A FOREST LAND CAPABILITY CLASSIFICATION FOR THE MARSH HEAD DEMONSTRATION AREA WHITECOURT FOREST, ALBERTA

PROJECT A.92

by

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ABSTRACT

An illustration of the Canadian Land Capability Classification for Forestry (ARDA, Canada Land Inventory) was prepared for a 30-square mile tract which was the scene of intensive forest growth and yield study in recent years. The classification of soil and forest conditions was made after using aerial photo interpretation methods and ground checking at sample plot sites. A forest land capability map was compiled at a scale of 1:15,840.

Several useful soil-forest relationships were described but the identification of site factors which limit forest growth has proven evasive and should be the subject of further research. This paper is meant to be a demonstration of the aforementioned classification and, as such, does not probe ecological causes of forest growth variations.

ACKNOWLEDGEMENTS

This paper is based, in part, on the extensive field data gathered by J. R. B. Holmes (deceased), Research Officer, Canada, Department of Forestry, Calgary, Alberta. Data was also used from field studies by E. S. Atkins, formerly Research Officer with the Department of Forestry.

Z. Nemeth, Forest Research Technician, Alberta-Territories Regional Forest Research Laboratory, Calgary made substantial contributions to the analysis of data and in map compilation.

The Alberta Department of Lands and Forests, Forest Surveys and Planning Branch, Edmonton supplied the aerial photographs for this work.

TABLE OF CONTENTS

A FOREST LAND CAPABILITY CLASSIFICATION FOR THE MARSH HEAD DEMONSTRATION AREA, WHITECOURT FOREST, ALBERTA[1]

by

H. Knight and P.J.B. Duffy[2]

INTRODUCTION

A national system for rating the capability of forest land was developed as a part of the program of the Canada Land Inventory of ARDA. This system was prepared from all available information on forest site classification and forest-soil relationships, McCormack (1965a). An important feature of the system is that it provides direct comparisons with similar classifications developed for agriculture, wildlife and recreation.

The purpose of this paper is to present an example of the Canadian Land Capability Classification for Forestry (McCormack, 1965) for a 30 square-mile demonstration area near Whitecourt, Alberta. Previous field studies by J. R. B. Holmes and E. S. Atkins extended over a 10 year period and resulted in the accumulation of sufficient forest and soils data to prepare this illustration in report and map form.

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[1] Canada Department of Forestry and Rural Development, Contribution No. .

[2] Research Scientists, Canada Department of Forestry and Rural Development, Calgary, Alberta.

DESCRIPTION OF THE STUDY AREA

The Marsh Head Demonstration Area[3] is a 30.3 square mile tract of woodland located about 40 miles west of the town of Whitecourt and three miles north of the Athabasca River (Figure 1). It lies within Township 60, Ranges 19 and 20, West of the 5th Meridian. The elevations range from 2700 feet in the Marsh Head Creek lowland to 3600 feet at the Pass Creek Forest Lookout Tower. Access is by a forestry road from Highway 43 about 35 miles northwest of Whitecourt.

Climate

The climate in the study area is characterized by a long cold winter and a relatively short warm summer. Weather stations at Edson and Whitecourt record an annual precipitation of about 21 inches, 80 percent of which falls during the period April to October, inclusive. Climatic data were compiled from the records of the Canadian Meteorological Branch and are presented in Table 1.

Over nine years, precipitation for the May to October period was 25 percent higher at the Pass Creek Lookout Tower (which is located on the height of land on the study area) than at the Edson and Whitecourt stations. This supports the observation that highlands in this region receive more precipitation than lowland sites (Muttit, 1961). According to Canadian Meteorological Branch records (Table 1) the frost free period is appreciably longer at the Pass Creek Lookout Tower. This is probably because of the hilltop position at the station.

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[3] The term "Marsh Head Demonstration Area" is used only in connection with the present report and map.

Figure 1. Map of Alberta showing location of study area.

Table 1. Summary of Climatic Data for Edson, Whitecourt, and Pass Creek Tower (extracted from records supplied by Meteorological Branch, Canada Department of Transport, Toronto, Ontario).

