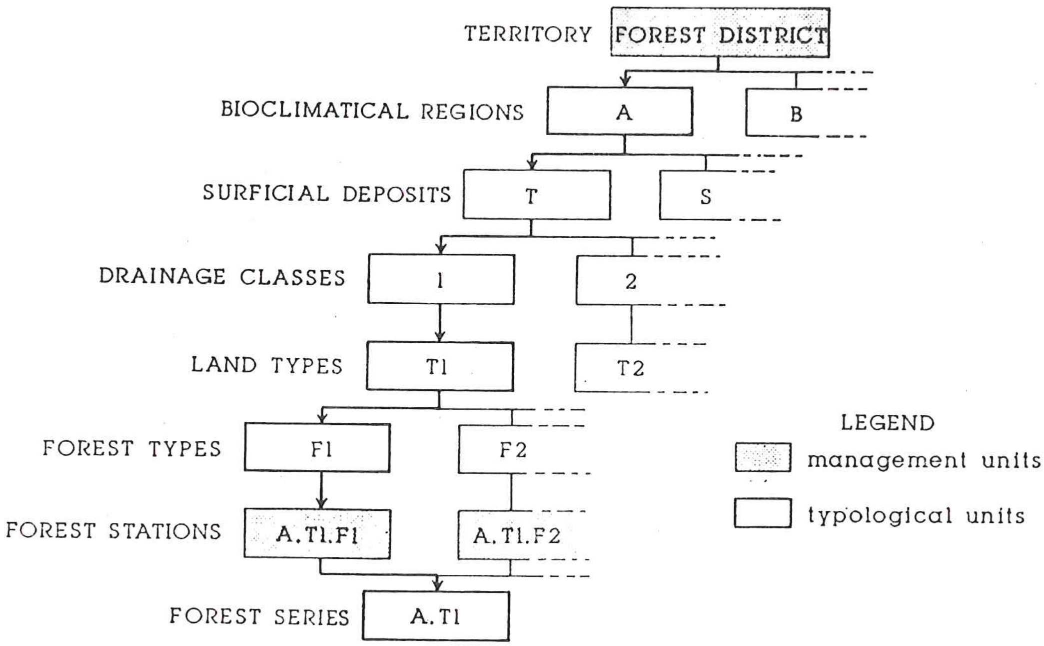


Fig. 3. Model for a forest station typology.

according to the different levels of management (Table 1), most recent maps are drafted on medium scales (1 : 20000 to 1 : 50000). At these scales, mapping units are landscape units displaying a distinct geomorphology controlling a particular pattern of soils and drainage. The unit's name indicates its dominant features in terms of geomorphology, drainage and slope gradient, while the internal organization (model) is described in a file (Fig. 5). Only large-scale maps (1 : 10000, preferably 1 : 5000) could successfully map pure units in the Québec context (Fig. 6).

2.3. *Interpretation*

Mapping and ecological classification of forest sites should be used to produce the interpretative documents (keys and maps) used in forest management (Fig. 7). The forester is generally confronted with a variety of interpretations: forest growth potential (Fig. 8); potential competition between natural and artificial regeneration; good source of road construction materials; erosion hazard after deforestation; physical limitations on logging, and so forth.

2.4. *Field guide*

The field guide is designed to enable field staff to recognize conditions and technical properties through keys and evaluation grids and allow them to select the ecologically appropriate management option (Fig. 9).

2.5 *Training*

In addition to benefitting from the above working tools, users can attend training sessions on how to use the available data.

