2554 Bowker Avenue
Victoria, British Columbia
Canada V8R 2G1
t: 250/598-2635
f: 250/598-2630
kjones@tnet.net

R. Keith Jones & Associates

A Strategy for Habitat Supply Modeling for British Columbia

Volume II: Appendices

Vision — Decision-makers and practitioners in British Columbia will use habitat supply modeling effectively as a part of a suite of tools to evaluate options for the sustainable management or restoration of habitats, and to predict the potential implications of development alternatives on habitat supply.

Prepared for —

Habitat Modeling Steering Committee

Prepared by —

Keith Jones — R. Keith Jones & Associates
Rick Ellis — Strategic Management Services
Rachel Holt — Veridian Ecological Consulting
Bruce MacArthur — The McGregor Group
Greg Utzig–Kutenai — Nature Investigations

Final Project Report — March 2002

Disclaimer

The use of trade, firm or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the Government of British Columbia of any product or service to the exclusion of others that may also be suitable. This document should be regarded as technical background only.

National Library of Canada Cataloguing in Publication Data
Main entry under title:
A strategy for habitat supply modeling for British Columbia

"Draft. Final project report – March 2002"
Consists of 2 v.; v.2 comprises Appendices.
Includes bibliographical references: p.72.

ISBN 0-7726-4759-3

1. Habitat (Ecology) - British Columbia – Mathematical models. 2. Habitat conservation - British Columbia.
3. Wildlife habitat improvement - British Columbia.
4. Environmental monitoring – British Columbia – Mathematical models. I. Jones, R. Keith, 1950- .
II. British Columbia. Habitat Modeling Steering Committee. III. British Columbia. Ministry of Water, Land and Air Protection.

QH77.C3S87 2002 333.95'09711 C2002-960083-9

Table of Contents

Appendices Note

The following four appendices are referenced in Volume 1 of the strategy report.

Appendix A provides a list of people that were interviewed as a part of the strategy development. These interviews were conducted in the fall of 2000. Individuals in the first list are natural resource managers and decision-makers. A total of 28 people were interviewed in this group. They provided valuable insight into a number of issues and opportunities regarding habitat supply modeling from a user and decision-maker viewpoint. These discussion findings are summarized in Section 4 — State of Modeling: Resource Professional Perspectives in Volume 1 of the strategy report.

Individuals in the second list in Appendix A are modelers and researchers. A total of 18 people were interviewed in this group. They provided an exceptionally useful volume of information on a range of existing habitat supply model–modeling approaches. These discussion findings are summarized in Section 5 — State of Modeling: Modeling Approaches in Volume 1 of the strategy report. Appendix B provides a list of the functional capabilities, model features and system requirements used in the interviews. This list of features represents a first approximation schema for a future *Model Registry* being planned by government to support the habitat supply modeling community. Appendix C provides the detailed responses for each of the 18 interviews. These responses were reviewed by the modelers to ensure the information was interpreted correctly.

The consulting team would like to express its gratitude to all of those who provided freely their information, perspectives and time with these important discussions.

Appendix D provides useful supporting information regarding Forest Growth and Yield Projection Models. It is has been taken from existing information available on line at: http://www.for.gov.bc.ca/research/gymodels/About/about.htm and has been included here for quick reference and to supplement Section 5 in Volume 1 of the strategy report. A number of discussion points included in this material are equally applicable to habitat supply modeling situation.

Appendix A List of Interviewees

Natural Resource Managers & Decision-Makers

Name	Ministry/Company
Bond, Allison	Ministry of Sustainable Resource Management
Brade, Bob	Ministry of Water, Land and Air Protection
Cuell, James	Ministry of Water, Land and Air Protection
Davis, Rod	Ministry of Water, Land and Air Protection
Dunsworth, Ken	Ministry of Water, Land and Air Protection
Fenger, Mike	Ministry of Water, Land and Air Protection
Fuglem, Peter	Ministry of Forests
Hamilton, Evelyn	Ministry of Forests
Heinrichs, Rick	Ministry of Water, Land and Air Protection
Hemphill, Greg	Ministry of Forests
Holmes, Peter	Ministry of Water, Land and Air Protection
Kennah, Jerry	Ministry of Forests
Kurz, Werner	Canadian Forest Service
Mackinnon, Andy	Ministry of Sustainable Resource Management
McDougall, Ian	Ministry of Water, Land and Air Protection
Nyberg, Brian	Ministry of Forests
Packham, Roger	Ministry of Water, Land and Air Protection
Ritchie, Chris	Ministry of Water, Land and Air Protection
Wolfe, Dwight Scott	The McGregor Group Inc.
Simpson, Brian	Ministry of Forests
Stern, Cindy	Ministry of Forests
Stevens, Tory	Ministry of Water, Land and Air Protection
Stewart, Rob	Ministry of Water, Land and Air Protection
Stewart, Rodger	Ministry of Water, Land and Air Protection
Turney, Lawrence	Ardea Biological Consulting
Vanderberg, Ken	Ministry of Sustainable Resource Management
Walker, Jim	Ministry of Water, Land and Air Protection (retired)
Warner, Bill	Ministry of Forests
Wood, Colene	Ministry of Water, Land and Air Protection

Modelers

Name	Ministry/Company
Apps, Clayton	Aspen Wildlife Research
Beukema, Sarah	ESSA Technologies Ltd.
Bonar, Rick	Weldwood of Canada Ltd., Hinton
Bonner, Lynne	Ministry of Sustainable Resource Management
Buell, Michael	Cortex Consultants Ltd.
Davis, Reg	Interior Reforestation, Ltd.
Demarchi, Dennis	consultant
Demarchi, Michael	LGL, Ltd.
Eng, Marvin	Ministry of Forests
Fall, Andrew	Gowlland Technologies Ltd / Simon Fraser University
Hovey, Fred	Ministry of Forests
McNay, Scott	Slocan Forest Products Ltd.
Morgan, Don	Ministry of Sustainable Resource Management
Niziolomski, Chris	Forest Ecosystem Solutions, Ltd.
Olivotto, Gerrard	consultant
Reimer, Don	DR Systems Inc.
Robinson, Don	ESSA Technologies Ltd.
Seip, Dale	Ministry of Forests
Serrouya, Rob	consultant
Steventon, Doug	Ministry of Forests
Sulyma, Randy	Forest Floor Contracting
Tolkamp, Calvin	Ministry of Sustainable Resource Management
Turney, Laurence	Ardea Biological Consulting
Utzig, Greg	Kutenai Nature Investigations
Valdal, Eric	Ministry of Sustainable Resource Management
Voros, Steve	The McGregor Group Inc.
Wells, Ralph	University of British Columbia
Wilson, Steven	Consultant, Gabriola Island.

Appendix B Detailed List of Model Features Used in Interviews

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	
2. Brief Description: Describe the purpose, primary use and functions of the tool	
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer: User: Collaborator:
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Position: Organization: Address: Tel: Fax: Email: Website:
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure - e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – All/Most Life Requisites** **(FF)** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range**	**Project 1.** Project Title: Project Sponsor: Management Issue or Decision Type: Project Purpose: Size of Area: ha Location: **Project 2.** Project Title: Project Sponsor: Management Issue or Decision Type: Project Purpose: Size of Area: ha Location: **Project 3.** Project Title: Project Sponsor: Management Issue or Decision Type: Project Purpose: Size of Area: ha Location:

(FF) All/Most Life Requisites - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	
6. Spatiality Can the tool analyze spatial relationships?	
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. b.
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. b.
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	

12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	a. b.
13. Population component a. Does the model have an integral population analysis component? (i.e.: predict population size?) b. Is it deterministic or stochastic?	a. b.
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. b.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	

System Requirements & Features	
1. Required hardware, devices & operating system?	
2. What commercial software, including version, is required to provide full functionality?	
3. What is the typical set-up time to load program?	
4. What is the typical set-up time to prepare and input data? (range)	
5. What are the minimum data input requirements?	
6. What data formats can be imported?	
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	
8. How long does it take to run a typical data set (not including plotting of map)**?**	
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	
11. What programming language(s) is the model written in?	
12. What level of expertise is required to set-up and maintain the program?	
13. What level of expertise is required to run the program?	
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	
15. What capabilities are there for user-defined outputs?	
16. Is the software proprietary?	

17. What are the purchase/maintenance fees?	
18. What modeling techniques are used in developing the species-habitat relationships?	
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. b.
21. Training, user support?	
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. b.

General observations about the functionality, system requirements and features of a number of habitat supply models that are being used in British Columbia:

Appendix C Modeler Interview Findings

1.1 Adaptive Management of Forestry Practices in Pine-Lichen Winter Range for Northern Caribou in North-Central British Columbia

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Adaptive Management of Forestry Practices in Pine-Lichen Winter Range for Northern Caribou in North-Central British Columbia**
2. Brief Description: Describe the purpose, primary use and functions of the tool	Use of NETICA as a hypothesis generation tool for describing relationships and forecasting expected outcomes related to the abundance of terrestrial lichen.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	User: Randy Sulyma (Interviewee) Collaborators: • Scott McNay – Slocan Forest Products Ltd. • Brian Nyberg – Ministry of Forests, Forest Practices Branch
4. Contact Information: (e.g.: Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Randy Sulyma Position: Forest Ecologist/Biologist Organization: Forest Floor Contracting Address: Box 271 Ft St. James BC, Canada V0J 1P0 Tel: (250) 996-8499 Fax: (250) 996-8499 Email: sulyma@cnetdirect.com Website: None.
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: Site series – structural stage combinations, - e.g. : old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure	**Project 1.** Project Title: Adaptive Management of Forestry Practices in Pine-Lichen Winter Range for Northern Caribou in North-Central British Columbia. Project Sponsor: Forest Renewal BC, BC Ministry of Forests, Vanderhoof IFPA Management Issue or Decision Type: **D** Project Purpose: To use NETICA as a monitoring tool to get an indication of how disturbance from forestry activities impacts lichen growth and regeneration. A series of treatments regimes examine different forms of harvesting (e.g.: cut to length forwarding, ground based skidding), season of harvest, and different site preparation techniques. There are currently two project sites each containing 6 treatment regimes (~10 hectares each). Two of the treatment regimes overlap between the two sites. In year one ground sampling conducted to established

e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite (FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – (FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	baseline data. Both sites are in late stages of succession in terms of terrestrial lichen development. Future years sampling will measure the level of lichen abundance after the forest overstory is removed. Expected management decisions arising from the research will be related to forestry activities that can be conducted on these sites – specifically level of disturbance that is acceptable regarding impacts on the lichen community, and in turn the timing of forest harvesting practices and suitability of harvesting methods. Size of Area: ~100 hectare sample sites across forest landscape. Location: Two areas: (i) Southern extent of Mackenzie Forest District - Omineca Northern Caribou Project; and (ii) Vanderhoof Forest District-Laidman RMZ – Vanderhoof IFPA caribou project.
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Lichen response – percent cover of terrestrial lichens
6. Spatiality Can the tool analyze spatial relationships?	Not independently. However, using NETICA model to assign and change values associated with each polygon – information can be summarized using a GIS such as ArcView to map the results.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	No.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes. NETICA can be used to evaluate spatial relationships of pine-lichen-caribou habitats for various ranges in conjunction with a GIS (e.g: various elevations and movement corridors).
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Indirectly. The relationships established by experts are defined in the NETICA model (i.e.: BEC subzone variant information is an input to the NETICA model). b. Theoretically any. Subject to the data and geographic extent – some ArcView limitations are being experienced with too many pixels for to analyze.
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. ~ 1 million cells. b. 950,000 hectares at a 1 hectare resolution.
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive	Workshops were held with a number of experts to identify relationships and expected outcomes. The main intent was to build the model without using

participatory process "workshop" OR derived through regression analysis)	data and then collect and use data to test and refine the model over time.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	a. Yes. The use of NETICA was used defined to explicitly represent and quantify the expected relationships and resulting outcomes. The key factors related to lichen were associated with disturbance, stand age and site factors (e.g.: ecological unit, slope, aspect, elevation.) b. A user interface is under development (Rob McCann)
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?) b. Is it deterministic or stochastic?	a. No. Caribou Population using the outputs from sub-models is under development. b. Deterministic.
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. No. In conjunction with in others tools (SELES and ArcView) can do forecasting. Using NETICA model to identify good, medium, poor availability of lichen abundance. b. Assessment – Bayesian Belief
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	SELES, ArcView3.1, MS Access, MS Excel

System Requirements & Features	Response
1. Required hardware, devices & operating system?	WIN 98+, WIN NT, ArcView3.1 GIS and Spatial Analyzer
2. What commercial software, including version, is required to provide full functionality?	NETICA 1.37
3. What is the typical set-up time to load program?	5 minutes
4. What is the typical set-up time to prepare and input data? (range)	Can take several weeks to prepare input data for the model, however time is dependant on the size, availability and quality of data.
5. What are the minimum data input requirements?	Trim, Forest Cover, TEM, Roads, Cut-blocks, BEC, Towns, Management Units from BC Environment, RMZ/LU from BC Forest Service, Moose population units, caribou migration routes, future mainlines to allow harvest of the THLB.
6. What data formats can be imported?	Ascii — Data sources are BC standard datasets (described above) and input routines are built to handle those formats.
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Ascii
8. How long does it take to run a typical data set? (not including plotting of map)	Dependent on the number of sub-models and the geographic extent and resolution.
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes. Data preparation issue.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	N/A. Function of the GIS or spatial model
11. What programming language(s) is the model written in?	NETICA (C++), ArcView (Avenue), MS Access (SQL)
12. What level of expertise is required to set-up and maintain the program?	Low – to develop belief network. Medium to High – to integrate with other software packages
13. What level of expertise is required to run the program?	Low to Medium.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Ascii File Some NETICA probability graphs.
15. What capabilities are there for user-defined outputs?	None. Data output formats allow for post-processing and

	display.
16. Is the software proprietary?	No. For Belief Network and Sub-models. Yes. Enabling software NETICA, ArcView, MS Access and MS Excel.
17. What are the purchase/maintenance fees?	None. For Belief Network and Sub-models. See appropriate website vendor for above-mentioned enabling software.
18. What modeling techniques are used in developing the species-habitat relationships?	User-defined to develop initial model species-habitat relationships. Eventually replace expert systems with empirical models as they become available.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	Yes. Some basic statistics.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets**)**	a. Potentially, the model would be transferable provided that the user recalibrates relationships to reflect local conditions. b. Fairly generic however subject to complexity of sub-models.
21. Training, user support?	Currently, some training and user support is available through NETICA. Documentation for the modeling system is fairly limited.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Online manual at the NETICA website. Project specific documentation for the Omineca Northern Caribou Project is expected by April 2002. b. Omineca Northern Caribou Project: • www.otaku.unbc.ca/nfrep/caribou/main_frame.html NETICA: • www.norsys.com

1.2 SELES - Spatial Explicit Landscape Event Simulator

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**SELES - Spatial Explicit Landscape Event Simulator**
2. Brief Description: Describe the purpose, primary use and functions of the tool	The purpose of the SELES is to allow people to think about their problems in the way that they would normally think about landscape patterns and processes. SELES allows people to have the flexibility to implement the models required to address their problems – as opposed to trying to adapt their problems to fit an existing tool. SELES is not a model, but is a tool to design, construct, implement, and run spatially explicit landscape models. SELES provides a language for specifying models and a simulation engine for running models written in that language. The SELES language uses terminology that is familiar to ecologists and biologists in terms of dealing with landscape scale problems.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Main Developer and User: Dr. Andrew Fall
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address)	Name: Dr. Andrew Fall Position: Researcher Organization: Gowlland Technologies Ltd and Simon Fraser University Address: 2637A Chilco Road, Victoria, BC, Canada V9B 3J8 Tel: (250) 391-1918 Fax: (250) 391-1918 Email: fall@cs.sfu.ca
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features (CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability (CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability (CF)** - Variable area	**Project 1.** Project Sponsor: BC Ministry of Forests Project Purpose: To examine how uncertainly and variability in natural disturbance impacts on timber supply. This project evaluates the use of empirical models of natural disturbance (e.g.: fires, Western Hemlock Looper, Mountain Pine Beetle) and succession in relation to timber supply. Management Issue or Decision Type: **D** Size of Area: 1.4 million ha Location: Robson Valley TSA Resolution: 6.25 ha per cell (coarse) **Project 2.** Project Sponsor: Parks Canada Project Purpose: Examining connectivity of Caribou habitat to help define protected area boundaries and

- Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite (FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – (FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	assist with negotiating different management zoning adjacent to the proposed park boundaries to help maintain connectivity of Woodland Caribou habitat in the park and surrounding landscape. Telemetry information on the Woodland Caribou was incorporated in empirical models. Management Issue or Decision Type: **A, D** Size of Area: 10 million ha Location: Manitoba (Proposed National Park) Resolution: 4 ha per cell (coarse) **Project 3.** Project Sponsor: BC Ministry of Forests Project Purpose: Hydrological flow modeling project to identify key habitat features based on digital elevation models. To try to reduce the costs of terrestrial ecosystem mapping using predictive ecosystem mapping. Management Issue or Decision Type: **A** Size of Area: 1 million ha Location: Prince Rupert Forest Region Resolution: 20 m per cell (fine) **Project 4.** Project Sponsor: NSERC Project Purpose: Individual-based bird dispersal models for landscape connectivity analysis. To assess implications of forest fragmentation on bird species persistence and dispersal ability across different spatial patterns of forest. Using individual based bird dispersal models to assess the implications on forest fragmentation. Individual agents model parameterized using extensive field data. Management Issue or Decision Type: **D, F** Size of Area: 2,000 ha Location: Alberta and Quebec (southern Boreal where agriculture land mixes with forest fragments) Resolution: 20 m per cell (fine) **Project 5.** Project Sponsor: SFM Network Centre of Excellence Project Purpose: To assist in development of SFM policy options in the boreal forests of central Quebec. To develop management plans that integrate habitat requirements for a variety of boreal species (e.g.: birds, late seral dependant species such as Pine Marten) Management Issue or Decision Type: **A, D** Size of Area: 3 million ha Location: Central Quebec boreal forests Resolution: 14 ha per cell (coarse) **Project 6.** Project Sponsor: Slocan Forest Products Project Purpose: To examine interactions between

	management and Caribou Habitat. To develop a model of long term landscape change for assessing and comparing Caribou management strategies. To provide input to NETICA a bayesian belief network system. The model provided input from different management regimes (biodiversity guidebook, patch size distribution, LRMP Caribou management strategies, BC Forest Practices Code strategies, etc) in comparison to alternative fire regimes. Management Issue or Decision Type: **E** Size of Area: 2 million ha Location: Mackenzie Forest District Resolution: 1 ha (medium) **Project 7.** Project Sponsor: BC Ministry of Forests (Peter Hall, Entomologist), in collaboration with the Canadian Forest Service (Terry Shore, Les Safranyik, Bill Riel).Project Purpose: Landscape level Mountain Pine Beetle modeling. To assess impact on timber supply and forest structure of mountain pine beetle outbreaks using a population model scaled up from a CFS stand-level beetle population model. Management Issue or Decision Type: **A** Size of Area: 1.2 million ha Location: Kamloops Forest District and Lakes Forest District Resolution: 1 ha per cell **Project 8.** Project Sponsor: FRBC - BC Ministry of Forests Project Purpose: To assess how to scale multivariate models of caribou habitat models based on telemetry data and examine how to integrate into a long term projection of landscape change. Combining management and disturbance models with statistical habitat models and projecting them through time. Considered different seasonal habitat requirements (early winter, late winter, spring, summer, fall). Management Issue or Decision Type: **A, D** Size of Area: 2.4 million ha Location: Columbia Mountains Resolution: 6.25 ha per cell
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Example indicators addressed in the above projects: Project 1: Non-recovered loss by disturbance agent, age class distribution, growing stock, area and volume disturbed, Etc. Project 2: Measures of connectivity of Woodland Caribou habitat – correction length (average radius of gyration over the whole landscape at different scales), radius of gyration (how far a caribou can move within a cluster of patches before hitting an edge), minimum spanning tree (graphical representation of how the patches connect together

	into a cluster), and nearest neigbour, Etc. Project 3: Biophysical features derived from digital elevation model include: contributing area, estimates of slope position (toes, crests), ecological features (floodplains, soil moisture), Etc. Project 4 – Connectivity measures: number of steps and distance traveled to traverse a landscape (which varies depending on how fragmented the landscape is), number of forest and non-forest edges to traverse a landscape, estimate of the time to traverse which is correlated with the total distance traveled to traverse the landscape, Etc. Project 5: species composition, age class structure, spatial pattern of disturbance and management, mean patch size, Etc. Project 6: For each management and fire regime – produce a sequence of harvested or burned disturbance patches for input into the NETICA bayesian belief model. Project 7: – volume and areas attacked by Mountain Pine Beetle, area treated by different management options, Etc. Project 8: – Spatial habitat maps projected through time - habitat suitability index at different time periods, Etc.
6. Spatiality Can the tool analyze spatial relationships?	Yes. Can be used for static (atemporal) analysis or dynamic spatial temporal analysis.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Yes. Data preparation of static data layers pre-processing use ArcInfo. Dynamic data processing supported within SELES.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model deal with spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes. Analyst must develop conceptual model to enable this capability within SELES. Models are not pre-built but SELES provides the flexibility to build appropriate model to answer questions. A model must use the same cell size and extent (i.e.: all data layers must have same resolution (grain or cell size) and extent (area)).
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes. Provided that this information (data layers) are provided. b. Any scale or resolution up your limits of memory.

10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells?	a. Memory dependent – Models have ranged from a few thousands cells to 30 million cells.
b. What is the largest project area it has been used for? and at what resolution?	b. Largest area: 10 million ha at 4 ha resolution.
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	User builds the concept model either themselves or by means of a participatory workshop involving specialists. The model is specified in the SELES language and through text files and tables.
12. User defined species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined?	a. User builds the concept model (either themselves or by a workshop process) and specifies in the SELES language, text file, and tables
b. How does the model allow the user to enter or load these relationships? Is there a user interface?	b. User-defined – no defaults but can re-calibrate and adapt old models to new objectives.
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?)	a. Supports Population Modeling. User defined. For example population models have been built in SELES for Mountain Pine Beetle and bird dispersal population model.
b. Is it deterministic or stochastic?	b. Stochastic model
14. Forecasting a. Does the model predict future conditions?	a. Yes.
b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	b. Scheduling and Assessment.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	GIS – ArcInfo Statistics Packages – SYSTAT, SAS Graphing – MS Excel Database – MS Access

System Requirements & Features	Response
1. Required hardware, devices & operating system?	SELES executable and Landscape Event editor Microsoft Win NT, Win 2000, Win 98 (some functionality is limited) e.g. 1 million cell – 128 megabytes, 400 megahertz
2. What commercial software, including version, is required to provide full functionality?	Microsoft Software listed previously.
3. What is the typical set-up time to load program?	5 minutes to install
4. What is the typical set-up time to prepare and input data? (range)	0.5 to 5 days – assuming data is clean (Arc Ascii grids) and ready for input. A function of the model and how much data preparation is required.
5. What are the minimum data input requirements?	No minimum. Subject to model at least one parameter to 100's of parameter or layers Can generate theoretical models that do not require spatial data.
6. What data formats can be imported?	ArcGrid (Ascii), ERDAS, GRASS
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	ArcGrid, tab separated text files of records
8. How long does it take to run a typical data set? (not including plotting of map)	Model dependant – from seconds, to hours, to days. Project 2: 6 hours Project 3: 1 day (large data set) Project 4: 1 hours Project 5: 2 hours
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes. This a more of a user problem. The tool can handle this if mapped on raster layer or specified in the input file or table.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	User defined raster-based.
11. What programming language(s) is the model written in?	SELES – C++ Models built in SELES are built using SELES modeling language.
12. What level of expertise is required to set-up and maintain the program?	Moderate Expertise – to adapt and modify existing models (i.e. GIS with higher than average skills, Ecologist with quantitative skills) Moderate to High Expertise – to design new models (i.e.: Ecologists)

	Moderate to High Expertise – to implement new models (i.e. must know SELES, someone with quantitative understanding of spatial temporal models)
13. What level of expertise is required to run the program?	Low Expertise – to run model (i.e. anyone)
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	User defined single attribute grids – Maps, data tables. Uses external mapping and graphing tools. The visual capabilities within SELES are more for model development rather than for generating visual outputs.
15. What capabilities are there for user-defined outputs?	User defined single attribute grids – that are exported to ArcInfo for plotting. Uses external mapping and graphing tools.
16. Is the software proprietary?	Public domain versions. Proprietary versions.
17. What are the purchase/maintenance fees?	No purchase fees. Maintenance fees are services based.
18. What modeling techniques are used in developing the species-habitat relationships?	Habitat Suitability Index models (multivariate statistical regression, and analysis of variance) using yield curves or process models Population model Individual based model Expert opinion model
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	Yes. Indirectly through post analysis tools.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Highly transferable. Easily adapted to situations with similar modeling objectives. b. Highly generic. Ease of loading new knowledge sets depends on user knowledge and experience.
21. Training, user support?	Annual training course available or via specific fee-for- service contract
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. User guide, language reference, user documentation and system documentation, sample tutorial data sets and models. b. www.cs.sfu.ca/research/SEED/

	Note: Andrew Fall is developing a new SELES Website - target implementation date: April 2002.

General observations about the functionality, system requirement and features of a number of habitat supply models that are being used in British Columbia:

1. SELES can be an appropriate and useful tool if you want flexibility in being able to design conceptual models that are most appropriate to address your objectives.
2. Because developing complex modes involves a lot of uncertainty it is important to build the most concise model to address the objectives – that feature is very important.
3. Habitat supply modeling does not have the same consistency as timber supply modeling – this has both advantages and disadvantages. Openness to the use different modeling approaches can limit broad acceptance.
4. Defining a set standard habitat feature requirements – i.e. base level features for habitat supply modeling may be help to address broad acceptance of the interpreted results from habitat supply analysis models.
5. Habitat Supply modeling is broader the timber supply modeling and therefore requires more flexibility. However there could be some standard benchmark outputs and documentation that would assist decision makers.
6. As people become more familiar with spatial habitat supply analysis, they want to handle more and more information and finer and finer resolution.
7. The types of indicators outputted or forecast depend on the nature of the project and questions being addressed. In other words there is no single universal set or suite of indicators for habitat supply analysis modeling.

1.3 Use of Resource Selection Functions

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Use of Resource Selection Functions**
2. Brief Description: Describe the purpose, primary use and functions of the tool	To provide a direct link between habitat selection data collected by radio telemetry to a map of habitat suitability. The approach uses logistic regression analysis to calculate a predictive equation (Resource Selection Functions) that can determine the probability of an animal using specific habitat types.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	User: Dale Seip (Interviewee)
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address)	Name: Dale Seip Position: Wildlife Habitat Ecologist Organization: BC Ministry of Forests Address: 1011- 4th Avenue Prince George, BC, Canada V2L 3H9 Tel: (250) 565-6224 Fax: (250) 565-6671 Email: Dale.Seip@gems3.gov.bc.ca
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range –** **(FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear	**Project 1.** Project Sponsor: CLUPE Project Purpose: Parsnip Grizzly Bear Project, Central Rockies Threatened Caribou Project– To develop Resource Selection Functions based on habitat selection data from radio telemetry studies (caribou or grizzly bears) for use in availability analysis. This compares habitat use in relation to habitat availability. A GIS is used to calculate at every pixel the necessary attributes to be fed into the predictive equation in order to calculate a probability (ranging from 0 (no habitat) to 1 (best habitat). This technique is used to map current habitat capability. This information is used to identify and map species habitat areas or zonal boundaries and associated management strategies (e.g.: Caribou medium – partial harvest or extended rotations; Caribou High – total protection or no harvest). Management Issue or Decision Type: **D** Size of Area: 20,000 km^2 Location: Parsnip

Type F: Single Species – Small Area Home Range **(FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Percentage of landbase in the various habitat capabilities ranging from 0 = no caribou to 1 = high caribou use.
6. Spatiality Can the tool analyze spatial relationships?	Yes. This approach can be calculated based on either a point locations or proximity relationships.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Yes.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes. While this approach is empirically driven, based on telemetry data, it can be used to calculate winter and summer range.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes. Site series mapping can be incorporated into relationships thought regression analysis. b. Any resolution can be used.
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. Unlimited number of analysis or cells. b. 1.5 million hectares at any resolution.
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Logistical regression analysis Using empirical species habitat data construct logistic regression equations based on habitat selection attributes (e.g.: forest cover type, BEC subzone, age class, TEM, VRI , Etc.). Decide whether to analyze as a point location or spatial proximity. Use GIS to calculate that habitat capability values at each point.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	a. Yes. Fixed empirical equations. b. No formal interface.

13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?) b. Is it deterministic or stochastic?	a. Yes. Resource Selection Functions values are correlated to population samples. b. Deterministic.
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. No. But can if linked scheduling model that predicts changes in forest condition. b. Assessment Model - Logistic Regression.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	Any statistical analysis tool. Any GIS.

System Requirements & Features	Response
1. Required hardware, devices & operating system?	Models can be calculated using any operating system that supports commonly available statistical and raster GIS software.
2. What commercial software, including version, is required to provide full functionality?	Require both statistical and GIS software. Logistic regression is available in most statistical packages (e.g., SAS, Statistica, SPSS, Stata). Typically, a raster GIS (e.g., IDRISI, ARC Grid) is used to generate probability maps from statistical models.
3. What is the typical set-up time to load program?	Depends on system (Unix vs. PC) and software, but likely minutes to < 1hour.
4. What is the typical set-up time to prepare and input data? (range)	Widely variable depending on size of study area, required data manipulation or creation (e.g., proximity surfaces or DEM derived data), quality of spatial data, and amount of spatial data (i.e., number of spatial layers used to describe habitat relationships).
5. What are the minimum data input requirements?	Layers of forest land inventory and telemetry data (>500 points).
6. What data formats can be imported?	Statistical software will accept any text formatted spreadsheet. Import of spatial data is dependent on import routines available in GIS.
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Most generic raster formats (e.g., TIFF, GEOTIFF, JPEG). Dependent on export utility available in GIS software.
8. How long does it take to run a typical data set? (not including plotting of map)	Widely variable depending on amount of time used to prepare GIS data and complexity and extent of telemetry data. Most analyses will be greater than 1 week.
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)?	Raster-based calculations done at every pixel.
11. What programming language(s) is the model written in?	Model coefficients are calculated with generic statistical packages. Programming utilities may be useful for batch processing of models or preparing spatial data.
12. What level of expertise is required to set-up and maintain the program?	High level of expertise to generate the logistic regression.