Station	Edson		Whitecourt		Pass Creek Tower	
Elevation in Feet above sea level	3033		2430		3725	
No. of years of record	30		22		9	
	Temp.	Precip.	Temp.	Precip.	Temp.	Precip.
January	8.5	1.0	4.0	1.0	-	-
February	14.0	0.7	10.0	1.0	-	-
March	23.5	1.0	21.0	0.8	-	-
April	37.0	1.1	35.0	1.1	-	-
May	48.0	2.1	48.0	1.9	-	2.65
June	54.0	3.6	53.5	3.2	-	4.3
July	58.5	3.6	59.0	3.9	-	3.9
August	56.5	3.1	56.0	3.2	-	4.0
September	49.9	1.7	48.0	1.4	-	2.4
October	38.0	1.0	38.0	1.3	-	1.7
November	24.0	1.1	21.5	0.8	-	-
December	13.0	1.0	11.0	1.0	-	-
Mean Annual Temp. °F	35.3	-	33.8	-	-	-
Mean Annual Precip., Inches	-	21.0	-	20.6	-	-
Growing Season Averages	50.7	15.1	50.4	14.9	-	18.95
Average frost free period (Days)	74		75		104	

Topography and Soils

The topography in the study area is a result of Continental glaciation of the sandstone and shale bedrock hills (Gravenor and Bayrock, 1961). Glacial till is present on the highlands and low-lying ground is covered by alluvial and lacustrine materials which were laid down by post-glacial melt waters[7]. The Marsh Head Creek valley contains extensive deposits of aeolian sands which were blown in by north-westerly winds following the retreat of the ice. A schematic illustration of a north-south section is presented in Figure 2 to show the surficial materials and the corresponding forest cover types.

Soil survey reports on the area state that the soils developed on well-drained, fine-textured glacial till are classed as Orthic Gray Wooded or Bisequa Gray Wooded[8] (Lyndsay, Wynnyk and Odynsky, 1963). On dry aeolian sands some soils may be classed in the Subgroups of the Podzol Great Group. On imperfectly drained and poorly drained sites, the soils may be classed as Gleyed Gray Wooded or as Low Humic Eluviated Gleysols[9].

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7 St. Onge, D. A. 1965. Notes on the Quaternary geology of Township 60, Ranges 19 and 20, W5. Geological Survey of Canada, Ottawa. 5 pp. Unpublished.

8 Anonymous. 1961. Report on landforms of Townships 60 and 61, Ranges 19 and 20. Research Council of Alberta, Soil Survey Section, Edmonton, Alberta. 2 pp. Unpublished.

