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FOREST LAND CLASSIFICATION IN ALBERTA, CANADA

by

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ABSTRACT

The importance of forest land classification for industrial and government forestry agencies is described together with programs of supporting soil and geology survey organizations.

Alberta soils and forests are reviewed and a variety of major research findings are presented. Past research has followed a physiographic approach, with parent material and drainage class being the major classification criteria. Most classifications have been developed for general productive capacity but others have dealt with regeneration potential on cut-over lands and with statistical analyses of site-factor-tree growth relationships in pine forests.

Current forest land research follows the same physiographic approach but with the employment of more controlled experimentation and sampling methods.

FOREST LAND CLASSIFICATION IN ALBERTA, CANADA[1]

by

P. J. B. Duffy[2]

INTRODUCTION

Decision making in forest resource management in Alberta has required the development of forest land classifications for different purposes. Broad classes of land productivity are mapped by the Alberta Forest Service for the preparation of management plans. A land inventory is maintained by North Western Pulp and Power Limited at Hinton for guidance in regeneration plans, road location and in wood yield predictions. The Federal Department of Forestry has conducted research in forest land classifications at several sites in Alberta; the Crowsnest Forest, the Bow Forest, the Clearwater Forest, in the High Foothills at Hinton, in the Low Foothills west of Rocky Mountain House, near Whitecourt and in the Lesser Slave Lake - Lac la Biche area.

Forest land classification has been greatly assisted in Alberta by Provincial and Federal Soil Surveys and by the Geological Survey of Canada, Pleistocene Section.

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1 Based on a paper given at the VIIIth Congress of the International Society of Soil Science, Commission V (Soil Genesis, Classification and Cartography), Bucharest, Rumania, September 2, 1964.

2 Research Officer, Canada, Dept. Forestry, Calgary, Alberta, Canada.

The purpose of this paper is to review recent Alberta forest land classification research and to give a discussion of current methods.

ALBERTA SOILS AND FORESTS

The Province of Alberta is 256,000 square miles in area and includes the east slope of the Canadian Rocky Mountains, the foothills and a plains region. Over half of the total area (56%) is forest land, being concentrated in the northern half and along the foothills. Dark Grey, Dark Grey Wooded and Grey Wooded soils are the soil zones associated with forests (Figure 1).

Agricultural soils are concentrated in the southeast quarter of the Province and in the Peace River Block in the northwest. The moisture deficit increases towards the southeast and this is reflected by the soil zonation. Brown soils predominate in the dry belt and with increased moisture, soil zones progress from Dark Brown to Thin Black and Black soils. Higher levels of moisture are associated with Dark Grey, Dark Grey Wooded and Grey Wooded soils. Brown Wooded and Acid Brown Wooded soils have been described in the northeast corner of the Province.

Forest cover is found on Dark Grey Wooded and Grey Wooded soils, that is on all soils except the Brown, Dark Brown and Thin Black soils. Regional forest descriptions are given in Rowe's "Forest Regions of Canada" (1959). A study of his descriptions of Alberta conditions will show that there is an approximate association between soil zones and forest sections. In the Boreal Forest Region, Thin Black soils are associated with the Aspen

