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A PRELIMINARY STUDY OF LAND SYSTEMS IN THE L-3 MANAGEMENT UNIT, LAC LA BICHE FOREST, ALBERTA

Project A-81

by

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FORESTRY BRANCH

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A PRELIMINARY STUDY OF LAND SYSTEMS IN THE L-3 MANAGEMENT UNIT LAC LA BICHE FOREST, ALBERTA

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INTRODUCTION

The Forest Surveys and Planning Branch of the Alberta Department of Lands and Forests has maintained a forest site classification survey program over much of the Alberta forest since 1958. In order to assist in the development of survey methodology, a co-operative project, involving provincial and federal forestry staffs, was initiated in 1962, in Management Unit L-3 of the Lac La Biche Forest. In the meantime, the forest land capability classification survey of the Canada Land Inventory has intervened and rendered the previous site classification survey somewhat obsolete.

The purpose of this report is to describe photo interpretation and field work operations employed in 1962 and

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to present a preliminary land system map (scale 1:125,000) of the L-3 management unit. The map scale is that which has been employed in Canada in pilot projects of the Biophysical Land Classification System of Lacate et al. (1967)[2]. This is to illustrate the type of information obtainable from aerial photo interpretation and extensive field sampling of land resources in a comparatively inaccessible portion of Alberta.

The map compilation of the survey area permitted trial use of land classification methods employed in Australian surveys by the Commonwealth Scientific and Industrial Research Organization, Division of Land Research. The surveys are of the broad reconnaissance type and have potential for application in Canada. The mapping units are land systems, defined as "areas with recurring patterns of land forms, soils, and vegetation" (Christian and Stewart, 1953). The component elements of land systems are termed "land units" which are groups of related sites associated with a particular land form. Land units also have fairly homogeneous patterns of soils and vegetation". Land units can be identified on air-photographs but their extent is generally too limited to be shown separately in small scale maps. However, similar units have been mapped at a

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[2] Lacate, D.S. 1967. Revised guidelines for land classification pilot projects. National Committee on Forest Land. Sub-Committee on Biophysical Land Classification (Chairman: D. S. Lacate). Unpublished progress report.

scale of 1:15,840 (4 inches to the mile) in the Whitecourt Forest of Alberta (Knight and Duffy, 1967).

DESCRIPTION OF THE STUDY AREA

The L-3 Management Unit is a 700 square mile area of forested land located on the east side of the Athabasca River about 50 miles north and west of the town of Lac La Biche (Figure 1). It lies within Map 83-P. Access is by the Athabasca River, forestry roads, and the Fort McMurray Highway.

Climate

The study area is between Lac La Biche and Fort McMurray and the May Tower weather station is the only one within its boundaries. The climate in the study area is characterized by a long cold winter and a short relatively warm summer. Annual precipitation is about 18 inches most of which falls between April and October. June, July and August are the wettest months. A climatic summary is given in Table 1.

Muttit (1961) has shown that in Alberta higher rainfall occurs on lands at higher elevations during the summer months. This is confirmed by rainfall data for the

