REFORESTATION IN QUÉBEC : A FIELD GUIDE FOR THE SELECTION OF SOFTWOOD SPECIES

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I INTRODUCTION

This field guide is an abridged version of a document entitled "Le reboisement au Québec : choix des essences résineuses."*

The procedures outlined in the following pages will help users of the Guide to identify the charateristics of the areas to be reforested. The tables and charts can be used to determine the most suitable species for a given site.

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* CAUBOUE, Madeleine (CERFO). Le reboisement au Québec : choix des essences résineuses. Ministère de l'Énergie et des Ressources, Québec (forthcoming).

II SOFTWOOD SPECIES

The present guide covers softwood species used for reforestation in Québec :

White spruce	Picea glauca (Moench) Voss	(PICGL)
Black spruce	Picea mariana (Mill.) B.S.P.	(PICMA)
Norway spruce	Picea abies (L.) Karst.	(PICAB)
Red spruce	Picea rubens Sarg.	(PICRU)
Jack pine	Pinus banksiana Lamb.	(PINBA)
Red pine	Pinus resinosa Ait.	(PINRE)
Eastern white pine	Pinus strobus L.	(PINST)
Scots pine	Pinus sylvestris L.	(PINSY)
Tamarack	Larix laricina (Du Roi) Koch	(LALA)
European larch	Larix decidua Miller	(LADE)
Japanese larch	Larix leptolepis (Seiber and Zucc.) Gordon	(LALE)

III SPECIES SELECTION : PRELIMINARY PROCEDURES

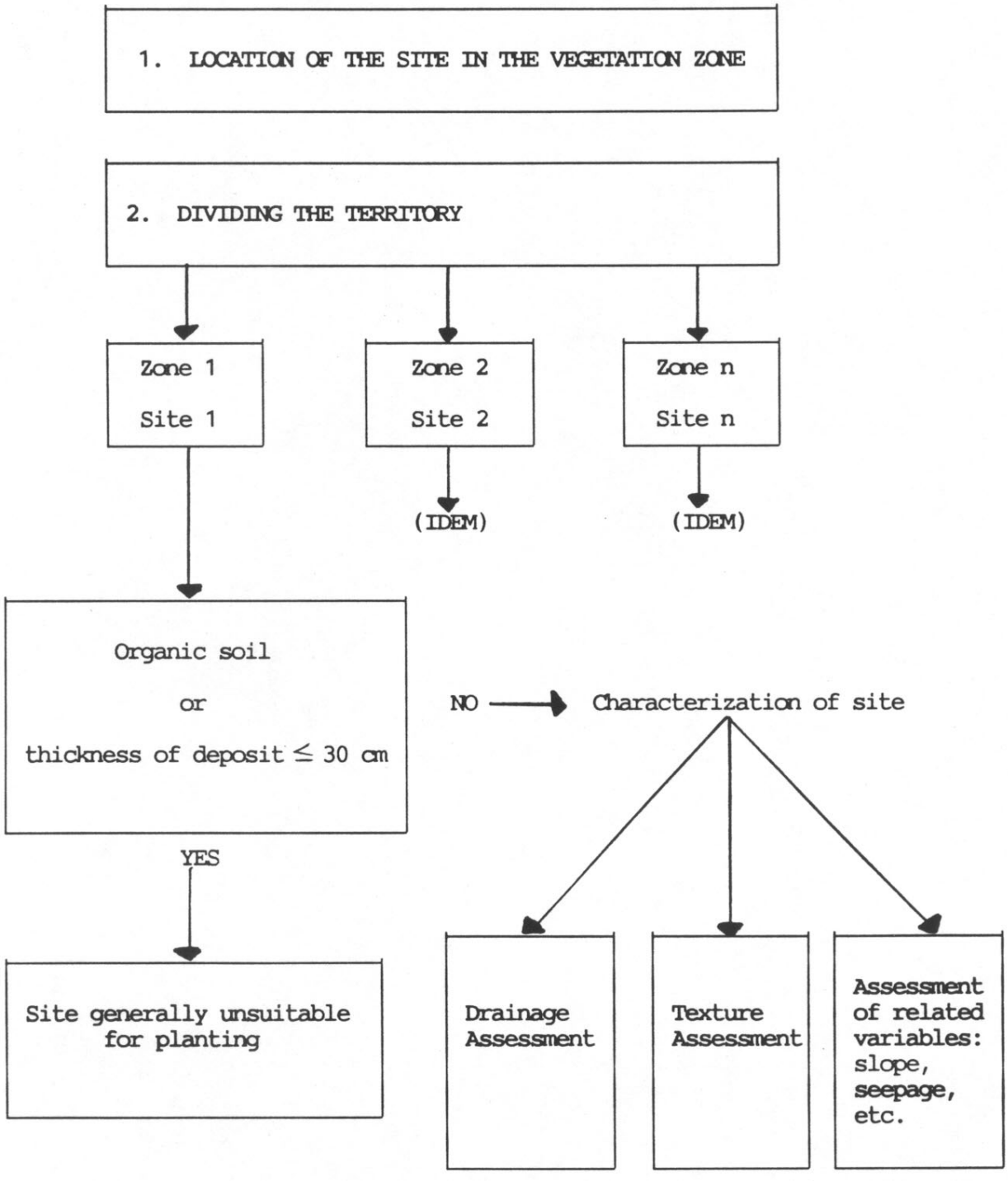
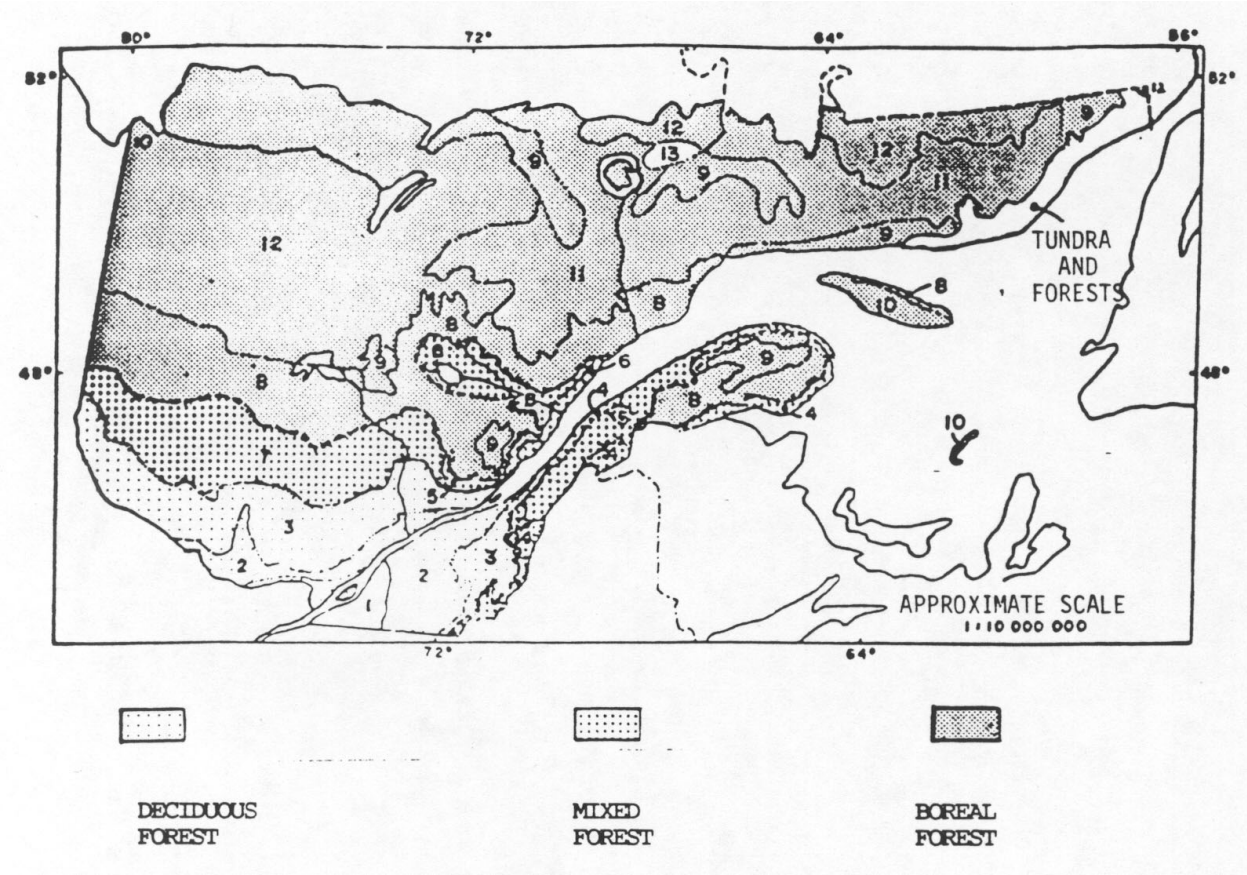


