ECOLOGICAL CLASSIFICATION OF FORESTS IN ALBERTA

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INTRODUCTION

Over the past quarter of century, the consumption of forest products has drastically increased along with the rapid socio-economic growth of modern society. This trend will likely continue for the foreseeable future, generating a heavier demand for the limited supply of forest products. Furthermore, man's ever-expanding social activities have created various kinds of land use conflicts that are inevitably apt to reduce the area of forest lands. Man is now facing a difficult task, never experienced before, in terms of forest resource management and utilization, which requires his serious concern and efforts. He has to satisfy the social demand. On the other hand, he must protect forests from a total exhaustion due to unscrupulous depletion. He has to maintain the renewability of forest resources to guarantee a continuous supply not only for himself but also for future generations yet to come. This seems to be a time of challenge to test his intelligence, responsibility, and moral integrity.

In order to cope with the problems and to develop improved forest management techniques, it is indispensable to have a better understanding of the forest as an ecosystem and to obtain accurate knowledge of forest ecosystems' structure, function, behavior, and ecological characteristics. It is also important to have an ecologically sound classification of forests to provide an ecological framework and guidelines for forest management and practices.

In the Province of Alberta, thanks to the Alberta Forest Service, recently a new research project has been initiated to establish an ecosystematic classification of forests, that will provide an ecological rationale for improved forest management and practices.

This paper primarily intends to describe the project in some detail together with a brief review of forest land classification in Alberta.

A REVIEW OF FOREST LAND CLASSIFICATION IN ALBERTA

Although, at present, Alberta is a "booming" province for energy resources, forestry is also a vitally important industry. Indeed, an area of approximately 390,000 km^2, 60% of the total area of the province, is classified as forest land, and nearly 70% of it is considered to be productive forests. The total volume of timber of the province was estimated to be 1.5 billion m^3 (Alberta Forest Service 1968). Forest products in the province amounted to $85 million for the 1975-76 fiscal year (Alberta Energy and Natural Resources 1976a).

Attempt to classify the forest land in Alberta can be traced back as early as 1937 to Halliday's paper and map (1937), which was preceded by Weaver and Clements (1929). Based on the climax formation of Clements, Halliday recognized three formations for the province, i.e. tundra formation, grassland formation, and forest formation. The forest formation was subdivided into three forest regions, i.e. boreal, subalpine, and montane forest regions. The forest regions were further subdivided into sections: five sections for the boreal forest region, and one section each for the subalpine and montane forest regions. Halliday's classification was succeeded and refined by Rowe (1959, 1972). Principally following Halliday's original map, Rowe subdivided the boreal forest region into three subregions. He recognized eight sections for the boreal forest region, and one section each for the subalpine and montane forest regions of Alberta. These studies provided an excellent opportunity to obtain a broad overview of forests of the province. They have been extensively used and referred to in various ecological as well as forestry studies.

After World War II, a growing demand for wood products necessitated an accurate assessment of forest resources in the province so that management plans aiming at sustained yield could be developed. In the early 1950's, the Alberta Forest Service initiated a forest inventory program and started a full-scale survey of forest land in the province. As a result of this, by the late 1950's, forest cover type maps at a scale of 1" = 2 miles covering most forest lands were completed and became available for forestry management planning and practices. The program was completed in 1962 (Alberta Forest Service 1968).

During the early 1960's, rapid socio-economic development of the country resulted in various levels of land use conflicts throughout the province as well as Canada. To resolve such conflicts and to decide the best use of land resources, it was felt that

an accurate knowledge of the capability of lands, their location, and extent was necessary. In the early 1960's, the Canada Land Inventory program was initiated to meet this demand. It was endorsed by the Agricultural Rehabilitation and Development Act, established in 1961. It was a land capability evaluation for different land use purposes to provide essential information on land capability at a reconnaissance level for land use planning by various levels of governments. The broad objectives of the C.L.I. were to classify lands for their capabilities and to obtain an estimate of their location and extent (Department of Regional Economic Expansion 1970, McCormack 1972). In 1964, the Province of Alberta participated in the program. The land capability classification for forestry was carried out by the Land Classification Section, Alberta Forest Service, in cooperation with the Canadian Forestry Service. Approximately 75% of the forest lands of Alberta was covered by the program. Nineteen maps at the scale of 1:250,000 were completed and published. The program was terminated in 1973 (Prokopchuk and Archibald 1976).

In Alberta, as a continuation of the land inventory, the Alberta Land Inventory was established primarily to cover those areas which were not mapped by the C.L.I. This program is being undertaken currently by the Resource Inventory Section, Alberta Forest Service. It is expected that the previously unmapped forest lands will be covered by this system by 1979.

