Spatial Distribution

of

Mature and Old Forests

Phase I:

Uncertainty Related to Pattern

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February 25, 2008

Preface

This report contributes to Phase I of project 2007-4P: *Spatial Distribution of Mature and Old Forests*, undertaken for the Babine Watershed Monitoring Trust. The overall objective of the project, described in the invitation for expressions of interest, is to

reduce uncertainty related to old and mature forest distribution and check for negative consequences in applicable regions. It will attempt to reduce uncertainty related to pattern.

This report addresses the second aspect of the objective. It aims to inform the Babine Watershed Monitoring Trust about new research related to spatial patterns on landscapes, and to thereby reduce uncertainty related to pattern. Phase II will analyse old and mature forest distribution.

Table of Contents

Appendices

Appendix 1: Ecological Background on Landscape Pattern
Appendix 2: Do near-to-natural size distributions of cutblocks create near-to-natural patterns of old forest?

Introduction

Forest management strategies in the Babine Watershed aim to *attain a natural landscape pattern* in order to maintain biodiversity[1]. By creating patches of young forest within a matrix of older forest, harvesting alters the spatial arrangement of both young and old forest habitat (usually, conservation planning focuses on older forest). Historically, harvesting has tended to create a "checkerboard" spatial pattern of harvest units. More recent strategies, implemented within the last decade, model cutblock size on natural disturbance patch size. The merit of these more recent strategies, however, is still quite uncertain.

Two general approaches are typically used in BC to assess the ecological merit of conservation strategies on forested landscapes. The first compares landscape condition to the range of natural conditions (a coarse filter). The second assesses the value of landscape conditions for specific species (a fine filter). This report examines landscape pattern from both of these perspectives. Appendix 1 provides a brief overview, with references, of ecological knowledge in relation to landscape pattern.

This report is divided into five sections. The first section reviews objectives, strategies and uncertainties related to landscape pattern, described in the Babine Watershed Knowledge Base[1]. The second addresses the uncertainty about the relationship between harvesting-induced and natural patterns. The third addresses the uncertainty about species response to habitat pattern. Sections two and three focus on old forest, because it is usually most impacted by forestry. The fourth section comments on uncertainty about the natural disturbance benchmark. The fifth recommends modifications to the knowledge base.

Appendix 1 provides ecological background about landscape pattern. Appendix 2 describes the study upon which the second section of this report is based.

1. Review of Babine knowledge base

Within the overall goal of maintaining biodiversity within the Babine River Watershed, three objectives address the spatial arrangement of mature and old forests (p 4[1])

- Maintain core ecosystems in an ecosystem network
- Maintain connectivity in landscape corridors
- Attain a natural landscape pattern

The first two objectives aim to maintain specified proportions of mature and old forest within an ecosystem network, consisting of core patches, linked together with landscape corridors. They influence the overall pattern of mature and old forest on the landscape

[1] Price K. and D. Daust. 2005. Appendix 2 knowledge base: information used for estimating risk, uncertainty and probability of success. Report to the Babine Watershed Monitoring Trust. http://www.babinetrust.ca/DocumentsBWMT/MonitoringFramework/App2KnowledgeBase.pdf.

and can be considered to contribute to the third objective of attaining a natural landscape pattern.

With regard to the third objective, the knowledge base indicates that risk to landscape pattern increases as the percentage of area in each patch-size class (e.g., 0-40, 40-250, 250-1000, 1000-10000 ha) moves further from natural (Figure 1). It also indicates that, while patch size is an ecologically relevant measurement, uncertainty around the risk curve is high for several reasons:

- different species respond to different scales and interactions among species generate complex response patterns;
- patch size indicators consider only a single age class (area logged in the Kispiox; area near rotation in the Bulkley); this assumption increases uncertainty about patch sizes in older seral stages because initial post-harvest pattern will be modified by natural disturbance and by subsequent harvesting (second rotation);
- different age class definitions (e.g., 0-20yr versus 0-40 yr) lead to different patch sizes;
- the natural benchmark may not be accurate.

