

Regulation through Forest Modeling

Regulation through Forest Modeling

- Concepts of the normal forest, sustained yield forestry, and forest regulation through the use of formulae were grounded in a forestry tradition with a history of approximately 400 years
- The implementation of this style of management based on the sustained yield model of forest regulation has resulted in what is commonly seen through much of Europe today

Regulation through Forest Modeling

- That is, a relative dearth of natural forest land and an abundance of forest plantations
- The maximization of timber yield is a key underpinning of classical forestry however, unfortunately, it often results in a loss of forest diversity and wildlife habitat

Regulation through Forest Modeling

- These principles have resulted in activities such as the export and development of extensive Radiata Pine plantations throughout sub-tropical regions of the earth with significant resulting loss of biodiversity in these areas

Regulation through Forest Modeling

- Modern forestry and resource management has largely evolved away from the idea of managing *timber* to more holistic approaches to forest management or ecosystem management which value and attempt to sustain all of the biodiversity within the forest

Regulation through Forest Modeling

- Simple area or volume based calculations of allowable cuts and simplistic notions of the “normal forest” are incompatible with ideals of forest ecosystem management
- In order to deal with the added complexity associated with more holistic forms of management; modern forestry relies on the use of models to help balance objectives within the context of managing the forest

What is a model?

- A **model** is a representation (normally a simplification) of a real system or circumstance which is used to illustrate, understand, or forecast how the real system or circumstance might respond to various, stimuli, or forces in the real world.
- In forest management, models are normally computer programs which forecast how a forest will develop and what outputs and outcomes can be expected in response to a particular set of management actions

What is a model?

- A forest management model is not unlike a forestry video game.

Regulation through Forest Modeling

- Most forest management (wood supply) models are optimization models which are based on a mathematical concept known as linear programming.
- Regulation/management of forests aided by the use of linear programming appears in the literature first in the 1960's and has gained increasing prominence as the availability, power and flexibility of computers have developed

Regulation through Forest Modeling

(With apologies to any one who actually understands LP, from Bill's perspective, ...)

- LP is essentially based on repetitive iterations (by the computer) to try to obtain an optimal stream of outcomes within a particular set of constraints
- it is not unlike the thought process one goes through in determining their next move in chess except that the analysis of alternatives is more comprehensive and alternatives are evaluated much more quickly

Regulation through Forest Modeling

- Unlike the human mind however, LP does not deal well with uncertainties which are not easily expressed as an objective function; in order to function LP requires that a stream of events must be foreseeable with relative certainty.
- Sensitivity analysis is therefore not implicit, it is only achievable through successive sets of analysis or "runs" of the model

Regulation through Forest Modeling

- Modern Forest Management Models can be broadly categorized as either being Non-spatial Models or Spatial Models
- Examples of Non-Spatial Models
 - SFMM ~ Strategic Forest Management Model
 - this is a product developed by the MNR and is the default modeling tool for Ontario Forest Management Planning
 - Woodstock
 - this is a product created by Remsoft Inc based out of New Brunswick with strong linkages to UNB
 - Woodstock is the most widely used model by provincial governments across Canada

Regulation through Forest Modeling

Examples of Spatial Models

- Patchworks
 - this is a product developed by Spatial Planning Systems based in Deep River-Ontario
 - Strongly linked to the CFS and the Petawawa Forest Research Centre
- FSOS (Forest Simulation and Optimization System)
 - developed Forest Ecosystem Solutions Ltd. based in North Vancouver
- Spatial Woodstock
 - this is a product created by Remsoft Inc based out of New Brunswick with strong linkages to UNB
 - a spatially relevant upgrade of the standard woodstock program

Regulation through Forest Modeling

- a non-spatial model (like SFMM) works by projected virtual areas of similar forest management conditions forward through time
- these virtual areas are aggregates of forest stands normally defined by forest unit and age class

Regulation through Forest Modeling

- the virtual areas do not exist in a spatially relevant way in the forest since they represent the accumulated area of '00s or '000s of forest stands
- It is therefore impossible to answer spatially relevant questions with the model and the results must always be checked from a spatial reality perspective

Regulation through Forest Modeling

- a spatial model (like Patchworks) works at a stand level
- the model itself is linked to a GIS system and so queries, and results are geographically specific
- Spatially relevant questions related to topics like landscape design can be easily addressed within the model itself

Regulation through Forest Modeling

- Clearly spatial models are the state-of-the-art however most forest management modeling still uses non-spatial models.
- Non-spatial models are less complex, require less computing power and operate with smaller data sets
- They can be learned fairly easily by non-computer “forestry professionals” and are adequate for Strategic level decision support

Regulation through Forest Modeling

- As forests get further along in the management cycle more geographical limitation typically arise,
- couple this with a seemingly endless supply of new policies (many of which have a spatially relevant component)
- and the limitation of non-spatial models become very apparent;
- none-the-less they are still the work horse for most of the country and especially in Ontario