In the late 1960's and the early 1970's, the concept and approach of the C.L.I. evolved to a new land classification system, namely, bio-physical land classification. It is a multidisciplinary approach of land classification, aiming "to differentiate and classify ecologically-significant segments of land surface, rapidly and at a small scale (reconnaissance survey); it is to satisfy the need for an initial overview and inventory of forest land and associated wildland resources" (Lacate, 1969). It is, therefore, a quite efficient way to cover large areas within a limited time. In Alberta the system is being adopted by the Technical Division, Alberta Department of Energy and Natural Resources, to carry out land capability studies for special land use assignment study areas. Such areas have been and are being mapped at the scale of 1:250,000 (Alberta Energy and Natural Resources 1975, 1976b, 1977).

The Canadian Forestry Service, in cooperation with the Alberta Institute of Pedology, has been involved in a bio-physical land classification of Banff and Jasper National Parks since 1974. It is expected that the entire parks will be mapped at the scale of 1:50,000 when completed by 1980 (Holland, 1976).

There are numerous vegetation as well as ecological studies on the vegetation of Alberta, conducted by the research groups of the universities of Alberta and Calgary. A vegetation map of Alberta has been completed and published (North, 1969, 1976).

Through those various studies, a considerable amount of knowledge has accumulated, providing an opportunity to obtain a better overview of land resources of the province. Such knowledge and information are especially useful to decision-making and planning processes and solving land use conflicts at the regional level.

However, from the forestry point of view, it was strongly felt that a somewhat finer and more elaborated classification as well as large-scale mapping were desirable for forest management and daily operations. The information obtainable from the previous studies seemed to be too general and not sufficient in most cases. For instance, a land pattern shown in 1:250,000 maps is quite broad and not necessarily homogeneous in terms of forest vegetation, soils, and forest productivity. One land unit in the maps may include a certain diversity of forest ecosystems, each of which may require different types of the forest operations. Also, delineation of land units may not be necessarily adequate ecologically. It should be mentioned, however, that this is not due to inherent defects of the system itself but due to different objectives of the previous studies, because most of them were intended to cover large areas quickly for an initial overview at a reconnaissance level.

For the past few years, the Alberta Forest Service has been contemplating the development of a new classification system of forests, a post-reconnaissance type classification that would be ecologically sound and more specifically suitable for forest management purposes. In 1976, an agreement was reached between the Alberta Forest Service and the Canadian Forestry Service, whereby the Canadian Forestry Service would undertake a research project, on a cost-sharing basis, to develop an ecosystematic classification of the forests of Alberta. It was also agreed that the system would basically follow the concept and approach of biogeoclimatology, developed and established by V.J. Krajina of the University of British Columbia.

BIOGEOCLIMATIC ECOSYSTEM CLASSIFICATION

Since we have been directly involved in the project, it is appropriate for us to describe the project in some detail. The project was initiated in 1976. It is a four-year project to be completed by 1981. Its objectives are: (1) to classify Alberta into biogeoclimatic zones and to produce a zonation map at the scale of 1:1 million, (2) to classify forests of the province

into plant associations (sensu Krajina, 1960), (3) to analyse forest-environment relationships, (4) to provide basic information on the plant associations in terms of their structure, ecological characteristics, and potential for forest production, and (5) to promote application of the classification in forest management and research programs.

Before going into more detail, however, we should make one point clear: the biogeoclimatic classification is not a land classification but an ecosystem classification. Let us briefly discuss the ecosystem concept. Ecosystem, first proposed by Tansley (1935), is a complex of biotic and nonbiotic components occupying a definite place on the earth. Within an ecosystem, all the components are closely linked together and mutually interacting, forming an inseparable weblike network. Energy and material flow in and out of it. It rests upon a dynamic equilibrium or approaches it. It changes, evolves, becomes senescent, and rejuvenates. Vegetation is a part of an ecosystem. It is not only governed by other components of the ecosystem, it also governs them: hence, it defines the characteristics of the ecosystem to a certain extent. A forest is one kind of ecosystems, characterized by the presence of trees dominating the vegetation portion of the ecosystem. It is one of the most complex ecosystems in the terrestrial environment.

Although ecosystem is a conceptual entity per se and may be difficult to discern as a whole, we could assume that vegetation as well as soil are a tangible form of the ecosystem, i.e., a total expression of intricate internal and external ecological processes. Should this assumption be correct, then we could further assume that by classifying vegetation we are in fact classifying ecosystems as they are manifested in the form of vegetation. This is the rationale for using vegetation as one of the important criteria for ecosystem classification.