13. What level of expertise is required to run the program?	Low to moderate level of expertise required to run the program.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Ascii tables. Post processing map generation.
15. What capabilities are there for user-defined outputs?	None.
16. Is the software proprietary?	No.
17. What are the purchase/maintenance fees?	No.
18. What modeling techniques are used in developing the species-habitat relationships?	Logistic Regression Analysis
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	Yes.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. The approach is very transferable. The results are most reliable within the area in which the telemetry data was collected. Validity of the results becomes more questionable as one moves further from where the data was collected. b. Ease to incorporate.
21. Training, user support?	None. Expertise specific
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Project Website(s):**	a. None. b. None.

General observations about the functionality, system requirement and features of a number of habitat supply models that are being used in British Columbia:

- Should place emphasis on developing models that can consider habitat within a spatial context – a hectare of a certain habitat will have different values depending on what surrounds it.

- Typical Steps in Developing Resource Selection Functions:

    1. Collect telemetry data.
    2. Analyze the data to identify what specific habitat types the animal is selecting.
    3. Use logistic regression analysis to calculate a predictive equation (resource selection functions) that can determine the probability of an animal using specific habitat types.

4. Apply GIS do the calculations across the landbase and generate a map.
5. Future Development Opportunity - incorporate the resource selection functions within a simulation model to calculate habitat capability over time as the forest condition changes. This could provide habitat supply analysts with a useful assessment tool in relation to other resource value objectives.

1.4 Implemented Management Regime in SELES - Use Harvest Forecast – FSSIM

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Implemented Management Regime in SELES - Use Harvest Forecast – FSSIM**
2. Brief Description: Describe the purpose, primary use and functions of the tool	To investigate the long-term consequences of management actions on habitat using detailed spatial-temporal landscape models and sophisticated data management techniques.
3. Developer and/or User: (e.g.: Name, Position, Organization)	Developer and User: Don Morgan (Interviewee)
4. Interviewee Contact Information: (e.g.: Mailing address, Street address, Telephone number, Fax number, Email address)	Name: Don Morgan Position: Planning Systems Biologist Organization: BC Ministry of Sustainable Resource Management Address: Bag 5000, 3726 Alfred Avenue Prince Rupert Forest Region Smithers, BC, Canada V0J2N0 Tel: (250) 847-7440 Fax: (250) 847-7643 Email: Don.Morgan@gems7.gov.bc.ca
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range –** **(FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear	**Project 1.** Project Title: Landscape Analysis of Caribou Habitat Project Sponsor: Forest Renewal BC Management Issue or Decision Type: **A and D** Project Purpose: An investigation of the long-term consequences of management actions on Mountain Caribou habitat using detailed spatial-temporal landscape models and sophisticated data management techniques. ▪ Applied collaborative model building framework to construct the Columbia Mountains Landscape Model, which integrated the following existing models: Logistical regression model, FSSIM and SELES. Four management regimes implemented within SELES were benchmarked against FSSIM. The Caribou logistical regression model developed by Bruce McLellan (based telemetry information: age, species, elevation, and aspect) was applied at different time steps throughout the simulation. ▪ A number of different scenarios were evaluated including: i) management options for the Revelstoke portion of the Kootenay Boundary Land Use Management Plan; ii) no harvesting scenario with natural disturbances (i.e.: Hemlock Looper).

Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	▪ Compared two analytical techniques for assessing species-habitat relationships: a) Logistical Regression; and b) Mahalanovis Distance Statistic Mutli-Variate Technique. Size of Area: 2.5 million hectares Location: Golden TSA, Revelstoke TSA, TFL 55, TFL 56 and Revelstoke National Park and Glacier National Park Unpublished Report on Website – Simulated Effects of Forest Management Options on Timber and Caribou Habitat in the Northern Columbia Mountains. Website: www.for.gov.bc.ca/research/lach **Project 2.** Project Title: North Coast LRMP Grizzly Bear Analysis Project Sponsor: BC Ministry of Water, Land and Air Protection Management Issue or Decision Type: **A** -Project Purpose: To assess Grizzly Bear population effectiveness methodology using SELES in support of the North Coast LRMP. A temporal analysis is conducted linking to grizzly bear population units (based on factors such as: bear density, roading, traffic patterns, salmon availability, human use implications) and adjusting population density estimates as part of the effectiveness methodology. Additional sub-models include: displacement, mortality, forage, and critical habitat. Size of Area: 1.96 million hectares Location: North Coast TSA Contact: Don Morgan **Project 3.** Project Title: North Coast Goshawk Model Project Sponsor: Forest Renewal BC Management Issue or Decision Type: **D and F** Project Purpose: To undertake a territory analysis considering nest site availability, forage supply, and spacing in support of the North Coast LRMP. Size of Area: 1.96 million hectares Location: North Coast TSA Contact: Don Morgan
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	▪ high quality habitat ▪ well connected habitat ▪ available Caribou habitat ▪ amount of timber supply ▪ growing stock
6. Spatiality Can the tool analyze spatial relationships?	Yes.

7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Yes.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes. Provided that these habitat relationships are adequately described.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes b. Any scale. Typically 1:250,000 strategic @ 25 m^2 resolution
10. Size of area that can be analyzed a. What is the maximum number of analysis units? b. What is the largest project area it has been used for? and at what resolution?	a. Unlimited b. 4 million hectares – 1,500,000 @ 500 m^2 resolution
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Collaborative model building using expert knowledge, existing literature, interaction between specialists, stakeholders, and modelers. A workshop process that involves specialists and others to: ▪ Identify sub-models that need to be built (e.g.: fire sub-model, habitat supply sub-model, timber sub-model, access management sub-model). ▪ Development of conceptual models (references to literature); ▪ Specify key parameters and/or functional relationships (tables) ▪ Formulate model code. See the following website for further details: www.for.gov.bc.ca/research/dulp Reference Paper: Fall, A., Daust, D. and Morgan, D. 2001. A Framework and Software Tool to Support Collaborative Landscape Analysis: Fitting Square Pegs into Square Holes. *Transactions in GIS*. 5(1):67-86. A Landscape Model Document is produced that describes how the project will be conducted, including data, analysis assumptions and planned scenarios.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model	a. Yes. User-defined through a collaborative process that captures the species-habitat

structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	relationships through a series of tables. b. The modeler enters the relationships. Once the relationship are entered into the model a dialogue box can be customized to allow the user to quickly re-run the model.
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?) b. Is it deterministic or stochastic?	a. Yes. A sub-model is developed for b. Either deterministic or stochastic
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. Yes. SELES b. SELES – Scheduling and Assessment Model Caribou Resource Selection Functions – Logistic Regression Model
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	Any software tool MS Excel, Access, Oracle, Arcinfo, NETICA, FSSIM, SELES language.

System Requirements & Features	Response
1. Required hardware, devices & operating system?	NT, Win 95+
2. What commercial software, including version, is required to provide full functionality?	None.
3. What is the typical set-up time to load program?	5 minutes
4. What is the typical set-up time to prepare and input data? (range)	Minutes assuming data is clean.
5. What are the minimum data input requirements?	Minimum of one parameter. Can generate theoretical models that do not require spatial data.
6. What data formats can be imported?	GRASS Ascii, GRASS Binary, Arc Ascii, text files
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	GRASS Ascii, GRASS Binary, Arc Ascii, text files
8. How long does it take to run a typical data set? (not including plotting of map)	Minutes to days depending on the complexity of the model.
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes. Model can address cohorts (e.g.: tracking 3 cohorts within a raster cell)
10. At what resolution does the tool operate (e.g.: raster-based pixels or vector-based polygons)?	Raster-based polygons User-defined resolutions
11. What programming language(s) is the model written in?	SELES modeling language
12. What level of expertise is required to set-up and maintain the program?	High level of expertise.
13. What level of expertise is required to run the program?	Low level of expertise.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	SELES outputs maps internally. Graphs and tables handled externally.
15. What capabilities are there for user-defined outputs?	Data formats are user defined. Uses external mapping and graphing tools.
16. Is the software proprietary?	No.
17. What are the purchase/maintenance fees?	No.
18. What modeling techniques are used in developing the species-habitat relationships?	Collaborative model building process using expert knowledge, existing literature, interaction between specialists, stakeholders, and modelers.

19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	Yes. Some statistics part of the model and other statistics generate through post-analysis.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Highly transferable. b. Easy to load new relationships.
21. Training, user support?	Training course available through SELES developer – Dr. Andrew Fall
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. User guide available, language reference, user documentation and system documentation, sample tutorial data sets and models. b. www.for.gov.bc.ca/research/lach www.for.gov.bc.ca/research/dulp www.cs.sfu.ca/research/SEED/

General observations about the functionality, system requirement and features of a number of habitat supply models that are being used in British Columbia:

1. Recommend that habitat supply analyst undertake habitat supply analysis – equivalent to timber supply analyst responsible for timber supply analysis.
2. Formalization of habitat supply analysis through training, and skills training.
3. Gap in having a pool of habitat supply analysts.
4. Important to establish a baseline in terms of historical range of variability – where habitat supply has historically been and how it fluctuates through time under natural disturbance. Use research and/or expert opinion to establish baselines as a comparison of impacts on habitat supply under different management scenarios.
5. Habitat supply analysis needs to integrated with alternative harvest scenarios.

1.5 OPTIONS

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**OPTIONS**
2. Brief Description: Describe the purpose, primary use and functions of the tool	Options is a model designed to support strategic analysis and decision support for questions related to biological sustainability and related assessment of financial viability. Options was originally built in 1983 and since then has undergone continuous revisions and upgrades. Options has been applied to approximately 200 million hectares worldwide.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer and User: Don Reimer/D.R. systems staff
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Don Reimer Position: President Organization: D.R. Systems Inc. Address: 1615 Bowen Road, Prince George, BC V9S 1G5 Phone: (250) 755-3041 Fax: (250) 755-2063 Email: dreimer@drsystemsinc.com Website: DRSystemsInc.com
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure - e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – All/Most Life Requisites** **(FF)** - Usually large **a**rea home range	**Project 1.** Project Title: Manitoba's Forest Plan - Towards Ecosystems Based Management (Report to Manitoba Ministry of Natural Resources published December 1995). Project Sponsor: KPMG Study for Manitoba Provincial Government – D.R. Systems responsible for analysis. Management Issue or Decision Type: **A and D** Project Purpose: To devise a new forest land management strategy for the province of Manitoba. Compared traditional fiber-based approach with net downs for protected areas against habitat and ecosystem-based forest management scenarios. Applied habitat suitability index equations developed for 6 key indicator wildlife species. Demonstrated that there was flexibility with the landbase to achieve habitat objectives. Size of Area: 23 million hectares Location: Manitoba forest lands **Project 2.** Project Title: The Potential Impacts of Enhanced Forestry on B.C. Forest Productivity and Yield. (published 1997). Project Sponsor: KPMG-led project completed for the BC Forest Alliance and Jobs and Timber

- All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	Commissioner – D.R. Systems responsible for modeling and analysis, Edwin Bluett & Associates responsible for provincial econometrics. Management Issue or Decision Type: **A** Project Purpose: To examine intensive forest management opportunities in British Columbia within the context of the BC Forest Practices Code (FPC). The project also examined a number of scenarios including intensive management, habitat based land management strategy and some potential revisions to the FPC (some of which were eventually implemented). Three Timber Supply Areas (TSAs) were treated as individual case studies each considering eight scenarios. The case studies considered long-term fiber supply issues, and habitat seral stage distribution. A regional economic model was use to produce estimates of jobs, government revenue. Identified better land management strategies that could be employed to meet both environmental and economic objectives when compared to the base case status quo. Size of Area: ~15 million hectares Location: British Columbia (Strathcona TSA, Lakes TSA, and Kamloops TSA) **Project 3.** Project Title: Plum Creek Habitat Conservation Plan (HCP) (1994 – 1996) Project Sponsor: Plum Creek Company Management Issue or Decision Type: **A,C,D,E,F** Project Purpose: Devised a land management strategy based upon known and assumed habitat requirements for 285 species (16 guilds as well as 6 featured species) on their Cascade landbase. GIS layers were prepared to reflect the objectives associated with these species habitat requirements and then run through the Options Model. A Habitat Conservation Plan was prepared that was both economically viable for the company and allowed them to meet all their habitat requirements. Plum Creek received several awards for this HCP. A challenging aspect of this project was trying to define habitat and seral stage requirements and then relate back to forest inventory data that can be grown and projected. A science team was formed to identify the habitat requirements (field work, literature reviews) to identify the individual habitat requirements for particular species. Undertook risk assessments which Size of Area: 223,000 hectares Location: Cascade Crest (I-90 Corridor) **Project 4.** Project Title: State Trust Lands - Sustainable Harvest Analysis Project Sponsor: State of Washington Management Issue or Decision Type: **C**

	Project Purpose: To develop a Sustainable Harvest Plan that will provide acceptable levels of revenue for the various State Trust Lands Beneficiaries (Public Schools, University Trusts, Counties) while meeting all the environmental requirements and social expectations. This requires consideration of the State Habitat Conservation Plan, State Forest Board (practices and regulations) and incorporation of approximately 30 resource objectives. Size of Area: 607,000 hectares Location: Cascade Crest to Pacific Coast(West side)
6. 5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Indicators used are both quantitative and projectable. Core indicators are based on forest inventory and stand structure information such as number of trees of certain species and size, basal area, and relative density.
7. Spatiality Can the tool analyze spatial relationships?	Yes. Spatial relationship rules are set up for each GIS layer or combinations of layers. The Options model contains a mathematical algorithm that dynamically maintains the spatial topology across all polygons and all GIS layers.
8. Proximity Capability to analyze proximity to features/polygons relative to each other?	Immediately adjacent only. A proximity rule is currently under development.
9. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes.
10. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes. If available b. Can handle any scale or resolution of mapping.
11. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. No maximum. To date largest number is 1.25 million analysis units. Typically running files with 450,000 to 600,000 analysis units b. 15 million hectares in one file at a resolution of 0.005 hectares, minimum polygon size.
12. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	A user interface enables the user to enter specific management relationship rules for each layer as part of creating a particular scenario. A user interface permits the user to import GIS data

	layers covering different resources and/or land classifications. The GIS layers are then used to depict different spatial relationships for different parameters. This is information is required for the model to build the necessary topological relationships and to apply constraints or targets and management objectives.
13. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	a. Yes. Relationships are explicit. However, the level of transparency depends on how the species habitat rule is articulated in a spatial context. User defined. b. User interface. Screens with pick lists that allow the user to set up mathematical relationship rules to management of resources.
14. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?) b. Is it deterministic or stochastic?	a. No. However, can be derived through post processing. b. Deterministic
15. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (Bayesian Belief, population, logistic regression.), growth and yield.	a. Yes. Can predict future vegetation, and related management activities. b. Options – Scheduling and Assessment Model
16. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	- Any GIS - to generate an input file, generate all the coverages and overlays. - Statistical analysis packages.

System Requirements & Features	Response
Required hardware, devices & operating system?	Win95+, Win 98+, Win NT, Win 2000, PC current platforms
1. What commercial software, including version, is required to provide full functionality?	GIS package
2. What is the typical set-up time to load program?	5 minutes
3. What is the typical set-up time to prepare and input data? (range)	Depends on the complexity of the project: Can normally build a scenario definition in 4 hours or less. Project 1: 3 days for initial scenario (subsequently can build new scenarios in a few minutes to hours) Project 2: 1 day Project 3: 3 months elapsed time (function of working with the Science Team on defining habitat relationship for 285 species (16 guilds) Project 4: 3 months elapse time for same reasons as Project 3 (subsequently can build new scenarios in a few minutes to hours)
4. What are the minimum data input requirements?	For a polygon – area, species, site index, and age.
5. What data formats can be imported?	Any windows – Ascii, Dbase standard
6. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Windows based MS Excel, MS Access, any xbase format Ascii
7. How long does it take to run a typical data set? (not including plotting of map)	Function of PC hardware and number of GIS overlays (complexity). Assume PC running at 800 megahertz and 20 GIS overlays: 400,000 Analysis Units ~3-4 hours for 200 year run >100,000 Analysis Units ~1 hours for 200 year run 40,000 Analysis Units ~20 minutes for 200 year run
8. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes. Runs on the resultant overlay file and maintains all topology.
9. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	Vector -based design , but also can be run on rasters --- strictly up to user. The model uses the resolution of the source database. Can run on raster, however each raster will be considered a single polygon.

10. What programming language(s) is the model written in?	Visual Basic 6
11. What level of expertise is required to set-up and maintain the program?	Medium to high level of expertise. User must have working knowledge of the landbase, understanding of forest inventory, growth and yield, and modeling.
12. What level of expertise is required to run the program?	Low to medium level of expertise.
13. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Standard reports – menu driven. Series of Ascii files that relate to information for each polygon.
14. What capabilities are there for user-defined outputs?	Menus allow for some variation in the kinds of graphs and charts that are produced.
15. Is the software proprietary?	Yes.
16. What are the purchase/maintenance fees?	See DR Systems
17. What modeling techniques are used in developing the species-habitat relationships?	User defined The model can use either habitat suitability index or threshold values or other – as defined by the user.
18. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No. Post processing possible.
19. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Highly transferable – have applied the Options in numerous countries to address different issues (such as water, wildlife, forest management issues, carbon sequestration, etc.). b. Highly generic – provided that new knowledge relationships are quantitative.
20. Training, user support?	▪ Mandatory 3 day (minimum) training session with model purchase. ▪ 2 years of technical support provided with the purchase of the model. ▪ After 2 years user-fee based.
21. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. User manual available, sample data sets, and internal proprietary system documentation. b. DRSystemsInc.com

General observations about the functionality, system requirement and features of a number of habitat supply models that are being used in British Columbia:

1. Need to get serious inventory information as an asset, rather than treat it as a cost.
2. Habitat based modeling where you can directly address forest stand dynamics (to be capable of forecasting stand development, complete with silviculture interactions) including natural disturbance events - is a direction for development.
3. Need to be meld together timber supply analysis and habitat supply analysis and get away from net downs process – to some form of habitat based strategy.
4. No FSSIM look alike – Use a science team approach and tie the habitat supply models to the forest inventory parameters – whatever you do it must be spatial.
5. Indicators that appear to work the best are based on stand structure.

1.6 Prognosis EI (Environmental Indicators)

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Prognosis EI (Environmental Indicators)**
2. Brief Description: Describe the purpose, primary use and functions of the tool	Prognosis EI model is designed to assist with forest management planning problems. The model can provide detailed quantitative environmental impact projections and expected timber flows under user-defined scenarios.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developers: Julee Greenough, Don Robinson, Werner Kurz and Sarah Beukema, ESSA Technologies Ltd. Collaborator: Nancy Densmore Ralph Winter and Barry Snowdon, Forest Practices Branch, BC Ministry of Forests; 62 contributing biologists, foresters and resource managers.
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Don Robinson Position: Systems Ecologist Organization: ESSA Technologies Ltd. Address: Suite 300, 1765 West 8th Avenue, Vancouver, BC Canada V6J 5C5 Tel: 604-733-2996 Fax: 604-733-4657 Email: drobinson@essa.com Website: www.essa.com
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management or Decision Type(s) as follows: **Type A: Landscape Level Habitat Features (CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability (CF)** - Variable area - Rare to limited occurrence - e.g.: Site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability (CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite (FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range	**Project 1.** Project Title: West Arm Demonstration Forest Case Study (1999) Project Sponsor: Forest Renewal BC Management Issue or Decision Type: **A,B,C,D,E,F** Project Purpose: Purpose of the project was to demonstrate the model's ability to quantify timber and non-timber issues including water quality, visual quality objectives and wildlife needs. The model was designed with those issues in mind. Looked at 21 different kinds of harvesting and retention scenarios (for example: ▪ status quo ▪ unmanaged with and without root disease ▪ partial harvesting (~25% basal area removal) ▪ patch cutting ≤ 1 hectare openings ▪ small clear cuts ▪ large clear cuts ~20 hectares ▪ low intensity fires (natural under canopy burns) ▪ 4 Atlas scenarios designed to meet adjacency and biodiversity constraints ▪ snag retention scenarios (retaining wildlife trees) ▪ snag removal for fuel wood near active roads (to

Type E: Single Species – Large Area Home Range – (FF) All/Most Life Requisites - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	assess impact on songbirds, pileated woodpecker, and bats) Management Issues: ▪ Ungulate (habitat suitability index) models to identify the suitability of a stand for deer based on age, slope and thermal cover. ▪ Grizzly and black bear winter denning models. ▪ Pileated Woodpeckers – roosting and drumming trees. ▪ Bats – tree species and size preference for roosting. The model(s) allowed for assessment of the implications of multiple management objectives and/or trade-offs. Other information: ▪ Detailed forest inventory, soils, understorey inventory, 41 variable radius plots and 69 additional fixed area sample plots completed prior to harvesting. ▪ Applied Most Similar Neighbor (MSN) technique to expand the coverage across the entire landbase. This was necessary to generate a complete coverage for purposes to project the landbase though time using the simulation model. Size of Area: 3,300 hectares Location: West Arm Demonstration Forest, Nelson, BC
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Prognosis EI – Timber Projection Model Stand Structural Indicators: ▪ Overstorey characteristics – stand height , diameter breast height (dbh), basal area, species composition, total and merchantable standing volume, canopy cover (all trees >5m ht and non-deciduous trees), number of canopy layers in developmental stage. ▪ Understorey conditions - percent cover by species by layer (shrub and herb layers), total percent cover (moss, lichen, epiphyte layers), volume of coarse woody debris (CWD) (by diameter class by species and hollow and solid state), number of snags (by species, dbh, height, decay class and hollow and solid state, Class 2 live trees (by species, dbh, height), seral stage, summary measure of structural diversity based on number of canopy layers, shrub cover, volume of CWD and volume of snags. Species Specific: ▪ 3 habitat measures for pileated woodpeckers including: winter foraging habitat quality (f: proximity to suitable roosting trees), availability of drumming trees, nesting habitat quality ▪ 3 habitat measures for bats including: amount of high contrast edge available for foraging and roosting habitat quality, ▪ 2 measures of winter foraging habitat quality for

	ungulates ▪ 4 measures of habitat quality for bears including: summer foraging habitat quality (based on understorey condition), grizzly denning snags and black bear denning snags, black bear denning trees. Landscape Level Indicators: ▪ Patch size distribution across the watershed based on stand age, location and amount of interior old growth in the watershed. Water Quality Indicators and Active Roads: ▪ 23 measures of water quality including: Equivalent Clearcut Area (ECA) (calculated under each of 3 sets of assumptions) in each of 3 elevation bands, length of streams bordered by 3 levels of canopy cover, 11 of 13 indicators defined in the Interior Watershed Assessment Procedures Guidebook (IWAP) Dec 1995 Visual Quality Indicators: ▪ alteration of designed designated viewsheds and resulting status ▪ preservation, retention, partial retention and modifications of viewshed Timber Values Indicators: ▪ Mean Annual Indicators (MAI), total and merchantable harvest volume, diameter and species distribution of harvest timber across the entire landscape.
6. Spatiality Can the tool analyze spatial relationships?	Yes. Linked to Prognosis EI interface under ArcView GIS, which provides the mapping and graphing features to compare and contrast alternative scenarios (spatially and temporally). General Steps: 1. Analyst familiar with Prognosis EI configures the issue(s) or problem(s) by designing a management scenario to be addressed. 2. Spatial data layers and other data inputted into Prognosis EI. 3. Run Prognosis EI to analyze the management scenario. 4. Results are automatically output to ASCII file to be mapped or graphed externally through use of custom ArcView interface.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	No. Analysis of proximity to features is accomplished using GIS (ArcInfo) tools to prepare derived data layers, such as riparian zones through stream buffering.

8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	No.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes. Site series mapping is required. b. Requires a single resolution for all spatial data used in the model for a single analysis. The West Arm Demonstration Forest Case Study used 1:20000 resolution for spatial information. Stand resolutions were patches between 1 ha (small) and 20+ ha (large)
10. Size of area that can be analyzed a. What is the maximum number of analysis units? b. What is the largest project area it has been used for? and at what resolution?	a. 2000 stands is a feasible upper bound b. 3,300 hectares @ 1:20,000
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Participatory process
12. User defined species-habitat relationships a. How does the model build relationships? (i.e. How does the model allow the user to enter or load these relationships? a user interface?) b. Is it fixed or user defined?	a. User-defined default values. Options for users to vary species-habitat relationships. b. User-defined.
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?) b. Is it deterministic or stochastic?	a. No. Habitat suitability broadly defined. b. Primarily deterministic. However, the Prognosis EI Growth Model and root disease sub-model have stochastic components.
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistical regression.),	a. Yes. Default projection intervals are 5-year periods up to 100 years. However, the user can redefine the time period intervals. b. Prognosis EI – Scheduling and Assessment Model, growth and yield

growth and yield.	
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	▪ Western Root Disease Sub-Model ▪ Fire and Fuel Effects Model ▪ Atlas Scheduling Model

System Requirements & Features	Response
1. Required hardware, devices & operating system?	Microsoft WIN NT, WIN 98+ Will also compile under Intel-based Unix
2. What commercial software, including version, is required to provide full functionality?	▪ ArcView V3.0 and add-on Spatial Analyst V1.0 ▪ Standard Unix tools ▪ Most Similar Neighbour (MSN)
3. What is the typical set-up time to load program?	Less than 30 minutes.
4. What is the typical set-up time to prepare and input data? (range)	Data cleaning: ~5 days to develop first scenario with themes in registry and clean data – may require several iterations to fix data errors in geographic coverages. Mapping inventory sample points into the landscape: ~ 2 days to apply Most Similar Neighbour (MSN) software to derive estimates of inventory attributes using a recommended minimum of 30 % of the landscape in inventory status. Preparing keywords: ~5 days for first scenario and then 1 day for each subsequent scenario. Effort to collect over-understory inventory not included here
5. What are the minimum data input requirements?	Road network, steam network, stand inventory, understorey inventory including non-tree (shrubs), soils maps, Digital Elevation Model (DEM).
6. What data formats can be imported?	ArcView compatible files
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Comma separated values (CSV) Raw output of the model is in the form of ASCII flat text files
8. How long does it take to run a typical data set? (not including plotting of map)	~ 12 hours
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes. Defined by the analyst as either two separate stands or one stand (with two components).
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	All polygon coverages are Vector-based. However, there is some raster-based post processing analysis @ 10 m resolution.
11. What programming language(s) is the model written in?	Fortran GIS interface components: ArcView, Avenue
12. What level of expertise is required to set-up and maintain the program?	Set-up – highly competent programmer Maintain – moderate level of expertise

13. What level of expertise is required to run the program?	Modest level of expertise
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Maps, graphs, and tables.
15. What capabilities are there for user-defined outputs?	Can suppress outputs. ArcView interface allows selection of alternative output criteria
16. Is the software proprietary?	No.
17. What are the purchase/maintenance fees?	None.
18. What modeling techniques are used in developing the species-habitat relationships?	Expert driven.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No. Possible but would require multiple runs – not practical.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Highly transferable. b. Requires programming – for example, to add a new species that is not a surrogate for an existing species would require an expert to understand the inputs and then program those relationships– requiring several days.
21. Training, user support?	No. Not presently but available under service contract.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. User manual and documents available from BC Ministry of Forests b. Website: www.essa.com/forestry/prognosis_ei

General observations about the functionality, system requirement and features of a number of habitat supply models that are being used in British Columbia:

1. Consider development of a registry of habitat supply models, and project approaches. Recommend that consideration be given to the needs for a custodian to assess and evaluate the various models, modeling approaches, studies to validate the information, and ensure criteria for posting the information in the registry has been met.

2. Selected publications and sources and other contacts for Prognosis EI and the West Arm Demonstration Forest Case Study:

Beukema, S.J., J.A. Greenough, D.C.E. Robinson, W.A. Kurz, E.D. Reinhardt, N.L.Crookston, J.K. Brown, C.C. Hardy, and A.R. Stage. 1997. An Introduction to the Fire and Fuels Extension to FVS. In: R. Teck, M. Moeur, and J. Adams. 1997. Proceedings: Forest Vegetation Simulator Conference; 1997 February 3-7; Fort Collins, CO. Gen. Tech. Rep. INT-GTR-373. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Frankel, S.J. (tech. coord.) 1998. User's guide to the Western Root Disease Model, version 3.0. USDA Forest Service, Pacific Southwest Research Station, Albany, CA. Gen. Tech. Rep. PSW-GTR-165. 164 pp.

Greenough, J.A. , S.J. Beukema, D.C.E. Robinson, and W.A. Kurz. 1999a. Prognosis environmental indicators model description. Prepared by ESSA Technologies Ltd., Vancouver, BC. 66 pp.

Greenough, J.A., D.C.E. Robinson, S.J. Beukema, and W.A. Kurz. 1999b. Prognosis environmental indicators model: WADF case study methodology. Prepared by ESSA Technologies Ltd., Vancouver, BC.

Greenough, J.A., D.C.E. Robinson, S.J. Beukema, and W.A. Kurz. 1999c. Prognosis environmental indicators model: WADF case study. Prepared by ESSA Technologies Ltd., Vancouver, BC.

Utzig, G. and M. Ketcheson. 1998. Redfish Vegetation Database Description. Prepared by Kutenai Nature Investigations Ltd. & JMJ Holdings Inc., Nelson, BC for ESSA Technologies Ltd., Vancouver, BC. 5 pp.

1.7 Netica Modeling Framework

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Netica Modeling Framework**
2. Brief Description: Describe the purpose, primary use and functions of the tool	To evaluate to relative risk and policy implications of various land use scenarios on habitat supply for the North Coast LRMP.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	User: Doug Steventon
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address)	Name: Doug Steventon Position: Wildlife Habitat Biologist Organization: BC Ministry of Forests Address: Bag 5000, 3726 Alfred Avenue Prince Rupert Forest Region Smithers, BC V0J2N0 Canada Phone: (250) 847-7761 Fax: (250) 847-7643 Email: Doug.Steventon@gems3.gov.bc.ca
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: Site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range –** **(FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range** **(FF) All/Most Life Requisites** - Small **a**rea home range:	**Project 1.** Project Title: North Coast LRMP Marbled Murrelet Environmental Risk Analysis Project Sponsor: Forest Renewal BC Management Issue or Decision Type: **A, B, D** Project Purpose: To evaluate to relative risk and policy implications of various land use scenarios on habitat supply for the North Coast LRMP. To accomplish this a habitat supply model was developed that feeds into a combination population viability/ population projection stochastic model to output various relative risks of scenarios (i.e.: changes to habitat supply, changes to population size, and relative viability) generated by Netica. Hierarchical steps: 1. Prediction of biophysical description of landscape condition (forest age class, height class, BEC variant, slope, elevation) from either a GIS or spatial temporal model. 2. Habitat Supply Model – uses biophysical descriptions of landscape condition which then predicts habitat suitability - potential nesting density (and associated belief probability) and risk of nest predation. 3. Stochastic Population model (using input parameters, such as: starting/ending nesting carrying capacity, amount of edge in the landscape, various estimates of adult survival.) 4. Output dataset from the Population Model is used by Netica to assess changes in population size that occur by varying various parameters.