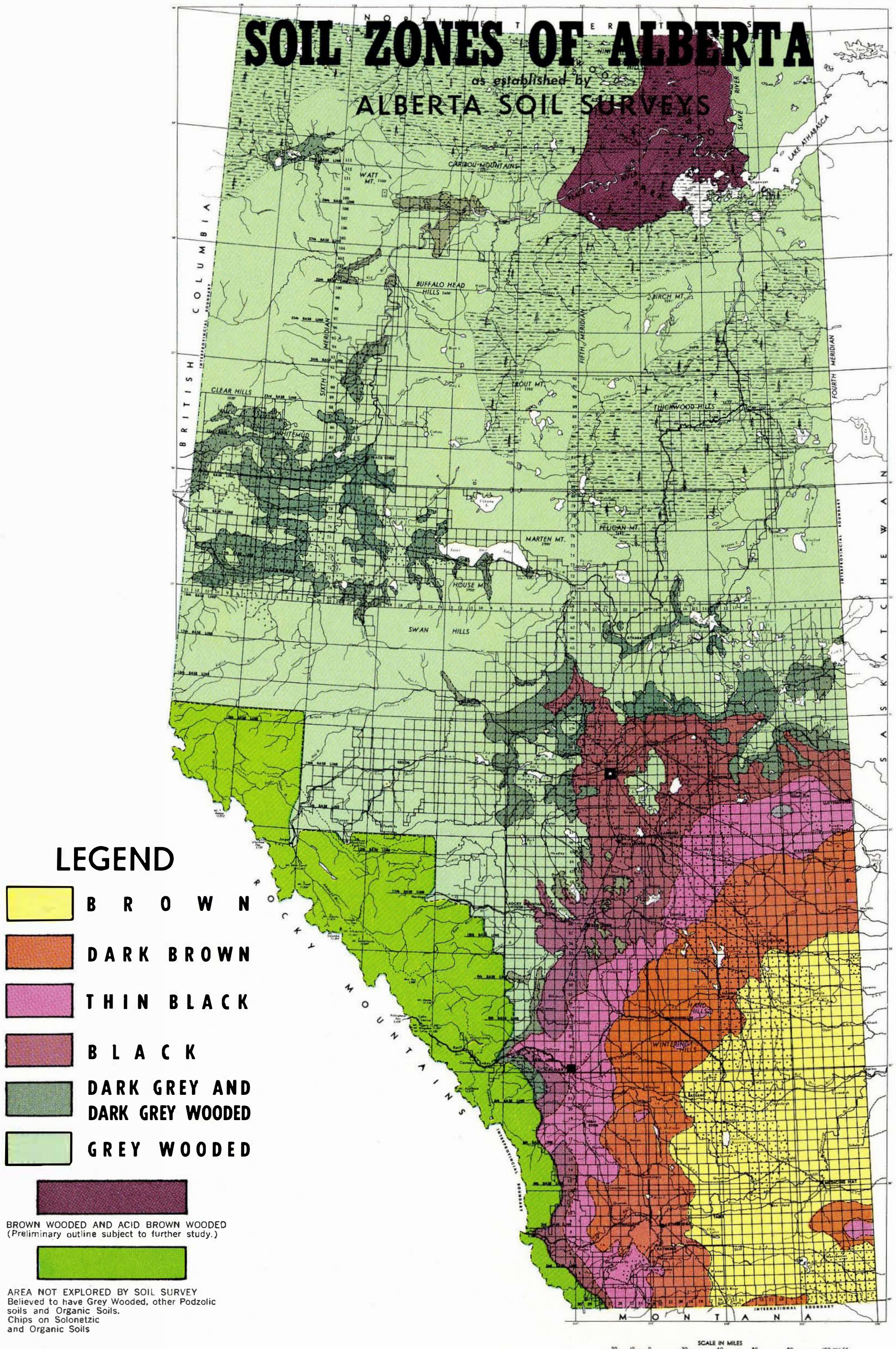

Figure 1—Soil zones of Alberta

Supplied by the Department of
Extension, University of Alberta.

Grove Section, where aspen (Populus tremuloides) is the dominant species, Grey Wooded soils with Mixedwood Section (Picea glauca and Populus tremuloides) and the Hay River Section, a northern variant of the Mixedwood. Grey Wooded soils also predominate in the Upper and Lower Foothills Section of the Boreal Forest Region where lodgepole pine (Pinus contorta var. latifolia) is the dominant. The Acid Brown Wooded and Brown Wooded soils are found in the Upper Mackenzie Section (Picea mariana, Pinus banksiana and Larix laricina). A substantial portion of the northern forest land is in non-productive muskeg.

REVIEW OF FOREST SITE RESEARCH AND MAPPING

An important early work in forest land mapping was Crossley's forest soils report on the Kananaskis Forest Experiment Station in the Sub-alpine Forest Region of west-central Alberta (1951). The Great Soil Group was employed as a mapping unit, and approximately 9,000 acres were mapped. Alluvium, Chernozem, Rendzina, Brown Forest and Podzol soils made up the main groups and their forest capabilities were discussed. No attempt was made to name or map soil series because it was not known what forest soil characteristics were of importance. Based on samples taken on a 10 chain grid of the entire area, the map and report served as "basis for further investigation".

In 1952 J. Quaite[3] initiated forest site research in the Mixedwood

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3 Formerly Forestry Officer, Department of Northern Affairs and National Resources, Forestry Branch, now Department of Forestry, Forest Research Branch.