Required Inputs for a Non-Spatial Model

- Non-spatial models require aggregated “parcels” of virtual area; primarily these parcels are defined on the basis of Forest Unit. (or a similar term depending on jurisdiction)

Required Inputs for a Non-Spatial Model

- Forest Units
 - Forest units are used to classify forest stands which have similar conditions and which will be managed in a specific manner
 - Examples of these groupings could be based on:
 - Working group species
 - Particular ranges of species composition
 - Site Class
 - Ecosite
 - Site limitations

Required Inputs for a Non-Spatial Model

- Stands are aggregated into virtual parcels of area based on their forest unit and a pre-defined age class (i.e. 20 year, 10 year, 5 year)
- So we may take 80,000 individual stand records and aggregate them into 12 forest units with 20-10 year age classes
- i.e. we have taken 80,000 real polygons and classified them as 240 virtual parcels of area for the model to work with.

Required Inputs for a Non-Spatial Model

- We now need to instruct the model regarding how to “grow the forest” over time
- This is done through the use of yield curves which plot yield (growing stock) against stand age

Required Inputs for a Non-Spatial Model

- Typically there will be a set of yield curves for each forest unit:
 - Present yield curves ~ how the existing natural forest is currently growing
 - Extensive yield curves ~ how a harvested forest will grow with natural regeneration
 - Basic yield curves ~ how a harvested area will grow with a “basic” level of artificial regeneration
 - Intensive yield curves ~ how a harvested area will grow with an “intensive level of artificial regeneration

Required Inputs for a Non-Spatial Model

- Yield curves are derived in various ways:
 - Poor;
 - Current yield curves based on a standard set of yield curves (Normal Yield Curves) which have been modified based on the average species composition, average site class and average stocking of the forest unit
 - Future yields speculative based on the level of management intervention in the forest

Required Inputs for a Non-Spatial Model

- Yield curves are derived in various ways:
 - Better:
 - Current yield curves are based on actual inventory measurements from the forest
 - Future yield curves based on achievements from FTG surveys
 - Best:
 - Current yield curves are based on actual inventory plus information from Growth and Yield Plots
 - Future yield curves are also extrapolated from permanent sample plots established in various intensities of management

Required Inputs for a Non-Spatial Model

- Natural and Managed Fire Cycles
- Successional Pathways
- Preferences for Strategic Silviculture;
 - i.e. what happens to a particular forest unit after natural or artificial regeneration
 - Maximum and minimum percentages for various specific silvicultural treatments
 - Silvicultural treatment costs
 - Stumpage costs

Required Inputs for a Non-Spatial Model

- Linkage to wildlife habitat outputs
 - Wildlife habitat units
 - Wildlife habitat matrix
- Operational controls
 - Operational age ranges for harvest
 - % of accumulating reserves (for protection of values)
 - % losses due to roads
 - % of timber not harvested; i.e. leaving snag trees or trees for various silvicultural purposes
 - relative value ranking of various species and forest products

General Modeling Methodology

- STEP 1. The Base model
 - The inventory, the yield curves and the basic operational controls are loaded into the model and it is tested to make sure that it runs
- STEP 2. Natural benchmark
 - Typically, in 2010, we are in the business of trying to manage in a more holistic and natural manner; i.e. we are trying to pattern our management after natural process

General Modeling Methodology

- Natural benchmark (Cont'd)
 - To facilitate this create a natural benchmark that we then use to measure our modeling outputs against.
 - The natural benchmark "run" involves instructing the model to use the natural fire cycle, and to eliminate harvesting; we let the model run for 100 or 200 years and we see how things develop
 - Specifically we are interested in such things as:
 - The general forest unit and age class distribution and especially the amount of old growth timber
 - Varying amounts of wildlife habitat for a range of species

General Modeling Methodology

- STEP 3. Scoping Analysis
 - We try to see what the boundary lines are by investigating such things as:
 - What is the maximum amount of timber that can be produced, in the short term, sustainably
 - What is the maximum amount of habitat that can be produced
 - What are the impacts of spending more or less money on silviculture
 - What is the relationship between harvest level and other outputs
 - Can we meet current mill demand
 - What are the impacts of various forest management guidelines

General Modeling Methodology

- STEP 4. Objective Setting
 - What are the ideal outputs from the forest
 - What does the industry want
 - What does MNR want
 - What does the public want
 - What is the vision of the management team and what is the most “natural” stream of benefits that is achievable

General Modeling Methodology

- STEP 5. Management Strategy
 - More Scoping: We test the tradeoffs between the various objectives with the model
 - We come up with complete model scenarios providing a variety of different outputs
 - We decide on one scenario and call it the Management Strategy

General Modeling Methodology

- Management Strategy (cont'd)
 - The selected management strategy will specify the outputs in terms of the allowable cut, and various predicted outputs concerning forest structure and wildlife habitat
 - It will specify how much (and what age class) of various forest units should be cut
PLUS
 - What levels of silvicultural treatments and investments need to be made