- All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	5. Now can use Netica to test various scenarios such as changes in population size or viability under various combinations of biophysical parameters. Size of Area: ~1.95 million hectares Location: North Coast TSA Originally this research started as part of the Marbled Murrelet Recovery Team that was assigned the task of writing a Coastal Recovery Conservation Strategy for the species. At the same time the province wanted to do a review of the Identified Wildlife Management Strategy for Marbled Murrelet. Therefore, the Netica tool was built to assess different general management policies in different landscape contexts.
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Example: ▪ habitat abundance ▪ habitat quality ▪ population size (relative) ▪ population persistence
6. Spatiality Can the tool analyze spatial relationships?	No. Spatial relationships are analyzed externally in either a GIS or spatial temporal model.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	No. GIS or spatial temporal model.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Not currently in Project 1. However, the Netica model can be structured to address nested habitat relationships.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes. b. Any scale
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. No limits other than PC limitations. b. Model still under development.
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Netica Process to build Habitat Suitability Model used a combination of literature review, statistical relationships, speaking to researchers, expert opinion, core scientific team, one formal workshop, recovery team discussions and email exchanges.

12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined?	a. Yes. User defined.
b. How does the model allow the user to enter or load these relationships? Is there a user interface?	b. Yes. Netica interface.
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?)	a. Yes. Built in MS Excel to provide parameterization inputs for the Netica Model.
b. Is it deterministic or stochastic?	b. Primarily Stochastic but has both.
14. Forecasting a. Does the model predict future conditions?	a. Yes. However, SELES or GIS produces the physical attributes of the landscape whereas Netica interprets habitat suitability and population size through time.
b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistical regression.), growth and yield.	b. Netica – Assessment Model (Bayesian Belief)
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	SELES – Spatial Explicit Landscape Event Simulator MS Excel – for graphing SAS – Post processing statistical analysis GIS Spatial Analysis Models

System Requirements & Features	Response
1. Required hardware, devices & operating system?	PC – Win NT , Win 95+, 98, 2000
2. What commercial software, including version, is required to provide full functionality?	Netica 2.06 – required Process Cases to enable analysis of land use scenarios.
3. What is the typical set-up time to load program?	5 minutes
4. What is the typical set-up time to prepare and input data? (range)	days to weeks
5. What are the minimum data input requirements?	Can have a variety of inputs. The model does not require a rigid set of inputs because it will make assumptions. Predictions based on few inputs will be less precise.
6. What data formats can be imported?	ASCII
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	ASCII or into an MS Excel Spreadsheet
8. How long does it take to run a typical data set? (not including plotting of map)	Landscape Units scale scenario – 1 minute
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes.
10. At what resolution does the tool operate (e.g.: raster-based pixels or vector-based polygons)?	N/A Function of the GIS or spatial model.
11. What programming language(s) is the model written in?	C++
12. What level of expertise is required to set-up and maintain the program?	High level of expertise.
13. What level of expertise is required to run the program?	Low to medium expertise.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Can view Belief Networks and Influence Diagrams Interactively can view outputs. ASCII file Writing into MS Excel Spreadsheet Probability graphs – not useful for large complex analysis

15. What capabilities are there for user-defined outputs?	Minimal. Data output formats allow for post-processing and display.
16. Is the software proprietary?	Yes. Norsys Systems Corp. - Netica Software
17. What are the purchase/maintenance fees?	See Norsys Systems Corp Website http://www.norsys.com/sitemap.htm
18. What modeling techniques are used in developing the species-habitat relationships?	Build belief networks relationships within Netica model. Relationships are parameterized using either data and/or expert opinion and/or statistical analysis.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	Yes.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Very transferable. b. Highly generic.
21. Training, user support?	No. Netica Software provides some online general user support but not for user designed custom applications.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Netica Software has an online user manual. b. www.norsys.com/sitemap.htm

General observations about the functionality, system requirement and features of a number of habitat supply models that are being used in British Columbia:

1. Netica's main strengths is in building relationships and their associates probabilities around projections as opposed to other approaches that tend to fix solutions based on look up tables.
2. Netica enables the opportunity to interface with population models.
3. Need to incorporate habitat supply analysis into strategic and operational land use planning.
4. Need realistic spatial and temporal projections of timber and habitat supply projections to better inform decision making.
5. Suggest the use of formal decision analysis techniques (e.g. Beysian and fuzzy logic) to assess trade-off's that are most appropriate. Reason that these decision analysis techniques are not generally used in BC because most decision makers (planning tables) are not familiar with the benefits of their application.

1.8 SIMFOR

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**SIMFOR**
2. Brief Description: Describe the purpose, primary use and functions of the tool	The tool acts as a forum for applying species-habitat relationships to deterministic landscape altering events that occur through time.
3. Developer/User/Collaborator: (e.g.: Name, Organization)	User: Eric Valdal (Interviewee) Collaborators: ▪ Ralph Wells, Centre for Applied Conservation Biology, UBC ▪ Christoph Steeger, Pandion Ecological Research ▪ Pierre Vernier, Centre for Applied Conservation, UBC
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address)	Name: Eric Valdal Position: GIS Analyst Organization: BC Ministry of Sustainable Resource Management Tel: (250)342-4249 Fax: (250)342-4247 Address: 625 Fourth Street Invermere, BC, Canada V0A 1K0 Email: eric.valdal@gems9.gov.bc.ca
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: Site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range –** **(FF) All/Most Life Requisites**	**Project 1.** Project Title: SIMFOR Habitat Analysis of Two FSSIM Harvest Scenarios in the Rocky Mountain Trench Project Sponsor: Forest Renewal BC - Invermere Enhanced Forest Management Pilot Project (EFMPP) Management Issue or Decision Type: **A and B** Project Purpose: Strategic Assessment - evaluating the spatial and temporal impacts of alternative harvest scenarios. Size of Area: 258,000 ha Location: The EFMPP study area is a 258 000 hectare area southeast of Invermere, encompassing the White and Lussier River drainages. **Project 2.** Project Title: Analyzing Individual and Groups of Species for Habitat and Structural Issues. Project Sponsor: Forest Renewal BC - Invermere Enhanced Forest Management Pilot Project (EFMPP) Management Issue or Decision Type: **D and F** Project Purpose: Invermere EFMPP – analyzing species or group of species as a flag for broad habitat and structural issues – primary cavity nesters

- Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range** **(FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	(modeled forging habitat by applying the Shore-Safranik formula for determining risk to endemic Mountain Pine Beetle. Modeled specific species habitat relationships for nesting habitat (northern goshawks, and songbirds) using certain species of trees and snag models based on cruise data. Size of Area: ? Location: Invermere Forest District **Project 3.** Project Title: Evaluation of Base Case Timber Supply Forecast in Relation to Habitat Requirements for Northern Goshawk and songbirds. Project Sponsor: Forest Renewal BC - Invermere Enhanced Forest Management Pilot Project (EFMPP) Management Issue or Decision Type: **A** Project Purpose: TSR II – Informal analysis of the Invermere Forest District evaluating the base case timber supply forecast in relation to habitat requirements for northern goshawk, and songbirds. Size of Area: 1.3 million hectares Location: Invermere Forest District **Project 4.** Project Title: Analysis of Grizzly Bear Habitat for the Kootenay-Boundary Higher Level Plan Project Sponsor: BC Ministry of Forests Management Issue or Decision Type: Project Purpose: Kootenay-Boundary Higher Level Plan (grizzly bear model for TFL 14) spatial analysis project addressing timber and environment values. (Project details currently being formulated – plans are to use SIMFOR to analyze habitat values). Size of Area: 1.3 million hectares Location: Invermere Forest District
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	**Kootenay-Boundary Higher Level Plan** (TFL 14 grizzly bear analysis) – using SMIFOR as a tool for doing an environmental impact assessment on a spatial timber analysis to test grizzly bear habitat supply through time. Using research on grizzly bear assess the structural configuration of the habitat supply such as the proximity of berry producing stands relative and the effect of fragmentation of habitat and impediments to movement. Using structural indicators: i) primary cavity nesters require snags; ii) grizzly bear are impacted by road activity and proximity to stands that produce berries or avalanche chutes with lilies; and iii) goshawks require large trees for nesting and coarse woody debris within the immediate area for fledging chicks.
6. Spatiality Can the tool analyze spatial relationships?	Yes, Simfor can analyze spatial relationships however; it is best suited for habitat supply analysis. Can undertake detailed spatial ecological analysis assessment of edge habitat, interior habitat and patch

	analysis. Simfor is not specifically designed for advanced spatial analysis.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Indirectly. In the design of input habitat maps and post analysis in GIS (Simfor is linked to GIS). Normally the user does this in a GIS which has specific functionality to facilitate proximity analysis.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes. Simfor is designed for this type of analysis. For example: have run nesting and post fledging habitats and felt unnecessary to run home range and foraging.
9. Ecosystem Classification Resolution a. Can model approach incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes b. Yes but more a function of the analyst and quality of the data being used in the analysis. Not a function of the model.
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. No limit. b. 1,100,000 ha at 1ha pixels
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Combination of participatory workshops, expert opinion and data supported relationships
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	a. All user defined relationships which are usually based on research. b. User defined entered through a user interface.
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?) b. Is it deterministic or stochastic?	a. If you run a regression analysis can predict population size. b. Deterministic.

14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. Yes. Simfor predicts the habitats impacts based on stochastic disturbance forecasts (SELES) and deterministic timber supply models. inputs b. SIMFOR – Assessment Modeling Language
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	ArcView MS Access MS Excel

System Requirements & Features	Response
1. Required hardware, devices & operating system?	Standard PC, NT and WIN 95+, 98, 2000 ARCVIEW Viewer Database MS Access
2. What commercial software, including version, is required to provide full functionality?	Minimum Access 97 ArcView3.2
3. What is the typical set-up time to load program?	5 minutes
4. What is the typical set-up time to prepare and input data? (range)	- 2 to 3 days to build species habitat relationships by analysis units create 30-50 analysis units - 2 weeks to input spatial data layers (function of the number of data layers)
5. What are the minimum data input requirements?	- age - timber harvest blocks - patches in operable (blocks) and inoperable (other shape) - map of stands - map of analysis units - BEC map - land base map - species specific attribute maps (e.g.: proximity to road , crown closure, water sources, avalanche chute, herb meadows)
6. What data formats can be imported?	ArcGrid data
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	ArcGrid data format can exported and translated to other formats Ascii format – can be exported for use in Excel, Word , Access Data base
8. How long does it take to run a typical data set ? (not including plotting of map)	5 minutes to run one scenario (30 to 50 AU's)
9. Can the model deal with complex polygons? (e.g., 60% A and 40% B site series)	The analyst is responsible to input this information into the model - can deal with complex forest stands, multi-aged and multi-leveled.
10. At what resolution does the tool operate (e.g., raster-based pixels or vector-based polygons)?	Normally trying to match the detail in the timber supply model (e.g.: TSR 1 ha pixels)
11. What programming language(s) is the model written in?	C Programming and later transformed to other language

12. What level of expertise is required to set-up and maintain the program?	Need to have spatial analyst or have someone that has spatial analysis capabilities (GIS, biologists, timber supply analyst)
13. What level of expertise is required to run the program?	Depends on the issue – same as above. Need qualified people that can interpret the results.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Maps, graphs, word documents, data export capabilities
15. What capabilities are there for user-defined outputs?	User can classify output to suite problem analysis.
16. Is the software proprietary?	No. Software is public domain.
17. What are the purchase/maintenance fees?	No. May need to purchase ARVVIEW or can use freeware map viewers available
18. What modeling techniques are used in developing the species-habitat relationships?	Simfor uses regression analysis developed through statistical analysis done by statistician or researcher. Can use biologist expert opinion where there is no supporting research (i.e.: analyzing point data from collared animals)
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No. Statistical analysis/equations are generated outside SIMFOR and applied within SIMFOR.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. SIMFOR can use species habitat relationships wherever those are defined and can be mirrored in other models (i.e.: SELES). b. Relationships generated based on scale of data (e.g.: using forest cover database to create species habitat relationships verses specific cruise plot data)
21. Training, user support?	User manual available Example database available
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Yes b. www.for.gov.bc.ca/nelson/district/invermer /Pilot/projectsummary.htm

General observations about the functionality, system requirement and features of a number of habitat supply models that are being used in British Columbia:

- Simfor is not a model. It is a piece of software that allows the user to build a model or parts of a model. The model should be designed based on clear well-defined objectives and not based on the limitations of any one piece of software. Most species-habitat models require a plethora of software to deal with issues around both habitat composition and its resultant functional configuration.

1.9 Habitat Supply Model for Grizzly Bears

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Habitat Supply Model for grizzly bears in the North Fork of the Flathead River in Southeastern BC.**
2. Brief Description: Describe the purpose, primary use and functions of the tool	To provide this Habitat Supply Model for grizzly bears as an assessment tool for use with scheduling models to examine effects of alternative timber harvesting and management scenarios in relation to grizzly bear habitat supply.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer: Fred Hovey (Interviewee) Collaborators: ▪ Bruce McLellan, Wildlife Biologist, BC Ministry of Forests, Revelstoke, BC, Canada ▪ Richard Mace, Research Wildlife Biologist Montana, Department of Fish, Wildlife and Parks, Montana, USA
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Fred Hovey Position: Wildlife Habitat Analyst Organization: Columbia Forest District BC Ministry of Forests Address: Box 9158 Station 3, 1761 Big Eddy Road, Revelstoke, BC, Canada V0E 3K0 Tel: (250) 837-7619 Fax: (250) 837-7626 Email: Fred.Hovey@gems8.gov.bc.ca Website: www.dir.gov.bc.ca
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range	**Project 1.** Project Title: Testing a Landscape Evaluation Model Developed for Grizzly Bears Project Sponsor: BC Ministry of Forests and Forest Renewal BC Management Issue or Decision Type: **D** Project Purpose: To test a landscape evaluation model for grizzly bears (developed by Richard D. Mace et al. (1999), Research Wildlife Biologist, Montana Department of Fish, Wildlife and Parks, Montana, USA for the South Fork of the Flathead River that uses a "greenness" pseudo habitat layer derived from Landsat imagery) in the North Fork of the Flathead River. Poor results resulted from Rick Mace's South Fork model because the model was unable to discriminate between habitats selected by bears from those habitats seldom used by bears (e.g.: regenerating cutblocks which tend to have high greenness values but very low use by grizzly bears). The modeling approach for the North Fork of the

- Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – (FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	Flathead River was revised to incorporate new habitat information related to grizzly bear ecology (i.e.: seasonal habitat areas based on grizzly bear diet – such as riparian areas which provide spring forage and open burns that provide summer forage) based on radio telemetry data. Additional factors incorporated into the revised model included measures of road density, distance to roads, human impact points (e.g.: campsites, houses, trail buffers). Preliminary results of this approach are promising and will be published soon. Size of Area: ~200,000 hectares Location: Extreme southeastern BC and adjacent northwestern Montana.
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Proportional probability of use of grizzly bears - evaluating the probability that a grizzly bear will occur at a specific pixel.
6. Spatiality Can the tool analyze spatial relationships?	No. However, this tool enables post processing within a spatial analysis context.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	No. However, this tool enables post processing within a spatial analysis context.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Statistically based methodology (logistic regression) based on radio telemetry data.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. No. b. Any scale or resolution. Currently 1:20,000
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. No maximum. b. Currently, 200,000 hectares.
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Logistic regression using telemetry-based data and appropriate GIS information.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model	a. Yes. Coefficients that express the importance of habitat are fixed.

structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	 b. N/A
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?) b. Is it deterministic or stochastic?	a. Yes. Probability of habitat use is related to animal density. b. Deterministic (mechanistic)
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (Bayesian belief, population, logistic regression.), growth and yield.	a. No. But the outputs can be inputted in other forecasting models through post processing. b. Logistic Regression.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	Statistical assessment model (e.g.: SAS/STAT) Custom software Any GIS.

System Requirements & Features	Response
1. Required hardware, devices & operating system?	High end PC 16. GIS
2. What commercial software, including version, is required to provide full functionality?	None.
3. What is the typical set-up time to load program?	N/A
4. What is the typical set-up time to prepare and input data? (range)	N/A
5. What are the minimum data input requirements?	Logistic Regression variables based on grizzly bear telemetry data, derived habitat layers (based on forest cover maps using GIS), slope, elevation, aspect, human impact coverages (roads, campsites, trails) and other factors.
6. What data formats can be imported?	N/A
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	N/A
8. How long does it take to run a typical data set? (not including plotting of map)	N/A
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	N/A
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	Raster-based. Using a 1:20,000
11. What programming language(s) is the model written in?	N/A
12. What level of expertise is required to set-up and maintain the program?	N/A
13. What level of expertise is required to run the program?	High level of expertise
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	N/A
15. What capabilities are there for user-defined outputs?	None.
16. Is the software proprietary?	No.

17. What are the purchase/maintenance fees?	No.
18. What modeling techniques are used in developing the species-habitat relationships?	Logistic Regression
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No. Statistics are generated through separate analysis.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Conceptually transferable. However, the model is dependant on bear behavior – therefore will likely require additional sampling to calibrate seasonal diet/ vegetation/habitat relationships. b. Highly generic provided that new radio telemetry data is incorporated.
21. Training, user support?	No.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. No manuals. Documentation in the form of refereed journal article is being prepared. b. Project Website under construction.

General observations about the functionality, system requirement and features of a number of habitat supply models that are being used in British Columbia:

1. Many habitat modeling approaches are (i) generally weak on the data side of things or (ii) no way provided to test the voracity of the model.

2. Concern that there are many habitat projects underway with very little coordination amongst the projects or even discussion about the best ways to design and implement projects.

3. The province should support approaches that are science-based rather than subjectively determined. Wherever possible data should be collected to support the development of science-based relationships on which model can be used to make predictions.

4. Frustrated by the delphi approach of group consensus – rather preferring models that are objectively derived through statistical modeling.

5. Advantage of this approach is that the model can be incorporated into other models to examine effects of alternative timber harvesting and management scenarios in relation to grizzly bear habitat supply.

6. Predictive Ecosystem Mapping good in concept but needs accompanying ground sampling to ensure robust vegetation/habitat relationships.

7. The province should incorporate succession information within forest inventories so that resource manager can understand what vegetation will likely be present in the future.

8. We should be referring to the “Supply of Effective Habitat” rather than “Habitat Supply” – perhaps we need a defined set of rules to achieve effective habitat and a low risk of mortality. Part of the solution is shutting down roads to reduce access (i.e.: gates with locks and signage that says no hunting with motorized vehicles) with enforcement.

9. Interested in a workshop to discuss various approaches (limitations, weaknesses, advantages) and web access registry of projects and modeling approaches

1.10 Assessment of coarse–filter habitat trends

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**An approach – An assessment of coarse–filter habitat trends**
2. Brief Description: Describe the purpose, primary use and functions of the tool	Purpose: to forecast simple yet meaningful coarse–filter indicators of habitat quality and quantity; primarily used at regional, landscape and management unit levels
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer and User: Greg Utzig, Kutenai Nature Investigations Ltd. and Rachel Holt, Veridian Ecological Consulting. Collaborator: Eric Valdal and Graham Smith, Nelson Forest Region, BC Ministry Sustainable Resource Management
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Greg Utzig Position: Researcher Organization: Kutenai Nature Investigations Ltd. Address: 602 Richards Street Nelson, BC Canada V1L 5K5 Tel: 250-352-5288 Fax: 250-352-6430 Email: gutzig@telus.net Website:
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range	**Project 1.** Project Title: Assessment of environmental impacts of various options for the Kootenay Boundary Land Use Plan – Implementation Strategy (1996-1998) Project Sponsor: MELP and LUCO Management Issue or Decision Type: **A** Project Purpose: Predicted seral stage distribution by BEC unit for each LU and compared predicted values with estimated natural (present to 250 years into the future) based on output of FSSIM timber supply modeling for 11 management units Size of Area: 4.2 million ha Location: Kooenay-Boundary Region **Project 2.** Project Title: Assessment of environmental trends of various implementation strategies of the Kootenay Boundary Higher Level Plan Order (in progress) Project Sponsor: MWLAP, MSRM, MoF, Forest Renewal BC Management Issue or Decision Type: Primarily Type **A** (including some Types **B and C**) –tied to Eric Valdal MSRM fine–filter projects (Type **E**) Project Purpose: Predicting various habitat variables

Type E: Single Species – Large Area Home Range – (FF) All/Most Life Requisites - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	(as outlined below), based on output from various timber supply models for 11 management units (e.g. CASH, Atlas); outputs are compared with predicted values for the range of natural variation (present to 250 years into the future) Size of Area: 4.2 million ha total; individual management units 100-500,000 ha Location: Kootenay-Boundary Region
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Seral stage/structural stage distribution by BEC unit for each LU, and for various management zones (e.g. riparian, grizzly cover); ecosystem representation, patch size distribution, edge/interior habitats, risk to aquatic features (peak flow and sediment yield)
6. Spatiality Can the tool analyze spatial relationships?	Within an ArcView/ArcInfo environment
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Yes.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	It is possible, but only used in related fine–filter aspects of the overall projects.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes. b. Any.
10. Size of area that can be analyzed a. What is the maximum number of analysis units? b. What is the largest project area it has been used for? and at what resolution?	a. Into the thousands. b. Approximately 600,000 ha. Base data was at 1:20,000, with smallest units about 1 ha.
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Inclusive participatory process with a lead group and extensive consultation with appropriate specialists.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to	a. Because it is coarse–filter, the species/habitat relationships are not specifically included in the model – they are considered in the selection of indicators and further discussed in the conclusions and interpretations of results. b. N/A.

enter or load these relationships? Is there a user interface?	
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?) b. Is it deterministic or stochastic?	a. No. b. N/A.
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. Yes. b. Scheduling, growth and yield with structural stage outputs and assessment models.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	The approach requires a disturbance scheduler/recovery predictor model to generate a data base for applying the habitat analysis (e.g. FSSIM, CASH, Atlas); require ArcView and/or ArcInfo

System Requirements & Features	Response
1. Required hardware, devices & operating system?	ArcInfo/ArcView and necessary hardware for the size of database
2. What commercial software, including version, is required to provide full functionality?	ArcInfo/ArcView and MS Excel
3. What is the typical set-up time to load program?	Very dependent on area complexity and selected output variables.
4. What is the typical set-up time to prepare and input data? (range)	1-5 days, depending on size, complexity and format of data set.
5. What are the minimum data input requirements?	Spatial harvest scheduling model outputs combined with BEC/LU digital mapping provides basic seral stage and patch size distribution outputs. To add further outputs requires TEM/PEM, resource zone and hydrologic feature mapping in digital form. Detailed information on stand structural characteristics of analysis units at various ages allows for further analysis on stand level habitat features.
6. What data formats can be imported?	Most anything.
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Most anything.
8. How long does it take to run a typical data set? (not including plotting of map)	0.5 days
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	Either.
11. What programming language(s) is the model written in?	N/A.
12. What level of expertise is required to set-up and maintain the program?	GIS technologist and ecologist/biologist.
13. What level of expertise is required to run the program?	GIS technologist and ecologist/biologist
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Maps, tables and graphs – depending on user needs and data results.

15. What capabilities are there for user-defined outputs?	Completely open for user to define additional output, assuming base data is there to support new variables.
16. Is the software proprietary?	N/A.
17. What are the purchase/maintenance fees?	N/A.
18. What modeling techniques are used in developing the species-habitat relationships?	N/A.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No – but potentially could be calculated.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model? (i.e. ease of loading new knowledge relationship sets)**	a. Fully transferable, assuming base data availability. b. Extremely generic.
21. Training, user support?	No – except by contractual relationship.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Description of methods for each project – more detailed information under development. b. No

1.11 Environmental Indicators in Timber Supply Review

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Environmental Indicators in Timber Supply Review.**
2. Brief Description: Describe the purpose, primary use and functions of the tool	To interpret FSSIM outputs in relation to environmental sustainability issues and habitat supply implications for consideration in Timber Supply Review.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	User: Marvin Eng (Interviewee) Collaborators: Tory Stevens; Andy Mackinnon; Atmo Prasad
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Marvin Eng Position: Research Landscape Ecologist Organization: BC Ministry of Forests, Research Branch Address: P.O. Box 9519 Stn. Prov. Govt, Victoria, BC V8W 9C2 Tel: (250) 387-2710 Fax: (250) 387-0046 Email: Marvin.Eng@gems5.gov.bc.ca Website: www.for.gov.bc.ca/research
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range –** **(FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites	**Project 1.** Project Title: Environmental Indicators in Timber Supply Review. Project Sponsor: BC Environment and BC Ministry of Forests. Management Issue or Decision Type: **A** Project Purpose: To provide the Chief Forester with information on environmental sustainability issues as related to wildlife habitat supply implications to the TSR base case analysis. To accomplish this FSSIM outputs are interpreted in relation to environmental sustainability issues (specifically habitat supply) for consideration in Timber Supply Review. This method of interpretation of FSSIM output was applied in a pilot project for the Robson Valley TSA. Currently an inter-ministry team is working on revising the methodologies in another pilot for the Arrow TSA. Size of Area: Any Sustained Yield Forest Management Unit; i.e. a TSA or TFL Location: N/A

- e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Broad Ecosystems – BEC subzone variants Forest Composition – inventory type group and site index Structural Stage – age
6. Spatiality Can the tool analyze spatial relationships?	No. Aspatial approach.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	No.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	No.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. No. b. Subzone variant and forest cover mapping. Outputs will have the same spatial resolution as FSSIM.
10. Size of area that can be analyzed a. What is the maximum number of analysis units? b. What is the largest project area it has been used for? and at what resolution?	a. Theoretical maximum approximately 150 analysis unit – 30 analysis units in practice. b. ~1,500,000 hectares in the Robson Valley – any resolution .
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	User specified species – habitat relationships in relation to analysis units.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? **b. How does the model allow the user to enter or load these relationships? Is there a user interface?**	a. In development – the user specifies the relationships through a graphical user interface b. User-defined relationships entered through a graphical user interface (currently in development).

13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?) b. Is it deterministic or stochastic?	a. No. b. Deterministic.
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (Bayesian belief, population, logistic regression.), growth and yield.	a. Yes b. Assessment tool.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	• MS Access 97 • MS Excel • Refer to Website – for requirements to FSSIM and pre-processing methodologies: (i) calculate disturbances in the inoperable with in FSSIM; (ii) calculate range of natural variability & seral stage distribution.

System Requirements & Features	Response
1. Required hardware, devices & operating system?	PC Win NT, Win 98+, MS Access 97
2. What commercial software, including version, is required to provide full functionality?	MS Access 97, MS Excel
3. What is the typical set-up time to load program?	5 minutes
4. What is the typical set-up time to prepare and input data? (range)	Assuming that base case data is fully developed – a few hours are required to prepare the input data.
5. What are the minimum data input requirements?	Area by period by BEC subzone, inventory type, site index and age.
6. What data formats can be imported?	Any format that MS Access can accept. Normally CSV tables.
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Any format that MS Access can export to (e.g.: Ascii and MS Office and Dbase)
8. How long does it take to run a typical data set? (not including plotting of map)	30 minutes
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	No.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	N/A. The tools operates on aspatial summaries of FSSIM output.
11. What programming language(s) is the model written in?	• MS Access • Visual Basic For Applications
12. What level of expertise is required to set-up and maintain the program?	Qualified analyst with technical support provided by a biologist.
13. What level of expertise is required to run the program?	Qualified analyst with technical support provided by a biologist.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Data exported for use in MS Excel (tables and graphs).
15. What capabilities are there for user-defined outputs?	No. Accomplished through MS Excel
16. Is the software proprietary?	No.
17. What are the purchase/maintenance fees?	No.
18. What modeling techniques are used in developing the species-habitat	Expert opinion.

relationships?	
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Somewhat however the modeling approach would require some recalibration. b. Reasonably generic. Requires collaboration with the Timber Supply Analyst, early in the development of the data package to ensure that the analysis units used for FSSIM will be amenable to inclusion in the process used here.
21. Training, user support?	No. In development
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Not currently. (under development) b. No.

1.12 FSSIM Environmental Indicator Database

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**FSSIM Environmental Indicator Database**
2. Brief Description: Describe the purpose, primary use and functions of the tool	Function: To give MWLAP (or anyone) the ability review FSSIM output to monitor coarse–filter biodiversity patterns through time.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developers: Michael Buell (Interviewee) and Jordan Tanz, Cortex Consultants Inc. User: Tory Stevens, Analytical Ecologist, MWLAP
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Michael Buell Position: Programmer/Analyst Organization: Cortex Consultants Inc. Address: Suite 3a - 1218 Langley Street, Victoria, BC Canada V8W 1W2 Tel: (250) 360-1492 Fax: (250) 360-1493 Email: mbuell@cortex.ca Website: www.cortex.org
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features (CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability (CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability (CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite (FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – All/Most Life Requisites (FF)** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range All/Most Life Requisites (FF)**	**Project 1.** Project Title: FSSIM Environmental Indicator Database Project Sponsor: BC Ministry of Water, Air and Land Protection and BC Ministry of Forests Management Issue or Decision Type: **A and B** Currently focused at coarse–filter level – types **A or B** depending on data inputs in FSSIM. Project Purpose: The assessment tool utilizes FSSIM output from TSR base case run, and reports area by age for analysis groups that were created in FSSIM and reports it by period. The approach is focused at MWLAP staff doing state of environment reporting at coarse–filter level. MS Access database imports the FSSIM inv_ha.rep report and creates MS Excel files with data based on analysis groups chosen by the user. Note that it could be used to output data for each of the types, if habitat for that value were identified as an analysis group in FSSIM (e.g. UWR etc). To do this, the value needs to be identified in the FSSIM class.dat file. Size of Area: Any Management Unit Location: To date, been used to provide data for the Robson Valley TSA and Prince George TSA.

- Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	1) age class distribution 2) seral stage distribution
6. Spatiality Can the tool analyze spatial relationships?	No.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	No.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	No.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes – provided that the analyst had included those in the dataset b. Dependent on FSSIM.
10. Size of area that can be analyzed a. What is the maximum number of analysis units? b. What is the largest project area it has been used for? and at what resolution?	a. No maximum. This tool is not limited, but of course, it is limited by FSSIM. b. Prince George TSA 2.2 Million Hectares.
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	N/A.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	a. N/A. b. N/A.
13. Population component a. Does the model have an integral population analysis component?	a. No.