Section of the Boreal Forest which constitutes about half of the productive forest area of the Province. The work involved a physiographic approach using the methods of Hills (1952) and soil moisture regimes were rated on different parent materials[4]. A classification of the principal drainage classes on each parent material resulted in a rating of forest land using maximum dominant height growth of white spruce at 80 years as the site index. The best forest sites were found to occur on well-drained soils on alluvial, alluvial-lacustrine, and till parent materials. Less productive sites are on imperfectly drained to poorly drained soils on lacustrine clays, alluvial-lacustrine soils and on rapidly drained elevated alluvial terraces. Poorest sites are on wet poorly drained clay soils, on dry aeolian sands, and on wet muskegs (Duffy, 1965).

Land classification was stimulated by new land settlement policies which were adopted before 1950. Through the co-operative work of the Alberta Department of Lands and Forests and the Alberta Soil Survey, boundaries were established which separated agricultural and forest lands. The first map of these zones was published in 1948 and showed areas to be withheld from cultivation. This permitted the development of forest management plans of the zones classed for forest use. Boundaries were and remain tentative and are subject to change according to additional soil and forest information. These procedures stimulated interest in the soil resources in the large relatively inaccessible (northern) portion of Alberta and

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4 Terminology is defined in a glossary in Appendix I.

subsequently an accelerated program of preliminary soil survey was initiated using helicopter transportation. By this means about 87 million acres were examined between 1955 and 1965 inclusive. Potentially arable lands have been delineated and at the same time, relatively permanent areas for forestry development have been identified (Odynsky, 1965)[5].

The Forest Surveys and Planning Branch of the Alberta Department of Lands and Forests has conducted a program of forest land classification over the past decade. The work began with aerial photo interpretation (scale 1:3333) to separate forest land from agricultural land using topography and drainage as classification criteria. Muskegs, marshes, erosion slopes, hilly land and parts of rolling slopes were assigned to permanent forest land for forest management planning (Fytche, 1964)[6]. Reid (1959) conducted a two-year survey of forest land productivity in the vicinity of Lesser Slave Lake and the Swan Hills. The forest land was first divided into parent material classes. Then within the slope position categories the forest productivity (as estimated from height - age data for white spruce and trembling aspen) was correlated with such physical factors as slope, aspect, particle size analysis and pH. The work was continued by P. Heringa and by J. Schalkwyk. The present method is first to classify a new survey area according to land types on aerial photographs. Land units are then differentiated according to recurring land forms and drainage pattern. Then forest growth is sampled within each land unit. Finally

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5 Odynsky, W. Personal Communication, January 11, 1965.

6 Fytche, R.F. Personal Communication, April 10, 1964.

the preliminary photo interpretation is corrected and a forest land inventory map (scale 1:126,000) is included in a forest management plan for the survey area.

North Western Pulp and Power Limited at Hinton, Alberta manages a 3,000 square mile forest lease for pulpwood production. Gimbarzevsky (1964) has completed a forest land inventory of the lease area. The work was completed in two stages over four years. The first stage involved a general classification of a given compartment of land into "broad physiographic units composed of similar parent material" (land types) on aerial photographs of a scale 1:40,000. This initial breakdown of surface materials served to demonstrate general productive capacity. It was a foundation for the second stage, the detailed classification of land forms into five productivity classes based upon wood yield per acre at a rotation age (80 years). This work is done on aerial photographs with a scale of 1:15,840 and is based on photo-interpretation and ground inspection of landform, regional drainage, erosional features, vegetation, tone and land use. The detailed land inventory map and report serves as an important reference for the assessment of land capacity (wood yield potential), the establishment of management units, delineation of areas for summer or winter logging, the selection of highly productive sites for higher inputs of silvicultural practice, and the classification of surface materials for road location and construction. The North Western land inventory is the largest industrial forestry project of its kind in Western Canada and it presents a demonstration of the use of a physiographic classification in forest management.

Recently the Department of Forestry has been developing forest land classifications for productivity and for regeneration appraisals. In west-central Alberta a study was made of an agricultural soil survey report and map for forestry purposes. The report covers the Rocky Mountain House Sheet and is representative of current reconnaissance soil surveys being conducted in the forest-farmland fringe area of Alberta. The principal value of the soil survey report to the forest manager is the record of location and extent of the different soil types. In addition, information on the characteristics of the soil and the terrain may be useful in predicting potential forest growth and in planning for planting operations, seedbed preparation, cutting methods, and road location. Three soil series were ranked in order of productivity using dominant height of lodgepole pine at 55 years as the site index.

