

EcoGen – A Model for Predictive Ecosystem Mapping

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Introduction

Over the past few years, predictive ecosystem mapping (PEM) approaches to resource inventory have come on the scene as an alternative to more conventional mapping and classification methods such as Terrestrial Ecosystem Mapping. This PEM information, as with TEM, is purported to support a wide variety of resource planning needs ranging from strategic-level planning to more detailed on-site applications. Even though PEM is new to British Columbia, PEM models have been in development through the past decade. The EcoGen model is a PEM method being developed by the B.C. Ministry of Forests. Its development has been driven by the need to obtain TEM-like information for more geographically extensive areas, more readily and more cost-effectively, for application in determining site quality, ecologically based yield analyses, and wildlife habitat assessment.

Conventional resource inventories, as we have known them for decades, are undergoing both a technical and business model paradigm shift. The technical evolution is being driven by new capabilities for acquiring, processing, integrating and warehousing resource information and knowledge digitally. It is enabled by various technologies like remote sensing, image processing, GIS, knowledge-based systems and information networks. Concurrent with this is a trend towards greater data and information integration across inventory programs. With the present fiscal environment, people are now looking at opportunities for gaining efficiencies and greater information integration. Predictive ecosystem mapping is a response to these changes.

Predictive Ecosystem Mapping

Ecological classification systems provide a framework to organize and communicate our knowledge about the nature of physical and biotic features of landscapes. In British Columbia, the Biogeoclimatic Ecosystem Classification (BEC) system has provided a classification of the basic ecological units in the province and is an integral component of forest management. PEM and TEM are approaches to map the ecosystem units of BEC at a large scale.

Predictive Ecosystem Mapping (PEM) is a new and evolving inventory approach designed to use available spatial data and knowledge of ecological-landscape relationships to automate the computer generation of ecosystem maps. It typically involves the spatial overlay of mapped themes and the processing of the resultant attributes against a formalized knowledge base using automated inference methods. It offers the promise of providing surrogate terrestrial ecosystem maps. Figure 1 demonstrates the overall principle of PEM – that ecological map delineations can be derived from other digital maps and the attributes associated with their polygons.

EcoNotes are produced by the Ecology and Earth Sciences Section, Research Branch, BC Ministry of Forests. EcoNotes are available online at <http://www.for.gov.bc.ca/research/ecogen/furinfo.htm>. Contact Del Meidiger, Research Ecologist at Del.Meidiger@gems2.gov.bc.ca for further information.

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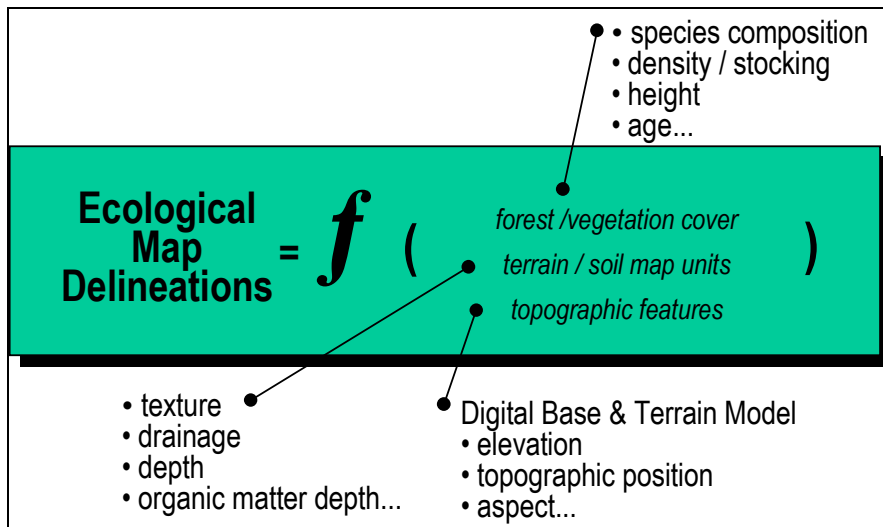


Figure 1. General model of predictive ecosystem mapping (adapted from Jones *et al.* 1999)