9 Soil classification terminology follows: National Soil Survey Committee of Canada (1965).

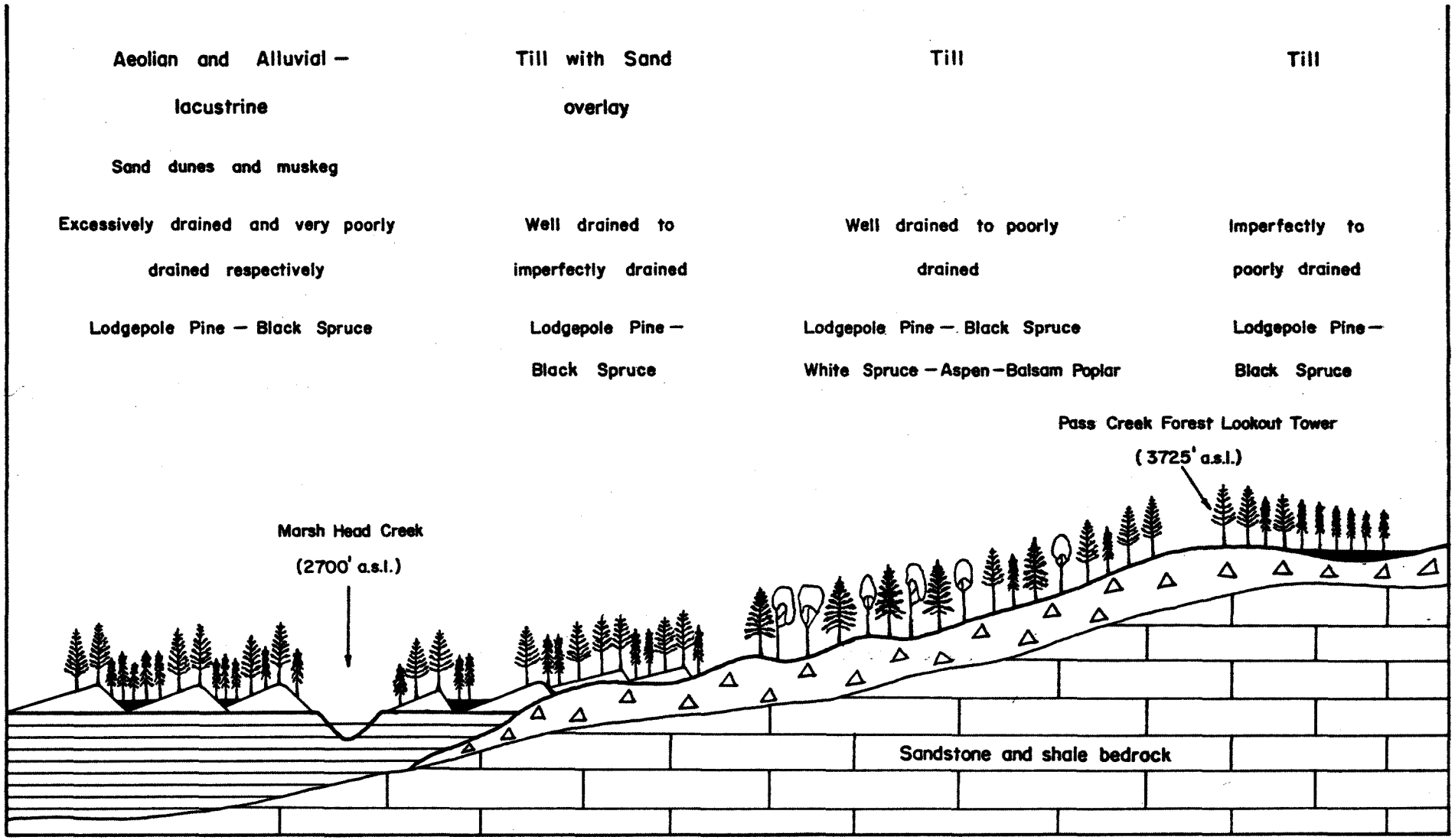

Figure 2. Forest — surficial material relationships, schematic section. Marsh Head - Demonstration Area, Whitecourt Forest, Alberta.

Forest Tree Species

The study area lies within the Lower Foothills Section of the Boreal Forest Region (Rowe, 1959). The dominant tree species is lodgepole pine (Pinus contorta var. latifolia Engelm.) which grows in pure stands throughout the area and with black spruce (Picea mariana (Mill.) B.S.P.) on imperfectly drained sites and in the sand dune - muskeg areas. White spruce (Picea glauca (Moench) Voss) grows in pure stands on the well drained till uplands and in mixture with trembling aspen (Populus tremuloides Michx.), balsam poplar (Populus balsamifera L.), lodgepole pine and black spruce on moderately well drained and imperfectly drained sites. Balsam fir (Abies balsamea (L.) Mill) and white birch (Betula papyrifera Marsh) have scattered occurrence on the slopes. Tamarack (Larix laricina (Du Roi) K. Koch) grows in muskeg sites and in mixture with lodgepole pine and black spruce on imperfectly drained lower slopes.

METHODS

As a prelude to field operations, photo interpretation of the landscape was carried out on aerial photographs at a nominal scale of 1:15,840. Major landtypes were identified from a map supplied by the Soil Survey Section, Research Council of Alberta and landforms and drainage conditions were delineated for checking in the field.

Field Sampling Procedures

All sample plots were located in fully stocked stands within a given landform. The following stand data were taken on 141 one-tenth acre plots by Holmes[10] and by Atkins[11] .

1. Diameter at breast height (d.b.h.) by species for all trees over 0.5 inches d.b.h.
2. Heights of 8-10 trees for the construction of height-diameter curves. One tree was measured in each diameter class of each species represented on the plot.
3. Age stump height on one dominant tree from each species represented. A correction factor was added to give total age.

Soil-land data were recorded at 46 soil pits as follows:

1. texture by feel,
2. soil structure,
3. soil color,
4. stone content,
5. depth of rooting and impervious layers,
6. depth to lime,
7. horizon thickness,
8. identification of parent material,
9. slope grade in percent,
10. slope position,
11. aspect,
12. drainage class.

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10 Holmes, J. R. B. 1961. A site map for the Whitecourt pilot management unit. Canada, Dept. Forestry. Project A-92. Unpublished.

11 Atkins, E. S. 1958. A preliminary development plan for the Whitecourt management area. Canada Dept. Forestry. Project A-36. Unpublished.

Calculation of Mean Annual Increment

Gross merchantable volume per acre was calculated for each plot using these volume tables:

1. Lodgepole pine (Blyth, 1955)
2. Black spruce, white spruce and balsam fir (Dominion Form Class Volume Tables, Form Class 65 - Anonymous, 1948). In the case of Holmes' data, white spruce volumes were calculated using MacLeod and Blyth's (1955) tables.
3. Aspen and balsam poplar (Dominion Form Class Volume Tables - Anonymous, 1948, p. 196) adjusted by MacLeod and Blyth (1955).

