Assessing the Effects of Forest Management on Wildlife: The Models

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Introduction

This report reviews characteristics of computer models used or potentially useful for predicting wildlife values in British Columbia's forests, as of March 2000. Table 1 provides descriptions of the criteria that were evaluated; subsequent pages provide details on individual models.

The contents of this report represent the conclusions of the author, based on reviews of written and on-line information plus conversations with model developers and users. The report contents do not represent an official position of the BC Forest Service.

Table 1. Criteria for Model Evaluation

Model	Name of Model
Organization	Organization that developed the model
Developer	Developer of Model
Scale	Tree, Stand or Landscape
Resolution	Pixel (m) or polygon size
Spatial	Spatially explicit, partial representation or non-spatial Stand models would be at the level of the tree Landscape models at the level of a stand or smaller
Input Data	Type of data, GIS, manual
Data Format	ASCII, MS Access, proprietary or other
Ease of Data Entry	Easy, Moderate or Hard Hard stand data may still be less time-consuming than moderate landscape data because of the larger quantity of data required at the landscape scale
Outputs	Tables, graphs, maps
Tree Species	Are individual tree species identified
Seral Stage	Is seral stage modeled
Stand Structure	Is the within-stand structure modeled and displayed
Landscape Pattern	Is the landscape pattern modeled and displayed
Habitat Quality	Is habitat quality for any species output
Species Maps	Are wildlife species maps produced
Ecological Functions	Are the values of species to other components of the ecosystem considered
Cost to Acquire	Is there a purchase cost or license fee
Time to Set Up	Relative time to set up one run (compared to other similar models) Typically a few hours for a stand model, 2 weeks for a landscape model
Time to Run	Time for one run (compared to other similar models)
Hardware	Computer requirements
Software Required	GIS or databases that must be used to run the model Operating system (WIN, UNIX)
Documentation	Is documentation available
Source	Web site reference
Operational Wildlife Examples	Are there operational examples of the model in use (not just prototypes)
Users	Who has used the model
Linkages	Does the model link to other models
Source Code Available	Is the source code available
Comments	General impressions

Model	**TASS**
Developer	BC Ministry of Forests (MoF)
Developer	Ken Mitchell
Input Data	Manual
Data Format	ASCII
Ease of Data Entry	Difficult
Tree Species	Even aged coniferous stands
Outputs	Growth and Yield Tables, Extensive characteristics for live and dead trees, 3D Graphical depiction of actual trees
Attribute Seral Stage	No, but might be generated
Stand Structure	Yes, each branch and each tree mapped and modeled
Habitat Quality	Some extensions for wildlife trees
Species Viability	No
Cost to Acquire	Run in BCMoF Research Branch only
Time to Set Up	High
Time to Run	Moderate
Hardware	Pentium
Software Required	None
Documentation	Extensive online and scientific papers
Source	http://www.for.gov.bc.ca/research/gymodels/TASS/
Operational Wildlife Examples	BCMoF (arboreal lichens), Olivotto Timber (wildlife trees)
Users	BCMoF (many users of output)
Source Code Available	No
Comments	The only truly spatial stand simulator; actually tracks every individual live and dead tree in the simulation and can include other attributes like branch diameter

Model	**TIPSY**
Developer	BCMoF
Developer	K. Mitchell/RAMSOFT
Input Data	from TASS/SYLVER
Data Format	ASCII
Ease of Data Entry	Easy
Tree Species	Even aged coniferous stands
Outputs	Tables/Graphs of volume/age, diameter distribution, mortality
Attribute Seral Stage	No
Stand Structure	No
Habitat Quality	CWD, snags
Species Viability	No
Cost to Acquire	None/Online
Time to Set Up	Low
Time to Run	Low
Hardware	Pentium
Software Required	None
Documentation	Extensive online and scientific papers
Source	http://www.for.gov.bc.ca/research/gymodels/TIPSY/
Operational Wildlife Examples	BCMoF
Users	BCMOF, extensive use throughout BC
Source Code Available	No
Comments	Links to Stand Density Management Diagrams, some approximations for mixed-species stands, uniform or clumped distributions

Model	**Prognosis BC**
Developer	USDA Forest Service (USFS)/BCMOF
Developer	Albert R. Stage, USFS
Input Data	Tree list, Field samples preferred
Data Format	ASCII
Ease of Data Entry	Moderate/Difficult
Tree Species	Single/Mixed, Even/Uneven-aged coniferous stands
Outputs	Tables/Graphs/Stand Diagrams
Attribute Seral Stage	Yes - Limitations
Stand Structure	Yes
Habitat Quality	No
Species Viability	No
Cost to Acquire	None
Time to Set Up	Moderate
Time to Run	Low
Hardware	Pentium
Software Required	None
Documentation	Extensive online, manuals and scientific papers
Source	http://www.for.gov.bc.ca/research/gymodels/progbc/
Operational Wildlife Examples	BCMOF
Users	BCMOF
Source Code Available	No
Comments	Based on USFS FVS (Forest Vegetation Simulator) which models tree vigor and dominance; large base of models from the US that can be adapted to BC, can be used to estimate many innovative silvicultural regimes