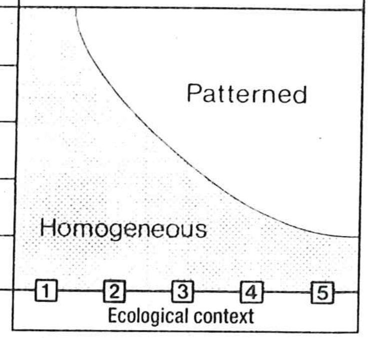
3. Ecological parameters

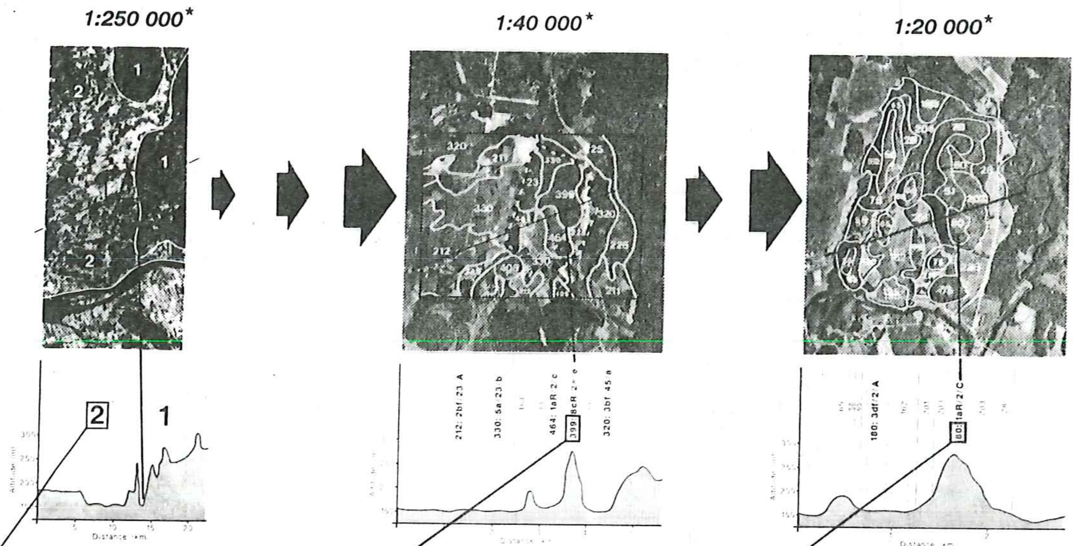
The ecological parameters selected must meet the following requirements:

INTEGRATION

ECOLOGICAL CONTEXT	DOMINANT CHARACTERS	COMMON MAPPING SCALES
[1] Bioclimatical	Natural vegetation	1:1 000 000
[2] Physiographical	Orogeny, geology	1:250 000
[3] Geomorphological	Surficial deposit	1:125 000
[4] Topographical	Slope: inclination, shape, length, ...	1:50 000 1:20 000
[5] Edaphical	Soil: depth, texture, drainage, ...	≥1:10 000

MAPPING UNIT HOMOGENEITY





1 Hilly Canadian Shield; shallow till and granitic outcrops; fluvioglacial deposits in the valleys.

[2] Undulated plain; glacio-marine deposits: clay and silt associated with sandy and gravelly soils and scattered hills of shallow till and granitic rock outcrops.

[399:] steep (30-60%) convex slope;
50% of well drained shallow till colluvium
30% of excessively drained bare rock
20% of well drained shallow till

[80:] convex summit, 10 to 15% slope;
80% of well drained, shallow till
20% of excessively drained bare rock

* Reduced 4 times

Fig. 4. Ecosystems levels of perception.

- They must be permanent, and unaffected by natural causes such as fire, epidemics or forest operations.
- They must be basic elements of the natural environment's spatial organization.
- They best reflect the potential uses of the environment through their influence on productivity and forest operations.

Four main factors are usually considered:

- Regional climate, which governs the distribution of species and their growth rate.
- Slope gradient, which determines water movement in the soil, modifies the regional climate and is the most significant element of terrain relief for forest operations.
- Surface material, defined by its mineralogy,

Table 1. Appropriateness of levels of perception of ecological information to forestry activities.

