Modeling a Historic Forested Landscape for Revelstoke Forest District

Eric Valdal
Resource Analyst
Integrated Land Management Bureau
March 27, 2006

1 Introduction

Landscape scale analyses with historical natural resource data provide invaluable insight into the past conditions of ecosystems (Morgan 1999, Mladenoff et. al. 2002, Wells and Valdal 2002). Applications of such data include the assessment of the extent of ecosystem change and the creation ecological baselines for habitat management, population modeling and species recovery (Mladenoff et. al. 2002, McNay 2005). Analysis of historic information may also provide understanding into the ecological function of current systems (Wells and Valdal 2002, Utzig and Holt 2002). The purpose of this project was to model a 1985 forested landscape in the Revelstoke Forest District, with the applied aim of contributing to a historic habitat suitability benchmark for the mountain ecotype of woodland caribou (*Rangifer tarandus caribou).*

In British Columbia, forestry and natural disturbances are updated into the digital forest cover inventory by the Ministry of Forests (MOF). Although comprehensive archives of forest cover data exist back to 1994, digital and hard-copy forest cover information before this time are often not available because of unstable archive media problems and destruction of historic data, in part due to a lack of corporate understanding of its value (Carpentier 2005, Beard 2005).

All methods for obtaining a historic forested landscape have drawbacks. The ideal method is to retype forest stands using old aerial photography; however, this process is prohibitively costly over large study areas. The MOF manages digital silviculture surveys containing stand level forest information that existed before a forest block was harvested. Incorporating this information is also problematic though, because it does not meet all the pre-disturbance information needs for the project, is relatively costly to incorporate over a large landscape, and the scale and spatial orientation of the survey's forest stand information is not in concert with the original forest cover inventory (Rousseau 2005). The most pragmatic and cost effective method is to simulate the composition of post 1985 disturbances using the adjacent forest inventory information within a modeling framework like the Spatially Explicit Landscape Event Simulator (SELES) (Fall and Fall 2001).

The use of adjacent inventory information to model missing forest stand information has had levels of success in the past (Wells and Valdal 2002). Using forest cover age class and leading species as testing targets, the modeling accuracy is generally higher in ecosystems with stand-initiating events and larger patch sizes rather than those with stand-maintaining disturbances and smaller patch sizes (BCMOF 1995). The forest ecosystems in the Revelstoke study area are characterized as having rare and infrequent stand-initiating events (BCMOF 1995) that align well with our project objectives.

2 Project Objectives

The objectives of this project were to:

- Use SELES to simulate the age and stand composition of forest stands within the Revelstoke Forest District and Revelstoke National Park
- Test the model results using 1994 archived forest cover information
- Incorporate the 1985 age and stand information into Predictive Ecosystem Model (PEM) polygons for its eventual application for modeling the historic habitat of the mountain ecotype of woodland caribou (*Rangifer tarandus caribou).*

3 Methods

3.1 Data Set Creation

3.1.1 Study Area

The study area consisted of the Revelstoke Forest District north of the Trans-Canada Highway (TCH). This area includes The Revelstoke TSA above the TCH, Tree Farm

Licence (TFL) 55, TFL 56 and Revelstoke National Park (RNP). Landscape Units (LU) were used to delineate the study area and consisted of LU's 5-12 and 14-20.

3.1.2 Dataset Creation for Revelstoke TSA, TFL 56 and RNP

Year 2005 Forest Cover information was extracted out of the Land Information BC (LIBC) Land and Resource Data Warehouse (LRDW) by Silvatech Consulting Ltd. and provided to the author. Arc\Info was used to create Arc GRID raster coverages with a 25m pixel size for the following forest cover attributes:

- Projected Age
- Forest species 1, species 2 and species 3
- Forest species percent 1, species percent 2, species percent 3.

Natural burns less than 20 years old were identified within the forest cover data set. A one hundred meter buffer was created around the burns. The burn and buffer around the fire were converted to an Arc GRID raster coverage.

All GRID raster coverages were converted to ACSII files for incorporation into the SELES modeling framework.

3.1.3 Dataset Creation for TFL 55

Due to limited data availability, a year 2000 forest cover data set was used as source information for TFL 55. Arc\Info was used to create Arc GRID raster coverages with a 25m pixel size for the aforementioned forest cover attributions in section 3.1.1.

The year 2000 forest cover data set did not have any disturbance history information. The spatial data was analyzed by eye to locate any possible forest polygons burned by wildfire. None were identified that had been disturbed since 1985. All TFL 55 GRID raster coverages were converted to ACSII files for incorporation into the SELES modeling framework.