Model	MGM - Mixedwood Growth Model
Developer	U of Alberta/BCMOF
Developer	Steve Titus, U of A
Input Data	Tree list
Data Format	Excel
Ease of Data Entry	Moderate
Tree Species	Mixed spruce, aspen, pine
Outputs	Yield tables/Graphs
Attribute Seral Stage	No
Stand Structure	No
Habitat Quality	No
Species Viability	No
Cost to Acquire	None
Time to Set Up	Moderate
Time to Run	Low
Hardware	Pentium
Software Required	None
Documentation	Online and printed tutorial
Source	http://www.for.gov.bc.ca/research/gymodels/MGM/
Operational Wildlife Examples	None in BC
Users	BCMoF Prince George, Alberta
Source Code Available	No
Comments	Yield tables for white spruce and aspen, and black spruce and lodgepole pine mixed-wood stands

Model	**Atlas/SIMFOR**
Organisation	University of British Columbia (UBC)
Developer	John Nelson/Fred Bunnell
Scale	Stand to Landscape
Resolution	Stand/Pixel
Spatial	Yes
Input Data	GIS/Access
Data Format	Proprietary Access Files
Ease of Data Entry	Difficult
Outputs	Maps and tables
Tree Species	Yes
Seral Stage	Yes
Stand Structure	No
Landscape Pattern	Yes - Maps
Habitat Quality	Yes
Species Maps	Yes
Ecological Functions	No
Cost to Acquire	None
Time to Set Up	High
Time to Run	Low
Hardware	Pentium
Software Required	None
Documentation	Manuals Available
Source	Not available online
Operational Wildlife Examples	Many throughout BC; e.g., goshawk habitat in the Kootenays
Users	BCMoF - Nelson
Source Code Available	No
Comments	ATLAS is a well-known harvest simulator, tends to harvest aggressively, SIMFOR calculates indices of habitat quality from ATLAS (or other) schedules, many species models under development

Model	**FSSIM**
Organisation	BCMoF
Developer	Dave Waddell
Scale	Management Unit (Timber Supply Area or Tree Farm Licence)/Landscape
Resolution	Stand or Aggregate Units
Spatial	No
Input Data	Multiple ASCII files
Data Format	ASCII
Ease of Data Entry	Difficult
Outputs	Tables, graphs
Tree Species	Yes
Seral Stage	No
Stand Structure	No
Landscape Pattern	No
Habitat Quality	Some Wildlife Tree extensions in tabular form
Species Maps	No
Ecological Functions	No
Cost to Acquire	None
Time to Set Up	High
Time to Run	High
Hardware	Pentium/UNIX
Software Required	None
Documentation	Online/Publications
Source	http://www.for.gov.bc.ca/ftp/Branches/Timber_Supply/external/!publish/FSSIM/
Operational Wildlife Examples	Many timber supply reviews
Users	BCMoF
Source Code Available	No
Comments	Spatial approximations (FSSIM GIS) are under development, standard model for timber supply reviews, some unofficial wildlife models (i.e. woodpecker snags) have been developed

Model	**Prognosis EI**
Organisation	ESSA - Vancouver/BCMoF
Developer	Julie Greenough
Scale	Stand
Resolution	ASCII
Spatial	Difficult
Input Data	Tables/Graphs/Stand Diagrams/Maps
Data Format	ASCII
Ease of Data Entry	Difficult
Outputs	Tables/Graphs/Stand Diagrams/Maps
Tree Species	Yes - Limitations
Seral Stage	Yes
Stand Structure	Yes
Landscape Pattern	Yes
Habitat Quality	Grizzly Bears, Woodpeckers
Species Maps	No
Ecological Functions	No
Cost to Acquire	None
Time to Set Up	High
Time to Run	High
Hardware	Pentium
Software Required	ArcView
Documentation	Online and Manuals
Source	http://www.essa.com/forestry/prognosis_ei/
Operational Wildlife Examples	West Arm Demonstration Forest (WADF) pilot in Nelson area
Users	WADF
Source Code Available	No
Comments	Combines multiple Prognosis runs over a landscape, with additional environmental variables, any stand model could provide the input (not just Prognosis)