(i.e. predict population size?) b. Is it deterministic or stochastic?	 b. N/A.
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. No. Forecasting done through FSSIM and this assessment tool utilizes results. b. Assessment tool.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	MS Access MS Excel 97+

System Requirements & Features	Response
1. Required hardware, devices & operating system?	Will function on a desktop computer, with as little as 64 MB RAM. Functions better with more RAM (e.g. 1.2 GB). Any MS Windows based operating system.
2. What commercial software, including version, is required to provide full functionality?	Requires FSSIM output MS Access and MS Excel required to provide graphing function.
3. What is the typical set-up time to load program?	Instantaneous
4. What is the typical set-up time to prepare and input data? (range)	Import data from inventory – takes 1 – 3 hours depending on size of report file and speed of the PC. The user has to be able to look at FSSIM input files, and determine how that analyst created the class.dat file – usually requires taking a SAS file of how the zones were created. Combinations of LU and BEC and Analysis units can be tricky because each analyst does it differently and has different requirements. This is the only portion that requires some technical knowledge.
5. What are the minimum data input requirements?	An output file from FSSIM.
6. What data formats can be imported?	FSSIM output There is a plan to adapt the model so that it takes Woodstock output. Probably available in March 2002.
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Ascii files MS Excel spreadsheets
8. How long does it take to run a typical data set? (not including plotting of map)	15 minutes to create flat file - assuming one batch run that looks at seral stage by analysis unit.
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	No.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	N/A.
11. What programming language(s) is the model written in?	Visual Basic and Perl
12. What level of expertise is required to set-up and maintain the program?	Very little – need to understand SAS files and creating groups that you want to report on. otherwise, minimal.
13. What level of expertise is required to run the program?	Very little.

14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Outputs tabular summaries and graphs of area through time. Can be also combined into seral stage through time.
15. What capabilities are there for user-defined outputs?	Key aspect is whether an analysis group was identified in the FSSIM class .dat file. If so, then it can be reported on. e.g. UWR
16. Is the software proprietary?	No. Available free through Cortex Consultants Inc. or MWLAP (Tory Stevens)
17. What are the purchase/maintenance fees?	None.
18. What modeling techniques are used in developing the species-habitat relationships?	N/A.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	N/A.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Totally transferable. b. N/A.
21. Training, user support?	Any problems – can contact Cortex Consultants Inc.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. User manual available b. No.

1.13 SIMFOR Version 3

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**SIMFOR Version 3**
2. Brief Description: Describe the purpose, primary use and functions of the tool	Strategic to tactical habitat and landscape analysis tool
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer, User: Ralph Wells, Centre for Applied Conservation Research , University of British Columbia (Interviewee) Project Director: Fred Bunnell, Co-Director, Centre for Applied Conservation Research , University of British Columbia
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Ralph Wells Position: Research Associate Organization: Centre for Applied Conservation Research , University of British Columbia Address: 3rd Floor, Forest Sciences Centre 3004-2424 Main Mall, Vancouver, BC V6T 1Z4 Tel: (604) 822-0943 Fax: (604) 822-5410 Email: rwells@interchg.ubc.ca Website: www.forestry.ubc.ca/simfor
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – All/Most Life Requisites** **(FF)** - Usually large **a**rea home range	Management Issue or Decision Type: **F** Numerous examples including black-throated green warbler in northeast B.C. (Canfor), several species with Alberta Pacific in Alberta, and several with Invermere EFMPP Pilot Project (East Kootenay) and Arrow IFPA (West Kootenay) (forest data incomplete for some). Management Issue or Decision Type: **E** Several examples including grizzly in the Flathead (East Kootenay; BC MoF) and for Joint Solutions Project on mainland coast. Management Issue or Decision Type: **D** Several examples including marbled murrelets (Western Forest Products, Joint Solutions Project), black-tailed deer (Western Forest Products, Weyco), mainland coast, Vancouver Island. Management Issue or Decision Type: **D** Several examples including shrub nesters and cavity users for Alberta Pacific, northern Alberta. All approaches incorporate types **A through C** to varying degrees depending upon data availability and the specific question. Work with Alberta Pacific was relatively complete, but the projection of forest and

- All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	stand data lacked considerable data. That being developed for Weyerhaeuser's forest project will likely be the most powerful (includes lichens, gastropods, and fungi as well as vertebrates), but projection techniques for variable retention are still being refined. See also references noted at end of survey.
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Landscape: seral stage, patches, edge Habitat: habitat attributes/ elements (e.g. snags) and quantitative/ qualitative predictions about species/ guilds (broad – to regression) (This seems to be an inappropriate question for a short answer. Indicators depend on the research or management question. Crudely: stand and forest elements projected independently or linked to organism relative abundance)
6. Spatiality Can the tool analyze spatial relationships?	Yes. For example, incorporates spatial explicit and temporally dynamic habitat features such as edge habitat. (see notes above that there is a new and improved Simfor) Spatial: not spatial in sense of SELES, but spatial in terms of 'neighbourhood variables'. (Two types: temporally static (e.g. slope); temporally dynamic (e.g. edge). Appends year number to these variables to run through time.) In terms of doing analysis of output in spatial terms, (e.g.: dispersal) you can do it directly in GIS.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	In the design of input habitat maps and post analysis in GIS (SIMFOR is linked to GIS)
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model deal with spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes. Spatial components can be analyzed in SIMFOR. This function is extended by SIMFOR's link to GIS. Some applications require script to deal with spatial questions (as Eric Valdal did for NOGO in Invermere EFMPP). But once scripted, the model is portable and usable by others.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes. b. User decides, no inherent limitation.
10. Size of area that can be analyzed a. What is the maximum number of analysis units?	a. No limit. (although "stand types" or "ecosystem classes" is less cryptic. AU is specific to MoF timber supply analysis, not habitat analysis in general. See JSP work.)

b. What is the largest project area it has been used for? and at what resolution?	b. Over 1 million hectares at 1 hectare resolution
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	The process of developing models is separate from the software used to model. Process should be designed to fit the objective. SIMFOR is flexible and transparent enough to be bought into many different approaches. Has been used in workshops, to deal with management issues or by individual users developing hypotheses for research projects.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined?	a. Full featured expression builder to retain transparency and permit user flexibility.
b. How does the model allow the user to enter or load these relationships? Is there a user interface?	b. As above (user defined).
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?)	a. No.
b. Is it deterministic or stochastic?	b. Deterministic. Can explore effects of landscape events resulting from stochastic modeling. See also 19.
14. Forecasting a. Does the model predict future conditions?	a. Better to say that it is designed to do projections. Links to spatial harvest schedulers to evaluate harvest scenarios. Can make predictions (generate hypotheses to test) if that is what is desired (e.g. project regression equations of songbird abundance for field validation).
b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	b. SIMFOR – Assessment Modeling Language
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	SIMFOR version 3 requires ESRI ArcView 3, for viewing output maps. Output is in ESRI Grid Format. Can be ported to ArcView 8

System Requirements & Features	Response
1. Required hardware, devices & operating system?	Mid-range PC.
2. What commercial software, including version, is required to provide full functionality?	ArcView 3 and spatial analyst. (No large spatial scale modeling is possible with out good GIS support.)
3. What is the typical set-up time to load program?	Minutes to install software, if that is the question, otherwise see 4.
4. What is the typical set-up time to prepare and input data? (range)	This is project specific. Contact time ranges from hours to days. Typically takes weeks of elapsed time when multiple agencies are involved.
5. What are the minimum data input requirements?	Not sure this is a helpful question. You can be as crude as you wish; we prefer not to be.
6. What data formats can be imported?	Map format is ESRI grid. Other fields are in tables of data in MS Access, import is simple.
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Map format is ESRI grid. Export as per ArcInfo functionality.
8. How long does it take to run a typical data set? (not including plotting of map)	Again, obviously dependent on use. However, we have run > 1 million cells in minutes for a typical analysis.
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes, but as separate layers, or aggregates. *Note:* incorporating aspatial information into spatial polygons is a poor strategic approach to designing spatial data sets. Ralph's response: is that building databases like this is problematic (e.g. PEM in Arrow and Canfor didn't have complex polygons). This type of database will limit utility for many modeling applications.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	Raster-based. User chooses resolution. Of course any serious large spatial scale modeling exercise will likely utilize both raster and vector data at the GIS stage – the modeling is often dependent on both.
11. What programming language(s) is the model written in?	Pure C for speed. (faster than C++). Interface in Visual Basic
12. What level of expertise is required to set-up and maintain the program?	Software is dead simple, but requires ability to work with Spatial Analyst. Designing good/effective analyses is anything but simple.

13. What level of expertise is required to run the program?	As above. Our experience is that industry and to a lesser extent MoF has more "in-house" talent than environmental agencies. Industry typically is running model in hours.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Arc grid maps, tables of area.
15. What capabilities are there for user-defined outputs?	All software designed to allow modeling must generate "user designed output". User controls output.
16. Is the software proprietary?	No.
17. What are the purchase/maintenance fees?	None.
18. What modeling techniques are used in developing the species-habitat relationships?	This is not a software question, it is a modeling question. Answer will vary widely depending on the question. Current versions incorporate everything from reasoned guesses to multiple and logistic regressions.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	Not directly. Adept users recognize that ranges of input curves can provide output that reflects estimates of error. We would like to add more tools to deal with error, but complex models have many, diverse sources of error.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Generic, based on associations to habitat types and elements. Has run using Alberta VRI, company-specific data, forest cover, site series, WLAP BEUs, more. b. See a., designed for ease of use and transparency.
21. Training, user support?	Developing a tutorial with forestry continuing studies. Adept analysts have never had problems figuring out how to use the software.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Full documentation example database, and runs included in documentation, tutorial under development with FCS. b. www.forestry.ubc.ca/simfor

General observations about the functionality, system requirement and features of a number of habitat supply models that are being used in British Columbia:

BC is blessed with a very active group of habitat supply modelers. Given that nobody has the correct answer, that diversity should be encouraged. Nobody has the "correct" answer because there is no

single form of question. It is likely that going down a list of existing models will find that every one of them is best-fitted to some specific question, to which others are less well adapted. For example, for strategic stochastic questions SELES appears best adapted and has been used by Centre personnel for such questions. SELES, however, is less well adapted to tactical questions. The Centre did create a combination of SELES plus Simfor and found it somewhat cumbersome especially for effective transfer to users. It was more revealing to separate strategic stochastic questions and specific forest practice questions. Other models are only quasi-spatial (e.g., OPTIONS) and thus poorly suited for some questions. Et cetera.

Simfor may be the most generic because it was designed initially as a research tool, then hijacked for planning purposes. The adaptation to planning emphasized the need for transparency and desirability of retaining a generic structure. It is probable that it is this generic capacity that provides Simfor's greatest utility and why so many users have selected it. Though that is circular: as the number of users increase, new capacities have been added to accommodate user requests. In short, its use by a variety of users sustains its refinement. It is likely that the biggest advantages are:

- Transparency – workshops suggest that most non-modelers can interpret outputs quickly; most users learn rapidly.
- Effective visualization – the user can readily determine what spatial or aspatial summary statistics they wish.
- Direct connection with GIS – some questions don't require simulation, but the overlay of "habitat" layers. Simfor permits the effective incorporation of simulation or projection techniques within the layers. You choose the approach depending on the question.
- Readily linked to various forms of stand or forest projection: Simfor has been linked to everything from company-specific data to VDYP, WINTIPSY, TASS, FORCYTE, specific attribute models (e.g., dead wood), to reasoned guesses. Depends on the question.
- Readily linked to any harvest projection software that is spatially explicit. ATLAS, and spatial versions of FSSIM have been used. Some models were not as effective due to the quasi-spatial nature of models (e.g. OPTIONS, most FSSIM runs).
- Various forms of projection are readily accommodated: data relevant to organism responses are highly variable. Simfor allows data to be incorporated as reasoned estimates in tabular or graphical form or as multiple regressions where data are well-developed. The latter permits evaluating and extending the generality of findings.

Some relevant publications:

Daust, D.K., and Bunnell, F.L. 1992. Predicting Biological Diversity on Forest Land in British Columbia. Northwest Environmental Journal. 8:191-192.

Daust, D.K., and Sutherland, G.D. 1996. SIMFOR: Software for Simulating Forest Management and Assessing Biodiversity. pp. 15-29 I*n:* The status of forestry/wildlife decision support systems in Canada: symposium proceedings. Thomson, J.D. (*ed*). 1994. Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Center, Sault Ste. Marie, Ontario.

Bunnell, F.L. 1999. What Habitat is an Island? Pp 1-31 *In*: Rochelle, J.A., Lehmann, L.A. and J. Wisniewski (*eds*). Forest Fragmentation: Wildlife and Management Implications. Koninklijke Brill NV, Leiden, The Netherlands.

Bunnell, F.L., Wells, R.W., Nelson, J.D., and L.L. Kremsater. 1999. Effects of Harvest Policy on Landscape Pattern, Timber Supply and Vertebrates in an East Kootenay Watershed. Pp. 271-293 *In*: Rochelle, J.A., Lehmann, L.A. and J. Wisniewski (*eds*). Forest Fragmentation: Wildlife and Management Implications. Koninklijke Brill NV, Leiden, The Netherlands.

Nelson, J and R. Wells. 2000. The Effect of Patch Size on Timber Supply and Landscape Structure. *In*: D'Eon, R.G., Johnson, J. and E.A. Ferguson (*eds.*). Ecosystem Management of Forested Landscapes: Directions and Implications. Papers from a conference held in Nelson, British Columbia, Canada, 26-28 October 1998. UBC Press, Vancouver, B.C., Canada.

Web links:

Habitat Analysis of Lemon Landscape Unit Management Scenarios (Arrow-IFPA)
Wells, R. and F.L. Bunnell. 2001. Innovative Forest Practices Agreement Report No. M-15. Nelson, B.C.
[http://www.arrow-ifpa.com/projects/719047B]

SIMFOR Habitat Analysis of Two FSSIM Harvest Scenarios in the Rocky Mountain Trench (Invermere-EFMPP)
Wells, R., Valdal, E., Steeger, C. and P. Vernier. 1999. Project Summary. Invermere Forest District, Invermere, B.C.

SIMFOR Habitat Modeling in the Invermere Enhanced Forest Management Pilot Project
PowerPoint presentation – locate download under "Provincial Workshops" section

Habitat Modeling in the Invermere TSA
PowerPoint presentation – locate download under "Day 2: Session 3" section

1.14 Use of Habitat Models in the 1999 Forest Management Plan for the Weldwood Hinton Forest Management Area

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Use of Habitat Models in the 1999 Forest Management Plan for the Weldwood Hinton Forest Management Area**
2. Brief Description: Describe the purpose, primary use and functions of the tool	To develop the 1999 Forest Management Plan using a framework of forest–level forecasting and habitat assessment tools. The framework was designed to allow multiple management alternatives to be considered in an interactive manner. HSI Models were developed using information from existing models, literature review, and expert opinion.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	User: Rick Bonar (Interviewee)
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Rick Bonar Position: Chief Biologist Organization: Weldwood of Canada Ltd (Hinton Division) Address: 760 Switzer Drive, Hinton, Alberta T7V 1V7 Canada Tel: (780) 865-8193 Fax: (780) 865-8164 Email: rick_bonar@weldwood.com Website: www.hintonforestry.weldwood.com
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity	**Project 1.** Project Title: 1999 Forest Management Plan Project Sponsor: Weldwood of Canada Ltd. Management Issue or Decision Type: **A, C, D, E, F** Project Purpose: Management scenarios were produced independently and forecast using Woodstock to predict future forest conditions at desired time intervals. A series of locally developed wildlife habitat assessment models were applied at each interval at the coarse and fine–filter levels. At the coarse–filter level, the analysis was directed at determining the supply of ecosystems defined by major forest type and seral stage. At the second fine–filter level, the analysis was directed at determining the supply of habitat for individual species using the HSI models. Spatial considerations were not included in the habitat supply forecast. Lesson learned from both long term analyses is that the scenarios were fairly insensitive to habitat change. Overall, the assessment indicated that there were no apparent habitat supply bottlenecks at the FMA scale for any of the modeled species' habitats.

nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – (FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	A comparison of current habitat quantity and predicted quantity at the end of the forecast period (180 years) indicated long-term habitat supply decrease (>10% decline) from the current situation in 16 species, increase (>10%) for 8 species and stability for 20 species, but in all valid cases an adequate habitat supply was maintained. Post analysis work underway to refine HSI relationships and incorporate stochastic events by understanding the Range of Natural Variation (RNV). Size of Area: 1million hectares Location: Hinton, Alberta
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Forest cover related – area by age class, seral stage, species volume. Species Habitat related – primary and secondary habitat associations by management emphasis. HSI software actually predicts levels of many stand-level variables, which are then combined to give an HSI score.
6. Spatiality Can the tool analyze spatial relationships?	Non-spatial. However, every hectare was mapped into contributing or non contributing (2 million polygons).
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	No. Level I and Level II analysis determined that there were no species habitat issues requiring this type of analysis.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	No. For reason stated previously. Doing this on a special cases only – 55,000 ha Caribou range.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. No. Ecosystem mapping was not be completed for the analysis. 2004 to be completed est. b. Ecosites is as fine or finer than forest inventory (down to 0.1 hectare)
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. 135 analysis units b. 1 million ha. Could be used for larger areas.

11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Level 1- Woodstock analysis based on new forest inventory, growth-based yield curves developed from long term Permanent Sample Plots (PSP's). Land base allocation removing areas for other resource values (e.g.: steep slope areas, isolated areas, seismic lines, roads, oil well sites, Etc.) and assigned harvest allocation rules. Ran multiple scenarios and preferred scenario reviewed by public advisory group. Level 2 – Seral Stage Analysis for a range of scenarios with set asides held constant. Level 3 – Habitat Suitability Index Modeling Analysis using habitat yield curves based on output from Woodstock. Models were initially built using literature review, expert knowledge and some local evaluation data.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	a. Yes. All species habitat modeling relationships and software can be downloaded from the Foothills Model Forest website - www.fmf.ab.ca b. Woodstock output is entered into a predetermined file format that can be read by the habitat models.
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?) b. Is it deterministic or stochastic?	a. Yes. Relationships were established between habitat quality and population density based on the literature. b. Deterministic.
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression), growth and yield.	a. Yes. The modeling approach assesses future conditions predicted by Woodstock. b. Scheduling and Assessment Models.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	• GIS • Landmine – to calculate Ranges of Natural Variability. • Woodstock – scheduler • Statistics Package – regression analysis to develop yield curves. • Habitat Models: HSI models were converted to habitat supply analysis software through an ongoing project in cooperation with the University of Alberta and

	Beck Consulting (Beck and Beck 1996, 1999). There are three separate software components: (1) CRITTER-CRUNCHER is programmed in C and runs on both DOS and UNIX systems. It produces strata-based yield tables for all non-spatial aspects of HSI models, to be used in either WOODSTOCK or GIS-Forman analyses; (2) WILD-WEASEL interprets CRITTER-CRUNCHER yield tables and produces a database that can express HSI value or population density using a set of related HSI/density relationship rules; (3) TRIBBLE uses the database produced by WILD-WEASEL and grid information from a GIS to determine HSI value for models with spatial relationships. See Beck and Beck (1995) for a complete description and documentation of the HSA software package and/or Foothills Model Forest Website.

System Requirements & Features	Response
1. Required hardware, devices & operating system?	High-end PC, Win NT, Win 98+
2. What commercial software, including version, is required to provide full functionality?	ArcInfo, MS Access, MS Excel
3. What is the typical set-up time to load program?	Several programs are required therefore it would take a few hours to install the various programs.
4. What is the typical set-up time to prepare and input data? (range)	~ 4 hours - assuming clean data.
5. What are the minimum data input requirements?	Spatial vegetation inventory covering the entire landbase, spatially determine areas that are deemed in and out of the analysis, yield curves
6. What data formats can be imported?	Ascii
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Ascii
8. How long does it take to run a typical data set? (not including plotting of map)	Minutes to hours – depending on complexity of analysis
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	No. This is addressed by a more detailed inventory.
10. At what resolution does the tool operate (e.g.: raster-based pixels or vector-based polygons)?	Primarily aspatial analysis. Land-based allocation was determined through vector-based GIS analysis
11. What programming language(s) is the model written in?	HSI Models – C Arc Macro Language
12. What level of expertise is required to set-up and maintain the program?	Medium
13. What level of expertise is required to run the program?	Once set up is complete – Low to Medium Habitat Supply Models interpretations – Medium to High
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Graphs, charts and tables
15. What capabilities are there for user-defined outputs?	Some standard charts Post processing MS Excel

16. Is the software proprietary?	Woodstock - Yes Landmine - Yes HSI Models - No
17. What are the purchase/maintenance fees?	Woodstock – See Remsoft Inc. Landmine – See Bundaloop Landscape Ecosystem Services
18. What modeling techniques are used in developing the species-habitat relationships?	Standard US Fish and Wildlife - Habitat Suitability Index Models methodologies.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No. Developed indirectly using statistical analysis package.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Generally transferable and applicable to Alberta Eastern Slopes. Potentially could be recalibrated for application in other western boreal coniferous dominated systems. b. Easy to load new knowledge sets.
21. Training, user support?	No user support.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Some limited documentation. b. HSI Models - www.fmf.ab.ca Woodstock - www.remsoft.com Landmine - andison@bandaloop.ca

General observations about the functionality, system requirement and features of a number of habitat supply models that are being used in British Columbia:

1. Some of the HSI models are overly complex for the questions being asked - for some species less complicated analysis may be sufficient – for predator species the habitat suitability index based approach does not work very well because the variety of prey habitats is difficult to predict. A better approach may be to apply a combination of prey habitat models and specific predator habitat requirements (eg raptor nesting).
2. Currently cautions against relying on utilizing spatial analysis for answering species "spatial questions" given the uncertainty associated with long term forecasting.
3. Being able to redo and game with the analysis is valuable.
4. Caution about using habitat models that have not been proven to make management decisions. Much work needs to be done to improve the reliability of habitat models so managers can be confident that they are accurate enough to use to make decisions. At present, most are very useful to direct further questions and lines of investigation, but they aren't at the levels where decisions based on them are likely to result in "real world" outcomes.

1.15 TELSA – Tool For Exploratory Landscape Scenario Analyses

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**TELSA – Tool For Exploratory Landscape Scenario Analyses**
2. Brief Description: Describe the purpose, primary use and functions of the tool	TELSA is a spatial version of VDDT, with many more capabilities, including more realistic application of disturbances and management, and the ability to set up various assumptions into different scenarios. See item 5 below for more information. VDDT- Vegetation Dynamics Development Tool is both a stand-alone tool and the engine within TELSA that enables groups of experts to describe how the ecosystem functions in terms of changes in cover and structure due to disturbances, management and succession.
3. Developer and/or User: (e.g.: Name, Position, Organization)	TELSA and VDDT: Main Developer: Name: Sarah Beukema (Interviewee) Position: Senior Systems Ecologist Organization: ESSA Technologies Ltd. VDDT: Main Support Name: Jim Merzenich Position: Planner, USFS Organization: US Forest Service, Portland, Oregon Phone: (503) 808-2284 Email: jmerzenich@fs.ed.us
4. Contact Information: (e.g.: Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Sarah Beukema Position: Senior Systems Ecologist Organization: ESSA Technologies Address: Suite 300, 1765 West 8th Avenue, Vancouver, BC Canada V6J 5C5 Phone: (250) 474-0948 Fax: (250) 474-0968 Email: sbeukema@essa.com Website: www.essa.com
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features (CF)** - Any landscape level parameter - Large area	**Project 1.** Project Title: TELSA – Tool For Exploratory Landscape Scenario Analyses Project Sponsor: BC Ministry of Forests (original sponsor. Sponsorship list has since expanded) Management Issue or Decision Type: **A, B, D, E** Project Purpose: TELSA is a spatially explicit tool that simulates vegetation succession, natural

- e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range –** **(FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range** **(FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	disturbances, and forest management activities. It is designed to allow users to specify various assumptions about management or natural disturbances within scenarios that then can be projected spatially and temporally. Tools enable the user to compare the results of the various scenarios. TELSA is a spatially explicit model that when run in simulation mode spreads disturbances from one polygon to an adjacent polygon and enables spatially explicit forest management practices. TELSA uses as inputs information outputted from VDDT (Vegetation Dynamics Development Tool). VDDT was originally developed in 1994 for use in the Interior Columbia River Basin Planning Process in the US. TELSA uses outputs from VDDT as the means for capturing the ideas about how experts think the system works in terms of structure and succession. It enables groups of specialists such as ecologists, fire experts, entomologists, topologists and resource managers – to formulate relationships about how vegetation changes over time. It is a state-based model (semi-marcovian model) where vegetation is measured as a series of states which have a cover type and structural stage. A single state of the landscape is unique combination of cover type and structure stage. Pathways from one structural state to another state are denoted by changes caused by succession, insects, diseases, management, disturbance (fire). Size of Area: 10,000 ha - 278,000 ha Location: Projects have been done, or are in progress in: BC north coast, BC southern interior, Alberta boreal forest, Idaho range-lands, US National parks or forests in MT, CA, OR, UT and other states, Siberian boreal forests.
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	• Seral stage distribution • Standing, harvested, or disturbed volume • Area of cover types, structural stages, age classes • Age • Defined attributes of habitat quality • State of the landscape • Area disturbed by different management and disturbance types • Patch size distribution and amount and distribution of interior habitat • Most indicators were produced as maps, tables, and graphs.
6. Spatiality Can the tool analyze spatial relationships?	TELSA yes– spatially explicit VDDT no – non-spatial

7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Yes.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes provided the relationships can be defined based state classes in the landscape (unique combinations of cover and structure).
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes – BEC variant. Developments are underway to incorporate site series. b. Any – Landscape Unit (i.e. McCully Creek, Barriere, etc.) limit is more the number polygons so larger areas can be done with lower resolution
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. 200,000 polygons – time function of processors and size of resulting database b. 278,000 ha with 180,000 polygons
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	An inclusive participatory process is used to build the model involving specialists (expert opinion), and researchers (analytical research results).
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	a. User-defined rules For example: The user defines what states are used? and how they are defined? what is meant by cover type or structural stage? how long it takes to move from one state to another? what disturbances are present? what management is present? What impact do disturbances and management have? What are the disturbance rules (probability, size, eligible states, etc.) and management rules (age, eligible states, amounts, constraints, etc.)? User-defined species-habitat relationship in TELSA. Relationships are defined based on state classes (unique combinations of cover and structure). b. Yes.
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?)	a. No. However, the model predicts the amount and change of landscape in different states, so if populations are tied to habitat, changes in populations levels can be predicted.

b. Is it deterministic or stochastic?	b. Both. – Disturbances are stochastic. – Management is generally deterministic.
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression), growth and yield.	a. Yes b. Scheduling and assessment.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	VDDT ARCVIEW (mandatory) MS Access (optional but recommended as it enables greater functionality)

System Requirements & Features	Response
1. Required hardware, devices & operating system?	PC Win NT, Win 95+
2. What commercial software, including version, is required to provide full functionality?	ARCVIEW (mandatory) 3.a or higher Spatial analyst 1.0a or higher Will not run under Arc 8.0 MS Access is optional, but required if user wants custom results not currently available through TELSA interfaces.
3. What is the typical set-up time to load program?	5 minutes
4. What is the typical set-up time to prepare and input data? (range)	Assume data clean. 1. Setting up vegetation model dynamics states and probability (2 day workshop and follow-up) 5 days Second and subsequent cycles much quicker 2. Classifying vegetation resources landscapes 2-3 days to classify structural stage 3. Management strategies, natural disturbance scenarios (set-up steps)
5. What are the minimum data input requirements?	Outputs from VDDT are imported directly into TELSA. Must have vegetation change information, LU map, one other boundary area map, information about applicable management and disturbances.
6. What data formats can be imported?	File that can be read by ARCVIEW Ascii files (user-created or from VDDT)
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	ArcGrid and any other format supported by the export functions in ArcView Ascii Bitmaps or windows-metafiles (graphs only). Any other export file format supported by MS Access
8. How long does it take to run a typical data set? (not including plotting of map)	2 hours for typical run 6 hours for larger units Actual run time depends on size and resolution of map.
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes. But addressed through data preprocessing. GIS
10. At what resolution does the tool operate (e.g.: raster-based pixels or vector-based polygons)?	Vector-based

11. What programming language(s) is the model written in?	Avenue, Visual Basic , C++
12. What level of expertise is required to set-up and maintain the program?	Medium to high level of understanding and knowledge
13. What level of expertise is required to run the program?	Low to medium experience
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Maps, graphs and tables
15. What capabilities are there for user-defined outputs?	User defined intervals for printing summary or detailed results describing state of the landscape. All results are in a database, which users can then query to get other output information.
16. Is the software proprietary?	TELSA – Yes. ESSA Technologies Ltd. – Source code is proprietary. – Controlled distribution through ESSA. – Executables freely available. VDDT – Partially – Freely downloadable from ESSA and USFS. – Source code is not distributed. No charge for use of TELSA or VDDT.
17. What are the purchase/maintenance fees?	No purchase fee for TELSA or VDDT. ESSA Technologies Ltd. charges service and support contract for TELSA (mandatory). Support contracts for VDDT are available upon request (optional).
18. What modeling techniques are used in developing the species-habitat relationships?	Expert opinion.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	Yes. Mean and variations of different scenarios. Most statistical analysis done through post processing.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Requires recalibration of relationships b. Easily transferable. All relationships in the model are user defined.
21. Training, user support?	• ESSA training and user support through services contract • USFS training and user support available through Jim Merzenich.
22. a. What type of documentation exists?	a. TELSA & VDDT - Users guide available.

