ECOLOGICAL LAND CLASSIFICATION

in

BANFF AND JASPER NATIONAL PARKS

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Abstract

The Ecological Land Classification (ELC) methodology is described as it was developed and used in Banff and Jasper national parks. Principles of standardization, maximization, specialization, synchronization, concentration, and centralization are applied to data collection for ELC. Guidelines are suggested to make an ELC function more effectively. Advantages and disadvantages of an ELC are given. Suggestions are provided for development of new ELC projects. The conclusion is a discussion of applications of ELC.

Ecological Land Classification in Banff and Jasper National Parks

Introduction

The Ecological Land Classification (ELC) methodology used in Banff-Jasper and the other national parks in the mountains is outlined in detail in the various published reports emanating from the CFS in Edmonton (Holland and Coen, 1982, 1983; Holroyd and Van Tighem, 1983).

Banff and Jasper National Parks occupy about 17,520 km^2 (6765 mi^2) in Canada's southern Rocky Mountains. The ELC of Banff and Jasper presents landform and soil, vegetation and wildlife information in a map and descriptive format at a scale of 1:50,000 using a legend that integrates the resource components in a holistic fashion. A three-level, hierarchical land classification system was developed using established landform and soil taxonomies (C.S.S.C., 1978) plus a classification of 85 vegetation types developed by the authors of the Banff-Jasper report. The three levels are based on existing guidelines for Ecological (Biophysical) Land Classification in Canada (Lacate, 1969: Wiken, 1980) and include, from highest to lowest level of generalization, Ecoregion, Ecosection, and Ecosite.

Ecoregion separations are based primarily on vegetation physiognomy and species composition which reflect macroclimate. Montane, Subalpine, and Alpine Ecoregions are recognized. The Subalpine Ecoregion is subdivided into Lower Subalpine and Upper Subalpine portions based on vegetational characteristics reflecting macroclimatic differences.

The Ecoregions are divided into 55 Ecosections. Ecosection separations are based on broad landform, drainage class, and soil differences. Landforms are comprised of ten genetic materials that have been divided into twenty genetic material units based on broad textural and chemical (calcareousness/reaction) differences.

The Ecosections are further separated into 124 Ecosites based on specific soil and vegetational differences that are considered insufficient, in magnitude or kind, to warrant separation at the Ecosection level. The Ecosites, plus eight Miscellaneous Landscapes, are the mapping units delineated on 1:50,000 maps. Wildlife information is presented at the Ecosite level. The importance of each Ecosite for most of the large and medium size mammals is described. Eighteen breeding bird associations and seven small mammal associations are defined using multivariate statistics. The association and its relative abundance are listed for each Ecosite.

The ideal ELC system does not exist. In Banff-Jasper our use of ELC differed somewhat from that in other parts of Canada. The differences are mainly in scale and some of the concepts used to develop mapping units. However, the basic ideas of what constitutes an ELC are the same. The physical resources of climate, geology, landforms, and soils are united into one taxonomic classification system, including the biological resources of vegetation and animal life.

The obvious reason for an ELC is to obtain a quantification of the existing resources and their distribution. However, an integrated ecological approach does more. It provides a better understanding of resource relationships and the processes that explain why certain ecological relationships occur. Such knowledge helps the resource managers to interpret the data easier.

ELC Principles and Guidelines

Canada is a forestry nation, mainly because of the size of its forest resource, and because, up to now, it has been able to provide wood at low cost (Williams, 1985)[1].

Toffler (1980) describes the six interrelated principles of standardization, specialization, synchronization, concentration, maximization, and centralization that are required for industrialization. A brief look at these principles shows how they might relate to ELC:

1. Standardization of data collection

   Imprecisely defined terms abound in the literature describing the biosphere. Simple, easily definable and quantifiable terms need to be used in order to improve understanding. Some standard of language is mandatory before technical communications can proceed.

   Biological systems are products of ecological processes. If uniform resource evaluations are required in order to make management decisions, then valid methods of measurement need some kind of standardization. Some data gathering systems (e.g., botanical classification) are accepted throughout the world, but other systems are not. Environmental interrelationships of local, national, international and global scale require standardized description, quantification, and evaluation.