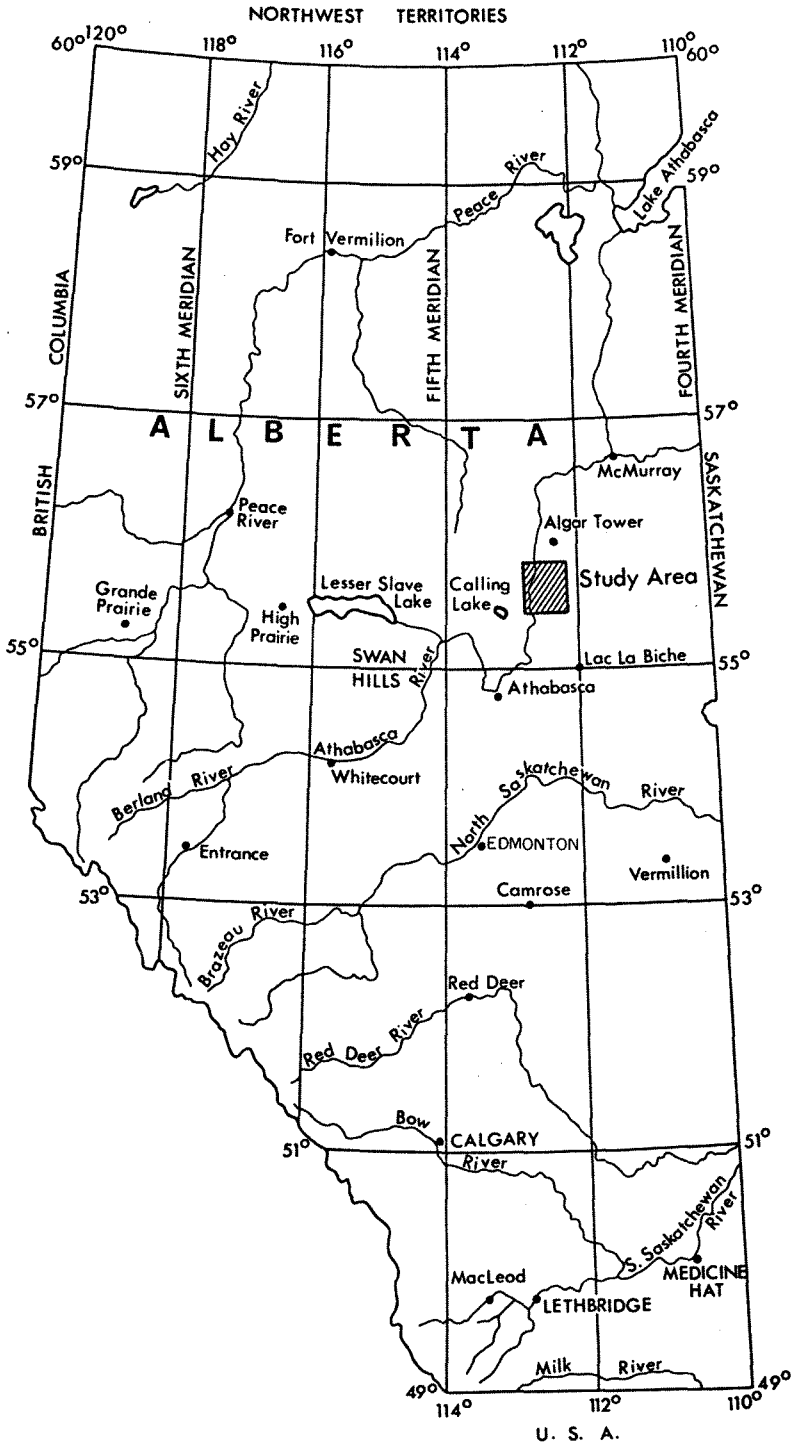

FIGURE 1. THE STUDY AREA

Table 1. Climatic Summary for Stations in the Lac La Biche Region

Station	Elevation in feet above sea level	No. of years of record		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean Annual Temp., °F.	Mean Annual Precip., Inches	Growing season averages	Average frost free period (days)
Pelican Mt. Tower	3000	1	T[x]	-	-	-	-	45.1	53.5	60.8	57.5	37.6	41.5	-	-	-	-	49.3	-
		14	P.[xx]	-	-	-	-	2.61	4.24	4.00	3.38	2.52	0.74	-	-	-	-	17.49	
May Tower	2940	1	T	-	-	-	-	45.5	54.3	62.1	58.4	36.8	40.4	-	-	-	-	49.6	-
		9	P	-	-	-	-	2.26	3.67	4.43	4.50	2.72	0.95	-	-	-	-	18.53	
Algar Tower	2560	-	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		7	P	-	-	-	-	2.51	3.82	4.18	4.04	2.87	0.96	-	-	-	-	18.38	
Round Hill Tower	2460	2	T	-	-	-	-	48.4	56.0	61.2	55.9	40.9	42.0	-	-	-	-	50.7	-
		14	P	-	-	-	-	1.46	3.47	3.6	3.48	1.82	0.72	-	-	-	-	14.55	
Athabasca	1900	16	T	-1.1	9.6	18.7	36.5	49.3	56.3	60.9	58.4	49.3	39.0	20.5	8.2	33.8	-	52.2	59
		16	P	1.07	0.84	0.75	.95	1.79	2.76	3.15	2.53	1.49	0.85	1.03	0.91	-	18.12	12.57	
Lac La Biche	1835	16	T	-1.2	9.1	17.3	35.8	49.8	57.2	62.2	59.5	49.9	40.0	21.6	8.5	34.1	-	53.1	106
		16	P	1.00	0.77	0.91	0.93	1.46	2.85	3.10	2.72	1.74	0.8	1.05	1.00	-	18.33	12.67	
McMurray Airport	1213	16	T	-7.8	3.5	13.7	34.2	48.4	56.5	61.6	58.5	48.1	37.5	17.5	2.4	31.2	-	51.8	67
		16	P	0.97	0.88	0.90	0.79	1.08	2.65	2.53	2.61	2.00	0.92	1.07	1.08	-	17.48	11.79	
Calling Lake Ranger Station	1950	4	T	-	-	-	-	46.8	56.4	61.6	58.8	50.4	43.4	-	-	-	-	52.9	-
		4	P	-	-	-	-	2.01	3.02	4.28	2.25	1.04	0.56	-	-	-	-	13.16	
Wandering River Ranger Station	1850	4	T	-	-	-	-	48.8	57.0	61.4	58.6	48.7	44.2	-	-	-	-	53.1	-
		4	P	-	-	-	-	1.93	3.03	3.86	2.20	1.19	0.45	-	-	-	-	12.66	