		BASIC DOCUMENTS AS WELL AS INTERPRETATIVE DOCUMENTS				
		TYPOLOGY	CARTOGRAPHY			
EXPRESSIONS	A unit of 10 cm2 on a map covers in the field (ha)	***	10	40/ 250	1 000/ 6 250	>25 000
	NUMBER of CARTOGRAPHIC UNITS of 10 cm2 for a TERRITORY of:					
	. 1 000 ha (average private forest)	***	100	25/4	1/0,2	<0,04
	. 25 000 ha (large private forest)	***	2 500	625/100	25/4	<1
	. 100 000 ha (publ. forest under contract)	***	10 000	2 500/400	100/16	<4
	. 500 000 ha (gov't local forest adm.)	***	50 000	12 500/2 000	500/80	<20
	. 4 000 000 ha (gov't region. forest adm.)	***	400 000	100 000/ 16 000	4 000/640	<160
	. 40 000 000 ha (Québec's total forest)	***	4 000 000	1 000 000/ 160 000	40 000/ 6 400	<1 600
	DOMINANT ENVIRONMENTAL PARAMETERS	deposit-drainage; slope; forest type	deposit-drainage; slope	pattern of deposit-drainage; slope	geomorpho-logy; topography	bioclimate; geology; physiogra-phy
	SCALE of PERCEPTION	1:1 (terrain)	>1:10 000	1:20 000/ 1:50 000	1:100 000/ 1:250 000	<1:250 000
UTILISATIONS	1. OPERATIONS					
	. seed orchard	1 a)	1	2	3	3
	. reforesting	1	1	2	3	3
	. inventories	1	1	2	2	3
	. road construction	1	1	2	2	3
	. scarification	1	1	1	3	3
	. harvesting	1	1	1	3	3
	. choice of machinery	1	1	1	3	3
	. ...					
	2. PLANIFICATION					
	2.1. public forest on contract					
	. annual	1	1	2	3	3
	. quinquennial	2	2	1	2	3
	. long term (25 years)	3	3	2	1	2
	2.2. quinquennial					
	. small private forest	1	1	2	3	3
	. public forest on contract	2	2	1	2	3
	. gov't local forest adm.	2	3	2	1	2
	. gov't region. forest adm.	3	3	2	2	3
	. Québec's total forest	3	3	3	2	1
	2.3 according to activity (b)					
	. road construction	1	3	2	1	2
	. choice of machinery	1	3	2	1	2
	. sylviculture	1	3	1	1	3
	. tree improvment	3	3	3	2	1
	. forest protection	3	3	3	1	1

a) 1: appropriate level of perception
2: acceptable level of perception
3: unappropriate level of perception

b) for a quinquennial planning on a public forest under contract.