   At present there are at least eighteen different methods of ecological land classification and about ten resource data banks in Canada. In other words, standardization leaves much to be desired. Standardization may be relatively simple to implement for single resource components, but although very desirable, may be difficult to implement with integrated

[1]Williams, D.H. Unpublished. Economic Wood Supply Modelling. Presentation to the Tenth Meeting of the Canadian Forest Inventory Committee. June, 1985 P.N.F.I., Petawawa, Ont.

data bases, simple because of their complexity. Nevertheless, some degree of standardization is necessary before the scientist, the land manager, and public can communicate at local and more global levels.

2. Specializaiton of data input:

There is usually plenty of information available about why we cannot produce certain things on certain lands (limitations) but not much about what can be produced (suitability). To obtain better land management, land suitability for various land uses needs to be determined and described. Such an exercise aids in deciding what data to collect. Development of an integrated data base encourages the incorporation of specialization into biosphere studies and can include teams of scientific specialists; e.g., soil and vegetation scientists, wildlife biologists, social scientists, etc.

3. Synchronization of research:

Research carried out in the field at the same spot and at the same time by specialists (soil, wildlife, vegetation, and other fields) is much stronger and provides a better integration of the various biosphere components than one where the work is done in separate segments.
An ELC team of specialists can encourage an interchange of ideas between geologists, soil scientists, vegetation scientists, and wildlife biologists. Also, there is a saving because all resource components are examined at the same time. Synchronization of research can result in a more thorough effort as well as better comprehension of the biosphere and consequent planning and management.

4. Concentration of data acquisition:

An integrated data base requires uniformity of data collection, both in intensity of sampling and quality of data. Greater success can be expected if the biosphere studies are carried out under one authority, thus coordinating the research and planning of provincial and federal agencies.

5. Maximization of data use:

Maximization of information and its use requires increased efficiency in terms of productivity and quality of data. Determination of how much data to collect, and what kind, is essential because of high costs of data acquisition. Reduced costs can be expected because data can be selected that is pertinent to the problem to be solved. Research is required to develop improved interpretation of resource data for land use purposes, including impact predictions of land management actions. Such research will increase the efficiency of resource data use and lead to maximization of return for the initial research input.

6. Centralization of data base:

A centralized data bank can provide an ELC technical centre. In addition, it can assist data users and provide encouragement of data use through data sharing.

It is not known whether use of the above principles is good or bad. Does Canada want to be an intensely industrialized forestry nation? What is the impact on the environment created by standardization, specialization, synchronization, concentration, maximization, and centralization?

An integrated data base could be used to develop a set of stop/go guidelines for land use management. A simple set of do's and don'ts. However, land use management goals must be clearly defined; e.g., the concept of sustained forest yield may have to give way to one of doubling or tripling of future yield. To answer such a question requires development of a predictive capability in the data base.

An integrated data base could be used for periodic land use review and monitoring of ecological change, especially in some of the monoculture types of land use. It could tell us about what is happening to nitrogen and phosphorus levels, the organic matter, soil pH, and all the other variables that we know are slowly changing but are rarely monitored over a long period of time. Comparison of land use within the ELC area with that outside can assist in the monitoring of ecological change and development of a predictive capability for impact of certain land uses.

A properly designed integrated data base would provide a great saving in time. A tremendous improvement over presently used methods would be development of a field to computer linkage where the data could be entered into the computer right in the field, doing away with field forms. An integrated data base developed over a number of years should be able to answer certain questions without the collection of additional data.

In addition to providing baseline resource studies, monitoring of the impact of various land uses on the environment, and prediction of response to management decisions, the ELC can provide some additional freedom for research. Some suggested topics are:

1. The relationship of forest to grassland and agriculture and to animal grazing, both wild and domestic.
2. The effect of ecological processes on environmental stability and fragility under different land uses. Included subjects are the intensity and time of land use (human and wildlife), development of interpretation for hazard ratings (e.g., windthrow, flooding and frost), determination of pathways and rates of vegetational succession, impact of insects and disease, and resource degradation.
3. The size, pattern, and distribution of land resources as it affects land use by wildlife and humans.
4. The impact of engineering (i.e., roads, trails, bridges, etc) on resource use.

5. Actual and predicted environmental response to various kinds of land management under specified land use: e.g., if an area is cut, how difficult is its regeneration on different kinds of land with different kinds of forests, and comparisons of different intensities of land use.

An immense amount of work is required between agencies and the public in order to gain acceptance of ELC concepts. Proposals are needed, responsible agencies need to be identified and involved, and the public informed through public meetings, mailings, etc.

The time for ELC is immediate. Environmental degradation can be so insidious that it is not noticeable until the cummulative impact is felt.