[x] T. - Temperature [xx] P. - Precipitation

Pelican Mountain, May, Algar, and Round Hill Lookout Towers (Table 1).

The frost free season varies from 106 days at Lac La Biche to 67 days at Fort McMurray (sixty miles north of the study area). Frequent invasions of polar continental air and occurrences of calm, clear weather bring late spring and early fall frosts.

Topography and Soils

The topography is level to gently rolling except for the May Hill system which lies across the centre of the area and has an east-west orientation, and the eroded stream and river channels. The following surficial deposits were identified from large-scale photo mosaics and from an exploratory soil survey report by Wynnyk et al. (1963):

1. outwash sands
2. glacial till
3. recent river alluvium
4. lacustrine deposits, including extensive muskegs.

The elevations range from roughly 1,850 feet on the Athabasca River to 2,940 feet at the May Hill Tower.

The Forest

The study area lies within the Mixedwood section of the Boreal forest (B. 18a) as described by Rowe (1959):

"The characteristic forest association of the well-drained uplands is, as the name implies, a mixture in varying proportions of aspen (Populus tremuloides) and balsam poplar (P. balsamifera), white birch (Betula papyrifera), white spruce (Picea glauca), and balsam fir (Abies balsamea), the last two species especially prominent in old stands. The cover type of greatest areal extent is the aspen, a result of the ability of this species to regenerate readily following disturbance. In addition to its usual dominance on sandy areas, jack pine (Pinus banksiana) enters into the forest composition on the drier till soils, and mixes with black spruce (Picea mariana) on the plateau-like tops of the higher hills. Lower positions and the upper water-catchment areas develop black spruce and tamarack (Larix laricina) muskeg in which, however, the accumulation of peat is not deep."

Preliminary photo interpretation of the area showed that the following associations of cover type and surficial materials occur:

1. jack pine on outwash sands and on sand overlying tills,
2. white spruce on tills, recent river alluvium, and well-drained[3] lacustrine deposits,
3. trembling aspen on all well-drained soils,
4. black spruce on imperfectly drained and poorly drained tills and lacustrine deposits, and

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[3] Drainage classes follow those given in the classification of Canadian Soils (NSSCC, 1965)

5. balsam poplar on recent river alluvium and on poorly drained uplands.

There is very little published literature on the forest and land resources of the survey area but the following references will aid the reader. Duffy (1965) has described some of the cover type - surficial material associations as they occur in other parts of the Mixedwood Section. The growth and yield of jack pine in a nearby portion of Saskatchewan have been described by Kabzems and Kirby (1956).