Model	**SHS - Spatial Habitat Supply**
Organisation	Weyerhauser - Nanaimo
Developer	Glen Dunsworth
Scale	Stand to Landscape
Resolution	10 m pixel
Spatial	Yes
Input Data	GIS maps and species models
Data Format	ARC/Info and text files
Ease of Data Entry	Moderate
Outputs	Raster maps and tables
Tree Species	Yes
Seral Stage	Yes
Stand Structure	Yes
Landscape Pattern	Yes - Maps
Habitat Quality	Guilds or Species Models
Species Maps	Yes
Ecological Functions	No
Cost to Acquire	None
Time to Set Up	High
Time to Run	Moderate
Hardware	Pentium
Software Required	ESRI
Documentation	Manuals Available
Source	Not available online
Operational Wildlife Examples	Yes
Users	Weyerhauser - Nanaimo (MB)
Source Code Available	Yes - Restrictions
Comments	Developed from ATLAS/SIMFOR basis; simulated annealing algorithms for harvest scheduling added to ATLAS; small pixels used to represent within stand structure (from retention harvesting); developers are unable to offer support

Model	**SELES/SEED**
Organisation	Simon Fraser University (SFU)
Developer	Andrew Fall/Ken Lertzman
Scale	Landscape
Resolution	Fine pixels
Spatial	Yes
Input Data	GIS
Data Format	ASCII
Ease of Data Entry	Moderate
Outputs	Maps
Tree Species	No
Seral Stage	Yes
Stand Structure	No
Landscape Pattern	Yes
Habitat Quality	Under development
Species Maps	No
Ecological Functions	No
Cost to Acquire	None
Time to Set Up	Moderate
Time to Run	Low
Hardware	Pentium
Software Required	None
Documentation	Online and downloadable manuals
Source	http://www.cs.sfu.ca/research/SEED/
Operational Wildlife Examples	BCMoF Invermere landscape, Kamloops grassland
Users	BCMoF
Source Code Available	No
Comments	Could be best called a modeling language; allows models to be easily developed; many algorithms already developed; new routines relating forest harvesting to road network make the results much more realistic

Model	**TELSA**
Organisation	ESSA - Vancouver/BCMoF
Developer	Werner Kurz/ Walt Klenner
Scale	Landscape
Resolution	Stand or smaller
Spatial	Yes
Input Data	GIS
Data Format	Proprietary Access Files
Ease of Data Entry	Moderate
Outputs	Maps and tables from ACCESS files
Tree Species	Yes
Seral Stage	Yes
Stand Structure	Yes
Landscape Pattern	Yes - Maps
Habitat Quality	Yes - Some Species
Species Maps	No
Ecological Functions	No
Cost to Acquire	None
Time to Set Up	High
Time to Run	Moderate
Hardware	Pentium
Software Required	ARC/View
Documentation	Manuals Available
Source	http://www.essa.com/forestry/projects/
Operational Wildlife Examples	No
Users	BCMoF - Kamloops., ALPAC, USFS
Source Code Available	Yes - Restrictions
Comments	Primarily looks at landscape patterns, includes stochastic estimates of future forest conditions, looks at forest fragmentation and risk

Proprietary

Model	**CASH-FM**
Organisation	Timberline
Developer	David Carson
Scale	Landscape
Resolution	Stand
Spatial	Yes
Input Data	GIS
Data Format	Arc/Info
Ease of Data Entry	Moderate
Outputs	Tables, Graphs, (Maps)
Tree Species	No
Seral Stage	No
Stand Structure	No
Landscape Pattern	Yes
Habitat Quality	Ungulate Winter Range
Species Maps	No
Ecological Functions	No
Cost to Acquire	Proprietary
Time to Set Up	Moderate
Time to Run	Moderate
Hardware	Pentium
Software Required	Arc/Info
Documentation	Papers/No Manuals
Source	http://www.timberline.ca
Operational Wildlife Examples	Crestbrook TFL 14
Users	Industry
Source Code Available	No
Comments	Continuous Area Simulation of Forest Management

Model	**Echo/Forest Estate Model**
Organisation	MacGregor Model Forest/University of Northern BC (UNBC)
Developer	Carey Lockwood/ Stephen Dewhurst
Scale	Landscape
Resolution	Stand
Spatial	Yes
Input Data	GIS
Data Format	Proprietary
Ease of Data Entry	Moderate to Difficult
Outputs	Maps/Tables/Graphs
Tree Species	No
Seral Stage	No
Stand Structure	No
Landscape Pattern	Yes
Habitat Quality	No
Species Maps	No
Ecological Functions	No
Cost to Acquire	Proprietary
Time to Set Up	Moderate
Time to Run	High
Hardware	Pentium
Software Required	None
Documentation	Publications/Manuals
Source	http://www.mcgregor.bc.ca/dss/modelling/about.html
Operational Wildlife Examples	Yes
Users	Northwood (Now Canadian Forest Products) Tree Farm Licence 30/BCMoF Invermere and Mackenzie
Source Code Available	No
Comments	Very detailed and complex strategic planning system, uses simulated annealing forest harvest scheduler that can incorporate multiple social and environmental constraints, Strategic planning uses linear programming