Volumes per acre for fully stocked spruce-aspen stands (over fifty percent of the volume in spruce, total basal area over 200 square feet per acre) were calculated by multiplying basal area per acre by the volume to basal area factor (MacLeod and Blyth, 1955). This volume was reduced by five percent to give the approximate merchantable volume per acre. This value was then divided by stand age to obtain the mean annual increment ($M.A.I._{.}$) which was adjusted to M.A.I. at 100 years using annual increment/age curves which were plotted for each of MacLeod and Blyth's yield tables (1955). The M.A.I. at 100 years was used to establish the forest land capability classification for each sample plot. Balsam fir, black spruce and tamarack volumes were grouped with white spruce volume data. Balsam poplar and white birch data were grouped with trembling aspen data.

For fully stocked lodgepole pine stands (basal area per acre over 200 square feet for medium to good sites) the gross merchantable volume per acre was calculated using Blyth's volume tables (1955). This value was divided by stand age to give the M.A.I. at stand age. This was adjusted to M.A.I. at 100 years using Smithers' mean annual increment curves (Smithers, 1962, p. 75). A forest land capability classification (McCormack, 1965) was then assigned to each plot location.

Map Preparation

The soil-land data were checked against the preliminary photo interpretation of landforms on 1:15,840 aerial photographs, and boundaries were adjusted. This information was then transferred to a base map (scale 1:15,830) using a Zeiss Sketchmaster. Mapping conventions, symbols and forest land capability classes were taken from an outline by McCormack (1965a) and were entered on the manuscript map. Conventions and symbols are described in Appendix II. The following limiting factors were noted on the map in symbol form:

1. climate,
2. soil moisture,
3. permeability and depth of rooting,
4. soil fertility or toxicity,
5. stoniness,
6. inundation.

Tree species which made up the capability for a given landform (indicator species) were indicated in the capability symbols by using the first letters of the botanical names.

RESULTS AND DISCUSSION

The main results of this study are shown in a forest land capability classification of the Marsh Head Demonstration Area in Figure 3 (in cover pocket), a map at a scale of 1:15,840 (4 inches to the mile). The following is a description of the sites associated with the different forest land capability classes.

Class 1. The M.A.I. is over 111 cubic feet per acre per year. There are no limitations to growth in this capability class. Although no part of the study area was mapped as Class 1, two plots were assigned M.A.I. values of over 111 cubic feet.

Class 2. The M.A.I. ranges from 91-110 cubic feet. This class is confined to moderately well-drained, sandy clay loam till sites on upper north-facing slopes. In some locations there is a 6 to 12 inch overlay of water deposited sandy loam. The cover type is pure lodgepole pine. Thirteen percent of the study area is in Class 2.

In keeping with conventions outlined by McCormack (1965), Class 2 forest land capability is assumed to be less productive than Class 1 because of the limitation of regional climate. The local climate and soil drainage conditions are probably optimum for forest growth on moisture-retentive till soils on upper slopes.

Class 3. (M.A.I. 71-90 cubic feet)

Class 3 covers thirty-eight percent of the study area and is situated mainly on moderately well-drained till soils on upper and

middle portions of south-facing slopes and on the imperfectly drained till soils on hill-tops. On some of the lower south-facing slopes Class 3 land is found on glacial till capped by aeolian sand. The cover types are pure white spruce, lodgepole-trembling aspen, pure lodgepole pine, and lodgepole pine-black spruce.

It is suggested, but by no means established, that limiting factors to tree growth in this class are unfavorable local climate and soil drainage characteristics.

Class 4. (M.A.I. 51-70 cubic feet)

Fourteen percent of the area is in Class 4 and this class is commonly intermingled with Class 3 land on apparently similar sites. Limiting factors probably include poorer drainage conditions than those found on Class 3 land and unfavorable local climate conditions on south-facing slopes and in low frost-prone sites.

Major cover types in this class are pure lodgepole pine, lodgepole pine-trembling aspen, lodgepole pine-black spruce and white spruce-balsam poplar.

Class 5. (M.A.I. 31-50 cubic feet)

This class covers about twenty-three percent of the study area. Forest growth is marginal in terms of merchantibility. It occurs on intermingled sand dunes and muskegs in the bottom lands and on deep aeolian sands overlying glacial till. Some wet sites on the flat hill-tops are also in this class. Cover types are pure lodgepole pine, lodgepole pine-black spruce, and trembling aspen-black spruce.