FIGURE 2 Summary Map of Southern Québec Ecological Zones



1 NUMBER OF THE ECOLOGICAL ZONE

Our users should refer to the original 1: 1 250 000 map. Do not forget that the forest zone could be change because of altitude.

SPECIES SELECTION : PRELEMINARY PROCEDURES

1. Location of the Site in the Vegetation Zone

The map of ecological regions (cf. page 7) will enable users of the Guide to determine whether the area considered for reforestation is located in a deciduous, mixed or boreal forest zone. Site elevation must also be considered, since this could lead to the selection of species normally recommended for a different forest zone.

Users are strongly advised to consult the original map (1: 1 250 000)

2. Dividing the Territory

The area to be reforested should be divided in such a way as to obtain relatively homogenous zones, each corresponding to the characteristics of a site in terms of slope, deposit and drainage. Topography can be very useful in making an initial subdivision of the territory. Observation of existing vegetation (or of the remains of previous vegetation) can also help in dividing the territory and determining sites to be sampled. The latter operation can be done in the filed or through the use of aerial photographs. The variables needed to characterize the site should be assessed for each zone; this information can also be obtained from an ecological map of suitable scale.

3. Site Characterization

Beside the vegetation zone, other permanent elements are used to characterize sites. The nature of the deposit must also be considered, as must soil drainage, soil texture, and the thickness of soil available for roots.

3.1 Nature of soil

It must first be determined whether the soil is organic or not. In the case of organic soil, assessment of other variables is unnecessary, since this type of soil is little suited to reforestation. However, if planting must be carried out on such sites, preferred species are the black spruce and the tamarack.

An organic (peaty) soil is one in which the thickness of organic material exceeds 40 cm. This organic material (peat) is made up of partly decomposed vegetation which grew in a moist environment (carex, sphagnum, etc.).

3.2 Thickness of Soil Available for Roots

The thickness of soil available for roots – i.e., the thickness of mineral horizons overlying either bedrock or a continuous indurated horizon (orstein) – must be more than 30 cm thick. Sites which fail to meet this requirement should not be reforested.

3.3 Soil Texture

The soil texture at a given site is determined by studying the respective proportions of sand, clay and silt which constitute the fine earth fraction.

In the present Guide, five textural classes will be used:

- very fine
- fine
- medium
- coarse
- very coarse

The class “extremely fine” has been omitted, since these soils are very rare.

Field assessment of soil texture is discussed in more detail in section VI.

3.4 Soil Drainage

The following soil drainage classes correspond to the manner in which excess water flows off from the soil profile. They indicate the quantity of water available for vegetation.