The experience gained in one ELC area can certainly be extended to other areas; if not directly transferable, then at least the methodology is transferable.

Suggested guidelines to make an ELC function better are as follows:

1. An ELC should be based on ecological principles, including suitabilities and limitations of resources for certain uses. Ecological principles are not adequately described in ecology texts; thus it seems appropriate to base them on biophysical relationships of heat, light, moisture, oxygenation, mechanical impedance to rooting, plant competition (e.g., light, moisture, nutrients), and damage and disturbance (e.g., undercutting and root pruning, or soil movement such as frost heaving and dessication cracking). However, it must be remembered that an ELC must include living things and their relationship to the above growth factors.
2. The map, legend, and report should be easily interpretable in order to assist with management decisions. There should not be too many map units and the system should be kept as simple as possible.

3. The map unit concept should be repetitive and holistic so that information obtained about land use response in a familiar area can be transferred to a similar but unfamiliar area. This is particularly useful when one wishes to develop response units for certain kinds of management.

4. The mapping must be based, as much as possible, on relatively permanent feature of the landscape; e.g., landforms, soil, climax vegetation, or seral stages with long term stability.

5. Mapped information should be of uniform intensity and reliability throughout the mapped area.

6. Classification units should not be confused with mapping units. Map polygons must be rigorously defined and maintained.

Advantages of Using ELC

See the principles and guidelines listed above, and the following:

1. First and foremost is the possibility of basing land classification on ecological principles.

2. A multi-disciplinary team of scientists can be assembled. This provides professional people with field experience and expertise.

3. An ELC can be designed with sufficient flexibility to suit your purpose.

4. ELC develops a holistic ecological viewpoint.

5. ELC replaces a variety of single discipline methods: e.g., landform, soils, vegetation.

6. It costs less than a number of separate inventories.

Disadvantages of Using ELC

1. Must have a multi-disciplinary team of scientists; decisions may take longer to develop.

2. ELC is difficult to apply where natural vegetation is severely disturbed or has been replaced; e.g., from Lethbridge to Calgary.

3. Because of the variety of disciplines involved, it is difficult to coordinate ELC work; i.e., to maintain concepts and guidelines; the team requires training and field trips that refresh concepts and use of ELC guidelines.
4. It may be a problem to satisfy all users; e.g. wildlife biologists, wardens, planners, botanists, etc. This is really a problem that needs to be handled by means of technology transfer through an extension service.
5. Occasionally there is not enough research available in order to establish ecological relationships; e.g. how to establish ecological response units where environmental conditions are assumed to be similar.

Suggestions for Development of New ELC Projects

1. Determine the objectives of an ELC through consultation with potential users. It is desirable to develop a set of specific criteria to guide formation of an ELC framework (Driscoll et al, 1983).

   The national parks, for example, imposed limitations on their ELC because they were not interested in vegetational growth data. Later, requests for reclamation work indicated that collection of growth data would have been useful. Similarly, some foresters impose limitations by confining their interests to stems of trees, or a single tree species such as white spruce or pine and excluding hardwoods, understory vegetation, water, and wildlife concerns.
2. Decide on the kind and amount of data that are required, recognizing any research needs.
3. Mappers should be selected early, remembering that soil survey has a mapping tradition whereas many wildlife biologists, and others, do not; i.e., fit people to the job.
4. Mapping parameters must be rigorously defined and maintained; e.g., mapping scale, polygon base, mapping unit, and type of legend (open or closed).

5. Use, or develop a hierarchical classification. It is particularly useful for describing ecosystems and their components, and provides a means of understanding the landscape at different scales. Mapping, however, is usually done in one hierarchical level; e.g., mappers do not mix ecoregions and ecosites.
6. An adequate correlation level must be maintained.
7. Become involved with the data users, but do not stop at the taxonomic level of an ELC. Classification should be followed by applications; e.g., interpretive classifications and development of land evaluation techniques for various land uses.
8. Be aware of regional variations of resource components; e.g., climate, landforms and genetic materials, and water. e.g., the Shield at Flin Flon and the Shield at Thunder Bay.
9. Be aware of ELC applications.

Applications of ELC

Applications of ELC are limited by the kind and amount of data collected. Interpretations and decisions should not exceed such limitations. The following list suggests uses for ELC:

1. Quantification of resources; i.e., their distribution in map form. The mapping process quickly reveals details of the amount of certain resources and their location; see Tables 1, 2, 3, and 4 (Holland, 1984) and Table 5 (Tarnocai, 1975).

