Natural Disturbance
& Forest Management

What's Happening and Where It's Going

March 5-7, 2001
Coast Terrace inn, Edmonton, Alberta

Co-sponsored by the Foothills Model Forest and the Sustainable Forest Management Network

SUSTAINABLE FOREST MANAGEMENT NETWORK

RÉSEAU DE GESTION DURABLE DES FORÊTS

foothills model forest
a growing understanding

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ORGANIZING COMMITTEE

- Kris McCleary, Biologist, Bandaloop Landscape-Ecosystem Services
- Dave Andison, Landscape Ecologist, Bandaloop Landscape-Ecosystem Services
- Fiona Ragan, Communications Coordinator, Foothills Model Forest
- Fran Hanington, Administrative Assistant, Foothills Model Forest
- Lisa Risvold, Communications Manager, Foothills Model Forest
- Steve Cumming, Boreal Ecosystems Research Ltd.

Agenda

Natural Disturbance and Forest Management:
What's Happening and Where It's Going

March 5-7, 2001
Coast Terrace Inn, Edmonton Alberta

Monday March 5, 2001

Morning – Natural Disturbance Research I

8:30 – 9:00 a.m. Welcome and opening remarks

9:00 – 9:50 a.m.

Data, assumptions, and objectivity: Fire history research in action
David Andison

Estimation of natural fire patterns from current landscape structures
Chao Li

9:50 – 10:20 a.m. Break

10:20 – 12:00 p.m.

Spatial ecology of fire in the boreal mixedwood
Steve Cumming

Spatial and temporal patterns of natural and human-caused forest disturbance on the J.D. Irving Ltd. Black Brook District: Past, present and future
David MacLean, A. Smith, J. Higdon, I. Methven, B. Wagner, J. Hagan, K. Porter and M. Reed

Variability in fire regimes in the boreal forest of Easter Canada: Implications for forest management
Sylvie Gauthier, Alain Leduc, Yves Bergeron, and Brian Harvey

Implications of climate change on forest fire potential in Western Canada
Mike Flannigan, K. Hirsch, V. Kafka, and M. Parisien

12:00 – 1:00 p.m. Lunch served in the Imperial Ballroom

Agenda continued

Monday March 5, 2001

Afternoon – Natural Disturbance Research II

1:00 – 2:15 p.m.

Signatures of sustainability: A multiscape landscape approach to assessing habitat suitability
Rob Rempel

Soils in natural disturbance and forest management: Are we out of the rut yet?
Ken Van Rees

What we know about fire in riparian zones – so far
Kris McCleary and David Andison

2:15 – 2:45 p.m. Break

2:45 – 4:00 p.m.

Riparian buffer zones: Small and large disturbance paradigms
Phil Lee and Cheryl Smith

Is the natural disturbance paradigm appropriate for white spruce regeneration in boreal mixedwoods?
Clive Welham and Brad Seely

The reality of creating "natural" disturbance events
David Andison

4:00 – 7:00 p.m. Social, poster sessions and evening slide show

6:15 p.m.

Fire in Alberta – a look back
Peter Murphy

Agenda continued

Tuesday March 6, 2001

Morning – Natural Disturbance Research III

8:35 – 9:50 a.m.

Interactions between fire and insects: Management applications
Brad Hawkes

A natural disturbance model based on Mountain Pine Beetle hazard in Alberta
Sunil Ranasighe, Hideji Ono and Mike Underschultz

Wood supply and fire regimes
Tory Stevens

9:50 – 10:20 a.m. Break

10:20 – 12:00 p.m.

Towards a landscape fire dynamics model
Kerry Anderson

Succession of plant communities following combined treatments of fire and harvesting
Susan Crites and Stephan Hanus

Post disturbance stand dynamics: Falldown of residual trees and snags following harvest and wildfire disturbances
Stephan Hanus, Susan Crites, and Shawn Wasel

Salvage logging: Does removal of post-fire timber results in the loss of a cavity nesting bird community?
David Stepnisky and Fiona Schmiegelow

12:00 – 1:00 p.m. Lunch served in the Imperial Ballroom

Agenda continued

Tuesday March 6, 2001

Afternoon – Interpretations and Linkages I

1:00 – 2:15 p.m.