Soil drainage is divided into seven classes :

0 very rapidly drained (excessive)
1 rapidly drained
2 well drained
3 moderately well drained
4 imperfectly drained
5 poorly drained
6 very poorly drained

Field assessment of soil drainage is discussed in more detail in section VII.

V HOW TO USE THE TABLES

The three tables which follow can be used to determine suitable species for reforestation in terms of the vegetation zone, soil texture and soil drainage.

The tables correspond to the following vegetation zones :

TABLE I	Deciduous forest zone (ecological regions 1, 2, 3)
TABLE II	Mixed forest zone (ecological regions 4, 5, 6, 7)
TABLE III	Boreal forest zone (ecological regions 8, 9, 10, 11, 12)

Each table is made of a series of boxes corresponding to specific drainage and texture classes.

Within each box, tree species are divided into three groups :

- **species which are recommended** given the region and soil drainage, and satisfactory as to soil texture;
- **species which are satisfactory** given the region, soil drainage and soil texture;
- **species requiring further experimentation**

It should be noted that “satisfactory” species, while perhaps able to grow in the region considered, are likely to do less well or would demand considerably more maintenance than “recommended” species.

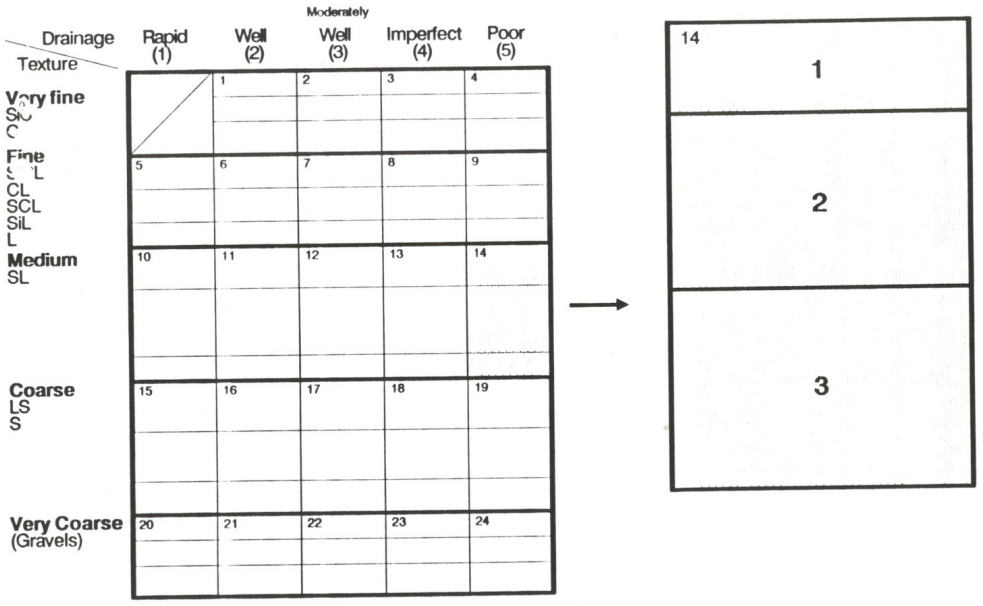
Species to be experimented are those which, in their country of origin, grow under conditions similar to those found in Québec, but whose behavior in Québec is not yet sufficiently known.

The final selection of species will also be guided by a number of other factors : regional characteristics, slope and seepage. Information on these subjects is included in the recommendations accompanying each table.

Sites for reforestation do not appear in the tables; such sites are characterized by :

- less than 30 cm of soil available for roots;
- very poor soil drainage (6);
- excessive soil drainage (0).

STRUCTURE OF TABLES



Species Groups

1. Species which are recommended given the region and soil drainage, and satisfactory as to soil texture.

2. Species which are satisfactory given the region, soil drainage and soil texture, and which are not found in category 1 or 3.

3. Species to be used on an experimental basis in terms of at least one of the following elements : region, soil drainage, soil texture.

TABLE I

DECIDUOUS FOREST ZONE:

SPECIES RECOMMENDED, SATISFACTORY AND TO BE FURTHER EXPERIMENTED

TEXTURE \ DRAINAGE	RAPID (1)	WELL (2)	MODERATELY WELL (3)	IMPERFECT (4)	POOR (5)
VERY FINE SiC C SC		[1] PICGL	[2] PICGL	[3] LALA	[4] LALA PICMA
		PICMA	PICMA LALA	PICMA PICGL	
		LADE LALE PINSY	LADE LALE PINSY	LADE LALE PINSY	
FINE SiCL CL SCL Si SiL L	5	6 DECIDUOUS PICRU PICGL	7 DECIDUOUS PICRU PICGL	8 DECIDUOUS LALA	9 LALA PICMA
	PICRU	PICAB PICMA	PICAB LALA PICMA	PICAB PICRU PICMA PICGL	
	PINSY	LADE LALE PINSY	LADE LALE PINSY	LADE LALE PINSY	
MEDIUM SL	10	11 DECIDUOUS PINRE PINST PICRU PICGL	12 DECIDUOUS PICRU PICGL	13 DECIDUOUS LALA	14 LALA PICMA
	PINRE PINST PINSY PINBA PICRU	PICAB PINSY PINBA PICMA	PINRE PINST PICAB PINSY PINBA LALA PICMA	PICAB PINSY PICMA PICRU PICGL	
		LADE LALE	LADE LALE	LADE LALE	
COARSE LS S	15	16 DECIDUOUS PINRE PINST PICRU PICGL	17 DECIDUOUS PICRU PICGL	18 DECIDUOUS	19 PICMA
	PINRE PINST PINSY PINBA PICRU	PINSY PINBA PICMA	PINRE PINST PINSY PINBA PICMA	PINSY PICMA PICRU PICGL	
		LADE LALE PICAB	LADE LALE PICAB	LADE LALE PICAP	
VERY COARSE (Gravels)	20	21	22	23	24
	PINBA	PINBA	PINBA	(PICMA)	(PICMA)
	PICRU	PICRU	PICRU	PICRU	

Recommendations

1. If the soil available for roots is between 30 and 60 cm thick, and if other conditions are favourable, red pine, red spruce and eastern white pine should be given priority.

