Morice & Lakes IFPA

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Summary No. 9

Morice & Lakes Innovative Forest Practices Agreement

PROJECT SUMMARY

The ecosystem management component of the Morice & Lakes IFPA has embarked on several projects that assess biodiversity, ecological attibutes, and fish and wildlife habitat. These projects will provide important ecological data that will be used in learning scenario development for the IFPA's Sustainable Forest Management Plan.

Successional Pathways

Introduction

Vegetation change over time can be modelled using basic successional theory (e.g., Noble and Slatyer 1977, 1980), in which the forest changes from one state to another as a function of ageing, management, and natural disturbances. One method of modelling vegetation change is to use a successional pathway diagram (SPD). Successional pathway diagrams use "successional classes," or combinations of structural stage and cover type, to represent the different states of the forest, and they use "pathways" to describe how a forest may change from one state to another. Changes in successional class can either be due to disturbance or because growth dynamics have changed the cover type, the structural stage, or both. The time required to "grow" from one class to the next defines succession in the absence of disturbance. Transition probabilities associated with a disturbance pathway define the likelihood of different disturbances in each successional class. At any point in time, a pixel or polygon is in only one of the successional classes described by one of the diagrams.

Successional pathway diagrams can be compiled using the Vegetation Dynamics Development Tool (VDDT, Beukema and Kurz 2000). This tool allows users to create the successional classes, to define the succession and disturbance pathways, and to test the consequences of their assumptions in a non-spatial modelling environment. Technically, VDDT uses a semi-Markovian approach to modelling succession. It combines transition times for succession with transition probabilities for disturbances.

This type of model is usually applied at a large spatial scale, to a landscape for which a limited amount of forest information is available. This constrains the formulation of the effects of disturbances, and requires that all rules be as simple as possible. Any type of disturbance can be defined in an SPD, as long as the disturbance affects the successional path of a forest by increasing or decreasing the amount of time in a class, or by moving a pixel to a different class because of changes in the structural stage or cover type of the forest. Linkages between disturbance types can be captured either through their independent effects on forest cover and structural stage or through disturbance types which are defined as the joint action of two or more biotic or abiotic factors.

The disturbance probabilities define the likelihood of a pixel being affected by disturbance in any given year. This probability is only a function of the current state of the pixel, and is not affected by events in previous years except to the extent that these are reflected in the current state of the pixel. Probabilities are also independent of the condition of the adjacent pixels. Therefore, this type of non-spatial model is not capable of modelling events connected in space (contagion) or time (such as defoliator outbreaks).

Probabilities can be assigned to represent different assumptions about the level of forest protection

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efforts, external drivers (such as global warming), introduction of exotic agents (such as white bark pine blister rust) or other factors. For example, there may be one assumed set of fire probabilities to represent the "natural" conditions, a set of reduced fire probabilities to represent fire suppression efforts, or a set of increased fire probabilities to simulate a climate change scenario.

Objective

The purpose of this project was to create successional pathway diagrams for each of the ten Biogeoclimatic Ecosystem Classification (BEC) variants which are found in the Morice and Lakes IFPA, in order to better predict how the ecosystems will change through the interaction of succession, natural disturbances (such as fire and pine beetle) and management.

Methods

Two two-day workshops were held with local ecologists, entomologists, and other scientists to develop the local successional pathway diagrams. For each BEC variant, the steps were as follows:

1. Stratify the landscape according to site series and/or cover types.
2. For each site series or cover type ("row"), start defining the successional classes and succession pathways. For each of these classes, define the dominant cover type and structural stage, and the number of years that a stand would stay in that state in the absence of management or major natural disturbance events.
3. Once all classes and succession pathways have been determined, add the natural disturbances: stand-replacing fire, ground fire, insects, and any other key disturbance agents. For each disturbance type, determine which classes are eligible, what happens to stands in that state after they are disturbed (i.e., determine the target class), and define the probability that a stand in that state will be disturbed by that agent. Not all classes will be disturbed by all disturbance agents, nor will all probabilities be the same for a single agent.

At the end of the first workshop, preliminary SPD for the major BEC variants were complete. A report was produced which included the diagrams and their assumptions, as well as some sample simulation results using VDDT. The simulations ran each SPD to equilibrium to help reviewers interpret the results of their assumptions. Workshop participants reviewed the document prior to the second workshop.