METHODS

Preliminary Photo Interpretation

Because of the reconnaissance nature of the 1962 field survey and because much of the study area is treeless muskeg the entire survey area was first examined on aerial photographs and on photo mosaics to ascertain the nature and location of the major surficial materials, forest cover types, stand density classes, and dominant height classes. Thus the survey area was stratified into land and forest cover categories for the purposes of field sampling. As much as it was practicable, considering accessibility and the time available, the locations of the samples of forest productivity and soil-site conditions were assigned randomly to each important cover type - surficial material combination. The sample sites were marked on photos ready for field sampling.

The Field Survey

The purpose of the field survey was to check the identification of surficial materials and to obtain growth and yield data from each cover type - surficial material combination.

The survey was conducted in June and July of 1962 by using the Athabasca River, winter roads, and helicopter for access to the sample plot locations. A total of 544 temporary sample plots were described by a field crew comprised of Alberta Department of Lands and Forests and Federal Forestry Branch staff members. The field operations were in two parts:

I. Growth and yield survey.
   1. Age at breast height from one dominant tree.
   2. Heights of one dominant and one codominant tree.
   3. Basal area per acre, in square feet, using a Spiegel relascope (10 factor). One observation at the plot centre.
   4. Tally of all trees counted with the relascope, by species and diameter class.

II. Soil-site sample.
   1. General site description including notes on landform, slope, drainage, and ground vegetation.

2. Soil description from samples taken with a shovel (to 18 inches depth) and with a 6-foot long soil auger (to 72 inches depth) including soil texture, horizon thicknesses and depths, and internal drainage.

In a continuous aerial photo interpretation operation the land forms and cover types on the study area were examined together with field data from 544 temporary sample plot sites, aerial photographs at a scale of 1:31,680, and two Old Delft Scanning Stereoscopes set in tandem. The purpose of the study was to incorporate the field survey data into the map.

Each land unit was classified according to relief, surficial material and cover type. Relief was taken to be a broad indication of drainage and was classified as follows:

undulating (u)	0 - 2% slope
gently rolling (gr)	3 - 9% slope
rolling (r)	10 -15% slope
hilly (h)	16% slope and up

The main surficial materials were identified as different forms of alluvium (including outwash sands), glacial till, and lacustrine. Large areas of alluvial sand cap were found overlying till and lacustrine substrates.

Cover types were identified according to Alberta

Department of Lands and Forests conventions. A maximum of two species was used in typing mapped units.

Details of relief, surficial materials, and cover type were transferred from the aerial photographs (scale, 1:31,680) to small scale aerial photo mosaics (scale 1:63,360). The manuscript map was then traced directly from the mosaics at the same scale. The final map was reduced to 1:125,000 scale to coincide with the scale of pilot project research in Biophysical Land Classification currently underway in Canada (Lacate et al. 1969).[4]

Forest growth data were compiled by surficial materials and drainage classes. Because many of the stands which were sampled were understocked, it was not feasible to calculate volume per acre figures and estimates of mean annual increment. Instead, height/age data for white spruce and for jack pine were listed to rank the land systems according to maximum dominant height at 80 years. This was the site index used in the development of a forest land classification for the Mixedwood Section (Duffy, 1965). These height/age data were then plotted for comparison of height growth between land systems.

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[4] See footnote, p.1.

RESULTS AND DISCUSSION

Land System Map

The land resources of the L-3 management unit are shown on a map (back cover pocket) at a scale of 1:125,000 (2 miles to the inch). The map units are land systems (areas with recurring patterns of land forms, soils, and vegetation) that include several forest site types. For instance on a rolling till with a spruce aspen cover type (map symbol: rtSwA) there are crest, slope, and bottom-land sites. These sites are called land units and are generally too small to be mapped at a scale of two inches to the mile.

Forest-Growth Relationships

It was found that maximum dominant height growth for white spruce followed the levels given in Duffy's "Forest Land Classification for the Mixedwood Section of Alberta" (1965). The review of height/age data and plotted graphs for the L-3 survey area did not present evidence to modify the ranking of physiographic sites given in the 1965 classification, which is reproduced here for reference. (Table 2, Figure 2).