Model	**Forum**
Organisation	Hugh Hamilton
Developer	Guoliang Liu
Scale	Landscape
Resolution	Stand or smaller
Spatial	Yes
Input Data	GIS
Data Format	Proprietary
Ease of Data Entry	Moderate
Outputs	Tables, Graphs, Maps, 3D Images
Tree Species	Yes
Seral Stage	Yes
Stand Structure	No
Landscape Pattern	Yes
Habitat Quality	Murrelet, Southern Caribou
Species Maps	No
Ecological Functions	Carbon Budgets
Cost to Acquire	Under Licence
Time to Set Up	Moderate
Time to Run	High
Hardware	Pentium
Software Required	None
Documentation	Some Manuals
Source	http://www.hugh-hamilton.com/forum.htm
Operational Wildlife Examples	Yes
Users	Slocan Forest Products , BCMoF Vancouver and Arrow
Source Code Available	No
Comments	Uses simulated annealing forest harvest scheduler that can incorporate multiple social and environmental constraints

Model	**OPTIONS**
Organisation	DR Systems
Developer	Don Reimer
Scale	Landscape
Resolution	Stand
Spatial	Yes
Input Data	GIS
Data Format	Proprietary
Ease of Data Entry	Moderate
Outputs	Tables, Graphs, (Maps)
Tree Species	Yes
Seral Stage	Yes
Stand Structure	No
Landscape Pattern	Yes
Habitat Quality	Wildlife Trees
Species Maps	No
Ecological Functions	No
Cost to Acquire	Proprietary
Time to Set Up	Moderate
Time to Run	Moderate
Hardware	Pentium
Software Required	None
Documentation	Some Manuals
Source	http://www.drsystemsinc.com/
Operational Wildlife Examples	No
Users	Industry
Source Code Available	No
Comments	Spatially explicit harvest scheduler incorporating economic valuation

Model	**WOODSTOCK/Stanley**
Organisation	REMSOFT
Developer	Karl Walters/Ugo Fuenekes
Scale	Landscape
Resolution	Stand
Spatial	Yes, strategies not explicit
Input Data	GIS
Data Format	Proprietary
Ease of Data Entry	Difficult (but Version 2 is improved)
Outputs	Tables, Graphs, Maps
Tree Species	Yes
Seral Stage	Yes
Stand Structure	No
Landscape Pattern	Yes
Habitat Quality	Some HIS models for Eastern species
Species Maps	No
Ecological Functions	No
Cost to Acquire	Proprietary
Time to Set Up	Moderate
Time to Run	High
Hardware	Pentium
Software Required	None
Documentation	Extensive online
Source	http://www.remsoft.com/
Operational Wildlife Examples	In New Brunswick
Users	Most widely used of these models
Source Code Available	No
Comments	Woodstock is a strategic planning tool, Stanley is a spatially explicit harvest scheduler; Linear programming optimization is used.

Conclusions (from original report)

Clearly, the level of modelling expertise in British Columbia is very high. We potentially have the world leading forest management models in this province, if some ease of use issues can be resolved.

All of the models work well for their intended purpose. Assessing the environmental impacts of incremental silviculture, however, is outside of the original design of most of them. Partly due to a narrow focus on strategic planning issues, few of the outputs are useful for operational planning. The patterns developed on the landscape are of general interest, but no one pattern is necessarily achievable by forest harvesting. The models tend not to link output to GIS, even when GIS provided the input data.

There has been relatively little consideration to the ecological functions of forests, or the wildlife that inhabits them. This results in models that do not consider the abundance of predators on their prey or the importance of stand structure as refuges

Few of the ecological outputs of the models have been tested. They are believed to be valid based primarily on literature sources. Sensitivity analysis (even of silvicultural outputs) is rarely conducted to see which inputs are most important in determining the critical ecological outputs. Such an analysis is useful to determine data that are necessary to provide sufficient resolution to make a decision as well as to help direct inventory efforts.

TASS could be used to assess the timber supply impacts of silvicultural prescriptions that are designed specifically to improve wildlife habitat supply. For example, the benefits of pruning to producing large branch diameters for marbled murrelet nesting could be represented. These beneficial strategies could then be incorporated into other models with the stand volumes corrected for the TASS results.

PROGNOSIS EI offers a useful model with the most complete environmental indicators. Development in the last 2 years has been targeted specifically at useful output, so this should be no surprise. The ability to represent a large amount of detail in stands that require it, at the same time as evaluating the impacts of stand-level strategies throughout the landscape is a significant strength. The EI extension could theoretically be used to provide landscape level modelling of many stand-level models, other than PROGNOSIS. VDYP, for example, could be used for the projection of unharvested stands. Further investigation of the

possibility of using different stand models within a single landscape model is definitely warranted.