2. On former agricultural lands, red spruce is vulnerable to frost and winter drying.

3. Norway spruce is vulnerable to spring frost. In the Appalachians, plantings of this species would seem to be compromised at elevations exceeding 400 m.

4. The fertility level of former agricultural lands must be verified. Fertilization with N, P and K may prove necessary.

5. Tamarack does well on sites where seepage is present and the soil is either well drained (2) (satisfactory species) or moderately well drained (3) (recommended species). The species generally grows best in depressions or in the lower part of slopes.

6. Eastern white pine should be planted under cover. If light does not exceed 45%, its growth rate is very good and damage caused but the white pine weevil is reduced.

   Eastern white pine should be planted on well ventilated sites (slopes, crests, well ventilated flat areas) where morning dew evaporates quickly and Ribes (currants) are not found. This will reduce the risk of infection by white pine blister rust.

7. Mixed planting is recommended, particularly for white spruce, red spruce and Norway spruce.

TABLE II

MIXED FOREST ZONE:

SPECIES RECOMMENDED, SATISFACTORY AND TO BE FURTHER EXPERIMENTED

TEXTURE \ DRAINAGE	RAPID (1)	WELL (2)	MODERATELY WELL (3)	IMPERFECT (4)	POOR (5)
VERY FINE SiC C SC		[1] PICGL PICMA	[2] PICGL	[3] LALA PICMA	[4] LALA PICMA
			PICMA LALA	PICGL	
		LADE PINSY	LADE PINSY	LADE PINSY	
FINE SiCL CL SCL Si SiL L	5	6 DECIDUOUS PICMA PICRU PICGL	7 DECIDUOUS PICRU PICGL	8 LALA PICMA	9 LALA PICMA
	PICRU	PICAB	PICAB LALA PICMA	PICAB PICRU PICGL	
	PINSY	LADE PINSY	LADE PINSY	LADE PINSY	
MEDIUM SL	10	11 DECIDUOUS PINRE PICMA PINST PICRU PINBA PICGL	12 DECIDUOUS PINBA PICRU PICGL	13 LALA PICMA	14 LALA PICMA
	PINRE PINST PINSY PINBA PICRU	PICAB PINSY	PINRE PINST PICAB PINSY LALA PICMA	PICAB PINSY PICRU PICGL	
		LADE	LADE	LADE	
COARSE LS S	15	16 DECIDUOUS PINRE PICMA PINST PICRU PINBA PICGL	17 DECIDUOUS PINBA PICRU PICGL	18 PICMA	19 PICMA
	PINRE PINST PINSY PINBA PICRU	PINSY	PINRE PINST PINSY PICMA	PINSY PICRU PICGL	
		LADE PICAB	LADE PICAB	LADE PICAP	
VERY COARSE (Gravels)	20	21 PINBA	22 PINBA	23	24
	PINBA			(PICMA)	(PICMA)
	PICRU	PICRU	PICRU	PICRU	

Recommendations

1. If the soil available for roots is between 30 and 60 cm, thick and if other conditions are favourable, red pine, red spruce and eastern white pine should be given priority.

2. On former agricultural lands, red spruce is vulnerable to frost and winter drying.

3. Norway spruce is vulnerable to spring frost. In the Appalachians, plantings of the species would seem to be compromised at elevations exceeding 400 m.

4. The fertility level of former agricultural lands must be verified. Fertilization with N, P and K may prove necessary.

5. Tamarak does well on sites where seepage is present and the soil is either well drained (2) (satisfactory species) or moderately well drained (3) (recommended species). The species generally grows best in depressions or in the lower part of slopes.

6. Eastern white pine should be planted under cover. If light does not exceed 45%, the growth rate is very good and damage caused but the white pine weevil is reduced.

   In general, eastern white pine is more vulnerable to blister rust in mixed forests than in deciduous forests. The species should be planted on well ventilated sites (slope crests, well ventilated flat areas) where morning dew evaporates quickly and Ribes (currants) are not found. This will reduce the risk of infection.

7. Jack pine does not appear naturally on the Gaspé Peninsula. Freezing rain and disease (gremmeneilla canker) have caused serious problems for plantings of the species in this region.

8. In some regions, jack pine may do well in fine textured soils.

9. Mixed planting is recommended, particularly for red spruce, white spruce and Norway spruce.

TABLE III

BOREAL FOREST ZONE:
SPECIES RECOMMENDED, SATISFACTORY AND TO BE FURTHER EXPERIMENTED

TEXTURE \ DRAINAGE	RAPID (1)	WELL (2)	MODERATELY WELL (3)	IMPERFECT (4)	POOR (5)
VERY FINE SiC C SC		1 PICMA PICGL	2 PICMA PICGL	3 LALA PICMA	4 LALA PICMA
			LALA	PICGL	
		PINSY	PINSY	PINSY	
FINE SiCL CL	5	6 PICMA PICGL	7 PICMA PICGL	8 LALA PICMA	9 LALA PICMA
SCL	(PICMA)		LALA	PICGL	
Si SiL L	PINSY	PICAB PINSY	PICAB PINSY	PICAB PINSY	
MEDIUM SL	10	11 PINBA PICMA PICGL	12 PINBA PICMA PICGL	13 LALA PICMA	14 LALA PICMA
	PINBA		LALA	PICGL	
	PINSY	PICAB PINSY	PICAB PINSY	PICAB PINSY	
COARSE LS S	15	16 PINBA PICMA PICGL	17 PINBA PICMA PICGL	18 PICMA	19 PICMA
	PINBA			PICGL	
	PINSY	PICAB PINSY	PICAB PINSY	PICAB	
VERY COARSE (Gravels)	20	21 PINBA	22 PINBA	23	24
	PINBA			(PICMA)	(PICMA)

Recommendations

1. Jack pine does not appear naturally on the Gaspé Peninsula or on Anticosti Island. Freezing rain and disease (gremmeniella canker) have caused serious problems for plantings of the species in these regions.