(e.g.: system documentation; user manuals; tutorials)	VDDT - tutorials available through the USFS ESSA Technologies Ltd. – maintains proprietary system documentation
b. Website(s)?	b. www.essa.com/forestry

1.16 Omineca Northern Caribou Habitat Supply Modeling

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Omineca Northern Caribou Habitat Supply Modeling**
2. Brief Description: Describe the purpose, primary use and functions of the tool	To enable: (a) the assessment of strategic policy options focused on balancing sustainability of habitat supply for caribou and supply of timber to the forest industry; particularly as the objectives are compared to conditions of natural disturbance; (b) "gaming" of strategic plans associated with maintaining or improving the supply of habitats for caribou within the context of the Mackenzie LRMP Caribou Management Strategy.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer and User: Scott McNay (Interviewee)
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Scott McNay Position: Forest Biologist Organization: Slocan Forest Products Ltd. Address: Mackenzie Operations, Box 310, Mackenzie BC, V0J 1C0 Tel: (250) 997-2585 Fax: (250) 997-2533 Email: mcnays@mackenzie.slocan.com Website: www.otaku.unbc.ca/nfrep/caribou/main_frame.html
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range –** **(FF) All/Most Life Requisites**	**Project 1.** Project Title: Omineca Northern Caribou Habitat Supply Modeling Project Sponsor: Forest Renewal BC Management Issue or Decision Type: **E** Project Purpose: This is intended to be a coarse-filter application in that "the" prominent predator (wolves & hunters) – prey (caribou & moose) relationships in the ecosystems of interest are modeled. The modeling has both habitat-level availability features (i.e., individuals selection and use of seasonal range types) as well as landscape-level features (i.e., herd population characteristics as based on landscape connectivity and balance of seasonal ranges). Size of Area: 1 million hectares Location: Mackenzie Forest District

- Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range** **(FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Primary indicators are logging opportunity (area in hectares by either conventional logging or cable logging, spatial location, volume by species, length of new roads required) and caribou population health (area in hectares of seasonal ranges, quality of movement corridors, population size). There is a long list of secondary indicators where these are essentially dependant variables from each relationship in the seasonal range habitat models.
6. Spatiality Can the tool analyze spatial relationships?	Yes. We use a weighted (proportional) analysis of moose winter range that exists within certain distances from towns that are coincidentally affected by roads (allowing access by hunters) to calculate the likelihood of sustenance hunting level for each winter range, the effect of which is then attributed to the specific moose population using that area.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Yes. We use proximity of moose habitat as a basis for assessing risk-of-predation for caribou.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes. We analyze herd values, several seasonal range values within that herd area, and individual polygons (forest stands) within each seasonal range. However, we don't do within-stand modeling of habitat elements (e.g., trees).
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes. TEM or PEM are the basic input data for wherever we have that information. b. Basically, we handle input data from either 1:20,000 scale or 1:250,000 scale sources.
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. We're starting to run into a bit of a problem at around 1 million cells. b. So far we've been modeling an area of about 950,000 hectares, at 1hectare resolution.
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR	Participatory workshop process.

derived through regression analysis)	
12. User defined species-habitat relationships a. How does the model build relationships? (i.e. How does the model allow the user to enter or load these relationships? a user interface?)	a. There is no user interface (allow we hope to develop that this coming year). Data entry is handled by a GIS technician using a series of market available software (see below).
b. Is it fixed or user defined?	b. Most of our input data are fixed and readily available digital data (Trim, Forest Cover, TEM, Roads, Cut-blocks, BEC, Towns, Management Units from BC Environment, RMZ/LU from BC Forest Service), although we also have 3 user-defined inputs (moose population units, caribou migration routes, future mainlines to allow harvest of the THLB).
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?)	a. Not at the moment. We have been attempting to get there.
b. Is it deterministic or stochastic?	b. This model is mostly deterministic but it does have some stochastic elements that are associated with the forest harvest (and natural disturbance).
14. Forecasting a. Does the model predict future conditions?	a. Yes. We forecast the future conditions in 10-year time steps for 300 years from the current time. Forest harvest is conducted every 5 year.
b. List model(s) by general model type (i.e. scheduling, assessment (Bayesian belief, population, logistic regression.), growth and yield.	b. Scheduling and assessment.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	Data input and exporting (wherever it occurs) is handled by a combination of MS Access and ArcView GIS. We use VDYP to reinitiate and extend forest stand conditions where needed. Harvest of forest stands (based upon policy rules) is conducted using SELES. Habitat conditions are modeled using NETICA. Product development (maps, tables, figures, etc.) is accomplished using MS Access, ArcView, MS PowerPoint, and MS Excel.

System Requirements & Features	Response
1. Required hardware, devices & operating system?	Windows 2000 or NT is the basic operating systems that we've been using. Hardware is a Pentium IV with a 1.4 GHz processor, 768 Mb RAM, and 60Mb disk space. We've been dedicating 2 machines per herd area to increase our speed at handling data (i.e., double tasking).
2. What commercial software, including version, is required to provide full functionality?	Office 2000, ArcView 3.1 GIS and ArcView 3.1 Spatial Analyzer, NETICA 1.37, SELES (we don't run it ourselves, rather we employ Andrew Fall directly)
3. What is the typical set-up time to load program?	We don't have any single user interface so I don't think that I can answer this.
4. What is the typical set-up time to prepare and input data? (range)	Because we're dealing with huge areas, preparing the input data sources (e.g., forest cover, trim, etc.) can take up to a person-month unless data are available in a well maintained data warehouse.
5. What are the minimum data input requirements?	Trim, Forest Cover, TEM, Roads, Cut-blocks, BEC, Towns, Management Units from BC Environment, RMZ/LU from BC Forest Service, moose population units, caribou migration routes, future mainlines to allow harvest of the THLB.
6. What data formats can be imported?	Ascii. In general, data sources and input routines are based on BC standard inventory data formats.
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Currently, data export is limited to ArcView and Ascii formats.
8. How long does it take to run a typical data set? (not including plotting of map)	Running a completely new policy scenario, along with it's natural disturbance comparison, on a whole herd area for the 300 year forecast takes about 110 hrs. Gaming with the results is basically interactive (but admittedly we have not tried this yet).
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	No.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	Raster-based.
11. What programming language(s) is the model written in?	Most scripting takes place in NETICA, ArcView (Avenue), SELES (C++), and MS Access (SQL).

12. What level of expertise is required to set-up and maintain the program?	Technically capable GIS graduates with a solid background in database management could maintain the program after specific training.
13. What level of expertise is required to run the program?	Technically capable GIS graduates with a solid background in database management could run the program after specific training and assuming SELES runs were handled by Andrew Fall.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Standard outputs include seasonal range maps (potential, natural disturbance, policy-based) and graphs and tables of primary indicator values.
15. What capabilities are there for user-defined outputs?	Any one capable of using Access or ArcView could manipulate the resultant data to derive their own outputs.
16. Is the software proprietary?	No. For Belief Network and Sub-models. Yes. Enabling commercial software NETICA, ArcView, MS Access and MS Excel.
17. What are the purchase/maintenance fees?	None. For Belief Network and Sub-models. See appropriate website vendor for above-mentioned enabling commercial software.
18. What modeling techniques are used in developing the species-habitat relationships?	Bayesian Belief Networks; the intent being that the expert systems would be fully replaced with empirical updates (as they became available) in a Bayesian analyses.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	Yes.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Theoretically, the modeling system is quite applicable to a very broad range of habitat-species relationships provided within-stand dynamics is not important. b. This is largely untested but I believe it to be fairly generic.
21. Training, user support?	Right now, the modeling system is not very user friendly.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Documentation is only at a very rough draft stage. We expect a draft to be ready by the end of March 2002. b. www.otaku.unbc.ca/nfrep/caribou/main_frame.html

1.17 McGregor Scheduling Model (MSM)

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**McGregor Scheduling Model (MSM)**
2. Brief Description: Describe the purpose, primary use and functions of the tool**.**	To provide decision support related to land use and resource management.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	User: Steve Voros (Interviewee), Senior Resource Analyst, Barry Wilson, Resource Analyst, The McGregor Group. Main Developer: Peter Hvezda, Senior Software Engineer, The McGregor Group.
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Steve Voros Position: Senior Resource Analyst Organization: The McGregor Group Address: P.O. Box 2130 Stn A. Prince George, B.C. V2N 2J6 Tel: (250) 612-4050 Fax: (250) 612-4070 Email: steve.voros@themcgregorgroup.com Website: www.themcgregorgroup.com
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g.: old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – All/Most Life Requisites** **(FF)** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear	**Project 1.** Project Title: Morice and Lakes TSAs - Innovative Forest Practices Agreement Project Sponsor: Forest Renewal BC and Tweedsmuir Forest Inc. Management Issue or Decision Type: **A** Project Purpose: For each TSA the various wildlife habitat management scenarios were developed and evaluated, as follows: • Wildlife Scenario – developed using targets based on wildlife specific management practices. For example, moose winter range zone may use a forest cover target for the percent of mature forest condition present in that zone. Another example is the use of species specific buffers for no harvest or no access as target. Reserve zones and forest cover targets for specific species – caribou, moose, mountain sheep. • Biodiversity Guidebook Scenario – biodiversity guidebook targets are trying to be achieved by natural disturbance type within landscape units. • Ecosystem-based Management Scenario – using local data and knowledge localized targets are trying to be achieved for patch size distributions and seral stage distributions by natural disturbance types. Through the evaluation of alternative scenarios participants can cooperatively define desired future

Type F: Single Species – Small Area Home Range **(FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	conditions and evaluate "what's possible" in an uncertain future and "which paths" offer the best hope of achieving a desired future state. Size of Area: 3.5 million ha Location: Morice and Lakes Forest Districts **Project 2.** Project Title: Robson Valley EFMPP Scenario Planning Project Project Sponsor: Forest Renewal BC Management Issue or Decision Type: **A, B, C** Project Purpose: To develop with the involvement of local interest groups, a series of future forest scenarios for the Robson Valley Enhanced Forest Management Pilot Project that represents a wide array of social, economic and ecological values and objectives. Spatial and temporal forecasts are being developed that incorporate specific non-timber resource values and objectives for the landbase as follows: grizzly bear habitat; caribou habitat (summer and winter range and corridors); riparian (salmonid) habitat; old growth management areas; wildlife tree patches by treatment unit; protected areas; biodiversity emphasis options at the landscape level; and natural disturbance targets using forecasts produces from SELES. Size of Area: ~1.2 million ha Location: Robson Valley TSA and Mount Robson Provincial Park. **Project 3.** Project Title: Scenario Planning Project TFL 30 Canfor Project Sponsor: McGregor Model Forest Association and Canadian Forest Products Limited Management Issue or Decision Type: **A** Project Purpose: To compare and contrast how timber and non timber resource values respond under alternative scenarios with specific resource emphases. For example, A wildlife learning scenario was developed which emphasized species-specific habitat requirements without other non-wildlife related targets. The purpose of this learning scenario was to assess management strategies for wildlife at the species-specific level in relation to other values and associated requirements. This helped people to understand the relationship between multiple resource values on the landbase – specifically where they are complimentary or in conflict. This information was used to decision scenario that incorporated understandings of species-specific management within the context of other resource values. This decision scenario became the basis for TFL 30 Management Plan 9. Size of Area: 181,000 hectares Location: Tree Farm Licence 30 located approximately 30 kilometers northeast of the City of

	Prince George, BC. **Project 4.** Project Title: LRMP Impact Assessment Mackenzie TSA Project Sponsor: BC Ministry of Forests Management Issue or Decision Type: **A** Project Purpose: To provide the necessary land use decision support for the Mackenzie Land and Resource Management Plan by quantifying the costs and benefits associated with alternative land use strategies – reflected in six scenarios involving protected areas and biodiversity emphasis options. Size of Area: 6 million hectares Location: Mackenzie Timber Supply Area **Project 5.** Project Title: Kidprice Landscape Unit Analysis – Canfor Houston Project Sponsor: Canfor (formerly Northwood Inc.) Management Issue or Decision Type: **A, B** Project Purpose: To undertake an analysis of the Kidprice Landscape Unit to assess implications of alternative management practices on the land base. In particular, to mitigate the likelihood of a Mountain Pine Beetle (MPB) infestation spurred the client to investigate the introduction of large patch openings and the impacts of such a decision on Forest Practices Code related indicators and future timber supply. MPB hazard was projected and fibre loss to infestation mitigated. BC Forest Practices Code biodiversity guidebook objectives were implemented to increase the size of clearcuts from 60 ha in a manner consistent with the structural characteristics and the temporal and spatial distribution of natural openings with the LU. The analysis revealed problems with forest landscape fragment that would potentially result from implementation of the green-up adjacency and 60 ha clearcut block size FPC policies. Size of Area: ~101,000 ha Location: Kidprice Landscape Unit in the south central portion of the Morice Timber Supply Area.
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	All resource management objectives and associated targets are forecast through space and time under alternative scenarios. For each project, specific indicators are developed in relation each objectives and management issues or question being addressed, for example: Wildlife habitat landscape indicators: • biodiversity seral stage by BEC subzone by NDT • biodiversity patch size distribution • forest ecological networks • watershed equivalent clearcut requirements

	• riparian management areas • visual quality requirements • environmentally sensitive areas • old growth management areas Wildlife habitat stand level indicators: • wildlife tree retention • tree species representation Wildlife species specific: • forest cover requirements (e.g.: mountain caribou habitat zones) Forest cover indicators: • Area and volume by species • Seral stage Forest health indicators: • Mountain pine beetle hazard
6. Spatiality Can the tool analyze spatial relationships?	Yes. MSM is spatially sensitive allowing users to assess land base changes not only using tabular and graphical summaries but also with maps.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	No (not directly). Currently accomplished through post-processing analysis of mapped outputs using any GIS (e.g.: ArcInfo, ArcView). Development is underway to enable MSM to enforce and monitor proximity requirements dynamically.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes. Where the necessary inventories and assessment criteria are available. For example goshawk habitat analysis: Large dead trees of a certain diameter within a certain distance of known food sources can be modeled provided that supporting inventories contain necessary attributes to spatially assess and forecast species habitat changes through time.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes, ecological mapping is considered as an inventory layer within the MSM dataset against which criteria and assumptions can be made that permit interpretations and forecasts using site series mapping. b. Any.
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. There are no limits to the number of records which can be assessed by MSM. Solution times are minimized when very large datasets are run with the implementation of clustering technologies. b. 6 million hectares, vector based, at the block level 274,206 polygons scheduled.

11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Various interests are involved (for example: six licensees, managing agencies, First Nations, local interest groups and communities) through scenario planning teams to identify resource objectives and management strategies and scenarios (e.g.: wildlife, ecosystem-based management, biodiversity emphasis) to be forecast and analyzed using the McGregor Scheduling Model.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined?	a. Yes, relationships are user defined and are transparent and explicit within the model's input file structure.
b. How does the model allow the user to enter or load these relationships? Is there a user interface?	b. Input data is entered via database tables in Access and/or Oracle. Some relationships are fixed while others may be user defined. The user interface for data input is based on the database program being used. MSM itself can be run interactively using its GUI or through command lines.
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?)	a. No. Not directly, however if the necessary inventory and assessment criteria are available then population numbers can be forecast.
b. Is it deterministic or stochastic?	b. Deterministic
14. Forecasting a. Does the model predict future conditions?	a. Yes.
b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	b. Scheduling and assessment model.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	Typically, ArcInfo (ArcView), ORACLE, MS Access, MS Excel and MS Word, however, data inputs and outputs from MSM can be used for additional assessments using other applications where necessary. Currently under the Morice and Lakes IFPA analysis, landscape level biodiversity targets were localized using the SELES model and these targets will be incorporated into MSM under the Ecosystem Scenarios. In addition, there is an interest to take outputs from MSM and use them in habitat assessment tools.

System Requirements & Features	Response
1. Required hardware, devices & operating system?	MSM is a Java based application and is therefore cross platform capable. Currently it has been run on Unix/Linex and MS Windows 98/2000/XP operating systems. MSM can be run on any hardware configuration, however, large datasets require workstations and very large datasets require multiple CPU configurations in order to keep solution times to within a reasonable threshold.
2. What commercial software, including version, is required to provide full functionality?	Preparation of spatial and attribute data necessary to support MSM require a GIS application (ArcInfo, ArcView) and a commercial database application is recommended for preparation of input files, otherwise, MSM is fully integrated.
3. What is the typical set-up time to load program?	1 hour
4. What is the typical set-up time to prepare and input data? (range)	This depends greatly on the level of complexity within the analysis being performed. Typically under any analysis, 60-70% of the total time is spent completing data preparation and input, less than 1% is consumed generating outputs and the remainder is spent interpreting results.
5. What are the minimum data input requirements?	This depends entirely upon the objectives for the analysis, however, at a minimum MSM would require forest cover attribute information along with volume over age data in order to perform its scheduling functions.
6. What data formats can be imported?	Data provided in row and column orientation can be easily imported.
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Outputs are dumped as comma separated Ascii files which can then be used/converted to virtually any other application/format.
8. How long does it take to run a typical data set? (not including plotting of map)	Depends entirely upon the size of the dataset and computer hardware MSM is using. To date, runs have taken several minutes to 2 days to complete.
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	MSM can produce forecasts using either raster or vector based data or it can use a combination of the two. To date, MSM has used vector based information since projects completed have required operational decision support in addition to strategic level planning.
11. What programming language(s) is the model written in?	Java

12. What level of expertise is required to set-up and maintain the program?	High level of expertise is recommended to input data (resource analyst). Moderate (resource professional) to high (analyst) level of expertise is required to interpret results depending upon the complexity of the analysis.
13. What level of expertise is required to run the program?	Anyone with object oriented GUI experience.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Maps, graphs and tables as mentioned.
15. What capabilities are there for user-defined outputs?	Currently, a core set of standard outputs are generated based on the data inputs provided which can then be summarized and assessed using other applications (Excel, Access, etc.). All indicators being monitored by MSM based on the data inputs provided are graphed in real time during a scheduling run. Future developments include user selected automated reporting applications that summarize results based on model outputs.
16. Is the software proprietary?	MSM developed and maintained by The McGregor Group is proprietary. A freeware version of the McGregor Model Forest Association scheduling model will be available April 1, 2002.
17. What are the purchase/maintenance fees?	Currently, MSM is not available as a standalone software product but rather is used as a tool by The McGregor Group to deliver professional services contracts.
18. What modeling techniques are used in developing the species-habitat relationships?	MSM is a spatially sensitive forest estate model capable of providing near optimal solutions using simulated annealing techniques. Species-habitat relationships and assumptions are input into MSM's input file structure to enable assessment.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	MSM has been used to perform sensitivity analyses that provide decision makers with an understanding of the possible impacts to indicators based on uncertainty around data inputs and assumptions however, MSM does not have integrated statistical analysis capabilities.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Transferable as long as habitat-species relationship criteria/assumptions can be provided along with the necessary supporting inventory information. b. Most constraints and data relationships within MSM's input file structure are user defined enabling MSM to effectively provide solutions for a variety of resource management problems

	without requiring alterations to the model's source code.
21. Training, user support?	Not provided at present since MSM is not available as a standalone software product.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Not provided at present since MSM is not available as a standalone software product. b. www.themcgregorgroup.com

1.18 Type 3 Silviculture Assessments for TFL 14 (Tembec Industries Inc.)

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Type 3 Silviculture Assessments for Tree Farm Licence 14 (Tembec Industries Inc.)**
2. Brief Description: Describe the purpose, primary use and functions of the tool	This purpose of this framework is to model silvicultural practices and assess how they affect wildlife habitat.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	User: Steven Wilson (Interviewee) Developer: Bruce Marcot, Program Manager, Pacific Northwest Research Station, USDA Forest Service
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Steven Wilson Position: Principal Organization: EcoLogic Research Address: 406 Hemlock Avenue Gabriola, BC V0R 1X1 Tel: 250-247-7435 Fax: 250-247-7436 Email: sfwilson@shaw.ca Website:
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: site series – structural stage combinations - e.g. old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – All/Most Life Requisites** **(FF)** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear	**Project 1.** Project Title: Type 3 Silviculture Assessments Project Sponsor: Forest Renewal BC Management Issue or Decision Type: **C, D, E, F** Project Purpose: Type 3 silviculture assessments – TFL 14 in progress. Columbia Basin Database. The database relates wildlife species to forest structure conditions at a scale broader than BEC. Includes 26 different conditions based on 3 variables: (i) tree DBH, (ii) canopy closure classes and (iii) multi/single canopies. The data base relates all wildlife species to these 26 combinations. The database also includes other values – habitat attributes (e.g. CWD/ Snags etc) that may be key to determining habitat value. Being used in linkage with the KBLUP Spatial Project (see Greg Utzig response). Taking TUMS and trying to derive these three attributes now, plus develop curves for how they change through time. Crosswalk structural conditions to the spatial project which gives abundance of structural conditions through space. Curves for DBH exist already, curves for other variables are being derived based on expert opinion. In this framework, is being used to model silvicultural practices and how they affect wildlife habitat. Note: as with the KBLUP project there is no actual modeling tool. The analyst is using the database to

Type F: Single Species – Small Area Home Range **(FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse–filter; FF: fine–filter***	link output from the timber forecaster to habitat values for species. GIS exercise – with algebra! No specific tool. Taking the output: AU with name X age. Then use curves to work out structural conditions. Once the package has been developed it can be used to look at habitat for any species or groups of species included in the database (which is all known species). Size of Area: ~150,000 ha Location: TFL 14 is situated in the East Kootenay region of British Columbia and is within the Invermere Forest District of the BC Ministry of Forests.
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	dbh, canopy closure classes, mutli-story / single story canopy - These three are used to link to specific species. Because any one combination of attributes could exist anywhere in the landbase, the database overlays species distribution maps with the values to determine what species may be present.
6. Spatiality Can the tool analyze spatial relationships?	Yes. Because linked to TIPSY. However, this project, and the database is really only set up to look for habitat supply, not to analyze proximity relationships. So, no, not really.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Theoretically possible but not without further post processing.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	No.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Whatever is in the timber supply model. Not a feature of this package. b. N/A.
10. Size of area that can be analyzed a. What is the maximum number of analysis units? b. What is the largest project area it has been used for? and at what resolution?	a. N/A. b. N/A.
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive	The relationships within the dataset were developed through huge expert opinion process (both in US and in BC). These cannot be altered in the database. In

participatory process "workshop" OR derived through regression analysis)	terms of determining relationships between TUMs in timber supply model and the temporal change in habitat attributes, the method for development has not been fixed yet. Either using information from FC, or from expert opinion in workshop form.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined?	a. In the database quite explicit and available.
b. How does the model allow the user to enter or load these relationships? Is there a user interface?	b. Not set up to do this. The database project collected what was considered 'state of the knowledge' and this is how it will be. No user interface.
13. Population component a. Does the model have an integral population analysis component? (i.e. predict population size?)	a. No.
b. Is it deterministic or stochastic?	b. Deterministic
14. Forecasting a. Does the model predict future conditions?	a. No. In this case forecasting accomplished through Tembec's Spatial Project (could be any timber supply forecasting model).
b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistical regression.), growth and yield.	b. Scheduling and Assessment Models
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	MS Access

System Requirements & Features	Response
1. Required hardware, devices & operating system?	Any desktop PC that runs Microsoft products
2. What commercial software, including version, is required to provide full functionality?	MS Access, MS Excel, ArcGrid to view output
3. What is the typical set-up time to load program?	N/A.
4. What is the typical set-up time to prepare and input data? (range)	N/A.
5. What are the minimum data input requirements?	N/A. Database can be used at any complexity of question as long as the three input variables are generated.
6. What data formats can be imported?	As long as the three indicator variables are generated, any format can be used.
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	GIS format ArcView
8. How long does it take to run a typical data set? (not including plotting of map)	N/A.
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	No.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	N/A.
11. What programming language(s) is the model written in?	N/A.
12. What level of expertise is required to set-up and maintain the program?	Not very much to set up the database. Is available on a CD ROM and is very user friendly. The difficulty is developing the relationships. Some things are poorly characterized e.g. If have a stand with certain DBH and CC and canopy layers, can that predict what else is in the forest (snags, CWD etc). Can make some reasonable guesses in some places. However, adding the silviculture component (for this project) will make this much more difficult (concerned about knowing how many snags remain after a silvicultural treatment)(none?).

13. What level of expertise is required to run the program?	Database is very user friendly.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	None.
15. What capabilities are there for user-defined outputs?	Anything you want to develop.
16. Is the software proprietary?	Database: available. General database is in HTML format. Will be on a website very soon. On a CD ROM right now.
17. What are the purchase/maintenance fees?	Buy the book: Johnson, D. H., and T. A. O'Neil. 2001. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press. Can copy CD freely
18. What modeling techniques are used in developing the species-habitat relationships?	Were developed through combinations of expert opinions. Not known exactly how this information was summarized.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	The database includes an index of confidence around the association between habitat variables and species. This could be used to set limits of confidence around predictions (but not statistical confidence).
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Useable within the Columbia Basin. The approach is useable anywhere, but not developed. b. N/A.
21. Training, user support?	Johnson and O'Neil (2001) explains development. CD is self-explanatory.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. See above. b. Website under development

1.19[1] Empirical habitat modeling – various methods, including logistic regression

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Empirical habitat modeling – various methods, including logistic regression**.
2. Brief Description: Describe the purpose, primary use and functions of the tool	Can predict relative habitat quality and/or population distribution, depending on nature and quality of underlying datasets. Can account for influence of spatial scale. Can provide decision support for forest management and land use planning
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer: Clayton Apps User: Collaborators: (researchers) Bruce McLellan, Trevor Kinley, Nancy Newhouse, Tony Hamilton, Jim Young, John Boulanger
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Clayton Apps Position: Consultant [Biologist] Organization: Aspen Wildlife Research Address: 2708 Cochrane Rd. NW Calgary, AB T2M 4H9 Tel: 403-270-8663 Fax: Email: aspen@cadvision.com Website:
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features (CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability (CF)** - Variable area - Rare to limited occurrence - e.g.:Site series – structural stage combinations, e.g. old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability (CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite (FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range –**	**Project 1.** Project Title: Revelstoke Caribou Habitat Project Sponsor: MOF Management Issue or Decision Type: A, E Project Purpose: Research, forest management Size of Area: 900,000 ha Location: north Columbia Mnts **Project 2.** Project Title: Southern Purcell Caribou Habitat Project Sponsor: Crestbrook Forest Industries, East Kootenay Environmental Society, MELP Management Issue or Decision Type: A, E Project Purpose: Research, forest management Size of Area: 400,000 ha Location: southern Purcell Mnts **Project 3.** Project Title: Columbia Highland/Northern Columbia Mtns Caribou Habitat Project Sponsor: MELP, Williams Lake, Kamloops Management Issue or Decision Type: A, E Project Purpose: Research, forest management Size of Area: 1.2 million ha Location: Columbia Highland & Northern Columbia

[1] Models numbered 1.19 – 1.27 were added by Diana Demarchi for the Habitat Modeling Steering Committee.

(FF) All/Most Life Requisites - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range** **(FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.:Woodpecker spp., bat spp., rodents ***CF: coarse filter; FF: fine filter***	Mtns ecosections **Project 4.** Project Title: Itcha, Ilgachuz, & Rainbow Mtns Caribou Habitat Project Sponsor: MELP, Williams Lake Management Issue or Decision Type: A, E Project Purpose: Research, forest management Size of Area: 1.0 million ha Location: Itcha, Ilgachuz, & Rainbow Mtns, west of Williams Lake **Project 5.** Project Title: West Slopes Grizzly Bear Project Sponsor: MOF, Research Branch Management Issue or Decision Type: A, E Project Purpose: Research, forest management Size of Area: 0.5 million ha Location: upper Columbia River Basin **Project 6.** Project Title: East Kootenay Badger Project Sponsor: MOF, Research Branch Management Issue or Decision Type: A, E Project Purpose: Research, public/private land management Size of Area: 0.4 million ha Location: East Kootenay Trench **Project 7.** Project Title: Central Purcells, Elk Valley/Flathead Grizzly Bear Project Sponsor: FRBC, MOF, MELP Management Issue or Decision Type: A, E Project Purpose: Research, population monitoring Size of Area: 1.0 million ha Location: Central Purcells and southern Rockies **Project 8.** Project Title: East Kootenay Lynx Project Sponsor: HCTF, MELP CBFWCP, Parks Canada Management Issue or Decision Type: A, E Project Purpose: Research, forest/habitat management Size of Area: 0.3 - 10 million ha Location: Southern Rockies and Kootenay Region **Project 9.** Project Title: East Kootenay Bobcat Project Sponsor: HCTF, MELP CBFWCP Management Issue or Decision Type: A, E Project Purpose: Research, forest/habitat management Size of Area: 0.4 million ha Location: East Kootenay Trench

5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Habitat suitability, species occurrence probability, or species population density and distribution
6. Spatiality Can the tool analyze spatial relationships?	Yes. The general approach accounts for the availability or dispersion of specific attributes in the surrounding landscape.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Yes, very spatially explicit.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes, depends on what the underlying data set is. It is possible to stratify the data such that it reflects [e.g.] only reproductive animals, or seasonal habitat use. There is the ability to look at different seasons and life requisites. Also, accounts for the different species-habitat relationships at different scales and integrates these into one predictive output.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes. You can incorporate anything as long as the data are there. b. Any resolution is possible, it depends on the resolution of the underlying animal location data set, typically ± couple hundred metres. Generally speaking, the finest resolution is 100m, but can also model at a home range scale.
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. b. The Kootenay Region – 100 m resolution and home range scale
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	This particular approach is derived entirely through data analysis.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	a. The relationships are based entirely on associations with the data. With empirical modeling, the relationships are based on an analysis of animal locations against these variables, and the relationships are derived from that, in this sense they are data-based and fixed not knowledge based. b.
13. Population component a. Does the model have an integral population analysis component?	a. Can predict population distribution. If data are sampled at an appropriate "population level", output

(i.e.: predict population size?) b. Is it deterministic or stochastic?	can be rescaled using a population density estimate for a fixed area. b. Deterministic
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. Potentially. It depends on how representative the underlying data were of expected future conditions. The same issue applies in extrapolation in space, outside the analysis area. b. Depends on the project, most are data-based using logistic regression, DFA, PCA. I am also involved in knowledge-based modeling not discussed here.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	Most data management, statistical analysis, and raster-based GIS/remote sensing software will suffice.