Jack pine was found to grow on a variety of land systems, but chiefly in association with trembling aspen (on well-drained sites) and with black spruce on imperfectly drained sites. Growth data were not suitable for the derivation of strong relationships between height-growth and soil-

TABLE 2. PHYSIOGRAPHIC SITES OF THE MIXEDWOOD SECTION, BOREAL FOREST, RANKED ACCORDING TO MAXIMUM DOMINANT HEIGHT OF WHITE SPRUCE AT 80 YEARS. BASIS: 80 ONE-FIFTH ACRE PLOTS

Surficial Material	Texture of Parent Material	Soil Moisture Status	Site Index at 80 yrs (feet)
PRODUCTIVITY CLASS I: 85 - 95 FEET AT 80 YEARS			
1. Lowland alluvial (Alluvium, High-Prairie)*	Stratified sand and silt	Moderately well-drained to poorly drained†	95
2. Alluvial-lacustrine (Kathleen)	Stratified sandy loam, and silt loam	Well-drained to imperfectly drained	90
3. Till: (Braeburn)	Clay loam to heavy clay loam	Well-drained to moderately well-drained	90
4. Till: with alluvial cap (Braeburn)	Sandy loam to heavy clay loam	Well-drained to imperfectly drained	87
PRODUCTIVITY CLASS II: 75 - 84 FEET AT 80 YEARS			
5. Lacustrine: (Donnelly)	Clay loam to clay	Well-drained to imperfectly drained	84
6. Alluvial-lacustrine (Kathleen)	Sand, silt, clay	Imperfectly drained to poorly drained	84
7. Till: (Braeburn)	Clay loam to heavy clay loam	Moderately well-drained to poorly drained	84
8. Alluvium: dry elevated terraces (Heart)	Stratified sand and silt	Rapidly drained to well-drained	82
9. Till: (clay-rich): (Snipe)	Heavy clay loam to clay	Imperfectly drained to poorly drained	78
PRODUCTIVITY CLASS III: 50 - 74 FEET AT 80 YEARS			
10. Lacustrine: (Kathleen)	Clay	Poorly drained	74
11. Aeolian: sheets and dunes (Heart)	Sand	Rapidly drained	60
PRODUCTIVITY CLASS IV: LESS THAN 50 FEET AT 80 YEARS			
12. Muskeg	Organic cap over heavy clay loam to clay	Very poorly drained	<50

* Some of the soils in the study area resemble mapped soil series (Names in brackets) on the High Prairie and McLennan Sheets (Odynsky, Wynnyk and Newton, 1952).

† Drainage classes follow those given in the classification of Canadian soils (NSSCC, 1965).