However, from the practical point of view, ecosystem, when used in our classification, connotes the smallest unit of vegetation-soil complex; hence, it is synonymous with "biogeocoenosis" (sensu Sukachev 1944, 1958). Similarly, a forest ecosystem is a segment of forest in which vegetation and soil are homogeneous throughout and which can be distinguished from others by different vegetation structure and soil characteristics.

Through the course of the project, biogeoclimatic zones of Alberta will be identified, described, and mapped at the scale of 1:1 million. A biogeoclimatic zone is a high level of generalization of ecosystems. It is a geographic segment of the earth surface, characterized by three major parameters, namely, macroclimate (regional climate), zonal soil or predominant soil-forming processes, and climatic climax vegetation. To a large extent, it

is primarily a product of the macroclimate which determines a course of soil and vegetation development. However, in practice, it is identified by the climatic climax vegetation that develops on mesic habitats. Such vegetation is presumably the best reflection of the macroclimatic influences. In other words, a biogeoclimatic zone is a geographical extent which can be delineated by the same climatic climax vegetation.

Since a biogeoclimatic zone covers a broad geographical area, it is necessarily heterogeneous in edaphic conditions, thus, in vegetation as well as soils. It includes, therefore, many kinds of ecosystems, ranging from those on dry rock outcrops to water-saturated wetlands. Forest productivity is also variable within a zone, from highly productive to poorly productive forests. Such diversity, however, can be classified on the basis of sample plots representing different ecosystems. Plant association (sensu Krajina, 1960) may serve as a basic unit of the classification.

A plant association is the fundamental unit of the ecosystem classification. It is the smallest unit discriminable floristically as well as environmentally. It is the smallest homogeneous unit derived from sample plots that have similar vegetation structure and occur repeatedly on similar habitats. Thus, it is homogeneous also from the standpoint of potential forest productivity.

Plant association will be identified and described for the forested biogeoclimatic zones. The description will include: (1) vegetation characteristics: species composition of the tree, shrub, herb, and moss layers, assessment of coverage of each species, and frequency and dominancy of species; (2) environmental characteristics: physiography and topography, type of parent material, physical and chemical properties of soils including texture, pH, cation exchange capacity, amount of major exchangeable cations, organic carbon, nitrogen, available phosphorus, base saturation, hygrotope, trophotope, type and thickness of humus, profile description and soil classification; (3) forestry characteristics: number of trees per unit area, total volume per unit area, mean annual increment, site index, and stand age. Characteristic species will be determined and listed, which may be used as key species to identify the associations. Successional trend of vegetation will be discussed.

USEFULNESS OF THE BIOGEOCLIMATIC ECOSYSTEM CLASSIFICATION

The biogeoclimatic ecosystem classification, when established, provides a rational classification of forest ecosystems at a generalized level (i.e. biogeoclimatic zones) and detailed level (i.e. plant associations). It also provides basic information on vegetation structure, environmental characteristics, forest-

environment relationships, and forest productivity. Such information will be of a great value in understanding forest ecosystems and their behavior, hence, will be used as guidelines how to properly manipulate forest ecosystems for man's benefit. This kind of study, incidentally, enumerates the ecological assets of the province.

As a broad ecological framework of the province, biogeoclimatic zones provide the ecological rationale for developing regional forest management policies, including developing policies for land use allocation, assessing potential productivity of forests in a region, establishing seed collection and breeding zones, selecting best-performing trees for a region, designing and developing tree improvement programs, and coordinating and correlating future research efforts related to forestry in the province.

The plant association, on the other hand, will serve as an operational unit. It provides site-specific information on forest ecosystems, hence, it is useful in developing and deciding forest management practices at an operational level, including selecting best-performing trees site-specifically, predicting species competition, prescribing thinning and fertilization programs, planning prescribed burnings, designing harvesting techniques and logging operations, predicting course of vegetation succession, and deciding the best use of land facets ecologically. It also provides some guidance in predicting consequences of man's impact on forest ecosystems.

SUMMARY

Lack of an adequate system to classify forests in Alberta has necessitated developing an ecologically sound classification of forest ecosystems. A research project of biogeoclimatic ecosystem classification is currently in progress. The project, when completed, is expected to establish an ecological zonation of the province in terms of biogeoclimatic zones and forest classification in terms of plant associations. It will also provide basic information on forest ecosystems in their structure, ecological characteristics, behavior, and forest productivity. Such a system will be of a great value in developing improved forest management and practices. It will also be able to identify some problem areas and suggest necessity of future research efforts.

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