In 1958, a regeneration survey made on logged-over land in the Crowsnest Forest to assess the variation in stocking per cent and numbers per acre of reproduction and to relate any variations to physiographic site and treatment factors (Day and Duffy, 1963). The site classification was designed so that simple physiographic features could be used to stratify the logged-over lands for reproduction surveys and for silvicultural treatment after cutting. The purpose of the site classification was to give some physical rationale to seedling establishment and survival. It was the first Alberta regeneration survey to be conducted within a site framework. Obvious differences in aspect, exposure, and slope were used as classification criteria together with physiographic factors of moisture regime, permeability, and ecoclimate (Hills, 1952). The following site classification was adopted:

A. Bottomland Alluvium

B. Moderate Slopes

i) Exposed - poorly drained

Exposed - well drained

ii) Protected - poorly drained

Protected - well drained

C. Steep Sloped

i) Exposed - well drained

ii) Protected - well drained

A broad relationship was demonstrated between stocking and physiographic site classification and future regeneration surveys in the Crowsnest Forest should yield more useful results if conducted within a framework of a similar physiographic stratification. The classification employed in this work provides a valuable basis for further regeneration research and forestry operations in the area. It was found out however that the most important factors affecting germination and seedling development are microenvironmental. Thus the type of physiographic site classification used in this study is only meaningful where the effects of major site characteristics are more important than those of microsite factors.

In 1960-1961, a study was made of forest land productivity between the Red Deer and Braseau Rivers in the Foothills Section of Alberta to facilitate the prediction of yields for lodgepole pine (Duffy, 1964). A preliminary site classification was developed on the finding that pine growth differs between parent materials. Pine growth in terms of dominant height, average height, basal area per acre, and total volume per acre is better on the Lobley soil series (till) than on the two other soils in the study area (Caroline seil series on lacustrine materials and the Horburg soil series on coarse gravelly alluvium).

Correlations between site, stand factors, and pine growth were used to construct prediction equations for the site expressions - dominant height, average height, and basal area, total volume, and merchantable volume per acre. It was found that height growth can be predicted with greater precision than basal area, total volume or merchantable volume per acre. Stocking level has an important influence on pine growth and the effect varies from one soil type to another. Dominant height and average height at an index age are good site indexes provided a correction is made for stocking level. New prediction equations for pine and other species on other soils could be calculated using the survey methods and techniques outlined in the study.

The lodgepole pine site study was based on 158 forest locations and an analyses of 458 soil samples. The analyses of field and laboratory data permitted an appraisal of different measures of forest land productivity. It is difficult to determine whether or not a lodgepole pine stand is fully stocked for a given site condition. Since full stocking is a prerequisite to the classification of forest land in terms of basal area per acre or total volume per acre, these site indexes are subject to error because of the relationship of stocking level and the indexes. Dominant height and average height at an index age are related to stocking level in that over-stocking may be associated with lower heights. These site indexes may be used without a correction for stocking level only on understocked to fully stocked stands. The multiple regression method used in the study permits the integration of stand and soil-site factors to estimate growth on different soils.

CURRENT FOREST LAND RESEARCH

Current research is directed to a variety of subjects. One project is concerned with the feasibility of carrying out a broad classification of forest land productivity from air photographs and extensive land surveys. The study deals specifically with the forest land inventory program of the Alberta Department of Lands and Forests. Much of northern Alberta is inaccessible and initial appraisals of forest land potential depend upon interpretation of aerial photos for the preliminary separation of land types. Ground checking is concerned with mapping and description of landforms. The preliminary land type map is subsequently corrected using the new field data and land unit descriptions are improved. The final map is included in forest management plans for forests which range in area from 1,000 to 3,000 square miles.

The industrial forest site classification methods of the North Western Pulp and Power Limited at Hinton is presently the subject of an analysis to find out the variation in forest capacity which exists within recognizable physiographic land units and the differences in capacity between these units. Important factors under study are parent material, soil depth, slope, aspect, and soil moisture regime.

To test the working hypothesis that different soils will yield maximum wood yields under different spacing levels, a series of white spruce-under-aspen plantations has been established on seven soils in the Lower Foothills Section of the Boreal Forest. Nine one-acre blocks constitute one plantation with three spacing levels (6 x 6, 9 x 9, 12 x 12 feet) replicated three times. The Forest Management Branch of the Alberta Department of Lands and Forests has established the plantations according to the experimental design recommended by the Department of Forestry.

Holmes (1962) initiated a land classification of a 14.5 square mile forest area to establish criteria for site classification in the Lower Foothills Section of the Boreal Forest northwest of Whitecourt. The classification had as its basis the identification of landforms and their soil moisture characteristics. Topographic position and slope class were used to subdivide landform units for forest productivity samples. A site classification map (scale 1:50,000) is under preparation.