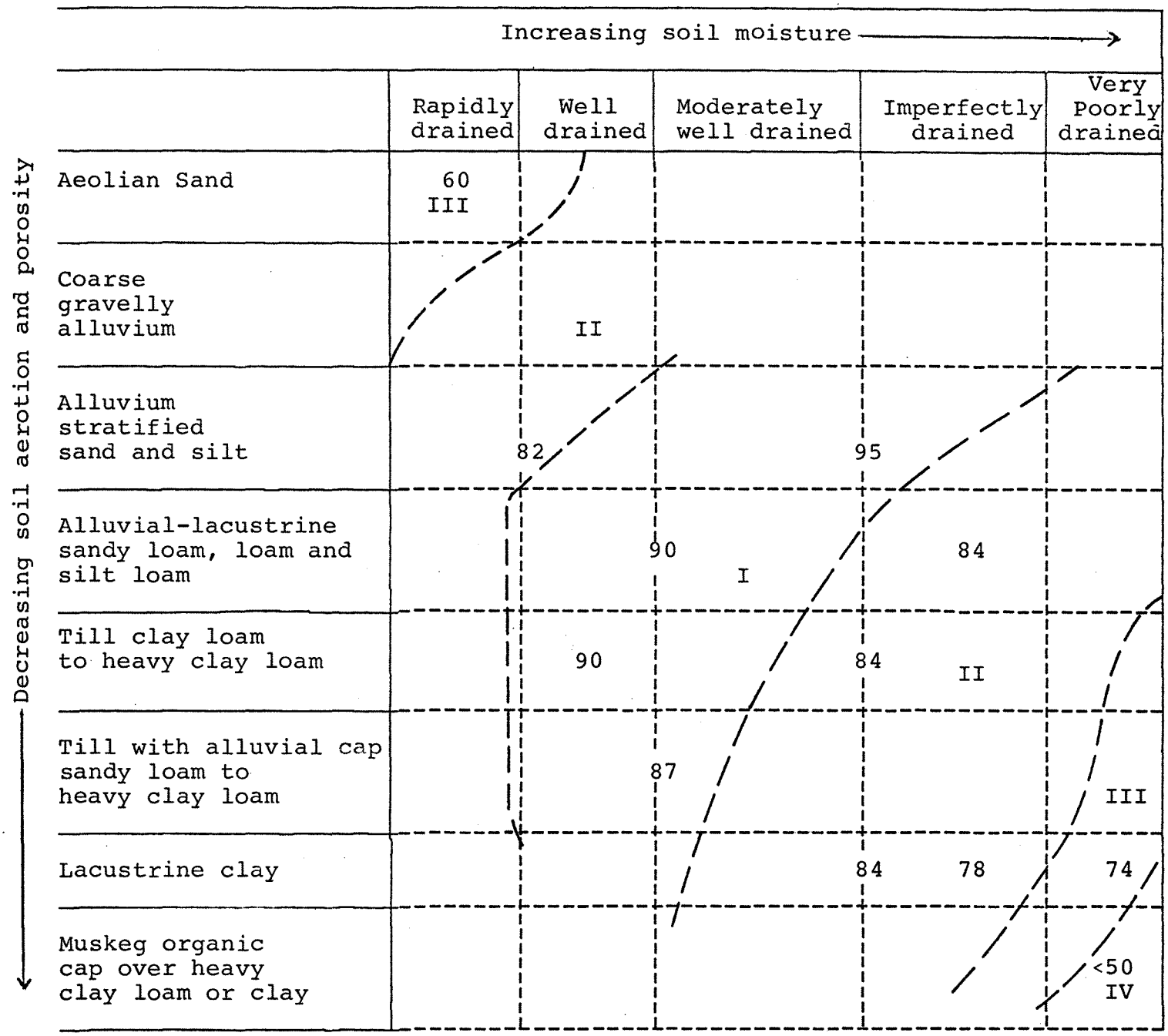

Figure 2 Maximum dominant height growth (in feet) for white spruce at 80 years by surficial material and soil moisture status. Oblique lines separate the productivity classes given in Table 2.

site conditions, but height/age graphs indicated the following maximum dominant heights for pine at 100 years of age in fully stocked stands on three important surficial materials:

Surficial material	Maximum dominant height at 100 years
Glacial till - well drained	85 feet
Alluvium - well drained uplands	75 feet
Lacustrine - imperfectly drained	70 feet

Maximum pine growth was generally found to be associated with an alluvial sand cap overlying a heavier-textured till or lacustrine surficial material.

A study of the preliminary land system map and the forest growth relationships has indicated that photo interpretation of aerial photographs, taken together with extensive ground surveys, permits a general classification of relief, geology and vegetation. The land system map would seem to provide a basis for the rating of forest land capability for broad forest management planning. It is suggested (chiefly on the basis of experience elsewhere in Alberta and in Canada) that the land system map is suitable for preliminary capability rating of land for other uses such as recreation, wildlife, and watershed management.

SUMMARY

A combination of aerial photo interpretation and broad field sampling of forest growth conditions was carried out in the L-3 Management Unit of the Lac La Biche Forest. The land was classified in terms of relief, surficial materials and forest cover type. A map of land systems (areas with recurring patterns of landforms, soils and vegetation) was prepared at a scale of 1:125,000 (two miles to the inch) by transferring details from 1:31,680 aerial photographs to 1:63,360 aerial photo mosaics and reduction to the map scale.

It was found that there was no apparent difference in white spruce height growth between the L-3 Management Unit and a large accessible area of the Mixedwood Section of Alberta which was surveyed previously. A review of jack pine growth data indicated that maximum dominant heights at 100 years of age reach 85 feet on well drained till, 75 feet on well drained alluvial uplands, and 70 feet on imperfectly drained lacustrine sites. An alluvial sand cap on heavier textured till or lacustrine parent material is associated with improved pine growth.

Land system maps appear to have potential in forest land-management planning and for land use planning in recreation, wildlife, and watershed management.

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