3.2 SELES Model

The SELES model used for this project was adapted from one made available from Andrew Fall through the Habitat Supply Research Network (Morgan 2005). Generally described, the adapted model used the current forest cover information adjacent to natural and forestry related disturbances to populate the disturbed areas. The ages of all forest stands undisturbed since 1985 were set back 15 years in TFL 55 and 20 years in the rest of the study area.

The attributes from adjacent forest stands were used to populate logging disturbances if they met the minimum harvest age for logging at the time of harvest. The lowest minimum harvest age (MHA) for all timber types in the Revelstoke district is 80 years (BCMOF 2004). As an example, if two forest stands, one 140 and one 50 years old were adjacent to a logged disturbance, the age and species attributes from the 140 year old stand would be used to populate the disturbed area. In a situation where two or more adjacent forest stands were above the MHA, the attributes from all stands greater than the MHA would be used to populate the logged block proportional to the amount of shared border they have with it.

Wildfire disturbances are more likely to start in certain stand types and topographic conditions however, they will indiscriminately burn all forest stands (Fiddis 1999). Given this phenomenon, there were no MHA constraints on adjacent forest stands to wildfire disturbances. The attributes of forest stands of any age adjacent to wildfires were used to populate the disturbed areas.

Natural disturbances not classified as wildfire were treated by the model as though they were logged disturbances.

There are many isolated forest stands that exist within the project study area. These are forest stands that are surrounded by shrub species like those found in avalanche paths or by rock in forest-alpine ecotones. Disturbed isolated forest stands were assigned the average age of stands within the study area that were older than 140 years. The tree species that were assigned to isolated disturbances were climax forest combinations according to its corresponding Biogeoclimatic zone (BEC) (Braumandl and Curran 1992). These were Spruce\Balsam for the Engleman Spruce Sub-alpine Fir (ESSF) BEC zone and Cedar\Hemlock for the Interior Cedar Hemlock BEC zone.

3.3 Model Validation

Results obtained from the SELES model were subject to a testing process using 1994 digital forest cover maps obtained from the BC Ministry of Forests. Ten percent of forest stands that had been logged since 1994 were validated against the model results. Ten percent of stands burned by wildfire were tested against the model results.

Model validation consisted of manually comparing model output maps with hardcopy 1994 forest cover maps provided by Marc Rousseau of the BC MoF. Automated comparison would have been difficult due to discrepancies in datums (i.e. NAD 27 vs. NAD 83) and due to a forest cover re-inventory conducted by Revelstoke Forest District in 1997. Nonetheless, we proceeded with model validation due to limited options in historic forest cover information independent from the input data for this model.

The goals for model validation consisted of predicting the correct age-class of a disturbed polygon or proportion of age classes for larger disturbances. The two leading species predicted by the model were validated against the two leading species indicated on the hardcopy 1994 maps. Comparisons between model output and 1994 forest data were deemed valid if the age-class and two leading species of adjacent stands to disturbances were not dramatically altered by the 1997 forest cover re-inventory.

3.4 Integration with PEM Dataset

A Predictive Ecosystem Map was provided for the study area by Silvatech Consulting Ltd. Model results were incorporated into the PEM map using Arc\Info software. A 25m Arc GRID raster was created from the PEM dataset and overlaid with the model result raster data using the ‘ZONALSTATS’ command and ‘MAJORITY’ option. This process incorporates the majority value of historic age, tree species 1-3 and tree species percent

1-3 over the area of a PEM polygon. Polygons that are less then 625m² or a polygon that has one axis less than 25 m will not be assigned historic age or species values using this process.

4 Results

4.1 Modeling Outputs

Raster coverages of historic age, tree species 1-3 and tree species percent 1-3 were produced for the study area and made available with this report. This information was also incorporated into a PEM data set for the study area. Maps comparing the 1985 and present day forest cover information were produced (Appendix 1). A comparison of the forested landscape composition between 1985 and the current landscape can be found in Table 1 and Chart 1.