2. In some regions, jack pine may do well in fine textured soils.

3. Tamarak does well on sites where seepage is present and the soil is either well drained (2) (satisfactory species) or moderately well drained (3) (recommended species). The species generally grows best in depressions or in the lower part of slopes.

VI ASSESSING SOIL TEXTURE

By Jacques Tremblay

The assessment of soil texture (proportions of sand, clay and silt) is generally carried out in the field using tactile methods. However, particle-size analyses in the laboratory should be carried out whenever possible.

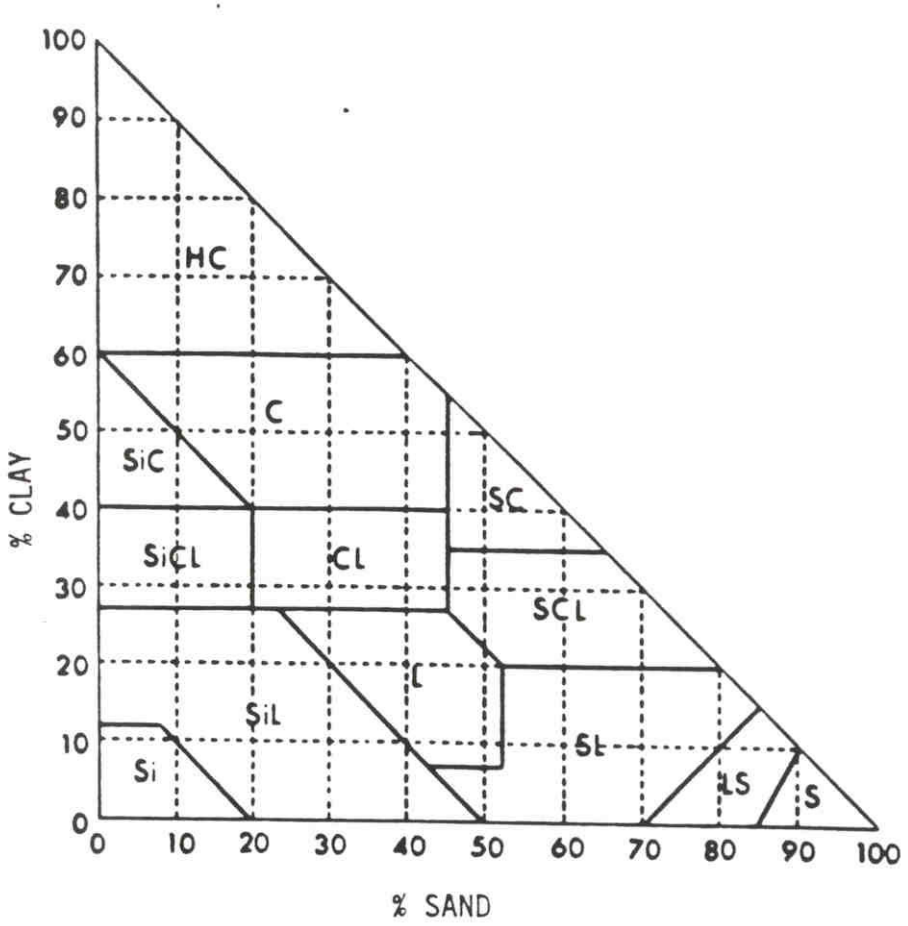
A few of the most frequently encountered textures are given below to help users of the present guide.

The tills of the Laurentians are fairly homogeneous with respect to texture (loamy sands), and outwash (glaciofluvial drift), is common. They are generally composed of sand, whose texture ranged from medium to very coarse, and varying amounts of gravel (eskers contain a higher proportion of gravel). Recent or old fluvial deposits are also composed predominantly of sands varying from medium to coarse. Silts, fine sands and very fine sands are generally associated with recent or old lacustrine deposits. Clay is usually encountered in old or recent marine deposits, but also occasionally in lacustrine deposits. Such deposits are most commonly found on the Saint-Laurent Plain (Champlain Sea), in Abitibi-Témiscaminque (Lake Barlow-Ojibway) and on the shores of Lake Saint-Jean (Laflamme Sea).

These generalizations are rough and they do not reflect the diversity encountered in the field. For example, the large clayey deposits in Abitibi-Témiscamingue are “dotted” with sandy marine beaches and marked by a various geomorphological processes. This variety exists in almost all extensive geomorphological features.

To evaluate soil texture, it is necessary to dig or bore to a minimum of 50 cm unless bedrock is situation nearer the surface.