Limiting factors to growth seem to be a deficiency of soil moisture on sandy soils, an excess of soil moisture on poorly drained muskegs and hill crowns, and an unfavorable local climate in low-lying sites.

Class 6. (M.A.I. 11-30 cubic feet)

Eight percent of the study area is in Class 6. The class is closely associated with Class 5 land as it is in similar topographic positions. The soil moisture and drainage characteristics are more extreme on the Class 6 land than on Class 5 land, being drier on the aeolian sands and wetter in the muskeg sites. Pure black spruce is the principal cover type and a black spruce-lodgepole pine type is also present in this class.

Class 7. (M.A.I. under 10 cubic feet)

Class 7 land comprises four percent of the study area and is confined to very poorly drained muskeg sites. Trees do not grow to merchantable size because of poorly drained conditions and unfavorable local climate.

SUMMARY

Forest growth and site conditions were studied on a 30-square mile tract of woodland called the Marsh Head Demonstration Area. The land was classified as to its capability to grow wood using the Canadian Land Capability Classification for Forestry. This information is presented on a map at a scale of 1:15,840. The map was compiled from aerial photo interpretation of landforms and from mean annual increment (M.A.I.) data.

It was found that the best forest growth (M.A.I. 91-110 cubic feet per acre per year; Capability Class 2) is associated with moderately well-drained, sandy clay loam till sites on upper north-facing slopes. Some of these sites have a thin overlay of water-deposited sandy loam.

Less productive land is found on moderately well-drained till soils on upper and middle portions of south-facing slopes and on imperfectly drained hill-tops (M.A.I. 71-90 cubic feet; Capability Class 3). As the soil drainage conditions and local climate become less favorable the M.A.I. drops to 51-70 cubic feet (Capability Class 4). The sand dune - muskeg complex in the lowlands is rated as Class 5 (M.A.I. 31-50 cubic feet). Dry sand dunes and poorly drained muskeg sites are rated as Class 6 (M.A.I. 11-30 cubic feet). Class 7 is confined to very poorly drained muskeg (M.A.I. less than 10 cubic feet).

APPENDIX I

Glossary

Drainage Classification[12]

1. Rapidly drained - Soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.
2. Well drained - Soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year.
3. Moderately well-drained - Soil moisture in excess of field capacity remains for a small but significant part of the year.
4. Imperfectly drained - Soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year.
5. Poorly drained - Soil moisture in excess of field capacity remains in all horizons for a large part of the year.
6. Very poorly drained - Free water remains at or within 12 inches of the surface most of the year.

Frost-free period - The average number of days between the last frost (32°F) in the spring and the first frost in the autumn.

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[12] Report on the Sixth Meeting of the National Soil Survey Committee of Canada. Canada, Dept. Agriculture, Ottawa, 1965.

Landform - A topographic and geologic feature of the landscape, recognized and identified by its form and nature as determined by its relief and geologic materials respectively.

APPENDIX II

CONVENTIONS IN MAPPING AND SYMBOLIZATION

1. When delineating units on aerial photos the level of detail which can be shown on the maps must be kept in mind.
2. It is recognized that complexing (grouping capability classes) will be necessary but it should be avoided if single classes can be used.
3. The proportion of each class in a complex should be estimated to the nearest 10 percent and the total should equal 100 percent.
4. Classes and subclasses will be ignored in the designation of a unit unless they constitute 10 percent or more of the unit.
5. As a general guide the minimum map unit will be $\frac{1}{2}$" x $\frac{1}{2}$".
6. Every delineated unit must be classified in a legible manner. Neat hand-printing of the symbols will be sufficient.

Symbolization

1. The capability classes will be shown as Arabic numerals.
2. For maximum readability subclasses will be shown in upper case.
3. Indicator species will be shown by the first letters in each of the words in the botanical name, e.g. lodgepole pine (Pinus contorta var. latifolia) is represented by the symbol Pcl.
4. In a complex, capability classes will be shown in the order of their relative proportion in the unit; the capability class occupying the greatest percentage of the area of the unit will appear first and so on.
5. The National Forest Land Inventory Technical Work Planning Meeting agreed that the symbol would consist of:

a. a capability class from 1 to 7;

b. a maximum of 3 subclasses (indicating limitations to tree growth) but generally not more than 2;

c. a maximum of 2 indicator species (major tree species in the map unit) with each capability class;

d. a maximum of 3 classes in a complex, but generally not more than 2, and ;

e. the proportion of each class of a complex to the nearest 10 percent.

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