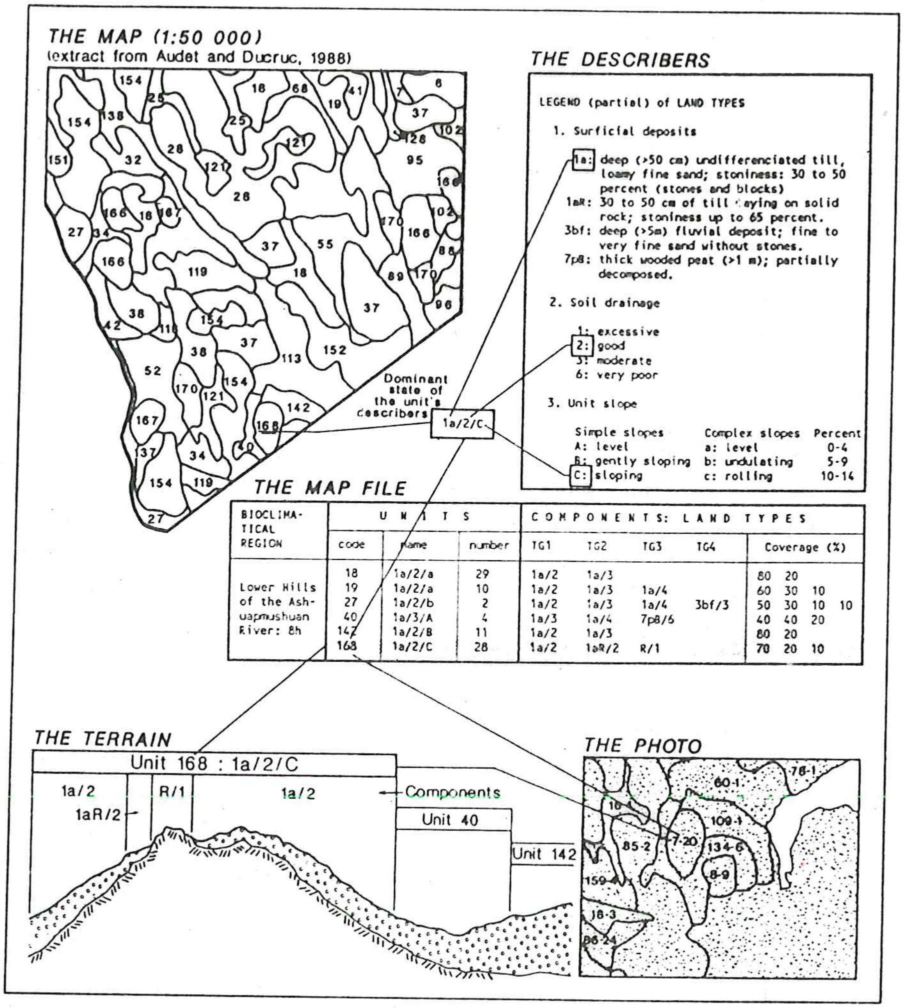


Fig. 5. The elements of ecosystems mapping; example for 1 : 50 000.

texture, stoniness and thickness. This feature is partly responsible for the distribution and growth of species and also strongly influences forest operations.

- Soil drainage (vertical drainage and seepage), which indicates the amount of water available, the richness of the nutritive solution, and soil aeration.

4. Mitigated success

Classification and ecological mapping of forest land must be treated primarily as a concrete prac-

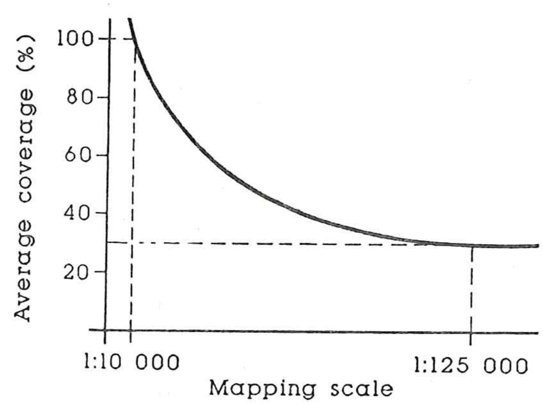


Fig. 6. Average coverage of dominant land type per map unit according to scale.

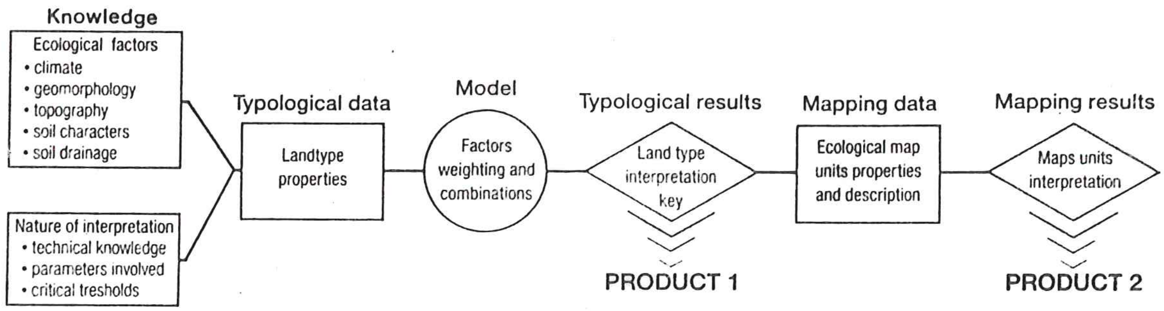


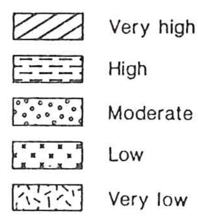
Fig. 7. Flow chart of the interpretative process.

tice which meets specific planning and management needs. There remains little doubt as to the need for such work, and in spite of the huge areas already mapped (Fig. 2) attempts to integrate typology and ecological mapping into forestry practices have thus far proven inconclusive.