Determining a workable signal from historic variability: Can we define forest management targets from natural disturbance regime?
Alain Leduc, Sylvie Gauthier, Yves Bergeron and Brian Harvey

Incorporating unplanned disturbances into forest management planning
Glen Armstrong

Examining assumptions about unsalvaged losses in timber supply analysis
Marvin Eng, Andrew Fall, and Glenn Sutherland

2:15 – 2:45 p.m. Break

2:45 – 4:00 p.m.

Fire harvesting and the natural range of variability in the distribution of forest birds
Steve Cumming, Fiona Schmiegelow and Pierre Vernier

Biodiversity assessment of forest management strategies in West-Central Alberta: The use of NDR for orienting choices
Frederic Doyon

Developing and testing wildfire based landscape design and cut-block operating guidelines in eastern Manitoba
James Ehnes

Agenda continued

Wednesday March 7, 2001

Morning – Interpretations and Linkages II

8:35 – 9:50 a.m.

Biodiversity conservation: Application of natural disturbance knowledge
Hugh Lougheed

Ecosystem management at low cost: Using nature's template to best advantage
Craig DeLong

Implementing the natural disturbance paradigm: The Alberta-Pacific experience
Tony Gaboury and Simon Dyer

9:50 – 10:20 a.m. Break

10:20 – 12:00 p.m.

From theory to practice: The implementation of the natural disturbance model in Weyerhaeuser Forest Management Areas in Alberta
Luigi Morgantini

Developing a forest management strategy based on natural disturbance dynamics for Northern Abitibi
Thuy Nguyen-Xuan, Yves Bergeron and Alain Leduc

Applying results of Foothills Model Forest natural disturbance research to vegetation management in Jasper National Park
Al Westhaver

Incorporating natural disturbance in a forest management framework
Carmen Wong and Dave Conly

12:00 – 1:00 p.m. Lunch served in the Imperial Ballroom

Agenda continued

Wednesday March 7, 2001

Afternoon – Vision

1:00 – 2:15 p.m.

The importance of communication and education in sustainable forest management research
Lisa Risvold

Using a natural pattern foundation for biodiversity monitoring in Saskatchewan
Dwayne Dye and David Andison

Smoke and Mirrors? A critical review of the use of fire history paradigms in forest management
Andre Arsenault and Walt Klenner

2:15 – 2:45 p.m. Break

2:45 – 4:00 p.m.

TBA
Hamish Kimmis

What are the critical issues of natural disturbance emulation?
Bob Udell

Integrating NRV into policy and planning in Alberta
Dennis Quintilio

Abstracts

Oral Presentations

1. Data, assumptions, and objectivity: Fire history research in action
   David Andison

2. Estimation of natural fire patterns from current landscape structures
   Chao Li

3. Spatial ecology of fire in the boreal mixedwood
   Steve Cumming

4. Spatial and temporal patterns of natural and human-caused forest disturbance on the J.D. Irving Ltd. Black Brook District: Past, present and future
   David MacLean, A. Smith, J. Higdon, I. Methven, B. Wagner, J. Hagan, K. Porter, and M. Reed

5. Variability in fire regimes in the boreal forest of Eastern Canada: Implications for forest management
   Sylvie Gauthier, Alain Leduc, Yves Bergeron, and Brian Harvey

6. Implications of climate change on forest fire potential in Western Canada
   Mike Flannigan, K. Hirsch, V. Kafka, and M. Parisien

7. Signatures of sustainability: A multiscale landscape approach to assessing habitat suitability
   Rob Rempel

8. Soils in natural disturbance and forest management: Are we out of the rut yet?
   Ken Van Rees

9. What we know about fire in riparian zones – so far
   Kris McCleary and David Andison

10. Riparian buffer zones: Small and large disturbance paradigms
    Phil Lee and Cheryl Smith

11. Is the natural disturbance paradigm appropriate for white spruce regeneration in boreal mixedwoods
    Clive Welham and Brad Seely

12. The reality of creating “natural” disturbance events
    David Andison

13. Fire in Alberta – a look back
    Peter Murphy

14. Interactions between fire and insects: Management implications
    Brad Hawkes

15. A natural disturbance model based on Mountain Pine Beetle hazard in Alberta
    Sunil Ranasinghe, Hideji Ono, and Mike Undershultz

16. Wood supply and fire regimes
    Tory Stevens

17. Towards a landscape fire dynamics model
    Kerry Anderson

18. Succession of plant communities following combined treatments of fire and harvesting
    Susan Crites and Stephen Hanus

