North American Forestry Models

Cutting edge technology used in forest management planning

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The Role of Modeling

Computer modeling tools are applied in forest management to provide solutions to a range of planning problems such as:

• forecasting the maximum sustainable yield

• producing schedules of silvicultural treatments and harvesting operations

• identifying ways to satisfy multiple and often conflicting sustainable forest management objectives.

Managers of forests on both public and private lands within North America are required to address increasingly more complex forest management planning issues due to environmental, social and economic expectations and restrictions. Consequently, new and more advanced quantitative approaches are being developed to model:

•Integrating strategic and operational planning level goals and constraints

•Improved representation and understanding of uneven-aged mixed species natural forest management

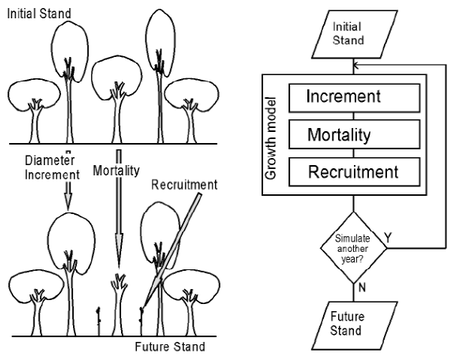
• Emulation of natural disturbance events to maintain biodiversity and enhancing wildlife habitat (continuity and diversity of forest cover)

•Modeling risk of biological losses (disease and insect outbreaks) and abiotic factors (catastrophic fires, wind) into silviculture and wood supply forecasts.

Forecasting Stand Growth

Growth and yield models simulate growth, silvicultural treatments and disturbances in forest stands.

Tree Level Model Mechanics

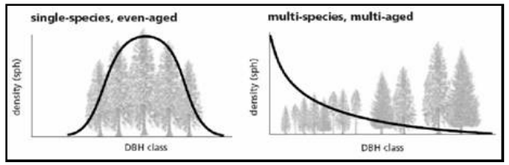


Modeling management of natural uneven-aged mixed species forests is challenging due to variation in structure, species composition, spatial patterns, and stand dynamics over time. This complexity is compounded by natural disturbance events and different types of silvicultural intervention required to match biological characteristics of the stands with management goals.

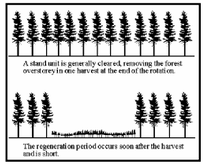
Growth and Yield models are developed for 2 broad groups of forests that differ in structure and appropriate silvicultural systems:

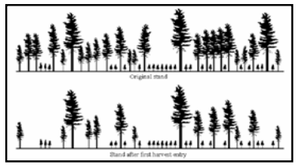
Even-aged forest	*Balanced uneven-aged forest*
Clearcut silvicultural system	*Single tree selection silviculture*

Forest Structure

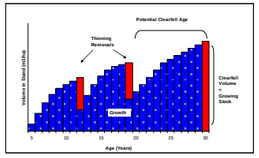


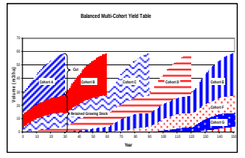
Silvicultural System





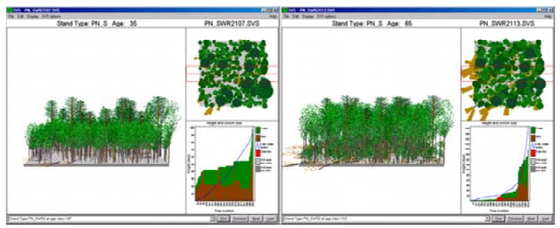
Simulated Growing Stock and Yields





Leading Technology: USDA Forest Service Vegetation Simulator (FVS)

- *FVS can simulate the growth and yield for a wide range of silvicultural treatments for most major forest tree species, forest types, and stand conditions. The model is designed to simulate even and uneven-aged, pure and mixed-species stand management.*
- *The FVS growth and yield model has been extended by a range of modules that simulate the effects of fire, pests, and disease. FVS is also compatible with the Stand Vegetation Simulator (SVS) module that provides 3-dimensional vertical and aerial views of forest stand structures by age or over time.*



Modeling Forest Management

Multiple Management Goals

Forest Estate Models provide managers the ability to manage an entire forest according to one or more goals (economic, social, environmental). Forest management has moved away from sustainable yield management to sustainable forest management that incorporates wood and non-wood values. Precise goals, expectations and restrictions on management vary by tenure, estate size, forest characteristics and location.