Refusal to consider the forest as an ecosystem, the vastness of the forest territory, the conservative attitude in forestry circles, overly theoretical or poorly presented typologies and mapping approaches, insufficient or inadequate higher education, and a short-term economic perspective may be the reasons behind the difficulty in accepting forest management based on an ecosystemic approach.

1. INTERPRETATIVE KEY

LAND TYPES	CLASSES OF POTENTIAL
R/1	Very low
R1/12	Low
1aR/23	Moderate
.	.
.	.
1a/23	High
1a/45	Moderate
.	.
.	.
5I/23	Very high
.	.



2. INTERPRETATIVE MAP

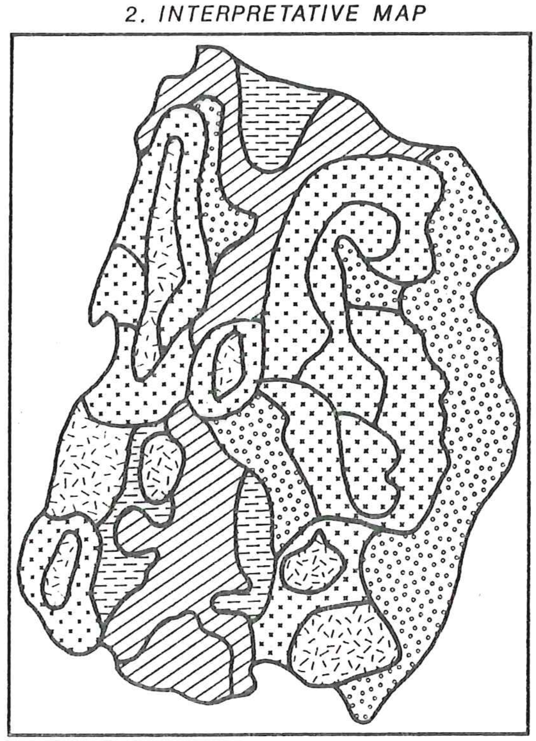


Fig. 8. Interpretative key and map of forest growth potential.

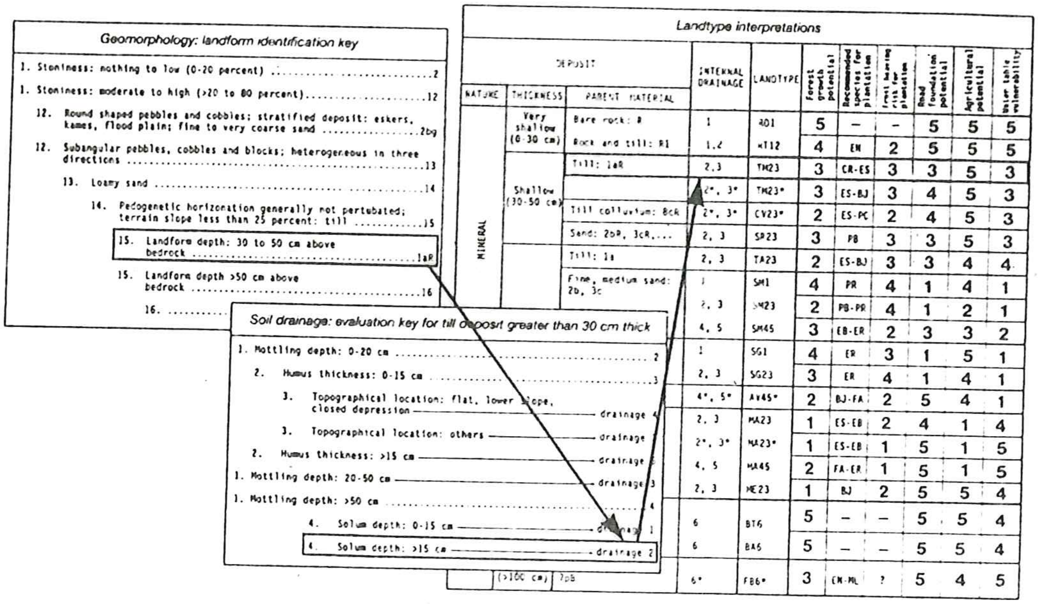


Fig. 9. Model for a field guide.

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