System Requirements & Features	
1. Required hardware, devices & operating system?	Not specifically.
2. What commercial software, including version, is required to provide full functionality?	GIS software (e.g. any raster-based GIS like Arc/Info Grid), and a statistical analysis package like SAS, SPSS or Systat
3. What is the typical set-up time to load program?	N/A
4. What is the typical set-up time to prepare and input data? (range)	This question doesn't really apply. Each new model is built from scratch. The whole approach/method involves getting the animal and GIS datasets together, deriving relevant variables, and other steps; generally it can take anywhere from a couple of weeks to a couple of months.
5. What are the minimum data input requirements?	build a database of animal locations and environmental variables [in statistical tool mentioned above], which often includes a logistic regression. Derive variables at specific spatial scales, generate random location databases at specific spatial scales, depending on analysis design.
6. What data formats can be imported?	Any raster-based format
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Arc/Info Grid or any other raster
8. How long does it take to run a typical data set (not including plotting of map)**?**	N/A
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes. This – often involves deriving individual raster variables from complex polygons. Need to derive individual raster variables for each attributes reflecting the attribute value or its proportional composition of the polygon. Often, databases need

	to be manipulated first to do this.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	Raster-based pixels
11. What programming language(s) is the model written in?	Uses existing software tools.
12. What level of expertise is required to set-up and maintain the program?	Digital output can be used by anyone with basic GIS skills.
13. What level of expertise is required to run the program?	Strong quantitative, GIS, and spatial analysis background, and an understanding of the ecology of the species of interest.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Raster-based GIS image output that predicts suitability (probability of habitat use) for each pixel given landscape conditions, or species occurrence probability. This is derived from an algorithm that is linked back to a GIS to provide the predictive output
15. What capabilities are there for user-defined outputs?	
16. Is the software proprietary?	No. General approach is published – see below
17. What are the purchase/maintenance fees?	
18. What modeling techniques are used in developing the species-habitat relationships?	May include logistic regression and other multi-variate techniques. Involves species and habitat expertise, plus strong background in quantitative and spatial analysis.
19. **Does the model generate statistics estimates of error?** (i.e. confidence limits on predictions)	Yes. The output is probablistic. Output reflects probability of habitat use or animal occurrence.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Very transferable among species. Must have a dataset that is based on representative sampling among habitats, animals, seasons, years, to the extent that output is intended to be used for prediction. b.
21. Training, user support?	This is a collaborative process.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Individual project reports, and Apps et al (2001) J. Wildl. Manage. 65 b.

1.20 Wildlife Habitat Ratings (WHR) for 1:250,000 Broad Ecosystem Inventory (BEI) Mapping

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Wildlife Habitat Ratings (WHR) for 1:250,000 Broad Ecosystem Inventory (BEI) Mapping**
2. Brief Description: Describe the purpose, primary use and functions of the tool	Purpose: to show distribution of potential habitat across the entire province for species of concern. Use: provincial/strategic level planning. E.g. regional land use planning, management of species at risk, provincial wildlife harvest strategies
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer: Ted Lea (BEI) Dennis Demarchi, Lynne Bonner, Calvin Tolkamp, Sal Rasheed (WHR) User: Dennis Demarchi, Tony Hamilton, regional biologists Collaborator: Larry Lacelle (BEI)
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Dennis Demarchi Position: Provincial Habitat Correlator (ret.), Consultant (current) Organization: (former) Min. of Environment, Lands and Parks, Resources Inventory Branch Address: 2816 Shoreline Drive, Victoria BC V(B 1M6 Tel: 250 382-7372 Fax: - Email: dmcdemarchi@pacificcoast.net Website: -
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.:Site series – structural stage combinations, e.g. old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range	**Project 1.** Project Title: Central Coast Land Resource Management Planning (LRMP) **Project 2.** Project Title: Okanagan LRMP **Project 3.** Project Title: North Coast LRMP **Project 4.** Project Title: Marbled Murrelet Strategic Plan **Project 5.** Project Title: Intergovernmental Land Use Planning Projects Sponsor: Land Use Coordination Office (LUCO) Management Issue or Decision Type: A, B Projects Purpose: resource allocation (area set aside and resources harvested), strategic level planning Size of Areas: 75,000 – 125,000ha Location: entire province

Type E: Single Species – Large Area Home Range – (FF) All/Most Life Requisites - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.:Woodpecker spp., bat spp., rodents ***CF: coarse filter; FF: fine filter***	
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Habitat potential and current habitat of the particular species being rated.
6. Spatiality Can the tool analyze spatial relationships?	Yes.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Yes, by buffers, but there would have to be relevance to do so because the data is so general.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes, based on general scale that is given (as long as it's appropriate for the species being evaluated).
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes, however, the mapping is based on generalized site series, so it depends on the resolution of the site series mapping. The model can better incorporate 1:50,000 TEM and 1:20,000 PEM data than 1:20,000 or 1:5,000 TEM. b. 1:250,000 to 1:2 million
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. No reasonable limit. b. The entire BC mainland coast for Marbled Murrelet (approx. 20% of BC). This system is intended to be used for the entire province ($\pm$ 1,000,000 km^2) at 1:250,000 Baseline Thematic Mapping (BTM).
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	The ratings are established through a workshop process using expert opinion and review of the results by both the correlator and the regional species experts.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user	a. Transparent. Defined by species accounts. Fixed

defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	 b. Through the GOAT (abbrev.?) to compare 2 species for further interpretations.
13. Population component a. Does the model have an integral population analysis component? (i.e.: predict population size?) b. Is it deterministic or stochastic?	a. Yes, based on highest expected densities that can occur in the province. b. Deterministic.
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. Through successional model (suitability index) b. Expert opinion (consensus).
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	SAS

System Requirements & Features	
1. Required hardware, devices & operating system?	10 gb, 512mb RAM, Oracle server, Arc/Info server
2. What commercial software, including version, is required to provide full functionality?	Oracle, ArcInfo, ArcView, Excel
3. What is the typical set-up time to load program?	2 months
4. What is the typical set-up time to prepare and input data? (range)	Weeks – months, depending on the quality and amount of data
5. What are the minimum data input requirements?	Standard ecosystem database and spatial data of a Broad Ecosystem Inventory plus a ratings table.
6. What data formats can be imported?	Excel or CSV
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	• Spatial data - ArcView shapefiles, ArcInfo coverages • Non-spatial – CSV
8. How long does it take to run a typical data set (not including plotting of map)**?**	One week to run all ungulates for entire province

9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	vector-based polygons
11. What programming language(s) is the model written in?	PL-SQL
12. What level of expertise is required to set-up and maintain the program?	Ability to setup Arcview, (Oracle) and Excel. The programs do not need to be edited.
13. What level of expertise is required to run the program?	Ability to run Arcview, (Oracle) and Excel.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Generally maps, but graphs and tables can also be created.
15. What capabilities are there for user-defined outputs?	Charting and summarizing capabilities of Excel, (Oracle) and Arcview.
16. Is the software proprietary?	No.
17. What are the purchase/maintenance fees?	Whatever the cost of Arcview, Arc/Info, (Oracle) and Microsoft Office (or other).
18. What modeling techniques are used in developing the species-habitat relationships?	Development of moisture X temperature X structural stage grids for: 1st Ecosections, 2nd BGC units, 3rd BEI habitats. Results are compared to known observations including inventory and radio telemetry data.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Transferrable to all species that directly interact or relate to mappable ecosystems. b. BEI specific
21. Training, user support?	Government supported contacts and standards manuals are listed on website.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials)	a. BEI Manual – Standards for Broad Terrestrial Ecosystem Classification and Mapping in British Columbia: Version 2.0. Resources Inventory Committee 2000. Victoria, BC. WHR Manual -Wildlife Habitat Ratings Standards: Version 2.0. Resources Inventory Committee 1999. Victoria, BC.

b. Website(s)?	b. Terrestrial Information Branch: http://srmwww.gov.bc.ca/rib/wis/

General observations about the functionality, system requirements and features of a number of habitat supply models that are being used in British Columbia:

1.21 Habitat Suitability Index used with FSSIM, Woodstock, and other custom programs

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Habitat Suitability Index used with FSSIM, Woodstock, and other custom programs**
2. Brief Description: Describe the purpose, primary use and functions of the tool	This method provides quickly generated, overall quantities of habitat (like FSSIM method) at the strategic level. Species responses to changes in habitat are completed in Woodstock. *See additional comment #1* This method is used as a function of stand age and structure. It involves building relationships between quality of habitat and apparent age of the forest (time since disturbance) – partial cutting is a partial disturbance, clearcutting is full disturbance. *For examples see additional comment #2 in section below.*
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer: User: Gerrard Olivotto Collaborator: *see additional comments #3 below*
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Gerrard Olivotto Position: Organization: Address: #203 – 733 Johnson St. Victoria, BC Tel: 250-920-6749 (cell) Fax: 250-386-3892 Email: gerrard@olivotto.com Website: www.olivotto.com
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features (CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability (CF)** - Variable area - Rare to limited occurrence - e.g.:Site series – structural stage combinations, e.g. old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability (CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite (FF)** - Variable area home range - Specific life requisite	**Project 1.** Project Title: Analysis of Three Alternative Approaches in a Fire-Maintained Ecosystem Project Sponsor: Squamish Small Business Program Management Issue or Decision Type: B, C, D Project Purpose: to attempt to answer: what is the timber supply consequence of [status quo] versus ecosystem management. Plus, short and long-term timber supply consequences of maintaining [status quo] which is clearcutting with buffers and adjacency rules versus partial cutting and under-burning Size of Area: 17,500ha Location: Interior transition zone **Project 2.** Project Title: Type 2 for TFL 39 Project Sponsor: Weyerhauser, Canada Management Issue or Decision Type: Project Purpose: silviculture and habitat considerations for general biodiversity. *For examples see additional comment #4 in section below.*

- e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – (FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.:Woodpecker spp., bat spp., rodents ***CF: coarse filter; FF: fine filter***	Size of Area: 800,000ha Location: BC coast **Project 3.** Project Title: Pine Mushrooms and Timber Production in the Cranberry TSA Project Sponsor: NW Institute for Bioregional Studies Management Issue or Decision Type: F Project Purpose: to study yield and economic tradeoffs and synergies when managing for 2 resources Size of Area: 77,000 ha Location: Northwest Interior
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	how species depend on either early, mid, or late seral stages and silviculture activities that affect them
6. Spatiality Can the tool analyze spatial relationships?	No, it's represented aspatially. *For a description of an aspatial model see additional comment #5 in section below.*
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	You could if you had specific information [e.g. adjacency information], however it would be better to use a spatial model for that [neighbouring] analysis.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	You can have lots of various habitat requirements overlapping at the same time over an area.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Can do, but in that case we did just some timber types and age, based on forest cover and age. b. N/A
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. No upper limit, commonly work with >1 million cells. b. It is being used regularly at the TSA level (for habitat)
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Workshop and integrated professional knowledge
12. Species-habitat relationships a. Are the species/habitat relationships	a. Species responses to changes in habitat are

transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	developed by other researchers and incorporated in the habitat supply model. b. Ascii files listing "habitat quality yield curves" by species.
13. Population component a. Does the model have an integral population analysis component? (i.e.: predict population size?) b. Is it deterministic or stochastic?	a. No, as far as I know, so far habitats are being modeled not populations. Species specific models are built by wildlife biologists. Within a certain area or home range, certain structural requirements are necessary (and linked spatially). b. either
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. Yes, but not where it is located. I firmly believe that we have to do our habitat modeling using maps. b. Woodstock: linear programming optimization model, FSSIM simulation model for stochastic studies.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	LP solver, text editor, charting tools

System Requirements & Features	*FSSIM related answers were taken from responses listed by R. Keith Jones & Assoc. from Michael Buell*
1. Required hardware, devices & operating system?	A standard PC
2. What commercial software, including version, is required to provide full functionality?	**FSSIM**: ***MS Access and MS Excel to provide graphing functions for FSSIM***
3. What is the typical set-up time to load program?	*FSSIM*: FSSIM is instantaneous
4. What is the typical set-up time to prepare and input data? (range)	There is considerable data checking/editing to complete subtotals for all attributes, but the data is provided from FSSIM, so there's no "data entry" It takes approximately 2-4 weeks to build the model.
5. What are the minimum data input requirements?	Descriptions of land base, forest growth and change, management intervention, and habitat requirements for species of interest.
6. What data formats can be imported?	Both FSSIM and Woodstock use standard Ascii files

7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Both FSSIM and Woodstock use standard Ascii files
8. How long does it take to run a typical data set (not including plotting of map)**?**	Once the data from the model has been tested and edited, then you run various scenarios. This process can be quite creative depending on the modeler's ability to create scenarios.
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	No. However, you can overlay a grid or polygon theme (e.g. by site series) over a map and determine the complexity within a grid cell. The result could give you the proportions of habitat in a particular site series within a certain landscape unit. [This process is still aspatial because you can't put habitats on a map]
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	either
11. What programming language(s) is the model written in?	Perl. It is highly efficient for modeling because the 'declaration' process is eliminated, and has excellent string handling capabilities. Perl is also used to build the input files into the model.
12. What level of expertise is required to set-up and maintain the program?	A significant level of expertise is required for the modeler. The modelers must be able to manipulate the data.
13. What level of expertise is required to run the program?	See question 8.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	graphs and tables
15. What capabilities are there for user-defined outputs?	There is a lot potential for user-defined outputs, however this will depend on the level of expertise of the modeler.
16. Is the software proprietary?	FSSIM is public, Woodstock, and an LP solver may be purchased
17. What are the purchase/maintenance fees?	FSSIM - $0 Woodstock $5,000 + $500/year
18. What modeling techniques are used in developing the species-habitat relationships?	For this type of model the species-habitat relationships are determined by wildlife biologists who provide me with those relationships. S*ee additional comment #6 in section below.*
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances?	a. Straightforward.
b. How generic is this model? (i.e. ease of loading new knowledge relationship sets)	b. Easy.

21. Training, user support?	Remsoft Inc. (maker of Woodstock) provides excellent tutorials and support.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. available on website below b. www.olivotto.com/timber

General observations about the functionality, system requirements and features of a number of habitat supply models that are being used in British Columbia:

1. The Woodstock tool/language is aspatial again, but you don't have the limitation of a single yield curve for a stand, you can have as many yield curves as you'd like. In FSSIM you yield cubic metres, when you write a model in Woodstock language you can yield much more, e.g. owls, deer, pine mushrooms, etc. at the same time.

2. This project was designed to look at species that depend on either early, mid, or late seral stages. In the case of spotted owl, after a clearcut the habitat value is 0 for approximately 60-70 years, then increases and by 180 years there is full habitat quality (for that species). Deer forage is best from right after the clearcut to approximately 20 years. For pine mushroom, useful habitat starts at approximately 70 years, to full quality at approximately 100 years, then declines at 140 years.

3. These names are other modelers doing interesting or similar work.

Cartwell Associates (Peter Rennie)	FORUM	Vancouver
MacGregor Group (Bruce MacArthur)		Prince George
Stirling Wood Group	TREES	Victoria
DR Systems (Don Reimer)	Options	Nanaimo
Industrial Forestry Service (Rob Schuetz)	FSSIM	Prince George
(Carey Lockwood, Tom Moore)	Patchworks (new model, used in Alberta)	Kelowna

4. E.g. wildlife tree retention and patch retention were examined. Plus, we looked at breaking up the second growth forest to create some diversity in single-age second-growth stands.

5. Aspatial model: Basically you generate statistics of quantity (of a tree species, how much gets cuts, how much was damaged by insects or fire, etc.) but not specific locations. I.e. take patches of land and similar ones are aggregated together (that's how FSSIM works). You can choose to keep them separate say by landscape unit, but then a certain species (e.g. old spruce) may be scattered all over the landscape unit. If you aggregate them then you combine several small [5ha] patches into a total of [150ha] of that species over the landscape unit. Determining which of that 150ha is to be harvested occurs at the operational level.

6. At the beginning of a project, there is a one-day workshop in the forest district that is interested in a particular issue. The regional administrator will assemble the team of biologists, modelers, etc. these groups are usually from 8 – 12 people. During that workshop the species and issues/questions to be addressed will be outlined. Over the next week or 2 the people attending the workshop will send in their data about the relationships amongst forest type, age and species of concern.

7. refer to the proceedings from the March, 2002 [modelers'] meeting, especially for terms of expressing habitat.

8. The next step: There are quite few consulting firms have spatial models, however they take longer to compute and an aspatial model can give you statistics (quantities) much more quickly. However, the spatial model is the only way you can determine distribution or locations (of varying sizes).

9. Cost: a **fast**, aspatial model of this type is probably ¼ **the cost** of a standard spatial model.

10. Planning System: is hierarchical in nature. The way the planning system works is that at the TSA level the inventory, yield information, requirements for biodiversity (habitat requirements) are assembled and set as constraints on harvesting. Then the model is run and sensitivity testing is done. Then based on that the Chief Forester sets the harvest rate (cubic metres/year). The next level is the operational level where they determine the actual cuts. with a spatial model there is less adjustment between the strategic and operational planning stages.

1.22 Wildlife Habitat Ratings (WHR) used with Terrestrial Ecosystem Mapping (TEM).

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Wildlife Habitat Ratings (WHR) used with Terrestrial Ecosystem Mapping (TEM).** There are 2 companion data capture tools: 1 in Arcview; 1 in Arc/Info
2. Brief Description: Describe the purpose, primary use and functions of the tool	To assign wildlife values to mapped ecosystems.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer: Dennis Demarchi, Lynne Bonner, Calvin Tolkamp, Sal Rasheed User: Collaborator:
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	#1 Name: Lynne Bonner Position: Organization: Min. of Sustainable Resource Management, Terrestrial Information Branch Address: Tel: (250) 387-1158 Fax: Email: Lynne.Bonner@gems1.gov.bc.ca Website: #2 Name: Calvin Tolkamp Position: Organization: Min. of Sustainable Resource Management, Terrestrial Information Branch Address: Tel: (250) 387-2729 Fax: Email: Calvin.Tolkamp@gems5.gov.bc.ca Website:
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features (CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability (CF)** - Variable area - Rare to limited occurrence - e.g.:Site series – structural stage combinations, e.g. old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability**	**Project 1.** Project Title: Wildlife Habitat Ratings (WHR) used with Terrestrial Ecosystem Mapping (TEM) Project Sponsor: (former) Min. of Environment, Lands and Parks, Forest Renewal BC Management Issue or Decision Type: D, E, F Project Purpose: To provide wildlife values on ecosystem maps to guide habitat management and decision-making. To provide habitat capability and suitability ratings for one to many wildlife species. Size of Area: 10,000 to1 million ha (RIC Standards, table 11) Location: projects throughout the province

(CF) - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range –** **(FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range** **(FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.:Woodpecker spp., bat spp., rodents ***CF: coarse filter; FF: fine filter***	
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Potential use of habitat (current or optimal). Capability/suitability of habitat based on an estimate of density (# of animals × unit of time ÷ area)
6. Spatiality Can the tool analyze spatial relationships?	Yes, at any scale that TEM is done. Usually from 1:50,000 to 1:5000.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Yes, the Arc/Info tool (tem_whm.aml) provides proximity analysis routines..
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	To some extent – based on structural stage and associated habitat, on a single map scale. Can generalize to a smaller scale, not vice versa. E.g. Central Okanagan TEM – <u>Mule deer:</u> food and security habitat in 1 theme. <u>Painted turtle:</u> ponds proximal to friable soils for nesting. <u>Barrow's Goldeneye:</u> potential cavities in old growth forests within 150m of water
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Absolutely. b. any scale that TEM is mapped at, commonly 1:5,000 to 1:50,000 (for TEM-based WHR)
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. Some projects have over 3,000 ecosystem units b. Largest so far was 700,000 ha at 1:50 000
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR	Ratings – workshop, expert knowledge Developing species accounts – literature review, relevant studies, and expert knowledge

derived through regression analysis)	
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	a. Resource ratings model (prototype) uses explicit relationships between attributes and expert knowledge to populate the ratings table. User-defined by the rater. b. Data is entered into an Excel spreadsheet. The user interface is the WHR data capture tool
13. Population component a. Does the model have an integral population analysis component? (i.e.: predict population size?) b. Is it deterministic or stochastic?	a. Indirectly because it is based on the estimated density of a species in an area. b. deterministic
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. Through capability, provides ratings for all potential structural stages, therefore future conditions (structural stages) will already be rated. b. Qualitative model – expert opinion stored in a knowledge base.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	

System Requirements & Features	
1. Required hardware, devices & operating system?	whatever is required to run Arcview, Arc/Info and Microsoft Office (or the like).
2. What commercial software, including version, is required to provide full functionality?	Arcview 3.1, Arc/Info 7.*, Excel 95 or better
3. What is the typical set-up time to load program?	seconds
4. What is the typical set-up time to prepare and input data? (range)	Days to weeks – depends on the number of ecosystem units and species rated.
5. What are the minimum data input requirements?	Standard ecosystem database and spatial data of a TEM product plus a ratings table.
6. What data formats can be imported?	Spatial data: Arc/Info coverage or shapefile Ecosystem database: INFO or CSV format Ratings table: Excel or other spreadsheet format

7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Shapefiles or Arc/Info coverage or grids
8. How long does it take to run a typical data set (not including plotting of map)**?**	30 seconds to 5 minutes
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	Initial themes: vector-based polygons Arc/Info tool: can convert to raster-based pixels of user-defined pixel size.
11. What programming language(s) is the model written in?	Arc/Info tools: Arc Macro Language (AML) Desktop mapping tools: Avenue Desktop data capture tools: Visual Basic, C+, or C++
12. What level of expertise is required to set-up and maintain the program?	Ability to setup Arcview and Excel. The programs do not need to be edited.
13. What level of expertise is required to run the program?	Ability to run Arcview and Excel.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Maps.
15. What capabilities are there for user-defined outputs?	Charting and summarizing capabilities of Excel and Arcview.
16. Is the software proprietary?	No. The tools are available from the website.
17. What are the purchase/maintenance fees?	Whatever the cost of Arcview, Arc/Info and Microsoft Office (or other). The tools are free.
18. What modeling techniques are used in developing the species-habitat relationships?	Currently the standards do not require modelling techniques. The prototype Resource Ratings Model (RRM) uses techniques similar to Habitat Suitability Index.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	Currently the Resource Ratings Model (for completing the ratings table) does not provide confidence limits. The upgrades for 2001/02 intend to incorporate confidence limits. Ecosystem mapping, upon which the habitat maps are based, do not provide confidence limits for neither the accuracy of ecosystem boundaries nor classification.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship	a. Transferrable to all species that interact or relate to ecosystems. Upgrades for 2001/02 are designed to rate resources other than wildlife. b. Very. The upgrades will allow a user to provide ratings for any resource as long as it relates to

sets)	ecosystems.
21. Training, user support?	• Forestry Continuing Studies Network course for developing species accounts and background on ratings. • Government support contacts and standards manuals are listed on website.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Data capture tools have user guides available online (varying lengths). b. Terrestrial Information Branch: http://srmwww.gov.bc.ca/rib/wis/

General observations about the functionality, system requirements and features of a number of habitat supply models that are being used in British Columbia:

1.23 Wildlife Habitat Assessment using Habitat Suitability Index (HSI)

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Wildlife Habitat Assessment using Habitat Suitability Index (HSI)**
2. Brief Description: Describe the purpose, primary use and functions of the tool	HSI values are derived from an evaluation of the ability of key habitat components to supply life requisites. (p. iii) * Assessing wildlife habitat entails 2 main elements: 1. determining habitat capability (i.e. the potential of an area to support a given species under ideal conditions), and 2. determining suitability (i.e. the present condition of an area in terms of its ability to support a given species). (p. 1)
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer: User: LGL Ltd. Environmental Research Associates Collaborator:
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Michael Demarchi Position: Wildlife Biologist Organization: LGL Ltd. Address: 9768 Second St, Sidney, BC V8L 3Y8 Tel: 250-656-0127 Fax: 250-655-4761 Email: demarchi@lgl.com Website: lgl.com
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: Site series – structural stage combinations, e.g. old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – All/Most Life Requisites** **(FF)** - Usually large **a**rea home range	**Project 1.** Project Title: Wildlife Habitat Assessment in the Nass Wildlife Area Project Sponsor: FRBC, MELP Management Issue or Decision Type: A through E Project Purpose: to present enhanced methodology of habitat assess and research findings on the value of different vegetation types for moose, grizzly bears and mountain goats (p. ii) Size of Area: 1,068,300 ha (p. 11) Location: Nass Wildlife Area, west-central British Columbia **Project 2.** Project Title: Project Sponsor: Management Issue or Decision Type: Project Purpose: Size of Area: ha Location: **Project 3.** Project Title: Project Sponsor: Management Issue or Decision Type: Project Purpose: Size of Area: ha

* all page numbers refer to the location of the information in the project report

- All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range (FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.: Woodpecker spp., bat spp., rodents ***CF: coarse filter; FF: fine filter***	Location:
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Habitat suitability ratings for a given area (i.e. habitat polygon) for each species being evaluated. Components such as life requisites, important habitat factors and measurable habitat variables are determined. (p. 18)
6. Spatiality Can the tool analyze spatial relationships?	Yes
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Yes
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	No. Each evaluation species may require more than one model and HSI values for habitat polygons may vary during the course of a year. Five separate models were developed: 1. grizzly bear: spring-early summer 2. grizzly bear: late summer-fall 3. moose: non-winter 4. moose: winter 5. mountain goat: winter (p. 18)
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Partially, due to difficulties in discriminating between site series without the data on the understory vegetation. (p. 12) b. 1:20,000 (p. 58) to 1:250,000 (p. 16)
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. No limit b. 1 million ha at 1:20,000
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Compilation of published and unpublished ecological requisite information for each species
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to	a. Yes. Fixed. b. No interface

enter or load these relationships? Is there a user interface?	
13. Population component a. Does the model have an integral population analysis component? (i.e.: predict population size?) b. Is it deterministic or stochastic?	a. No b. Deterministic
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. No b. Assessment (Bayesian belief)
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	n/a

System Requirements & Features	
1. Required hardware, devices & operating system?	Pentium III (at least) PC running Windows 98 or later
2. What commercial software, including version, is required to provide full functionality?	GIS software such as Arc/Info, ESRI's PC Arc/Info TIN (triangulated irregular network) module version 3.5, ESRI's Spatial Analyst software
3. What is the typical set-up time to load program?	n/a It does not exist as a compiled program, but rather as a series of algorithms applied through vector- and raster-based queries
4. What is the typical set-up time to prepare and input data? (range)	n/a
5. What are the minimum data input requirements?	n/a
6. What data formats can be imported?	n/a
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	n/a
8. How long does it take to run a typical data set (not including plotting of map)**?**	20 min
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B	No

site series)	
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	raster-based, 20 X 20 m pixels
11. What programming language(s) is the model written in?	n/a
12. What level of expertise is required to set-up and maintain the program?	n/a
13. What level of expertise is required to run the program?	n/a
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	maps, tables (indexes), algorithms
15. What capabilities are there for user-defined outputs?	n/a
16. Is the software proprietary?	n/a
17. What are the purchase/maintenance fees?	n/a
18. What modeling techniques are used in developing the species-habitat relationships?	Habitat Evaluation Procedures
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Not known b. Very
21. Training, user support?	n/a
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Described in the Methods section of the report b. No

General observations about the functionality, system requirements and features of a number of habitat supply models that are being used in British Columbia:

1.24 Habitat Suitability Index

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Habitat Suitability Index [supply of habitat features and response by wildlife species]**
2. Brief Description: Describe the purpose, primary use and functions of the tool	Interim tool to assist managers objectively identify elk habitat. Plus, can be used to examine future conditions through supply curves of various attributes that change over time, given forestry and natural disturbance, etc. Also used as part of the West Kootenay Ungulate Winter Range Committee to address finalizing ungulate winter range [linework] by 2003.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer: Rob Serrouya User: Collaborator: (First phase) – Rob D'Eon, Cliff Nietvelt (Validation model, second phase) – Kim Poole
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Rob Serrouya Position: Wildlife Ecologist Organization: Consultant Address: RR1,S12,C43, South Slocan, BC V0G 2G0 Tel: (250) 359-8289 Fax: Email: serrouya@kokaneeforests.com Website:
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.:Site series – structural stage combinations, e.g. old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range –** **(FF) All/Most Life Requisites**	**Project 1.** Project Title: West Kootenay Ungulate Winter Range mapping Project Sponsor: Guy Woods, Matt Besko Management Issue or Decision Type: A, E Project Purpose: Size of Area: ha Location: West Kootenay

- Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range** **(FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.:Woodpecker spp., bat spp., rodents ***CF: coarse filter; FF: fine filter***	
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Elk
6. Spatiality Can the tool analyze spatial relationships?	Yes
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Yes. There is an interspersion module in the model.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes b. 25m resolution
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	a. Restricted only by computing power b. 7200km^2, 50m resolution
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Literature review, then tested with empirical data, then adjusted based on those data
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	a. Yes, it is clear how elk respond to various forest cover and TRIM variables b.

13. Population component a. Does the model have an integral population analysis component? (i.e.: predict population size?) b. Is it deterministic or stochastic?	a. No. b.
14. Forecasting a. Does the model predict future conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	a. Yes, it can be used to examine future conditions through supply curves of various attributes that change over time, given forestry and natural disturbance, etc. when combined with the SIMFOR application b. projection – habitat supply and species response
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	Forestry or natural disturbance prediction tool, such as SIMFOR, Seles, Telsa, Atlas

System Requirements & Features	
1. Required hardware, devices & operating system?	Standard computer (PC or MacIntosh)
2. What commercial software, including version, is required to provide full functionality?	• Arcview or Arc/Info (programming) • projection tool (e.g. SIMFOR, SELES, TELSA) • Excel or Access
3. What is the typical set-up time to load program?	See point 3 in additional comments, below.
4. What is the typical set-up time to prepare and input data? (range)	Hours to days - this process depends on the data that user has available.
5. What are the minimum data input requirements?	1. Supply – occurrences of attributes, with time on x-axis and abundance on y-axis 2. Response – how a species responds to various supply scenarios
6. What data formats can be imported?	
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Any arcinfo compatible format
8. How long does it take to run a typical data set (not including plotting of map)**?**	An hour or more – running the analysis does not take much time, setting up the data layers (forest cover, TRIM, etc.) is more time-consuming.

9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	No.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	Raster-based, however it can be applied to either depending on the programmer.
11. What programming language(s) is the model written in?	In the arcinfo programming language
12. What level of expertise is required to set-up and maintain the program?	Specific knowledge is required of programming depending the tool. Programming expertise of a projection tool (e.g. SIMFOR) may not be required to run the habitat model as long as you collaborate with people who have expertise with the specific tool.
13. What level of expertise is required to run the program?	Should have a fairly high level of expertise in order to manipulate the data (see pp. 1-2 of first report).
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	GIS maps, raster based
15. What capabilities are there for user-defined outputs?	
16. Is the software proprietary?	No.
17. What are the purchase/maintenance fees?	None.
18. What modeling techniques are used in developing the species-habitat relationships?	Some regression, some expert
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Not easily, it is based on specific input variables b. Fairly generic, needs to be updated with new theoretical information
21. Training, user support?	Would need a moderate level of training to implement.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Algorithms for programming the model in Arc format, plus copies of both reports (in pdf format) are available upon request b. Not yet. Soon on: http://www.arrow-ifpa.com/

General observations about the functionality, system requirements and features of a number of habitat supply models that are being used in British Columbia:

- Provides information to be input into SIMFOR.

- Developed an elk model, since autumn 2000, have tested the model – themed it out and tested it with empirical data (which is rarely done). The results of which have been updated in a report – attached.