The knowledge base considers the first two uncertainties to be most important. In summary, the size distribution of cutblocks is not necessarily a good predictor of the size distribution of mature and old forest and even if mature and old forest pattern is known, the ecological consequences of a given pattern are not clear. These uncertainties are discussed in order below.

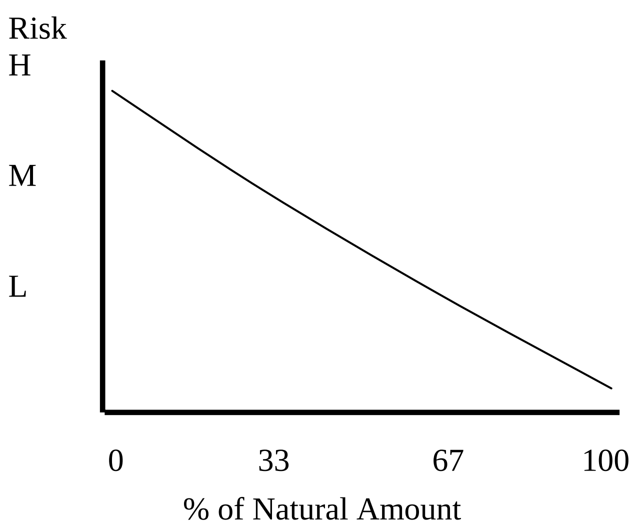

Figure 1 Risk to landscape pattern versus percent in each patch-size class relative to natural amounts (reproduced from Babine knowledge base[1]).

2. Uncertainty about the influence of cutblock pattern on old forest pattern: a comparison with natural pattern[2]

Introduction

The origin of landscape pattern objectives in the Babine Watershed can be traced back to the field of landscape ecology, and in particular, to recommendations found in the Biodiversity Guidebook[3]. Landscape ecology posits that maintaining near-to-natural amounts and patterns of habitat will maintain biodiversity. The Biodiversity Guidebook recommends specific cutblock size and spacing strategies, with the intention of limiting fragmentation of older forest. It does not, however, directly recommend a patch size distribution for mature and old forest. Mature and old seral stages are typically considered most at risk from forestry and thus merit special conservation attention. Do the recommended harvest patterns create near-to-natural patterns of old forest?

A given natural disturbance regime will produce a characteristic, but variable through time, pattern of mature and old forest on the landscape. The Biodiversity Guidebook implies that if cutblock sizes (and leave areas) are based on natural disturbance patch sizes, then the pattern of old forest left by harvesting should be similar to natural. Differences between harvesting and natural disturbance bring this assumption into question. For example, harvesting leaves less mature and old forest than natural disturbance and harvesting selects mature forest while natural disturbance often disregards forest age (thus, natural disturbances overlap and are less restricted in location and size than harvest units). The pattern left by disturbance reflects the interaction of disturbance frequency, size, spacing and intensity.

Methods

To explore the relationship between harvest pattern and old forest pattern, I modified an existing landscape model and conducted a small set of simulation experiments (Appendix 2). I compared "checkerboard" harvesting and "guidebook" harvesting to natural disturbance under different disturbance rate assumptions, over several hundred years. Both the amount of old forest, reflecting disturbance rate, and the type of disturbance influence old forest pattern.

Findings

The total amount of old forest on the landscape—a reflection of disturbance rate—has a large influence on pattern. The model was set to leave either 32% old forest, simulating the historic natural disturbance regime in the SBS, or 11% old forest, simulating guidebook recommendations. Reducing old forest from 32% to 11% greatly reduced the number of large patches (from 48% of patches greater than 1000 ha to 5%), whether disturbance arose from natural agents or from harvesting.