At the second workshop, the diagrams were revisited and some of the pathways or probabilities were refined. The main emphasis at the second workshop was, however, adding the clear-cut management pathways. The main steps involved were, for each BEC variant:

1. Determine which classes are eligible for management.
2. Determine what happens to stands in that state after management, and define the appropriate pathway. Note that this could involve creating new classes.
3. Once all management pathways have been added, determine the succession and natural disturbance pathways for any new classes that were defined in step 2. Note that additional management pathways may also need to be added for these new classes.

The results of this workshop were also written up and sent out for review. The final document for this project is the result of these workshops and any review comments that were received.

Results

Most of the landscape, 71%, is in the Sub-boreal Spruce (SBS) zone, and another 22% is in the Englemann Spruce Sub-alpine Fir Zone (ESSF) (Table 1). Therefore, the dynamics of these zones was the focus of the meetings. The Sub-boreal Pine Spruce Zone (SBPS), although only 2% of the landscape, was also addressed because mountain pine beetle is currently quite active there. No time was spent on the Coastal Western Hemlock Zone (CWH) because it contains few insects or pathogens, or on the Mountain Hemlock Moist Maritime Zone (MHmm) because it represented less than 1% of the landscape. Instead of creating an SPD for all the variants in the ESSF or SBS, some of those which occupied a small area were simply assigned to an SPD for one of the other variants (e.g., ESSFmv3 or SBSwk3, Table 1).

Diagram size ranged from 42 classes to 110 classes. Some of the classes represented cases that only occurred after management, and some classes represented rare but important instances. No check was done to ensure that all areas in the inventory could be mapped onto a class, or to see if there were any classes that would never be used in any scenario.

Each SPD described succession pathways, and the impacts of fire and mountain pine beetle (Table 2). Most diagrams also addressed other insects. All SPD, except that for the SBPSmc, also included clear-cutting management pathways.

The results of the runs to equilibrium, which were performed under the assumption that management was not present, differed in each SPD. The two SPDs for the ESSF showed that the landscape would tend towards climax vegetation or other old multi-storey stands. In contrast, in the SPS, the runs showed that the majority of the BEC would be in younger classes with extensive regeneration in the understory. Because these simulations were done without any knowledge of the actual distribution of stands in the landscape, and without considering management, actual distributions of classes could vary significantly.

Table 1. Summary of the BEC subzones or variants represented in the Morice and Lakes IFPA. The "covered" column specifies whether a SPD was created for that area, and the "#Classes" column gives the resulting number of classes in the completed SPD.

Subzone or Variant	Percentage	Covered?	#Classes
ESSFmc	15.2%	Yes	55
ESSFmv3	1.5%	Uses ESSFmc	
ESSFmv1	0.3%	Uses ESSFmc	
ESSFmk	6.5%	Yes	42
SBPSmc	2.0%	Yes	46
SBSmc2	42.1%	Yes	110
SBSwk3	1.7%	Uses SBSmc2	
SBSdk	27.9%	Yes	97
MHmm2	0.6%		
CWHws2	2.3%		

Table 2. Natural disturbances represented in each SPD. Other agents may exist in the BECs, but their effects were either incorporated into the succession pathways, or their impact was not severe enough to be explicitly included. See the full report for details on why different agents were not included.

		ESSFmc/ mv3/mv1	ESSFmk	SBPSmc	SBSmc2 /wk3	SBSdk
Insects	Mountain pine beetle	X	X	X	X	X
	Balsam bark beetle	X	X			X
	Spruce bark beetle				X	X
	Budworm				X	X
	Douglas-fir beetle				X	X
Fire	Stand-replacing	X	X	X	X	X
	Ground fire	X	X	X	X	X
Other	Flooding	X	X		X	X
	Rust					X

Discussion

These five forest succession pathway diagrams play an important role in the development of a sustainable forest management plan. They are critical to help others get a realistic portrayal of landscape dynamics especially as influenced by natural disturbances. When used as part of a management plan, the information compiled in the diagrams can help show the implications of different management options, in terms of how the forest vegetation and structure will change and the resulting impact of natural disturbances

References

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Morice & Lakes IFPA

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