SOIL TEXTURE CLASSES



Soil Texture Classes

Extremely fine

Very fine

Fine

Medium

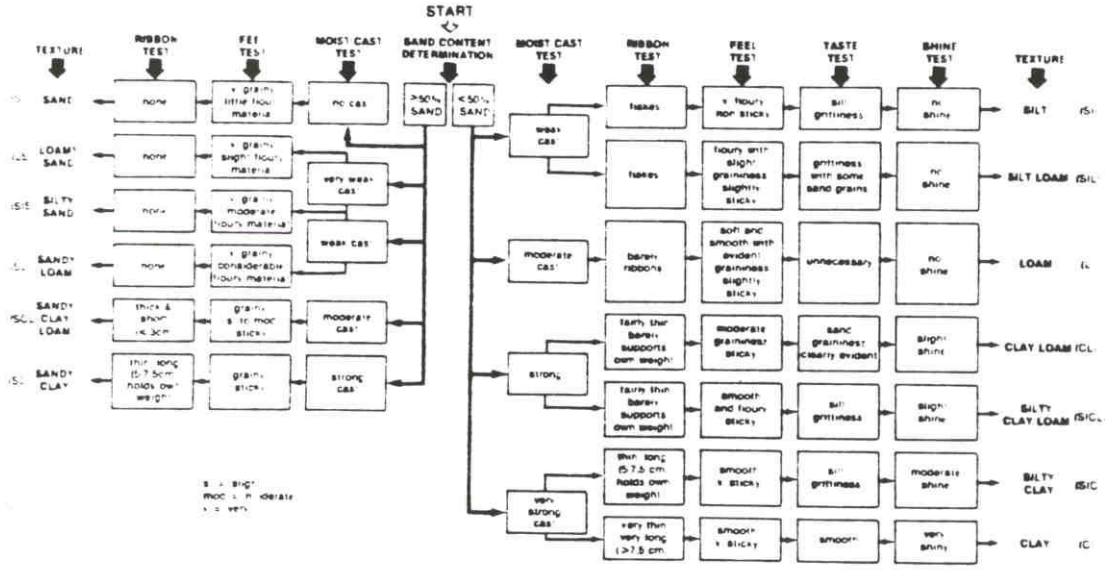
Coarse

The class “very coarse” (not represented in the triangle) consists mainly of gravel or very coarse sands.

* Abbreviations are those used by the Canadian Soil Survey Committee (1978)

FINGER ASSESSMENT OF SOIL TEXTURE

(Day and McMenamin, 1982)



SOIL TEXTURE FIELD TEST*

MOIST CAST TEST -- Compress some moist soil by clenching it in your hand. If the soil holds together (i.e., forms a cast) then test the strength of the cast by tossing it from hand to hand. The more durable it is, the more clay is present.

RIBBON TEST -- Moist soil is rolled into a cigarette shape and then squeezed out between the thumb and forefinger to form the longest and thinnest ribbon possible. The longer and thinner the ribbon, the finer the soil.

FEEL TEST

GRAININESS TEST -- Soil is rubbed between thumb and finger to assess the % of sand. The grittier the soil, the more sand it contains.

DRY FEEL TEST -- Soils with > 50% sand. Soil is rubbed in the palm of the hand to dry it. When particles are dry, they separate and their size can be estimated. The sand particles are then allowed to fall out of the hand and the amount of finer material (silt and clay) remaining is noted.

STICKINESS TEST -- Soil is wetted and compressed between the thumb and forefinger. Degree of stickiness is determined by noting how strongly it adheres to the thumb and forefinger upon release of pressure and how much it stretches.

* Day and McMenamin, 1982

TASTE TEST -- A small amount of soil is worked between the front teeth. Sand is distinguished as individual grains which grit sharply against the teeth. Silt particles are identified as general fine grittiness but individual grains cannot be identified. Clay particles have no grittiness.

SHINE TEST – A small amount of moderately dry soil is rolled into a ball and rubbed once or twice against a hard, smooth object such as a knife of thumbnail. A shine on the ball indicated the clay in the soil.

VII SOIL DRAINAGE ASSESSMENT

by Jacques Tremblay

1. Introduction

Soil drainage is assessed to determine how long and how often the sol is not water saturated. This is by no means an easy operation. In the pages which follow, we draw upon the soil drainage chart proposed by Bates et al.(1982), and provide the reader with information for each of the seven soil drainage classes (fig. 6). The soil drainage chart is based on a set of fairly specific criteria which, when combined with other criteria more familiar to forestry workers, should yield satisfactory results.

The general information below does not take seepage into account. However, it should be noted that the presence of seepage tends to improve the overall quality of the site.

2. Soil Drainage Assessment Indicators

VERY RAPIDLY DRAINED (excessive) -- CLASS 0

This extreme situation is encountered very rarely.

1. Soil Water

- Comes from precipitation and, occasionally, from seepage
- Water table absent
- Disappears very rapidly

2. Deposit Characteristics and Topography

- Very stony deposits
- Generally shallow
- Frequent on summits and gravely sites

3. Soil Characteristics

- Texture coarse to very coarse
- Very shallow humus (generally), or thick humus over rock
- No mottles (cf. p. 19) except, occasionally, at contact point with bedrock

RAPIDLY DRAINED -- CLASS I

1. Soil water

- Comes from precipitation
- Water table generally absent
- Soils have low absorbency

2. Deposit Characteristics and Topography

- Very stony deposits: 35 to 90% of volume is gravel, cobbles and stones
- Encountered on summits and/or steep slopes with thin soils
- Occasionally encountered in flat areas, in soil with textures varying from coarse to very coarse sands

3. Soil Characteristics

- No mottles except, occasionally, at contact point with bedrock
- Humus generally shallow
- Profile depth (i.e., fraction of profile colored by soil-forming processes) generally not extensive

WELL DRAINED -- CLASS 2

1. Soil Water

- Comes from precipitation
- Excess water flows away readily but not rapidly
- Water table absent in the first metre

2. Deposit Characteristics and Topography

- Generally thick deposits
- Variable textures
- Generally situated on the middle sections of slopes, over rough terrain
- Stoniness generally high in the tills of the Laurentians

3. Soil Characteristics

- Mottles absent to a depth of one metre
- Profile depth: (medium) approximately 40 cm
- Generally thick

MODERATELY WELL DRAINED -- CLASS 3

1. Soil Water

- Comes from precipitation, especially in soils whose textures range from medium to fine
- Excess water flows away fairly slowly
- Water table generally not visible in the profile