The advantages of PEM are many. Much of the drive behind PEM development has been to address the high cost of conventional ecosystem mapping approaches. While cost and time savings are possible over traditional approaches, there are other advantages that should be given equal emphasis. For example:

- Improvements in inventory cost, production and human resource capacity — PEM approaches provide a more systematic, consistent and repeatable stratification process; have reasonable flexibility, and can adjust to changing information and knowledge sources; and offer opportunities to increase mapping efficiency and the rate of mapping.
- Capitalize-on, add-value to and protect investments in classifications and resource inventories — as much inventory is already available digitally, and we have an existing ecological classification system, PEM will provide more explicit and documented capture of the relationship knowledge. This will provide greater understanding of ecosystem and landscape relationships and how to best map these features in subsequent iterations.

There are also some disadvantages. For example:

- Existing map information bases lacking in quality — existing map input sources for PEM may be absent, non-digital, of an inappropriate scale or survey intensity level, or may simply be of poor positional or thematic quality.
- Existing ecological knowledge of inadequate quality — ecological classifications may be absent or of limited value for the area under consideration.
- Relationships between ecosystem classes and attributes in existing digital data are poor — poor linkages may result in unacceptable or ambiguous predictions.

EcoGen Model

Figure 2 provides an overview of the EcoGen model. EcoGen uses available geographic and inventory data to map site series. Ecosystem maps from EcoGen can be used for wildlife interpretations in land management planning, for analyses of potential timber yields using site index – biogeoclimatic ecosystem classification (SIBEC) relationships, or for any other ecosystem-based interpretive needs.

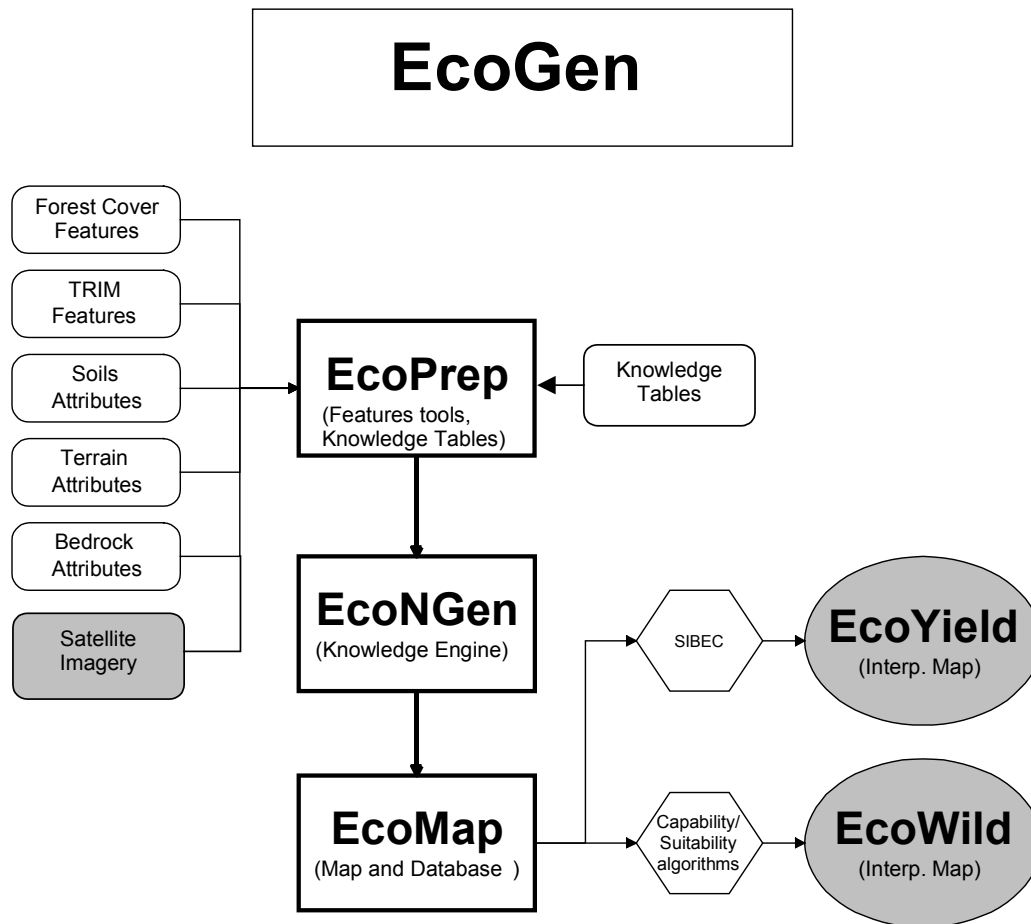


Figure 2. Components to EcoGen Model (see also: <http://www.for.gov.bc.ca/research/EcoGen>)

At present, EcoGen is not fully functional. The shaded shapes in Figure 2 identify components that are under development. The present status of each of the components of EcoGen is discussed below.