- 'What makes SIMFOR and other projection tools powerful is, for example if you want to examine 6 different harvesting scenarios – zoning with aggregated clearcuts, Forest Practices Code rules – running these options can take months, because you have to develop those harvesting scenarios for 100 years into the future. Thus, you need input from a harvesting simulator or harvesting scheduler program such as Atlas.

1.25 Atlas

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Atlas** (its new name is Forest Planning Studio - FPS)
2. Brief Description: Describe the purpose, primary use and functions of the tool	ATLAS is a harvest schedule generator. It is used primarily to model timber supply and spatial harvest patterns while meeting forest management constraints. Typical constraints are adjacency, older seral minimums and younger seral maximums. ATLAS by itself can output harvest volumes and harvest schedules, calculate patch sizes and interior/edge statistics, and process and output "user curve" data over time. ATLAS outputs are often "post-processed" to model other interests such as economic and environmental indices. Post-processing may be done by another stand-alone model such as SIMFOR (see ___ section) or by customized macros or programs. In turn, the outputs from post-processing models might be fed back into ATLAS for additional iterations. I am most familiar with the modeling projects in the Nelson Forest Region (NFR) which have examined: - adjacency and patch-size management - Habitat Suitability Indices, or more properly "resource selection functions" for cavity nesters, goshawks, mountain caribou and grizzly bear. - Equivalent Clearcut Area (ECA) and road density Other projects are occurring across the province. *See additional comment #1 in section below.*
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer: Dr. John Nelson and students at the Faculty of Forestry, and Dr. Fred Bunnell and students at the Centre for Applied Conservation Biology, U.B.C. User: UBC, contractors and licensees Collaborator: Various funding sources.
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Reg Davis Position: (acting as) Project Leader and modeler for the ATLAS / SIMFOR Project (1998-2003) Organization: Interior Reforestation Ltd. Address: P.O. Box 874, Cranbrook, BC, V1C 4J6 Tel: 250-426-5300 Fax: 250-426-5311 Email: rdavis@intref.bc.ca Website: na

5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features** **(CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability** **(CF)** - Variable area - Rare to limited occurrence - e.g.: Site series – structural stage combinations, e.g. old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability** **(CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite** **(FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range –** **(FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range** **(FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.:Woodpecker spp., bat spp., rodents ***CF: coarse filter; FF: fine filter***	**Example Projects (not a comprehensive list):** **Project 1.** Project Title: Cavity Nesting Bird Habitat Modeling Project in the Pend O'reille Landscape Unit (SIMFOR modeling portion) Project Sponsor: ATLAS / SIMFOR Project. Management Issue or Decision Type: A Project Purpose: (1) Develop a H.S.I. for cavity nesters and (2) model that H.S.I. Size of Area: 20,000 ha Location: Arrow Forest District **Project 2.** Project Title: Kootenay Lake Forest District Harvest Scheduling and Caribou Habitat Modeling Project Project Sponsor: ATLAS / SIMFOR Project Management Issue or Decision Type: A, E Project Purpose: (1) Examine several forest management options and their impacts on timber supply and caribou habitat, and (2) test software functionality. Size of Area: 54,000 forested ha Location: Kootenay Lake Forest District **Project 3.** Project Title: Modeling of Grizzly Bear Habitat and IWAP Indices in Landscape Unit C18 Project Sponsor: ATLAS / SIMFOR Project. Management Issue or Decision Type: A, E Project Purpose: Examine the relationship between forest management scenarios and road-influenced habitat indices, and road-influenced water management indices, test software. Size of Area: 86,000 ha (172,000 ha in the whole database that includes 3 landscape units). Location: Cranbrook Forest District **Project 4.** Project Title: Kootenay Lake Forest District Spatial Modeling Project Project Sponsor: KLFD forest licensees and the ATLAS / SIMFOR Project. Management Issue or Decision Type: A, a TSA-sized database. Project Purpose: Build spatial databases suitable for modeling either landscape units, or the whole TSA. Size of Area: 1.1 million ha. Location: Kootenay Lake Forest District.
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Most ATLAS / SIMFOR projects have concentrated on producing habitat quality-type ratings (e.g. H.S.I., resource selection function, suitability/capability) Examples: **Grizzly bears:** predicted general habitat ratings for spring, summer and fall seasons, and wet sites based

	on 1) P.E.M data, and 2) on algorithms developed by Fred Hovey (grizzly bear researcher). Also predicted structural stage, huckleberry and soopalallie production, based on PEM data. **Caribou:** predicted an all-season HSI, developed by Trevor Kinley, based on his fieldwork. **Fish (water quality)**: predicted weighted ECA and road density over time.
6. Spatiality Can the tool analyze spatial relationships?	Yes, in terms of using pre-loaded topological relationships derived via GIS. No, in terms of 'self contained' GIS functionality. Examples: 1) adjacency tables - used for modeling both adjacency and patch sizes in ATLAS, and 2) distance to roads tables - used to model the distance of habitat to an active road.
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	No, yes (see above) The most complex spatial relationship we have modeled was grizzly bear habitat values in relation to roads. Habitat value was partially influenced by the distance to active/closed roads - which changed over time as roads were built, activated, or deactivated.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Some relationships can be modeled totally within ATLAS as "user curves", on a per-polygon basis. This assumes a relationship can be established between the habitat value and [stand type - stand age]. More complex relationships, such as habitat value dependent upon stand type, stand age, slope and aspect are "post processed", for example in SIMFOR. Very complex relationships, such as the "distance-to-road" (above) are modeled with customized programs that are built for that specific algorithm.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	a. Yes – in terms that T.E.M. or P.E.M. tables can be accommodated inside ATLAS, or with SIMFOR, or with post processing (with these options ranging from simple to most complex). b. Most modeling has been at the landscape unit level (20 to 100 K ha.) although one ATLAS database was constructed for the Kootenay Lake TSA (1.1 million ha). It's resolution would be considered "landscape-level" by most analysts. Much finer databases have been produced by Steve Voros (McGregor Analysis Group, Prince George) to derive operational forest plans. Conceptually, resolution is whatever is reasonable. One can model tiny little detailed pieces for a smaller area, or model more general, larger pieces for a larger area. For example, one could set up an ATLAS database with individual tree-sized pieces of land. Size and detail must be balanced: one could model the province as one data record.

10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells?	a. ATLAS is an MS Access database. The file size limit for Access 97 is 1 gigabyte, for Access 2000 is 2 gigabytes.
b. What is the largest project area it has been used for? and at what resolution?	b. Largest geographic area: 1.1 million ha with a resolution appropriate for landscape unit-level planning. Largest number (detail) of stand groups: 16,000 (Steve Voros') with resolution appropriate for operational planning.
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	The ATLAS / SIMFOR Project has funded some field work to develop a cavity nester algorithm, but usually w rely on published papers and existing fieldwork if we derive an H.S.I. (or RSF) from scratch.
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined?	a. 1) If incorporated into ATLAS & SIMFOR, the relationship is represented as a value-versus-age curve for each stand type (ATLAS), or twin curves (supply and demand - SIMFOR). The user can add new ATLAS curves or adjust existing ones as they wish. 2) If represented as a post-processing routine, the transparency can vary from total to very little.
b. How does the model allow the user to enter or load these relationships? Is there a user interface?	b. 1) Through the user interface (ATLAS or SIMFOR). 2) Varies, might even be entered by a programmer.
13. Population component a. Does the model have an integral population analysis component? (i.e.: predict population size?)	a. We have not tried to predict population size. One could predict population size if the estimate was based on habitat quality.
b. Is it deterministic or stochastic?	b. Deterministic. We are examining how stochastic events should be properly modeled in the s/w as part of the 2002/2003 ATLAS / SIMFOR project.
14. Forecasting a. Does the model predict future conditions?	a. Yes, we model far into the future (probably well beyond reason).
b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	b. Scheduling, yield.
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	1) Software to prepare the map-type data, or to present results: a commercial GIS, database software, spreadsheet software, programming software, GIS-type data viewer, to

System Requirements & Features	
1. Required hardware, devices &	A normal PC in the $1500 CAD range.

operating system?	
2. What commercial software, including version, is required to provide full functionality?	None.
3. What is the typical set-up time to load program?	One half hour to load the software.
4. What is the typical set-up time to prepare and input data? (range)	If data is ready then the initial loading for a small dataset: 10 minutes, large dataset 1 hour. *See additional comment #2 in section below.*
5. What are the minimum data input requirements?	Map of harvest units, yield curves for forest types and forest management rules.
6. What data formats can be imported?	Through the interface: ASCII and ESRI shape. Through MS Access: all the common formats supported by Microsoft - MS Access, xBASE, CSV/ASCII, Excel, etc...
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	ATLAS: ASCII
8. How long does it take to run a typical data set (not including plotting of map)**?**	Small dataset: one minute, huge dataset: one hour. *See additional comment #2 in section below.*
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	This is not normally done as each record is assumed to be pure, i.e. 100% of one type. However, we have modeled mixed compositions (but not site series per se). While the outputs properly reflect that data the viewer still assumes one record is "the type."
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	All data types are used in particular modules. ATLAS uses vector-based polygons for the harvest scheduling viewer, vector linework for the road scheduler and the cartographic detail (such as streams), and rasters for the interior/edge calculations. SIMFOR is totally raster-based, and other post-processing routines vary.
11. What programming language(s) is the model written in?	Visual C++. Post processing routines vary.
12. What level of expertise is required to set-up and maintain the program?	Normal aptitude for a forest estate modeler.
13. What level of expertise is required to run the program?	For pushing the start button: not much. *See additional comment #2 in section below.*
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	ATLAS produces: 1) SIMFOR compatible input files, 2) ASCII data for use in other software, and 3) binary files used in its viewer. Graphs, maps, tables are typically produced by

	software appropriate for that purpose.
15. What capabilities are there for user-defined outputs?	ATLAS provides the opportunity for user-defined curves and user-defined fields, and allows the user to output the results as ASCII files. SIMFOR is more generic and allows great flexibility in outputing raster-format maps. *See additional comment #3 in section below.*
16. Is the software proprietary?	No, it is freeware from UBC.
17. What are the purchase/maintenance fees?	No.
18. What modeling techniques are used in developing the species-habitat relationships?	We have developed some algorithms for cavity nesters and Northern goshawks, but normally we depend on other researchers' results.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. ATLAS will model some relationships by itself. Normally we use a post-processing modeling environment. b. ATLAS (and SIMFOR) are relatively generic if compared to other models.
21. Training, user support?	UBC uses ATLAS in some course work. The ATLAS/SIMFOR Project staff will answer questions from users.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Manuals, software and sample datasets are available through the UBC ftp/website. b. www.forestry.ubc.ca/atlas-simfor

General observations about the functionality, system requirements and features of a number of habitat supply models that are being used in British Columbia:

1. The Atlas/SIMFOR Project operates on the interface of research and operation. We are trying to incorporate research results and tools (analytical modeling capabilities) into operational planning. Typical projects evaluate the impacts and trade-offs of alternate management scenarios. We are not developing software per se to model habitat relationships.

Rather than attempt to build one s/w model that incorporates all the functionality we need, we use several software packages. The difference is like the choice to 1) develop a flying tank, or 2) develop a tank and also develop an airplane. The former view leads s/w reviewers (and modelers) to a check-box mentality: does the model do this and this and this? If not then it is deficient. The latter option leaves it to the modeler to match the s/w components to the problem. In some cases all you need is within ATLAS itself. Typically though, ATLAS is used as the harvest scheduler and its outputs are fed into SIMFOR or other modules. As well, we use Excel to

produce charts, a dbase program like Access or FOXPRO to manipulate and summarize data, etc. In some cases very specialized algorithms require us to develop "one-off" code.

DD: "So you can program different scenarios, or if you want a certain result you can program that into the ATLAS or SIMFOR to get the results?"

RD: "No, we don't re-program ATLAS nor SIMFOR. We find or create bits of software that do what is needed and add that to the processing stream. With that approach we haven't been limited by any problem to date."

2. RD: I've read the Jones report (before this interview). Some of the people that responded to "how long does it take to do X" responded based on pushing a button once the data was ready. Other people responded based on, "*what does a typical planning project take, and how long does it require?*" It can take over one year to get everything together because of all the people involved."

"Then, if you consider "What's a typical run once you have the data until the production of final maps and data summaries" it varies from one hour for a crude product, to possibly weeks or months of analyses and iterations."

DD: "I didn't see any questions referring to the planning process. I thought it referred to loading the programs you need, and running the dataset."

RD: "I agree. Continuing... some people said it was easy to put data into their model. You just enter this data and run it in the program. I would say it is easy if the data is sitting there and it's in the format you need. The difference is that some of the people were a little more honest, or pragmatic in their responses. I thought some of the answers were almost 'naïve', and some readers are sure to get the wrong idea of what is realistic in the real world."

DD: "Most of the answers I tend to get are more along the lines of, 'once you get all your data, it only takes minutes.' How long does it take to get the data, or setting up your strategy was never really covered."

RD: "That's right. I know some of the spatial modeling projects in Nelson Region are very big with lots of participants. These have been grinding along for several years."

DD: "That's a good comment and I will add that it because I followed their structure, and I looked at their answers. Some people said it only takes overnight or it takes a couple of hours. I didn't know if they deliberately excluded the planning and the gathering of the information."

RD: It doesn't end there. You often get GIS data that is quite suspect. You might just accept it as verbatim, or try to rectify the obvious problems. If you were going upgrade the input data then that takes time too. Data quality is an issue that related to your question about "does the software produce estimates of error." It is a key question for modeling, but few persons produce error bars on their model outputs. (Researchers who study spatial accuracy and precision state that) most persons don't even understand the components of spatial error.

DD: "Many times you don't know what you're going to get, so for future reference it could be easier or it could be difficult. I will qualify it by saying that it's subject to the cleanliness or quality of the data."

RD: Regarding ease and complexity: Some modelers are running simple assumptions in their model. They may simplify a problem to the equivalent of 100 lines of codes, while others are running the equivalent of tens of thousands of lines with much more detail. If someone says they're doing timber supply modeling, for example, they may be using an Excel spreadsheet or a full forest estate model. A world of difference. So the readers must take care when comparing responses.
These differences also occur in the required skills to load or run a model. A programmer might state "average skills are required to set up my model" while most persons might think "expert level programming skills are required".

DD: "But they have that question in their questionnaire, 'What level of programming expertise?' I should've added 'What kind of species habitat knowledge would you need to have?' (maybe that's obvious) For your techniques you would have to use both."

RD: I'm not sure it was addressed, since I've used some of the models in the report. Some projects split the GIS work and data preparation off from the analyses. Hence, a modeler may never know the work involved to actually load his model. So you talk to the modeller and he says his model is easy to put data into. But the GIS guy slaved for a long time.

Regardless, for all modeling it is very useful if the modeler has a background in GIS functions, forestry, biology (of the species being modeled), database use and programming.

DD: "Can we say that a typical project takes you about eight months to one year to do?"

RD: Yes, from start to end, a bigger project usually does. If everything was ready, up-front then it could be shortened to one week for a simple project.

3. I think there is potential [for user-defined outputs]. However, a "point-and-click" type user might not recognize that opportunity. However, even experienced modelers may not see the obvious. For example, one software reviewer reported that ATLAS data is in a proprietary format (hence it is unavailable to the user) while it is actually in MS Access format and is totally available. The expertise and imagination of the user is extremely important in modeling. If a more experienced modeler can get the output from one model into a form that is suitable for another software then that user doesn't see any deficiencies in the former software.

4. Comment regarding extension. RD: "there's lots of this extension material around, most of it is for the general public or manager type - lots of pictures, not many words and not much technical detail. The majority of modeling is done by contractors and consultants, and they have the bulk of the 'hands-on' modeling experience. [Jones report gives a figure of ___ of the modeling is done by contractors.] The contractors are in a competitive role and hence not much information exchange takes place between contractors.

DD: "It seems like there's a huge amount of work being done at universities, and then there are the consultants. I'm not sure how the communication works between them, and whether they just keep the methodology to themselves once they get the contract."

RD: Researchers concentrate on research issues and gain conceptual knowledge. Contractors have a different focus, and they gain the pragmatic knowledge of getting to a final product, what works and what doesn't. That type of knowledge remains largely within each company.

DD: "There is so much potential out there. As you said, there's all these people working in-house, and what are they finding? What are their issues and how does it work?"

RD: "I found it a bit deja vu when I read the Jones Report. They proposed a habitat modeling framework. Most timber supply modeling is linked to habitat modeling. The Atlas/SIMFOR project identified the need for a collective framework several years ago, and even proposed taking a first crack at it, but it was perceived as outside our project's mandate. It will be interesting to see where the habitat modelers end up.

DD: "I'm wondering how many tracks there are, and whether they will all converge at some point. And hopefully we're not repeating the same mistakes"

RD: "I suspect that we're probably all following each other and eventually will converge - except we don't see it because it's so dark right now."

1.26 Forest Simulation and Optimization System (FSOS) [formerly Forum]

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Forest Simulation and Optimization System (FSOS) [formerly Forum]**
2. Brief Description: Describe the purpose, primary use and functions of the tool	The purpose of the model is to provide decision support capabilities for forest management. Primary use has been for strategic and tactical forest/landscape level planning projects. Main tool functions are to attempt to maximize, balance and sustain multiple resources (wildlife habitat, carbon storage, timber, watershed condition, visual quality, recreation, etc). FSOS can be used to evaluate an existing management plan but also used to produce forecasts that approximate desired forest conditions (defined by wildlife habitat, biodiversity, water, visual quality, carbon sequestration, timber, etc.). Typical habitat modeling has considered forest cover requirements, seral stage and patch size distribution. We have completed projects investigating interior forest condition, edge reporting and distance to cover analysis. More detailed habitat requires clear definitions of habitat and available data. If habitat attributes are dynamic they will be incorporated into the yield curves to provide a temporal assessment of a habitat yield for each land classification or stand types.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	**Developer:** Dr. Guoliang Liu at UBC Forestry Resource Management Dept., currently works at Forest Ecosystem Solutions Ltd. **Users:** Chris Niziolomski, and Antti Makitalo use FSOS as a commercial tool for analysis projects **Collaborator:** John Nelson, Ph.D. supervisor
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Chris Niziolomski Position: President, Resource Management Forester Organization: Forest Ecosystem Solutions Ltd. Address: #210 – 275 Fell Ave. North Vancouver, BC Tel: 604-980-5061 Fax: 604-986-0361 Email: chris_niz@forestecosystem.ca Website: www.forestecosystem.ca
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features (CF)** - Any landscape level parameter - Large area	**Project 1.** Project Title: Timber supply and twenty-year analysis for TFL 18 Project Sponsor: Slocan Group Management Issue or Decision Type: A Project Purpose: Satisfy management plan requirements for Tree Farm Licence. Size of Area: 75 000 ha

- e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability (CF)** - Variable area - Rare to limited occurrence - e.g.:Site series – structural stage combinations, e.g. old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability (CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite (FF)** - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range – All/Most Life Requisites (FF)** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range All/Most Life Requisites (FF)** - Small **a**rea home range: - All or most life requisites - e.g.:Woodpecker spp., bat spp., rodents ***CF: coarse filter; FF: fine filter***	Location: Clearwater, BC **Project 2.** Project Title: OGMA analysis for the Kamloops TSA Project Sponsor: Tolko Industries and Slocan Group Management Issue or Decision Type: A Project Purpose: Investigate the development of OGMAs using a spatial forest level model. Size of Area: 3 million ha Location: Kamloops TSA **Project 3.** Project Title: Sunshine Coast TSA Type 2 Intensive Silviculture Analysis Project Sponsor FRBC Management Issue or Decision Type: A Project Purpose: Investigate intensive silviculture options for the Sunshine Coast TSA. Size of Area: 1.1 million ha Location: Sunshine Coast TSA **Project 4.** Project Title: Slocan Valley SFM Analysis Project Sponsor Arrow IFPA Management Issue or Decision Type: B Project Purpose: Investigate SFM criteria and indicators for analysis of the Slocan Valley Size of Area: 95 000 ha Location: Arrow TSA
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Depends on the mgmt question for a given mgmt unit. *See additional comment #1 in section below.* Most of our analysis has incorporated a variety of indicators for forecasting. These have included a number of forest cover age and height based indicators. At the landscape level we would model seral stage and patch size distributions. We have also modeled deer and moose winter range, goat winter range, mule deer, and caribou. These coarse filer habitat modeling approaches have often utilized a specific seral stage requirement.
6. Spatiality Can the tool analyze spatial relationships?	yes, spatially explicit. *See additional comment #2 in section below.*
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Yes.
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and foraging)?	Yes, overlapping areas. We would zone those out, nesting zone versus a foraging zone (specific e.g. QCI) both zones have a specific rule/target associated with them and they can recognize the differences and similarities between them.

9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping?	a. Yes. Derived from a PEM, and there was some analysis by Dave Huggard (UBC) to derive a grouping of site series.
b. What scale/resolution of mapping can be used?	b. It varies, we combine many scales of data from 1:20,000 (with forest cover) up to 1:250,000 or more. Optimally, 1:20,000 - 50,000. We do a lot of data analysis prior to modeling, so when preparing our dataset we look at the scales (the coarser scales will have more variation in data).
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells?	a. no limit
b. What is the largest project area it has been used for? and at what resolution?	b. Kamloops TSA was up to 3.5 million ha.
Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	Workshop. *See additional comments #3 in section below.*
Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined?	a. N/A
b. How does the model allow the user to enter or load these relationships? Is there a user interface?	b. N/A
Population component a. Does the model have an integral population analysis component? (i.e.: predict population size?)	a. No.
b. Is it deterministic or stochastic?	b. We do not model populations, N/A.
Forecasting a. Does the model predict future conditions?	a. Yes.
b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	b. Harvest scheduling, timber supply model, target based – attempts to achieve desired forest condition as defined by indicators and objectives
What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	MS Access, Arcview, 3D world construction set (3D simulation program)

System Requirements & Features	
1. Required hardware, devices & operating system?	PC with ample storage, Min. 500MB of RAM, 1.5 GigaHz processing speed (more RAM is better)
2. What commercial software, including version, is required to provide full functionality?	MS Office (for Access), GIS software (like Arcview)
3. What is the typical set-up time to load program?	Depends on the data, if its clean and in a resultant dataset, we have the metadata, it's all documented, once that's all done we can load it within a couple of days and have it ready for analysis. Most of the time is spent in the data preparation, review and checking.
4. What is the typical set-up time to prepare and input data? (range)	Of source data, at least a couple of weeks to a month.
5. What are the minimum data input requirements?	Land classification data; presuming that there's some other values on the land, what and where they are (spatial data); adjacency; how land classes change over time; and objectives for analysis.
6. What data formats can be imported?	We have the ability to import any data format that is accepted by the GIS (Arc/Info format), first the data is brought into MS Access, if not a translation program should make it work.
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Text files, and Access files. We maintain our spatial linkage by unique polygon identification.
8. How long does it take to run a typical data set (not including plotting of map)**?**	For a scenario run – it depends on the complexity of the land base. *See additional comment #4 in section below.*
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes. We'll often aggregate into like polygons but we can handle multiple [tree] species, or site series within those aggregations.
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	Vector-based polygons.
11. What programming language(s) is the model written in?	The code is written in C++.
12. What level of expertise is required to set-up and maintain the program?	Using a manual and some training, anyone who is familiar with Access could set it up.
13. What level of expertise is required to run the program?	Running takes more modeling expertise especially with optimization framework, a user should have an above average level of expertise with forest level modeling.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	Maps, graphs, tables, 3D images. *See additional comment #5 in section below.*
15. What capabilities are there for user-	High. Having the capability to report on any feature

defined outputs?	or track any feature over time you can define anything that the data will support.
16. Is the software proprietary?	Under review for licencing (within 2002).
17. What are the purchase/maintenance fees?	Under review.
18. What modeling techniques are used in developing the species-habitat relationships?	N/A, we rely on experts to identify the species habitat-relationships for us.
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	No.
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. Is being used in a variety of geographic areas throughout BC and has been used in Manitoba and in Ontario. Easy to transfer if the appropriate biophysical and habitat-species relationships are known. b. Easy, it would have to be related to a feature that is present or can be added to the model dataset.
21. Training, user support?	Provided by Forest Ecosystem Solutions Ltd.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials) **b. Website(s)?**	a. Documentation, manuals, etc. are available upon request. b. www.forestecosystem.ca

General observations about the functionality, system requirements and features of a number of habitat supply models that are being used in British Columbia:

1. For TFLs the issues are around timber supply and forecasting that over time subject to constraints (can't log here for certain reasons), the emphasis is what is the harvest level based on different constraints. There are higher level plan issues and/or biodiversity/habitat issues that may come in as a sensitivity analysis (impact on timber supply from these other issues or uncertainties based on these issues, e.g. how is timber supply affected if old growth is 180 years instead of 250 years). A part of the management planning process is producing a 20 year plan [with] spatial output/validation. If you have a spatial model you can link those 2 level together (in the past we people didn't have access to these tools, it was a manual process so you did the best you could to account for adjacency, etc.) now with spatial model those 2 processes or steps can be linked.

2. One thing to clarify is that you don't have to run it spatially, with the model itself you have a lot of flexibility with how you want to run it, (you can go all the way from a non-spatial analysis to a fully spatial analysis. A non-spatial acts like a FSSIM model, whereas we actually want to schedule spatial units like blocks or patches over time). Driven by timber supply analysis process you don't have to do timber supply analysis spatially, so many don't when you add spatial complexity you add more questions to the problem, it can also complicate the analysis or slow the process down, people may still be interested in the results, yet the overall process can't 'deal' with it in some cases (reviewing agency wasn't prepared for the results, so it may be easier to take on a non-spatial approach, plus it depends on the question being asked like if you don't care where the timber comes from specifically).

3. Projects are management-based, working mostly with planners at the planning level, this model helps them with their operational plans and resource development permits. You need to set up the entire scope of the project in a workshop environment, because we want to ensure that the questions the clients have get answered and that the scope doesn't get too large. The model operates at a forest strategic level so you can look at broad timber supply issues or old growth issues. Outside biology/habitat expertise is also required and they are involved in the planning and project workshop definitely and as early as possible. Timelines are established and some considerable pre-planning [with regards to wildlife or habitat] should have occurred so that the data will be readily available and sufficient.

4. Simulation or optimization mode, have 2 separate algorithms. Simulation – inventory projection/time-step model it looks at an individual period and the entire land base with constraints, identifies all polygons available for treatment, and harvest at 5 year intervals. Optimization – not a linear program mathematical optimization, unlike simulation its heuristic technique/searching algorithm that set targets e.g. harvest level, patch, old growth, and better for habitat modeling (Ontario - large 10,000ha patches as a target).

5. You can report on any feature at any time period that you want (provided that it has been set up ahead of time). Standard reports include: e.g. age class; the diameter distribution; and amount of zone >100 years for every zone. Then you can map, graph, chart or 3D them (if possible).

Other comments:
RE: level. Landscape level is used for the most part, we don't really go below the landscape level in our 'full analysis' sense, we incorporate stand level inputs to the projects but our scale is landscape up to forest level, yet using a spatial model we can report our output at an operational level, the key management/operational unit is a landscape level.

RE: Applying general biodiversity or specific species requirements to habitat models. Using both, depending on the project. E.g. Specific level for MAMU, caribou, deer winter range versus coarse filter biodiversity based on BEC variant or site series type groupings, then put some sort of coarse habitat feature based on those zones (zone (def'n) grouped habitat areas or BEC subzone area, etc. As a way of geographically identifying that in the model, then we are able to control that area but setting a rule or target or by reporting on that area as well, 'how does it change over time?').

RE: Definition of habitat for the project. The most difficult issue we have when dealing with habitat modeling is having a specific definition of what habitat is and then having the supporting data to show changes over time. There needs to be increased understanding about wildlife & habitat from the modelers and modelling from the biologists therefore important to have a good dialogue between the 2 throughout the project.