19. Post disturbance stand dynamics: Falldown of residual trees and snags following harvest and wildfire disturbances
    Stephen Hanus, Susan Crites, and Shawn Wasel

20. Salvage logging: Does removal of post-fire timber result in the loss of a cavity nesting bird community?
    David Stepnisky and Fiona Schmiegelow

21. Determining a workable signal from historic variability: Can we define forest management targets from a natural disturbance regime?
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22. Incorporating unplanned disturbances into forest management planning
    Glen Armstrong

23. Examining assumptions about unsalvaged losses in timber supply analysis
    Marvin Eng, Andrew Fall, and Glenn Sutherland

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34. The importance of communication and education in sustainable forest management research
    Lisa Risvold

35. Using a natural pattern foundation for biodiversity monitoring in Saskatchewan
    Dwayne Dye and David Andison

36. Smoke and Mirrors? A critical review of the use of fire history paradigms in forest management
    Andre Arsenault and Walt Klenner

37. NVR and other paradigms for a "new forestry"; the role of ecologically-based decision support tools
    Hamish Kimmins

38. What are the critical issues of natural disturbance emulation?
    Bob Udell

39. Integrating NRV into policy and planning in Alberta
    Dennis Quintilio

Data, assumptions, and objectivity: Fire history research in action

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Abstract

Studying and quantifying historical fire history patterns is challenging on many different levels. Describing even the simplest measurements such as fire frequency, sizes, and shapes are confounded by fire control, cultural disturbance, and inadequate data sources. The application of many metrics largely assume that fire is always stand-replacing, climate is stable, and Aboriginal People's use of fire is minimal and quantifiable, none of which is necessarily true. Furthermore, a single landscape "snapshot" is only a sample size of one, from which the extraction of the al range of variation" is problematic. Data quality and quantity become even more critical for studying fire history patterns at finer scales, where detailed vegetation and terrain layers are as important as precise age data. Lastly, as we delve deeper into the complexity of fire regime patterns, we are quickly learning that the main difficulty lies not in answering questions, but rather knowing which questions to ask, can be asked, and how. In response to these challenges, a number of innovative methodologies are being employed, data gathering requirements are being re-evaluated, and research strategies are becoming increasingly integrated and more responsive to practical needs. However, science cannot eliminate these issues, it can only find ways of dealing with them or minimizing their impacts. Therefore, a better understanding of these challenges and the diversity of solutions can only help make natural pattern research more efficient. For those thinking about venturing into the fire pattern research arena, you should have realistic expectations of what your money will buy, and how long the work will take. For those already involved, you should have realistic expectations of what questions your baseline data will allow you to answer and with what level of confidence.

Estimation of natural fire patterns from current landscape structures

Chao Li, Research Scientist, Northern Forestry Centre, Canadian Forest Service, 5320 - 122 Street, Edmonton, Alberta Tel: 780-435-7240 E-mail: cli@nrcan.gc.ca

Abstract

To implement the idea of emulating natural fire regimes in harvest planning, forest managers need to know the natural fire size distributions and their spatial and temporal patterns, in order to decide the sizes of cutting patches over space and time. However, this information is not always available in most managed forest areas. In this presentation, a methodology of reconstructing natural fire regimes through ecological modeling, based on current forest landscape structure, shall be briefly presented. This methodology was based on the premise that a fire regime was the result of interactions among fire events, landscape structures, topography, weather, and fuels. The implication of this methodology in sustainable forest management shall also be discussed.

Spatial ecology of fire in the boreal mixedwood

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Abstract

Fires in the boreal mixedwood forest are not entirely random events: fires are more likely to start in some places than in others, and having started, are more likely to spread into certain areas than others. A statistical analysis of spatial patterns in detected lightning fires show that fires rarely start in deciduous stands, but do start in conifer-dominated stands, most frequently of all in white spruce stands. An analysis of mapped forest fires overlaid on forest inventory show that fires spread preferentially, avoiding aspen stands, and seeking out conifer, especially black spruce, but also white spruce. Some consequences of these results are:

1) as deciduous stands succeed to white spruce, their probability of burning increases dramatically,
2) the hazard of burning, or fire return interval, depends strongly on spatial context, and
3) by manipulating the distribution, abundance, and density of white spruce, forest management can influence fire hazard.