Table 1. Ecoregions and subdivisions

Montane	99 185	ha	5.5%
Subalpine	906 020	ha	50.3%
- Lower Subalpine	(512 831)	ha	(28.5%)
- Upper Subalpine	(393 188)	ha	(21.8%)
Alpine	101 665	ha	5.6%
Miscellaneous Landscape	691 650	ha	38.6%

The majority of the Montane Ecoregion occurs in Jasper. Approximately 2% of Banff national park is in the Montane. The climate of the Montane is warmer and drier than the harsher climate of the other ecoregions. This more-pleasing climate, along with the attraction of Banff townsite, causes humans and wildlife to use the Montane resources more intensively than those in other areas of the park. The result is overuse of resources in a small portion of the park and underuse elsewhere. The impact can be critical to some wildlife populations and to the appearance of the park, especially along the main entryway from the east. The ELC maps quickly indicate the location of the resources that are most in need of conservation.

Table 2. Dominant chemical characteristics of genetic materials by area

Miscellaneous landscapes (undivided)	38.6%
Calcareous	37.3%
Noncalcareous	15.5%
Variable (calcareous-noncalcareous mixtures or Undivided)	8.6%

This summary table indicates that less than half of Banff and Jasper are calcareous, upsetting previous concepts that the materials in the parks were nearly all calcareous.

Table 3. Banff-Jasper soil texture by area.

Miscellaneous landscapes	38.6%
Coarse	6.8%
Medium	42.0%
Fine (includes fine over medium or variable)	0.3%
Stratified (coarse stratified + fine stratified)	5.7%
Variable (coarse-medium-fine and medium-coarse mixtures)	6.6%

The percentage of fine clayey soil is extremely low.

Table 4. Banff-Jasper soil drainage by area.

Miscellaneous Landscape (undivided)	38.6%
Wetland soils (drainage classes 5-7)	8.0%
Well-drained or upland soils (drainage classes 2-4)	53.4%

The amount of poorly drained soil is low, only 8%. The impact on the wildlife resource can be predicted.

Table 5. Resource distribution in the Pas map area, Manitoba

Water	34%
Organic	32%
Poorly drained soil	14%
Well drained soil	20%

Twenty percent of the map area is suitable for most forestry operations. However, the pattern of distribution of well drained soils may well determine their usefulness. An examination of the resource map will indicate whether the useful soils are distributed in small scattered areas or whether they occur in larger, more contiguous blocks. The difference is one of economics.

2. Qualification of resource characteristics through determination of their suitabilities and limitations. In making an interpretive classification, several principles should be observed:
   a) Define clearly the purpose of each classification.
   b) Classifications are generally based on the kinds and degree of limitation for a specific land use. The ranges of the resource qualities that define the various classes should be defined as precisely as possible. Resource groupings are usually according to one resource quality.
   c) Classifications generally contain few classes. An odd number of classes permits two extremes as well as a mean average class, three to five being most common. More classes may be needed for intensive management, but a large number of classes becomes unwieldy and does little to help simplify the information.
   d) The intensity of management for a particular classification must be stated, because many limitations can be reduced by management. Thus, a factor such as high tree density, which may be severely limiting in a backcountry campsite with a low intensity of management, may present less severe limitations in a highly developed area where more intensive management permits clearing of access roads, paths, and tent pads.
   e) Interpretive classes are relative - good, fair, poor. Such groupings are dynamic and can be changed as situations change, for example, an altered management practice.

Examples of these principles applied to interpretive classifications based on soil limitations are in Soils of Waterton Lakes National Park (Coen and Holland 1976).

3. Gradient analyses can be developed from ELC data; e.g., moisture gradients from wet to dry according to vegetation types and soils.
4. ELC data can be used to make predictions, especially productivity. Predictions can also be developed for stability of resource use, impact of resource use on the environment, direction of vegetational succession, and management requirements (drainage, fertilizer needs, etc.).
5. ELC data can be used for modelling, especially for land use purpose. Serious efforts at land evaluation modelling have been done by the Land Evaluation Group, University School of Rural Planning and Development, University of Guelph, Guelph, Ontario.
6. ELC data can be used to develop management guidelines for such things as species suitability, fertilization needs, and silvicultural requirements for increased productivity.

Who are the successful people; regardless of activity? History shows it to be those that are best organized, in thought, research, planning, and action. ELC is one step along the road to progress.

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