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[2] This section summarises a brief study that I conducted to address an uncertainty identified in the Babine knowledge base. See Appendix 2 for details.
[3] Province of British Columbia. 1995. Biodiversity Guidebook. http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/biodiv/biotoc.htm

Other studies corroborate the important influence of total habitat amount on habitat pattern. They point out that reducing habitat amount leads to smaller patches, more isolated patches or both. Because of an inherent trade-off between patch size and spacing, retaining large patches while reducing habitat abundance leads to increased patch isolation.

Different harvest patterns do not have a large influence on old forest pattern (Figure 5 and 6, Appendix 2). With the amount of old forest held constant (either 32% or 11%), I found that checkerboard and guidebook harvesting were more similar to each other than to natural disturbance; harvesting produced larger patches than natural disturbance. Guidebook harvesting was, however, the most similar to natural.

The lack of difference among the quite different harvesting regimes is somewhat surprising. It may arise because old forest patches reflect the process of surviving disturbance rather than of being disturbed, thus, the actual size of disturbance events may matter less. The crucial difference between natural disturbance and harvesting may be that harvesting only affects old forest while natural disturbance affects many ages.

In the Bulkley portion of the Babine Watershed, the patch size indicator focuses on forest that is nearing rotation age. While I did not specifically examine the patch size distribution of harvested areas nearing rotation age (e.g., 60 to 80 year age class), they should not differ from the original pattern at the time of harvest (e.g., 0 to 20 year age class) because they were not disturbed again until after rotation age, in the model.

In summary, guidebook harvesting strategies, proposed for the Babine Watershed will not produce near-to-natural patterns of old forest for two reasons. First, harvesting (as planned) will leave less old forest than historic natural disturbance and the reduced forest area will alter the pattern. Second, even allowing for reduced old forest area, harvesting produces different patterns than natural disturbance. Allowing that harvesting will produce unnatural patterns, the "most natural" patch size distribution of old forest does arise from guidebook harvesting.

3. Summary of the Nadina landscape strategies study: value for different species[4]

Methods

Doug Steventon and I are using simulation to examine the ecological consequences of harvesting patterns in the Nadina Forest District[5]. We have developed a suite of models to simulate changes in forest cover (beetle disturbance, harvesting and growth) and to assess impacts to different types of wildlife. The context for the analysis includes a large

[4] An ongoing study led by Doug Steventon, MoF Research, entitled *Landscape strategies for mountain pine beetle management: some stewardship implications*.
[5] Doug examined several policies other than harvest pattern that are omitted from this summary.

mountain pine beetle outbreak and accelerated harvest rates for salvage on a 2.6 million hectare landscape.

Harvesting patterns reflect the distribution of harvestable forest (salvageable or mature) and rules determining block size and spacing. The model selects the size of each cutblock randomly from a specified range. Greenup rules prevent harvesting within a specified distance of a new cutblock for a specified period. We simulated typical historic harvest patterns (e.g., uniformly sized 80 ha cutblocks, with 15 to 20 year greenup) and more current practices (e.g., 60 to 3000 ha cutblocks with varying greenup periods) and some intermediate patterns.

The varying habitat preferences and mobility of different species make general conclusions about the ecological value of a landscape difficult to draw. We address this challenge by creating virtual animals that vary widely in their mobility (specifically, territory size and dispersal range) and habitat affinity (i.e., degree of dependence on old forest) and by assessing landscapes from these multiple perspectives. Some of the virtual animals are based approximately on real species (e.g., flying squirrel and marten); others simply ensure that a wide range of affinity and mobility have been considered. In addition to exploring very different "base" territory sizes, we also examine the effect of making small changes in the base territory size ("territory plasticity") without changing the amount of habitat required, essentially varying the energetic efficiency of the animal.

Habitat analysis consists of three steps. First the model determines the habitat value of every hectare on the landscape, based primarily on the age of the live trees and the habitat affinity of the virtual animal. Then it sums habitat values within territory-sized areas (territory size can vary within limits) to determine which portions of the map have sufficient habitat to support territories. Finally, it identifies territories that are close enough to allow dispersal. The number of connected territories provides a rough estimate of the population that can be supported on the landscape. Population estimates for virtual animals of different mobility are re-scaled as proportions of the maximum number of territories possible on the landscape to ease comparison of animals with different mobility. The three steps are repeated for different animals.