To date forest site classification has been on an exploratory basis. It has been established that an initial categorization can be achieved by mapping parent materials and soil drainage classes. Soil series, as mapped by the Provincial and Federal soil surveys, are useful in forest land appraisal where published soil survey reports and map are published. However only preliminary findings offer a guide as to which soil and other environmental factors are important in forest soil surveys and forest land classification. Until further research gives new and concrete indications on soil factor - forest growth relationships, we will continue to use soil and surface material maps and reports which were not prepared specifically for forestry.

APPENDIX I

GLOSSARY

<u>Drainage classes</u>

1. Rapidly drained - Soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.

   Soils are free of any evidence of gleying throughout the profile. Rapidly drained soils are commonly soils of coarse texture or soils on steep slopes.

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.

   They are usually free of mottling in the upper three feet but may be mottled below depths of three feet. B horizons, if present, are reddish, brownish, or yellowish.

3. Moderately well-drained - Soil moisture in excess of field capacity remains for a small but significant period of the year.

   The soils are commonly mottled in the lower B and C horizons or below a depth of two feet. The Ae horizon, if present, may be faintly mottled in fine-textured soils or in medium-textured soils that have a slowly permeable layer below the solum. In grassland soils the B and C horizons may be only faintly mottled and the A horizon may be relatively thick and dark.

4. Imperfectly drained - Soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year.

   The B and C horizons commonly are mottled; the Ae horizon, if present, may or may not be mottled. The matrix generally has a lower chroma than in the well-drained soil on similar parent material.

5. Poorly drained - Soil moisture in excess of field capacity remains in all horizons for a large part of the year.

   The soil profiles show evidence of strong gleying. Except in high chroma parent materials the B, if present, and upper C horizons have matrix colors of low chroma. Faint mottling may occur throughout.

6. Very poorly drained - Free water remains at or within 12 inches of the surface most of the year.

   The soil profiles show evidence of very strong gleying. Subsurface horizons are of low chroma and yellowish to bluish hues. Mottling may be present but at depth in the profile. Very poorly-drained soils usually have a musky or peaty surface horizon.

<u>Landform</u>: A topographic and geologic feature of the landscape, recognized and identified by its form and nature as determined by its relief and geological materials respectively.

<u>Land type</u>: A land pattern composed of repeated occurrences of a landform.

<u>Physiographic site classification</u>: A categorization of forest land

productivity using topography and soil factors as classification criteria within a homogeneous regional climate.

Site: The edaphic, climatic, and biological environment as it affects the forest stand.

REFERENCES

CROSSLEY, D.I. 1951. The soils on the Kananaskis Forest Experiment Station in the Sub-Alpine Forest Region in Alberta. Canada, Dept. Resources and Development, For. Res. Div. Silv. Res. Note No. 100. 32 pp. and 3 maps.

DAY, R.J. AND P.J.B. DUFFY. 1963. Regeneration after logging in the Crowsnest Forest. Canada, Dept. Forestry Publication No. 1007, 32 pp.

DUFFY, P.J.B. 1962. The use of soil survey reports in the appraisal of forest land productivity in Alberta. For. Chron. 38:2:208-211.

DUFFY, P.J.B. 1964. Relationships between site factors and growth of lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) in the Foothills Section of Alberta. Canada, Dept. Forestry Publication No. 1065. 60 pp.

DUFFY, P.J.B. 1965. A forest land classification for the Mixedwood Section of Alberta. Canada, Dept. Forestry Publication (In press).

GIMBARZEVSKY, P. 1964. The significance of landforms in the evaluation of forest land. Woodlands Review, July, 1964. pp. 302-317.

HILLS, G.A. 1952. The classification and evaluation of site for forestry. Ontario Dept. Lands and Forests, Division of Research Report No. 23, 41 pp.

HOLMES, J.R.B. 1962. A weighted effective soil depth concept of the evaluation of lodgepole pine sites. Department of Forestry Establishment and Progress Report. Mimeo 62-4. 5 pp.

REED, G.W. 1959. Site classification of forest lands in Alberta. Alberta Dept. Lands and Forests, Forest Surveys Branch MS. 47 pp.

ROWE, J.S. 1959. Forest regions of Canada. Canada Dept. Northern Affairs and National Resources, Forestry Branch Bulletin 123. 71 pp.