EcoPrep

EcoPrep involves the extraction of attributes and the manipulation of digital data layers in preparation for input into the model. In addition, knowledge tables that express the relationships between attributes of the digital data and the ecosystems to be mapped are prepared. The following steps are undertaken in the EcoPrep phase:

- Digital data layers (e.g., forest cover) are selected based on which ones are available or can be made available.
- Attributes of the digital layers that have predictive capability in the determination of site series are selected and added to knowledge tables.
- New attributes may be created as combinations of attributes or queries of the data (e.g., spruce in any of species 1 through 6, or spruce as any of first or second species).
- The data may be manipulated to create new data layers (e.g., identification of ridges or toe slopes using DEM from TRIM).

- Decisions on which digital layers will be overlaid and which will be used to attribute polygons need to be made.
- Relationships between attributes and site series or other ecological map entities are evaluated and entered into knowledge tables.
- The digital data layers, databases, and knowledge tables need to be converted to the proper format.

The EcoPrep phase also involves the development of large-scale biogeoclimatic maps by modelling the biogeoclimatic relationships onto TRIM maps (see <http://www.for.gov.bc.ca/research/bigbgc/>).

The first version (Version 1) of EcoPrep will have programming to allow the following attributes to be derived from the TRIM DEM:

1. Slope class (used in deriving PEM polygon).
2. Aspect class (used in deriving PEM polygon).
3. Riparian benches off of lakes and rivers.
4. Gullies and influence of gullies.
5. Hilltops and influence of hilltops.
6. Ridges and influence of ridges.
7. Toes of slopes.
8. Elevation.

Two other sets of features are extracted from the TRIM data files. First, the presence of landform features (i.e., esker, cliff/scarp, slide, beaver dam, flooded area, spring, moraine/skree, lavabed, avalanche track, snow/ice/glacier), and second, the density of streams in each PEM polygon.

These “features tools” within EcoPrep have been written in ArcInfo AML code and are presently being compiled into a package for release to the mapping community. They are also being applied in pilot projects in Telkwa and the North Coast Forest District.

EcoNGen

The EcoGen model engine, EcoNGen, is available and is being used to process data and knowledge tables for several large projects. The model has been released on the EcoGen web site: <http://www.for.gov.bc.ca/research/ecogen/download.htm>

At present, the following projects are using EcoNGen:

- Merritt Forest District (IFPA).
- Germansen Landscape Unit (Slocan Forest Products).
- Telkwa Planning Unit (Research Branch, MoF).
- Morice Forest District (Prince Rupert Forest Region).
- North Coast pilot (Research Branch, MoF and Prince Rupert Forest Region).
- NDT4 (Kamloops Forest Region).

EcoMap

The EcoMap module compiles the attribute data in a TEM-like database format and produces a map. We will be making some changes to the output format after the approval of the PEM digital data standards by the Resources Inventory Committee.

Interpretive Products

The interpretive products possible from predictive ecosystem mapping are similar to those that can be derived from TEM. These include ecologically-based yield analysis, wildlife capability mapping, conservation planning, and other landscape- or strategic-level planning decisions. In EcoGen, we are preparing modules to assign site index to PEM polygons for ecologically-based yield analyses and to develop wildlife habitat capability assessments. These are called EcoYield and EcoWild, respectively.

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Literature Cited

Jones, K., D. Meidinger, D. Clark and F. Schultz. 1999. Towards the Establishment of Predictive Ecosystem Mapping Standards: A White Paper. 1st Approximation. TEM Alternatives Task Force, Resources Inventory Committee, Victoria, BC.
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