1.27 Netica (Bayesian Belief Networks) and Habitat Suitability Index (H.S.I.)

Model Functionality	Response
1. Modeling System/Tool Name: Title and/or acronym of tool.	**Netica (Bayesian Belief Networks) and Habitat Suitability Index (H.S.I.)**
2. Brief Description: Describe the purpose, primary use and functions of the tool	We're using Netica and HSI techniques to model wildlife habitat suitability in the Morice and Lakes IFPA. The Morice and Lakes IFPA is running the McGregor Model, which is a forest management optimization model and we're using outputs from that model to drive our Netica models.
3. Developer/User/Collaborator: (e.g.: Name, Position, Organization)	Developer: Norsys Software Corp. Brent Boerlage User: Bruce Marcot, Martin Raphael, Scott MacNay, Doug Steventon Collaborator:
4. Interviewee Contact Information: (e.g.: Name, Position, Organization, Mailing address, Street address, Telephone number, Fax number, Email address, Website)	Name: Laurence Turney Position: Wildlife Biologist Organization: Ardea Biological Consulting Address: RR#2 Site 44 Comp 9 Smithers, BC Tel: (250) 877-6705 Fax: (250) 877-6806 Email: laurence@ardea.ca Website: www.ardea.ca
5. a. What projects has this been used for — please list? What types of issues were each of these projects to address? Identify the Management Issue or Decision Type, as follows: **Type A: Landscape Level Habitat Features (CF)** - Any landscape level parameter - Large area - e.g.: Seral stage distribution, patch size distribution, connectivity **Type B: Ecosystem Level Habitat Feature Availability (CF)** - Variable area - Rare to limited occurrence - e.g.:Site series – structural stage combinations, e.g. old growth Sitka Spruce in riparian areas **Type C: Stand Level Habitat Feature Availability (CF)** - Variable area - Various elements of stand structure e.g.: hollow logs, large diameter trees, snags **Type D: Single Species – Guild – Specific Life Requisite**	**Project 1.** Project Title: Project Sponsor: Morice/Lakes IFPA Management Issue or Decision Type: D, E, F Project Purpose:Model current and potential future forest management practices to determine effects of the different management practices on timber and habitat supply and other resource values such as recreation and agriculture.. *See additional comment #2 below.* Size of Area: Morice 1.5 million ha, Lakes 1.1 million ha Location: Morice and Lakes Forest Districts

(FF) - Variable area home range - Specific life requisite - e.g.: Suitable nesting trees / snags for cavity nesters, mule deer winter range **Type E: Single Species – Large Area Home Range –** **(FF) All/Most Life Requisites** - Usually large **a**rea home range - All or most life requisites - e.g.: Woodland caribou, grizzly bear **Type F: Single Species – Small Area Home Range** **(FF) All/Most Life Requisites** - Small **a**rea home range: - All or most life requisites - e.g.:Woodpecker spp., bat spp., rodents ***CF: coarse filter; FF: fine filter***	
5 b. Indicators What specific indicators did your model predict around the management question(s) that was being addressed?	Indicators that will be modelled include species habitat suitability, inputs from other look-up tables include indicator such as CWD type and level, snags, large trees, seral stage distributions etc.
6. Spatiality Can the tool analyze spatial relationships?	No, the tool can be used spatially in conjunction with a GIS, but it doesn't do spatial analysis on its own. We can use a GIS to tell us which polygons are associated with others and have that in the database as an input to the Netica model and then rate the habitats based on the their associations. At this point we are unsure about the ability of the tool to process the potentially large database that is associated with the Lakes and Morice forest districts. We may have to break the landscape up into smaller units to process the models efficiently. *See additional comment #3 below.*
7. Proximity Capability to analyze proximity to features/polygons relative to each other?	Similar to the spatial question, we use a GIS to determine polygon proximities using a series of buffers. For example, within the MacGregor resultant file, there's a series of buffers around roads and streams, lakes etc. based on our management objectives. Within our Netica models some species have habitat reductions due to proximity to roads and we can determine which polygons should have that reduction. We've also got thermal, security and forage components to some of our models, but we haven't tried to implement them yet. *See additional comment #4 below.*
8. Multiple scale life requisite/ habitats & their nested spatial relations Can your model concurrently analyze spatially nested habitat areas (e.g., Goshawk – nesting, post fledging and	Yes, we can definitely nest, but it will be iterative and will require taking basically one sub-component of the Netica model and plugging that into another component, likely with a GIS exercise between the

foraging)?	two iterations.
9. Ecosystem Classification Resolution a. Can model incorporate and interpret site series mapping? b. What scale/resolution of mapping can be used?	 a. Yes, site series is one of the attributes that we're tracking and using. b. The MacGregor Model is running off 1:20,000 forest cover and TRIM, with other base layers as well..
10. Size of area that can be analyzed a. What is the maximum number of analysis units or cells? b. What is the largest project area it has been used for? and at what resolution?	 a. Unknown at this time, we have processed files with 100,000 records with no problems b. The tool uses records so theoretically any size are is possible if there are a limited number of records
11. Model building process What process is used to build the model? (i.e. is the model built through an inclusive participatory process "workshop" OR derived through regression analysis)	We're using a variety of methods to develop the models. We started out with a literature review, followed by expert opinions and peer review. Some of the model relationships have been derived from regression analysis and some by expert judgement. We've tested some of the models with ground information and we hope to do further work on ground truthing in the future, but that will depend on funding and timing. We are currently in the draft model phase with a significant model verification task required..
12. Species-habitat relationships a. Are the species/habitat relationships transparent and explicit in the model structure? If yes, how are they represented? Are they fixed or user defined? b. How does the model allow the user to enter or load these relationships? Is there a user interface?	 a. The relationships between the model components are explicit and graphical in the form of a series of boxes and arrows b. The user enters the relationships as they develop the models, there is a very easy to use user interface to help develop the models
13. Population component a. Does the model have an integral population analysis component? (i.e.: predict population size?) b. Is it deterministic or stochastic?	 a. At this point, we haven't built a population component although that, is completely possible within the Bayesian system. It's simply a matter of developing those assumptions and applying it to the suitability data. b. We are using the tool in a deterministic way as that is how we are getting the information from the McGregor model. It is possible to use Netica as a stochastic model by introducing random error, but we haven't implemented that
14. Forecasting a. Does the model predict future	 a. No, we're relying on the McGregor Model to

conditions? b. List model(s) by general model type (i.e. scheduling, assessment (bayesian belief, population, logistic regression.), growth and yield.	provide us with those future conditions. b. Bayesian Belief
15. What companion software is often used with this tool? (e.g. statistical analysis package, natural disturbance prediction model)	We're exploring the ability to use some runs of SELES or something like that, to provide us with some boundaries to allow us to build uncertainty. But right now, that's an idea and I doubt we're going to get there in the timeframe we have. So the McGregor Model is basically the companion for this.

System Requirements & Features	
1. Required hardware, devices & operating system?	During the development of the model, the hardware requirements seem to be very low We've developed small models on 333 Mhz Celeron machines with 256Mb of RAM with no problems. Faster machines and more RAM improve performance and the size of the model that can be built. If you are developing models that are complicated and have large numbers of components or interactions, then PIII 1Ghz machines with 512Mb RAM are required.
2. What commercial software, including version, is required to provide full functionality?	If you are interested in mapping the results or graphing them, then a database or spreadsheet program capable of reading and writing text files is needed to pass the polygon record information to Netica. You would also need a GIS program to show your resultant maps. We're using Access and ArcView 3.2 as our testing platforms. The McGregor Model will feed us resultant information in Access which we will use in the Netica Models. [For McGregor Model specifically] It has its own proprietary software that they run using ArcView/ArcInfo-type files as their map base, and then they run a proprietary optimization set of routines.
3. What is the typical set-up time to load program?	For Netica it was relatively quick, once we got over the hurdle of how the software works It took myself, and the person that's been doing the bulk of the modelling 1-2 weeks to get going and be able to create complex models. We were able to get some help from the developer of the software and a local MOF Biologist (Doug Steventon) who has experience with the software. Now we can create a relatively complex model in a day and test it.
4. What is the typical set-up time to prepare and input data? (range)	Data input is variable, depending on the type of model that you are building. When you are building the model and putting in parameters it can be several hours for each model, depending on the complexity. Within Netica you can build equations like a typical

	HSI equation, or you can fill out a table using experts, or using your best opinion. Some of the HSI equations can take a number of iterations, depending on the number of input variables. Once you have a conceptual model and are building the inputs, it can take between a day and a week to get to where you're happy.
5. What are the minimum data input requirements?	Data input involves the setting of probabilities of an occurrence or a value occurring. For example if you've got two habitat types (A & B) and three habitat attributes (X, Y, Z), you can create a 3 x 2 probability table. You can then assign values to the outcomes so that AX would be a HIGH value site, while BZ would be a LOW value site. You can also build a probability that AX is 80% HIGH and 20% MODERATE value if you are unsure about your ratings. You can also build equations using the numeric values that are additive, multiplicative etc. just like and HSI equation.
6. What data formats can be imported?	Netica imports ASCII text files in a specific format that has a header and a series of fields. It's only a couple of lines in the header, and then the rest is just a straight ASCII, comma delimited file.
7. What data formats can the results be exported to? (i.e. ArcGrid, Ascii, etc.)	Netica exports as an ASCII file with either a variety of output information. For example you can obtain a single probability of your outcome, or a series of probabilities one for each category that you set up in your model.
8. How long does it take to run a typical data set (not including plotting of map)**?**	We're running 100,000 records in 5 to 7 minutes.
9. Can the model deal with complex polygons? (e.g.: 60% A and 40% B site series)	Yes, you can do either an averaging or bring in each component and decide how to deal with it. You can do that either in Access or in the Belief network. *See additional comment #5 below.*
10. At what resolution does the tool operate? (e.g.: raster-based pixels or vector-based polygons)	We're using a s a vector dataset, but the way that the Netica software accepts data as a text file, it doesn't really matter, because it's just a polygon value.
11. What programming language(s) is the model written in?	Netica is written in C-language, but the Netica software is a stand-alone program with the model being maintained in Netica.
12. What level of expertise is required to set-up and maintain the program?	The Netica software uses a graphical interface, so you don't need to know any programming to make it do simple models. More complex models using equations, need some expertise in understanding programming concepts similar to complex equations or queries in Access or Excel.
13. What level of expertise is required to	For the models we are completing there is a

run the program?	relatively high level of expertise required as we are manipulating large data sets using a variety of software packages. We are moving the data from the McGregor model, processing portions in ArcView and Access to provide additional variables and then importing to the Netica models. We are then exporting the results from Netica back to ArcView and Excel/Access for data presentation. If you were only looking at using our models to test single solutions or visualize potential habitat values then you don't need as much expertise.
14. What types of standard outputs are generated? (i.e. maps, graphs, tables)	We get a range of values in a table format, e.g. the probability of a value We take the output files and attach them to the polygon tag of a GIS file to allow us to colour the polygons based on the output values.
15. What capabilities are there for user-defined outputs?	You can manipulate some of the information that comes out of the Netica models You can obtain final values or intermediate values from the model.
16. Is the software proprietary?	The models that we are building are for use by the Morice and Lakes IFPA, the software (Netica) that we are using to build the models is published by Norsys and was purchased.
17. What are the purchase/maintenance fees?	Netica is sold by Norsys for $285 US. There is a free trial version available. Upgrades are free as far as I know
18. What modeling techniques are used in developing the species-habitat relationships?	We are using expert knowledge and some regression analysis to develop the species habitat relationships
19. Does the model generate statistics estimates of error? (i.e. confidence limits on predictions)	Yes, we can generate variance, standard deviation, etc..
20. a. How transferable is the model system or framework to other biophysical and habitat-species relationship circumstances? **b. How generic is this model?** (i.e. ease of loading new knowledge relationship sets)	a. The model system is transferable, the models would need local calibration though. b. Loading new knowledge relationships is very simple, we have used Netica to develop Goshawk nesting habitat models for coastal and interior forests very quickly.
21. Training, user support?	I'm not aware of any training courses for Netica. We've been fortunate enough to have people like Doug Steventon, who has worked on developing his own models, and has helped us a great deal.
22. a. What type of documentation exists? (e.g.: system documentation; user manuals; tutorials)	a. Netica comes with a manual and some online help, and you can talk to or e-mail the developer who is in Vancouver.

b. Website(s)?	Our models are in the process of being documented b. The Netica website is www.norsys.com. We will be posting information on the models on the Morice and Lakes IFPA website (www.moricelakes-ifpa.com) and at my company website www.ardea.ca.

General observations about the functionality, system requirements and features of a number of habitat supply models that are being used in British Columbia:

1. [McGregor Model] is a forest estate model that runs an optimization-type system, and decides where it's going to harvest and how it's going to harvest, based on a set of rules. We'll use data from that model every 20 to 50 years, and process it through the Netica models, to determine the habitat suitability. We'll use the results of the Netica models to create a variety of outputs including time series for habitat supply, maps that show where habitat is changing or maps that where suitable habitat is moving through time.

2. There will be a series of scenarios run in the McGregor Model such as biodiversity, wildlife, natural disturbance, agricultural, water resources, recreation scenario, and timber productivity scenario. All of these scenarios are grouping of management strategies into specific scenarios. For example, the timber productivity scenario will look at trying to maximize site index increases, harvesting at specific sites or over high elevation site series, and things like that. They'll maximize timber production, using harvesting and silviculture strategies.

For the wildlife scenario , we'll try to manage for key wildlife species (grizzly bear, moose, deer, Northern Goshawk, fisher, caribou and marten). The management strategies will try to address providing good Marten habitat or moose habitat. When we compare the scenarios, we'll see how the various management strategies play off against each other, and what groups of strategies may cover off other resource values without explicitly managing for them. At the end, we'll try to develop a "Decision Scenario" that will take the management strategies that provide the best solutions for the resource values and run that to see the effects on the resource values. Hopefully everyone will win in the end.

3. *DD: "It might help to break it down, or use a bigger application like Oracle?"*

LT: "Yes, that's probably how the McGregor Group is going to be storing their data now, so we may end up doing it like that as well. When we started this off, we were in the dark as to how big these files were going to get. The main reason we did it this way, instead of trying to implement something within the McGregor Model, was that we wanted to ensure that we could develop our models in parallel and test them relatively easily, without having to wait for their model to run to see what the suitable habitat looks like. We can game different types of habitat without having to actually run their Estate Model. This is one of the big advantages of using this Netica model."

4. Our idea is that we would basically model (or assess) both of those components, and assess the values for each component of a polygon under another Netica model. To see if they're adjacent, or within *x* hundred metres of each other, we will end up having to post-process the resultant file and do more GIS work. Another idea is to look at summing up of available/good habitat within a landscape unit, and then feed that back into a Netica model to tell us to whether to upgrade or downgrade the available habitat. At this point we are concentrating on doing single component models and then going forward in the future with more complicated multi-component/habitat interaction .

5. …What we're finding is that it's simpler to do some of the basic lookup table crunching in Access, rather than using the Netica models. Unless you really need to have the uncertainties involved in those components it is just quicker and a lot easier to bring those values into the model.

6. We have some PEM data for the Morice District, and they're trying to put together a similar PEM system for the Lakes. We'll have forest cover data and we'll be making some assumptions on structural attributes like

snags, woody debris and herb-shrub layers. There are also sets of sub-models that are imbedded as look-up tables from the flat forest cover PEM data that the MacGregor guys will be showing us. We'll assign specific values for these habitat attributes.

Appendix D Forest Growth & Yield Projection Models

Source: http://www.for.gov.bc.ca/research/gymodels/About/about.htm

Overview

The number of growth and yield models applicable to forests in western Canada is increasing at an unprecedented rate due to recent advances in computing technology. Technologically advanced growth and yield prediction tools can help resource managers make more informed management decisions, but users of these tools must first learn to be selective and cautious with these new tools.

Each model has a unique niche; no one model is applicable in all situations. To get the most benefit from these models, users need to understand the basic differences among them to select the appropriate model for a given situation. Differences among models stem from differences in the databases used to calibrate them and differences in model architecture. Perfect databases do not exist. Data quality and quantity are always in short supply since funds are limited and long-term growth data requires time.

Likewise, there is no one "best" modelling approach. A model's architecture stems from the modelling approach (philosophy) chosen by the modeller based on the intended application and available data. Limited databases along with our limited knowledge of tree and stand growth necessarily lead to different approaches for different needs and applications. For instance, a primary emphasis on supporting silviculture prescriptions is likely to lead to a different model than an emphasis on inventory or planning. Similarly, an emphasis on single-rotation yields will produce a different model than an emphasis on long-term sustainability. We are already seeing a merging of modelling approaches (e.g., trends toward individual-tree, spatially explicit models) but it will be years before our understanding and data enable us to create one model for all situations and applications. For the immediate future we must expect to deal with more models, not fewer.

What are Growth and Yield Prediction Models?

Growth and yield prediction models are abstract or simplified representations of some aspect of reality used primarily to estimate the future growth and yield of forest stands. A ***stand growth*** model represents an abstraction of the natural dynamics of a forest stand, and depicts growth, mortality and other changes in stand composition and structure. It also mathematically describes the growth and yield of trees and stands. Some models are developed to predict ***Yield***, which is the final accumulated growth at the end of a certain period (e.g., total volume growth in cubic meters per hectare); while others predict ***Growth***, which is the total increase in dimensions of one or more individuals in a forest stand over a given period of time (e.g., total volume growth in cubic meters per hectare and per year), as well as ***Yield***.

Traditional growth and yield models are classified into two major groups. The models which require stand summary information (e.g., volume per hectare and stand average diameter) are called ***Whole Stand Models.*** The models which require a sum of individual tree information (e.g., tree heights, diameters and crown lengths) to produce estimates of yield are called ***Individual Tree Models***. These models are further

subdivided according to how the stand density is modelled. For instance, variable density whole stand models can assess the effects of yield on variation in stand density (e.g., crown cover, basal area). Of the individual tree models, only distance-dependent models maintain a spatial record of the point density around individual trees.

Comparing and Selecting Models

Table 1: Growth & Yield Model Comparison Table (Stearns-Smith, 1999) lists and compares a number of model characteristics and features that may be helpful in selecting an appropriate model for a given situation. Even though there are several models available, it is entirely possible that there may be situations where none of them are appropriate or where even the "best" one should be used with caution. There are a few simple, intuitive steps or questions that can help us select growth and yield models.

- Keep in mind your intended application, for example, is it silviculture, inventory or planning?
- What type of stand do you have and what kind of information do you currently have about it? You can set aside models that are not calibrated for your species and stand types. You can also determine if you currently have sufficient data to run a particular model, as some require more detailed data than others (e.g., permanent sample plot data versus inventory data).
- What type of density management treatment(s) you are interested in and how much treatment flexibility do you require? Although all the models in the table have some capability for stand density management, most only support a limited number of options.
- Finally, you will no doubt be exposed to conflicting results regarding these and other growth and yield models. Some differences are due to the models themselves but others stem from an emphasis on biology versus economics, or different interpretations of the historic theory versus science. Data from reproducible experiments should always be the ultimate arbitrator for both scientific theories and models.

Managed vs. Unmanaged Stands

What Model Might be used?

The following information will help planners identify ***managed* vs. *unmanaged*** stands (polygons), for the application of appropriate yield models (curves). The distinction is important because managed stands tend to be more productive. A decision tree is provided to help make the distinction between ***managed*** and ***unmanaged*** stands and suggest yield models for various stand types (Nussbaum, 1998).

Managed stands

Managed stands are even-aged stands which have benefited from management activities to encourage their growth potential. They have known establishment conditions including species, density, and distribution of stems. ***Managed*** stands can be:

- planted or natural origin but have not experienced repression or overstory competition.
- harvested stands regenerated after 1986 which have achieved "free growing" status, as specified in the regional free growing guide books. For stands regenerated before 1987, silviculture records, management plans, and local knowledge are needed to determine if stands are managed.
- young spaced and fertilized stands if the establishment conditions can be approximated
- partially harvested stands, such as commercially thinned stands if they were unsuppressed or unrepressed during establishment, establishment conditions can be approximated, and removals are documented.

Unmanaged Stands

Even-aged stands have not had the benefits of management and their establishment conditions are unknown. Although some stands may achieve their potential, others may have inadequate stocking, experience overstory competition, or repression.

Uneven-aged stands are considered ***unmanaged*** for this exercise, as the concept of establishment conditions holds little meaning, and a large number of stems could be suppressed by an overstory. These stands generally contribute to non-timber objectives where maximizing growth is not the primary concern. They have historically been handled as "naturals".

Models Decision Tree

Forest growth and yield models have been developed for many different purposes. It is important to choose the proper model and understand it's assumptions and limitations. Models can be sophisticated computer models or simple yield tables derived from appropriate data. The above distinction between ***managed*** and ***unmanaged*** stands should help in choosing an appropriate yield model for your particular application.

A word of caution about models

Forestry and statistically-based biological experimentation are both relatively new sciences whose joint development is governed largely by the (slow) rate of tree growth. Seeming contradictions among the limited existing experiments serve to highlight our imperfect understanding of complex biological systems and discourage risk-laden investment decisions based on limited (or select) information. Decision making given imperfect information requires risk analyses which take into account the uncertainties regarding future biological and economic consequences. Models can be important tools, but we should not rely solely on them for making decisions. Use your professional judgement to examine your own data and assumptions before making the final management decision.

Model Application and Use

Selecting a model is only half the battle. Proper use of a model also depends on proper selection and preparation of the input data and proper interpretation of the model output. This is why most regulatory agencies avoid any open or implied sanctioning of specific models in favor of yield table approvals.

The main uses of growth and yield predictions are to:

- increment and update forest inventories;
- compare silviculture treatments by simulating treatments and predicting outcomes;
- influence stand and forest level decision making;
- provide input for forest management planning including timber supply analysis, Allowable Annual Cut (AAC) determinations and policy making;
- assess the impact of timber losses due to pests and fire;
- allow extrapolations for missing or inadequate data; and
- explore and teach tree and stand dynamics.

The application of any model in silvicultural decision support also requires a clear statement of management objectives translated into appropriate quantitative values that can be identified in model output. Care must be taken to understand the implications and limitations of using various quantitative measures as surrogates for management objectives.

References

Davis, L.S. and K.N. Johnson, 1987. **Forest Management. 3rd Edition**. McGraw-Hill Book Co. New York. 790 pp.

Di Lucca, C. M. 1999. **TASS/SYLVER/TIPSY: Systems for predicting the impact of silvicultural practices on yield, lumber value, economic return and other benefits.** *In*: Stand Density Management Conference: Using the Planning Tools. November 23-24, 1998, Colin R. Bamsey [Ed.] Clear Lake Ltd., Edmonton, Al. pp. 7-16.

Goudie, J. W. 1998**.** Model validation: A search for the magic grove or the magic model**.** *In* Stand Density Management Conference: Planning and Implementation, November 6-7, 1997, Edmonton, Al, Bamsey, C. pp. 45-58.

Munro, D.D. 1974. **Forest Growth Models - A Prognosis**. *In*: Fries (Ed.) Growth Models for Tree and Stand Simulation, Royal College of Forestry of Sweden, Res. Note No. 30. Pp. 7-21.

Nussbaum, A. 1988. **Which Stands are "Managed" for Yield Curve Generation and What Models Might be Used?** Description for TFL/TSA Data Package. Unpublished Note, BC. Ministry of Forests, Research Branch, 3 pp.

Oliver, C.D. and B.C. Larson, 1990. **Forest Stand Dynamics**. McGraw-Hill Book Co. New York. 467 pp.

Stearns-Smith, S. 1999. **Model comparison and overview**. *In*: Stand density Management Conference: Using the planning tools. November 23-24, 1998, Colin R. Bamsey [Ed.] Clear Lake Ltd., Edmonton, Al. pp. 78-81.

Thrower, J.S. 1989. **Introduction to Growth and Yield Modelling and Simulation**. Forest Management Institute of British Columbia, **Module III Training Course**, Surrey, BC. 7 pp.

T.M. Thomson & Associates Ltd.1991. **Growth and Yield Prediction Systems: Special Report Series #7**. BC Ministry of Forests: Victoria, BC, 31 pp.

Vanclay, J. K. 1994. **Modelling Forest Growth and Yield: Applications to Mixed Tropical Forests**. CAB International, England, 312 pp.

Growth and Yield Models and Related Software

- **Timber Decision Support System (TDSS)** : The Texas Forest Service TDSS is a web-based decision tool for non-industrial private forest landowners and others who are interested in timberland investment and management http://tfsfrd.tamu.edu/

- **FPS:** Forest Projection and Planning System http://www.forestbiometrics.com/index.html

- **DFSIM**: Douglas-fir simulator with economics http://forsys.cfr.washington.edu/~dfsim/

- **Woodstock:** a forest modelling system used mainly for harvest scheduling, wood supply analysis, wildlife management and simulation of forest ecosystems http://www.remsoft.com/forest/woodstock/index.html

- **Site Tools:** A Windows software for evaluation of site productivity http://www.for.gov.bc.ca/research/sitetool/

- **FVS:** (Forest Vegetation Simulator)-- The Forest Vegetation Simulator (FVS) is the USDA Forest Service's nationally supported framework for growth and yield modeling. http://www.fs.fed.us/fmsc/fvs/index.php

- **SPS:** (Stand Projection System) -- MASON, BRUCE & GIRARD, INC. Natural Resource Consultants. http://www.masonbruce.com/

- **ORGANON:** (**OR**egon **G**rowth **AN**alysis and projecti**ON**) **--** ORGANON is an individual tree growth model developed for Southwest Oregon, Northwest Oregon and the lands of the Stand Management Cooperative. http://www.cof.orst.edu/cof/fr/research/organon/

- **SORTIE** a mechanistic, spatially explicit, stochastic model of forests in the northeastern United States that describes local competition among nine species of trees in terms of empirically derived responses of individuals. http://dino.wiz.uni-kassel.de/model_db/mdb/sortie.html

- **SORTIE documentation at SCIENCE ONLINE** http://www.sciencemag.org/feature/data/deutschman/toc.htm

- **CACTOS/CRYPTOS: CA**lifornia **C**onifer **T**imber **O**utput **S**imulator/ **C**ooperative **R**edwood http://www.cnr.berkeley.edu/~wensel/cryptos/crypt.htm

- **PLANS:** Preliminary Logging Analysis System http://forsys.cfr.washington.edu/plans.html

- **SYSTUM-1:** Growth and Yield Simulator for Young Mixed-Conifer Stands http://redding.psw.fs.fed.us/systum.html

- **RVMM:** The Regional Vegetation Management Model http://www.cof.orst.edu/cof/fr/research/organon/rvmm/rvmm_idx.htm

- **GENGYM:** The Generalized Growth and Yield Model http://www.advancedforestry.com/software/gengym/gengym.shtml

- **TAUYIELD:** Growth and Yield Model Online. Stand level growth and yield model for DOS. http://www.fw.vt.edu/g&y_coop/models.htm

- **ASPEN:** A Circumboreal Growth and Yield Model for Populus tremuloides and P. tremula http://www.d.umn.edu/~ghost/FMSASPEN.HTM

- **FYCD:** Forest Yield Curve Designer. Canadian Forest Service http://www.atl.cfs.nrcan.gc.ca/index-e/what-e/downloads-e.html

- **WOODLOT:** a program that calculates non declining even flow harvest rates over multiple rotations on woodlot licenses in B.C. This program uses TIPSY and VDYP for yield predictions. http://www.enfor.com/software/woodlot/

- **Growth and Yield Simulators for Pacific States** http://redding.psw.fs.fed.us/sim.html

International Growth and Yield Modelling

- **Growth and Yield Modelling of Tropical Forests** http://www.symfor.org/home.htm

- **Institute for Growth and Yield, University of Goettingen,Germany** http://www.uni-goettingen.de/english/schools/forest/

- **Institute: Forest Growth and Yield Research, Vienna** http://www.boku.ac.at/wafo/allge.html

- **BUBBLE:** Mixed Forest Stand Model, Wissenschaftliches Zentrum für Umweltsystemforschung http://www.usf.uni-kassel.de/dframe.php3?reference=/modelle/bubble/bubble.htm

- **Ecological Modelling WWW-Server:** University of Kassel, Germany http://eco.wiz.uni-kassel.de/ecobas.html

Growth and Yield Educational Resources

- **Biogeoclimatic Ecosystems Classification of British Columbia**
  http://www.for.gov.bc.ca/research/becweb/becinfo/

- **How to Determine Site Index in Silviculture (Course Workbook)**
  http://www.for.gov.bc.ca/hfp/pubs/sicourse/index.htm

- **Site index estimates by site series for coniferous tree species in British Columbia**
  http://www.for.gov.bc.ca/resinv/G%26Y/Projects/SPWG/sibec/sibec1.htm

- **Ecosystems of British Columbia (.pdf format)**
  http://www.for.gov.bc.ca/hfd/pubs/Docs/Srs/SRseries.htm

- **Glossary of Forestry Terms by the British Columbia Forest Service**
  http://www.for.gov.bc.ca/PAB/PUBLCTNS/GLOSSARY/GLOSSARY.HTM

- **Introduction to Growth and Yield CBT:** A Windows software for learning basics of growth & yield concepts. http://www.for.gov.bc.ca/research/cbt/

Table 1: G&Y Projection Model Comparison

(Steve Stearns-Smith, 1999)

	Prognosis BC	**Mixedwood Growth Model (*MGM*)**	**Stand Density Management Diagrams (*SDMD*)**	**Variable Density Yield Prediction (*VDYP*)**	**Stand and Tree Integrated Model (*STIM*)**	**Tree and Stand Simulator (*TASS*)**	**Table Interpolation Program for Stand Yields (*TIPSY*)**	**Silviculture Yields, Lumber Value and Economic Return (*SYLVER*)**
Developer	USFS Intermtn variant adapted to BC by BCFS	Steve Titus, U of Alberta	Multiple authors	BCFS	CFS	Ken Mitchell, BCFS	BCFS	BCFS
Distributor and Cost	BC MOF (free)	U of Alberta free (web)	BC MOF (free, web), OMNR (free), others see literature	BC MOF (free, web)	BC MOF (free, web)	not distrib. BC MOF does free runs	BC MOF (free, web)	not distrib. BC MOF does free runs
Model Type	Individual tree, distance independent	Individual tree, distance independent	whole stand	whole stand	whole stand and diameter class	Individual tree, distance dependent	see TASS	TASS BUCK, SAWSIM, GRADE, FAN$Y
Tree Input Data	Tree list	Tree list or stand description	see outputs	Species composition, crown closure	Tree list or stand description	Establishment density & spatial dist.	Establishment density	see TASS
Site Productivity Input	Not SI, uses BC BEC and physiography	Site Index (SI)	SI for Top Ht	SI	SI	SI	SI	see TASS
Species	Pw, Lw, Fd, Bg, Hw, Cw, Pl, Se, Py, Hm	Sw, At, Pl, (Sb)	BC (all TIPSY); OMNR Pj, Pr, Pw, Sb	32 commercial BC species	Hwc, At	Fdc, Fdi, Hwc, Hwi, Ss, Bg, Cw, Pl, Sw	Fdc, Fdi, Hwc, Hwi, Ss, Bg, Cw, Pl, Sw	see TASS
Stand Types	single and mixed-spp, even and uneven aged	mixedwood, even and uneven aged	single-spp, even aged	single and mixed-spp, even aged	single-spp, even aged	single-spp, even aged	single-spp, even aged (multi-spp area prorated)	see TASS

	Prognosis BC	Mixedwood Growth Model (*MGM*)	Stand Density Management Diagrams (*SDMD*)	Variable Density Yield Prediction (*VDYP*)	Stand and Tree Integrated Model (*STIM*)	Tree and Stand Simulator (*TASS*)	Table Interpolation Program for Stand Yields (*TIPSY*)	Silviculture Yields, Lumber Value and Economic Return (*SYLVER*)
Post-establishment activities supported	PCT, partial cutting	PCT, partial cutting	exploration tool		PCT, partial cutting	PCT, partial cutting, fertilization, pruning	PCT	see TASS
Other growth modifiers	root disease			Decay, waste and breakage and VAF's		OAF's, some pests and diseases	OAFs, lodgepole repression	see TASS
Output besides yield tables	projected tree lists, diameter distributions	projected tree lists, crop plans	no yield tables, only variables are: Trees/ha, ave tree vol, ave diameter, top ht	ave diameter and culmination MAI	diameter distributions	stand and tree visualization, wood characteristics, projected tree lists, etc	diameter distribution, lumber and logs, mortality and snags, economic analysis	see TASS, plus economic analysis
Development Data Sources	USFS CFI and EP plus PSP from BC S. Interior	Alberta PSP	TIPSY in BC, PSP & TSP elsewhere	TSP	PSP & EP. Hwc BC, WA, OR; At Canada	PSP & EP. BC, AB, WA, OR	see TASS	see TASS
Unique Features & Applications	partial cutting in complex stands; pest and habitat models available	boreal mixedwood Requires EXCEL 97	simplified one page exploration tool, OMNR software	natural stands CFI updating and timber supply analysis	unique dual model architecture	spatially explicit; crown based, timber supply analysis, custom runs on request	yields from TASS, timber supply analysis and economic analysis	economic analysis based on lumber value

Abbreviations

- BC MOF - BC Min of Forest
- BEC - biogeoclimatic classification
- CFI - continuous forest inventory
- OAF's - operational adjustment factors
- CFS - Canadian Forest Service
- EP - experimental plots
- MAI - mean annual increment