Findings

Note that this study is ongoing and these findings are preliminary.

Population estimates for virtual animals increase as the total amount of old forest on the landscape increases. The amount of mature and old forest decreases for several decades in response to beetle disturbance and harvesting.

Over the range of old forest conditions simulated, the spatial arrangement of harvest units does not greatly affect population estimates. A partial explanation for the lack of effect may be that historic harvesting and recent beetle disturbance exert considerable control on harvest pattern, limiting management influence.

Population estimates varied with assumptions about habitat affinity, but for a given degree of affinity, harvest pattern did not greatly affect population estimates. Again, the lack of effect may result from the limited set of landscape patterns that can emerge given historic harvesting and beetle disturbance.

Animals with larger territories and dispersal ranges had smaller populations than animals with smaller spatial requirements. When population size was re-scaled as a proportion of maximum population, population estimates did not vary greatly with base territory size or dispersal range. By implication, the size of the virtual animal (which correlates with territory size and dispersal) does not influence the usefulness of the habitat pattern.

Population estimates did respond to pattern on contrived landscapes (i.e., specified amounts and size distributions of habitat placed randomly). Patch size affected population size. Larger habitat patches (exponential distribution with mean of 10,000 ha) tended to support larger, but less-well-connected populations of energy-limited (i.e., limited ability to expand territory size) virtual animals than did smaller habitat patches (exponential distribution with mean of 100 ha). Animals with a greater ability to expand their territories were not greatly affected by patch size. Irrespective of energetic assumptions, connectivity among territories varied among simulated landscapes, responding to particular arrangements of habitat. Connectivity tended to improve considerably (i.e., a weak threshold) on landscapes with more than 20% habitat.

Overall, although habitat pattern has the potential to influence population size under specific conditions, harvest pattern has a minor effect on population size. No harvest pattern emerges as clearly beneficial. The amount of old forest and life history traits (e.g., habitat affinity and territory plasticity) are much more influential.

4. Comments on uncertainty about natural benchmark[6]

The accuracy of estimated natural disturbance rates and patch size distributions vary by BEC zone (or subzone). Multiple studies lead to improved accuracy. Some zones, such as the SBS, have been studied in several areas and have reasonably accurate estimates.

While management tends to focus on mean patch size distributions, patch sizes vary considerably over time and space; the implications of this variation for conservation planning have not been adequately explored. In particular, variation increases as the size of the area considered decreases. Thus, it may not be appropriate to apply patch size distributions derived from analysis of large landscapes to smaller sub-units such as the Babine Watershed, however, no obvious alternatives exist.

[6] Based on comments from Doug Steventon, MoF Research, Smithers.

5. Recommendations

The premise that near-to-natural harvest size distributions produce near-to-natural patterns of old forest is central to using harvest patch size as an indicator for biodiversity. This premise is not upheld (see section 2) so the harvest patch size indicator should not be used.

The premise that some harvesting patterns create patterns of mature and old forest that are beneficial to a range of species is also central to using harvest patch size as an indicator for biodiversity. This premise is not upheld (see section three) so the harvest patch size indicator should not be used.

An alternative indicator would measure the pattern of each seral stage directly or perhaps just measure the pattern of mature and old forest directly, given their higher conservation focus. Ideally, measurements of pattern should assess patch isolation (and possibly edge) as well as patch size.

Another alternative is to not measure pattern at all, assuming that old forest pattern will be reasonably close to natural if old forest abundance is close to natural. This option simplifies indicator calculation.

Cutblock size targets (and related targets for leave areas) derived from the Biodiversity Guidebook should still be used. Although they create old forest patterns that deviate greatly from natural, they still create a "more natural" old forest patch size distribution than do uniform 80 ha cutblocks or large cutblocks with no leave areas.