2. Deposit Characteristics and Topography

- Encountered very often on the lower part of slopes and on gently inclined slopes
- Variable stoniness
- Textures range from medium to fine

3. Soil Characteristics

- Prominent mottles beginning at 50 cm
- Deep profile

IMPERFECTLY DRAINED -- CLASS 4

1. Soil Water

- In fine texture soils, water generally comes from precipitation
- In coarse textured soils, water comes from precipitation and groundwater
- Depending on the time of year, the water table may be situated more than 50 cm from the surface

2. Deposit Characteristics and Topography

- Variable textures
- Situated on flat terrain and/or on the lower part of concave slopes

3. Soil Characteristics

- Mottles generally distinct between 0 and 50 cm and prominent between 50 and 100 cm
- Traces of gleying rarely present

POORLY DRAINED -- CLASS 5

1. Soil Water

- Comes from precipitation and groundwater
- Soil is very wet, with excess water visible throughout the year
- Water table frequently shows on the surface

2. Deposit Characteristics and Topography

- Very common on flat terrain and in depressions
- Textures variable but more often fine

3. Soil Characteristics

- Prominent mottles between 0 and 50 cm
- Soil heavily gleyed
- Humus often very thick with sphagnum on the surface

VERY POORLY DRAINED -- CLASS 6

1. Soil Water

- Water table at or on the surface throughout the year

2. Deposit Characteristics and Topography

- Deposit very often organic

3. Soil Characteristics

- Organic soil, i.e. formed of partly decomposed vegetable matter
- Spongy soil

Apart from these indicators, users of the Guide will also wish to make use of regional soil maps, their own knowledge of the terrain and vegetation, and any other instrument judged useful for the region in question. In Abitibi-Temiscamingue, refer to Gérardin and Ducruc (1987) for drainage assessment.

USING THE DRAINAGE CHART:
INSTRUMENTS AND DEFENITIONS

Assessment of soil texture, like that of soil drainage, must be based on observation of the soil to a depth of 50 cm, unless the presence of water or bedrock makes this impossible.

The Munsell soil color charts are used to assess soil color and to correction apply the drainage chart.

SOIL COLORS

Soil colors are assessed using the Munsell charts and notations; users of the Guide need only compare the color of their sample with the colors on the charts. HUE, VALUE and CHROMA are recorded using Munsell notations. Thus, 10 YR 3/3 corresponds to only one color on the charts : 10 YR (HUE), 3 (VALUE) and 3 (CHROMA) = “dark brown”.

GLEY COLORS

These colors generally range from grey to bluish gray. They are usually found near the left margin of the color pages and therefore have a chroma of 1 or less. Such colors are characteristics of sites with poor to very poor drainage.

MOTTLES

Mottles are patches of soil which differ in colors or shade from the predominant soil color. The more soil drainage is low, the more mottles appear in the profile. Mottles are generally rust colored, and are particularly visible in greying soils. They are described in terms of their abundance and size, as well as their contrast in relation to

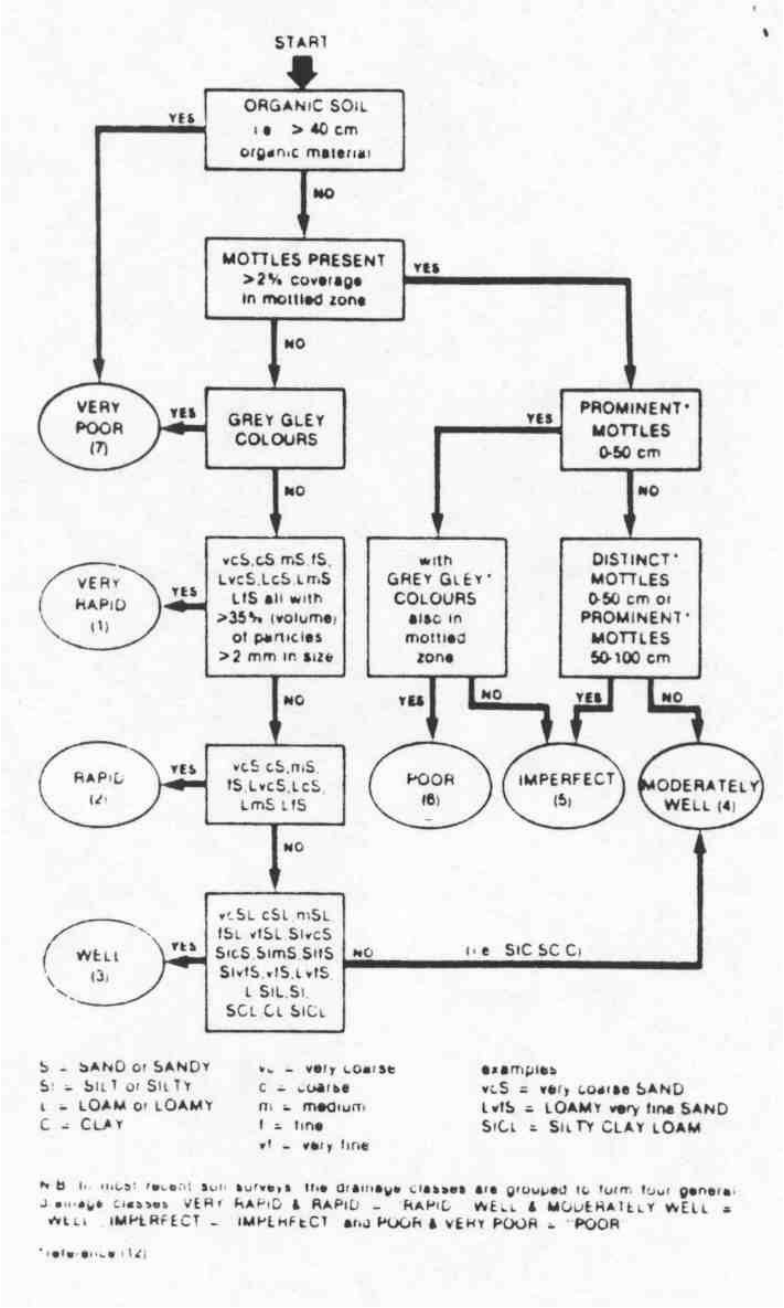
the horizon in which they are found. Contrast along with hue, value and chroma are also assessed according to Munsell color charts.