Study Area Forest Cover Area Summary		
Age Class	**Year 1985 Area (ha)**	**Current Landbase Area (ha)**
0 (NSR)	0	13564
1	23145.062	18627.75
2	14655.437	21927.593
3	16107.187	14539.122
4	19504.499	15637.855
5	23652.187	19151.862
6	14923.625	22027.044
7	18635.875	14257.293
8	188178.687	168944.365
9	65021.25	75101.608

Table 1 Forest Cover Age Class Area Summary by Year

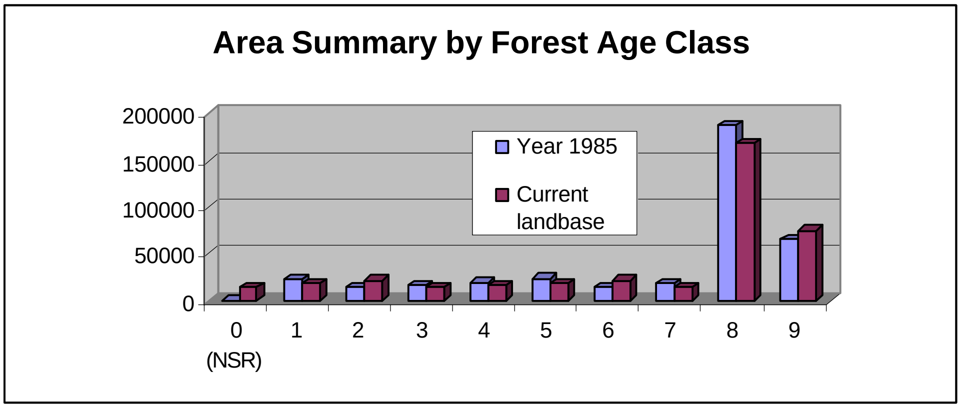

Chart 1 Area Summary by Forest Age Class and Year

4.2 Model Testing Results

The validation of the model results was complicated by differences in data standards and a forest cover re-inventory that occurred in the time between the contemporary data that was used as source for this modeling effort and the historic 1994 forest cover data used to test the model. Model results are listed in Appendix 2.

For the age class test, 50% (n=16) of the disturbances had similar adjacent forest age classes between the 1994 and current data sets. Of these disturbances, 100% of the predicted age classes matched the 1994 data.

For the two dominant species test, 22% (n=7) of the disturbances had similar adjacent species classifications between the 1994 and current data sets. Of these disturbances, 100% of the predicted dominant species matched the 1994 data.

The numbers of valid comparisons in this testing process are less than ideal for quantitative model validation. However, from a qualitative perspective, the predictions made by the model seem to be validated by actual forest stands in the 1994 forest cover data.

5 References

BCMof 1995. Biodiversity Guidebook. Forest Practises Code of British Columbia. BC Ministry of Forests and Range. 99 pp.

BC MoF 2004. Analysis Report for the Revelstoke TSA Timber Supply Review.

Beard, V. 2005. GIS Analyst, Columbia Forest District, BC Ministry of Forests and Range. Personal Communication on August 12, 2005

Braumandl, T.F. and M.C. Curran (eds.). 1992. A guide to site identification and interpretation for the Nelson Forest Region. British Columbia Ministry of Forests. Nelson, B.C.

Charpentier, P. 2005. Resource Information Auditor, BC Ministry of Forests and Range. Personal Communication on August 13, 2005.

Fall, A. and J. Fall. 2001. A domain-specific language for models of landscape dynamics. Ecological Modelling. 137:1–21.

Fiddis, R. 1999. Fire Protection Officer, Invermere Fire Zone Office. Protection Branch, Ministry of Forests. Personal communication in June 1999.

McNay, S. 2005. Phase II Habitat Suitability Modeling for Mountain Caribou. Unpublished document submitted to the BC Species at Risk Coordination Office. April 2005.

Mlandenoff, D.J., Dahir, S.E., Nordheim, E.V., Schulte, L.A. and G. Guntenspergen. 2002. Narrowing historical uncertainty: Probabilistic classification of ambiguously identified tree species in historical forest survey data. Ecosystems. 5(6) pp.539-553

Morgan, D. 2005. A.\Manager, Wildlife and Range, Research Branch, BC Ministry of Forests and Range. Personal Communication on August 6, 2005

Rousseau, M. 2005. Vegetation Update Specialist, BC Ministry of Forests and Range. Personal Communication on August 19, 2005.

Wells, R. and Valdal, E. 2002. Habitat Decision Support for the Invermere TSA Timber Supply Review. Invermere Enhanced Forest Management Pilot Project. Report No. 16. Available online at: http://www.for.gov.bc.ca/drm/Pilot/projectsummary.htm

Utzig, G. and R.F. Holt. 2002. Environmental trends: assessing the effectiveness of the Kootenay Boundary Land Use Plan Higher Level Plan in TFL14. Prepared for MSRM, Nelson Region.