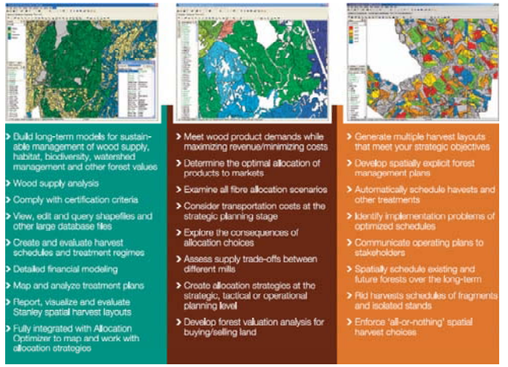
Models for different planning levels

Feature	Planning Level		
	Strategic	Tactical	Operational
Purpose	Availability / Resource Acquisition	Allocation / Resource Use	Execution
Answers Question	How much of what and when	Where (Approx)	Which blocks and precisely when
Planning Horizon	Long Term	Medium Term	Short Term
Management Planning Level	Top	Middle	Bottom
Information	External / Internal	External / Internal	Internal
Level of Detail	Highly Aggregated	Moderately Aggregated	Very Detailed
Uncertainty Level	High	Moderate	Low
Risk	High	Moderate	Low
Scope	Broad	Medium	Narrow
Spatial Detail (Resolution)	Low	Medium	High
Output	Wood Supply Forecast / Management Strategy	Operations Schedule (Indicative)	Operation Plan

Technologies

Remsoft Spatial Planning Systems integrates goals and constraints at different planning levels. The strategic model Spatial Woodstock uses linear programming to optimize long term sustainable management. Stanley translates strategic plans in operation schedules using heuristic techniques.

Other cutting edge optimization products have been developed by DR Systems (OPTIONS), Spatial Planning Systems (Patchworks) and Oregon State University (Harvest & Habitat Model).



Type of Decision	Example
Extent and distribution of reserves	Wilderness
Management emphases for area where active management will occur	High-intensity timber production, scenic areas, big game emphasis
Types of activities allowed	Timber harvest, prescribed fire
Aggregate harvest level over time	Even-flow, non-declining yield
Silvicultural system	Even-aged, uneven-aged
Age structure of forest	Area by 10 year age classes
Size and shape of treatment units	Small units versus large units
Spatial pattern of treatment units	Concentrated or dispersed cutting blocks
Protection strategy	Wildfire suppression policy
Vertical and horizontal diversity / stand density	Approach to partial cutting and prescribed burning
Regeneration harvest timing	Rotation age (even-aged), cutting cycle (uneven-aged)
Regeneration method	Clearcutting, clearcutting with leave trees, shelterwood, selection. Prescribed fire, natural disturbance.

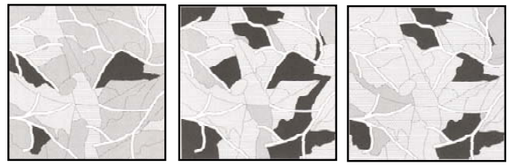
Applications

Landscape Modeling

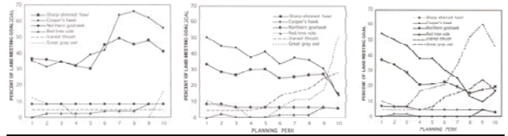
Clearcut *Clearcut emulating natural disturbance*

Ontario Canada Ministry of Natural Resources is using forest estate models for emulating natural disturbance patterns in the boreal forests. The aim is to create a managed landscape that more closely resembles those created by fire and replaces traditional clearcut patterns, with the aim of conserving biological diversity.

Wildlife Habitat Modeling



Maximize non-spatial wildlife species habitat goals *Maximize spatial goal requiring minimum harvest patch size for varied thrush habitat* *Maximizing the spatial goal requiring adjacent patch types for gray owl habitat*



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