SEEPAGE

Seepage is assessed only in terms of its presence or absence. If present, an asterisk (*) is placed after the drainage class.

Topographical setting, slope length and slope form can be used to determine the presence of seepage. Water veins, springs and mottles in the upper section of the soil generally indicate the presence of seepage.

SOIL DRAINAGE CHART (after Bates et al., 1982)



(1) Underlined textures are those in which particles larger than 2 mm occupy more than 35% of the soil.
(gravels : 0.2 to 10 cm; cobbles : 10 to 30 cm; stones: more than 30 cm)

(2) Usual colors except for soils formed in red shales. Grey gley colors are generally found within 50 cm of the surface.

Chroma ≤ 1 or hue bluer than 10Y, with or without mottles.

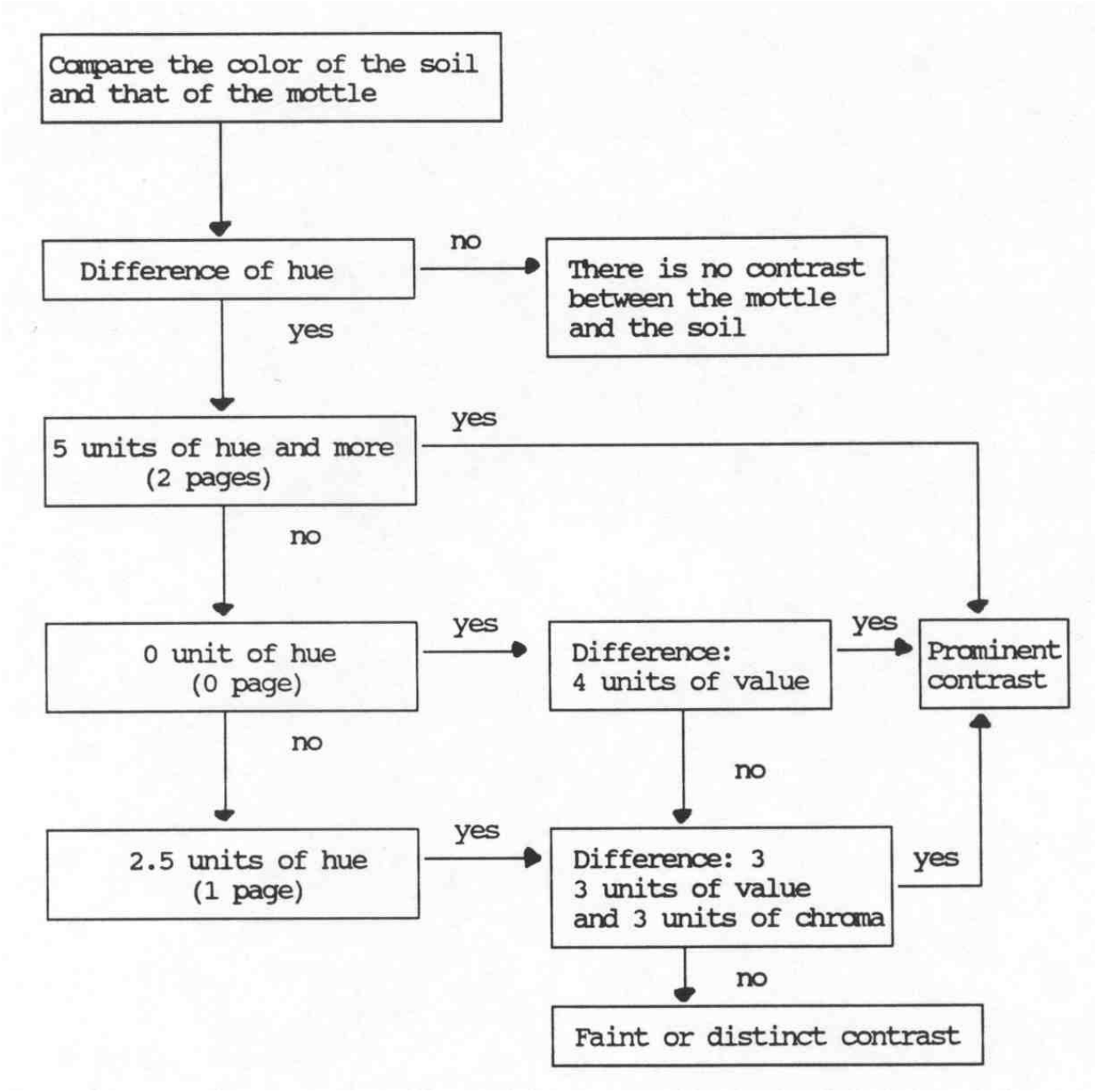
Chroma ≤ 2 for 10YR and 7.5YR with prominent mottles.

Chroma ≤ 3 for yellower than 10 YR with prominent mottles.

For sites where drainage is present, an asterisk must be placed after the drainage class.

(3) S = Sand or Sandy; Si = Silt or Silty; L = Loam or Loamy; C = Clay; vc = very coarse (1 – 2 mm); c = coarse (0.5 – 1 mm); m = medium (0.25 – 0.5 mm); f = fine (0.10 – 0.25 mm); vf – very fine (0.05 – 0.10 mm).

ASSESSMENT OF MOTTLE CONTRAST USING
MUNSELL COLOR CHARTS (after Day and McMenamin, 1982)



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