I will briefly discuss how these results are incorporated into spatial dynamic models of the mixedwood region (e.g. Feenix), and illustrate their application with some simulated fire-hazard maps.

Spatial and temporal patterns of natural and human-caused forest disturbance on the J.D. Irving Ltd. Black Brook District: Past, present and future

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M. Reed, Assistant Professor Conservation Biology, Department of Biology, Tufts University, Medford, Maryland 02155

Abstract

The 190,000 ha J.D. Irving Ltd. Black Brook District in NB represents some of the most intensively managed forest lands in Canada. Tools are being developed to facilitate managing for biodiversity and timber management, based on a coarse-filter approach, using Black Brook as a case study. The natural distribution of vegetation types by ecodistrict is being used to set objectives for minimum areas to be maintained, and natural disturbance regimes for each vegetation community (in terms of disturbance agent, cycle length, and resulting stand and forest characteristics) are being used to define guidelines for stand- and forest-level treatments that are consistent with natural stand structures and disturbance regimes. Methods and scenario planning tools are being developed to quantitatively analyze forest landscape patterns under managed and natural disturbance conditions. A "pre-management" covertype inventory has been established using photointerpretation and digitizing of 1948 aerial photographs for the entire landbase. Modelling is being used to project the current and simulated potential forests under alternative scenarios; analyze management and disturbance effects on species composition, patch size, and age class distributions; and compare temporal and size distributions of past and future (based on management plan) harvesting and silviculture with those potentially created by natural disturbances. Actual and projected landscapes will be assessed for the risk of extirpation of each vertebrate species, using a species sorting algorithm and spatially explicit landscape data. The NB landbase will be used as a case study to develop tools and procedures that can be broadly applied to sustainable forest management in Canada.

Variability in fire regimes in the boreal forest of Eastern Canada : Implications for forest management

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Abstract

Forest management is often considered as a disturbance having effects similar to those of natural disturbances. Although this analogy has some merit, it is important to recognize that it has limitations. In this presentation, we will discuss results on the variability of fire regimes (cycle, size, spatial patterns, severity and intensity) among ecoregions and its effect on stand dynamics in Quebec's boreal forest. Short fire cycles generally described for boreal ecosystems do not appear to be universal; rather, important spatio-temporal variations have been observed in Eastern Canada. Moreover, different regions with the same fire cycle have shown variations in mean and maximum fire sizes. These variations (fire cycles and fire sizes) imply important differences in forest composition and structure, together with spatial patterns, at the landscape and regional levels. The current forest management approach tends to reduce the variability as compared to the natural variability imposed by fire regimes. For instance, regular forest rotations truncate the natural forest stand age distribution and eliminate over-mature and old-growth forests from the landscape. Also, the severity and intensity of a single fire event is more variable than the disturbance usually caused by current forestry practices. We suggest that the development of silvicultural techniques that maintain a spectrum of forest compositions and structures over the landscape is one avenue to address this complexity, to maintain the variability and to minimize the risk of loss in biodiversity.

Implications of climate change on forest fire potential in Western Canada

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Abstract

The earth's climate is warming and this will directly influence the fire regime. Using General Circulation Models (GCMs) and a Regional Climate Model (RCMs) future fire weather severity is modelled for western Canada. On a more regional basis, we also assess the variations in fire behavior potential (or landscape flammability) associated with the predicted climate change. Ratios of present day seasonal severity rating (SSR) over 2xCO2 SSR were calculated for western Canada. The results suggest that the SSR will increase significantly over large portions of western Canada by the middle of the next century. Preliminary results suggest an increase in area burned, fire severity and the length of the fire season. The analysis of fire behaviour potential indicates similar results but emphasizes the extent and the spatial variation of the impact of simulated 2xCO2 and 3xCO2 climate conditions. Increased fire activity could have major implications for land managers; adaptation strategies to minimize the socio-economic impact of wildfire will be discussed.

Signatures of sustainability – A multiscale landscape approach to assessing habitat suitability

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Abstract

Forest management operations change the pattern of forested landscapes from the natural condition. The extent to which they change landscape pattern is determined by the policies and guidelines under which the logging companies operate. Rules governing harvesting systems (e.g., clearcuts, shelterwood, variable retention), clearcut size and shape (e.g., dispersed block, progressive clearcut), and green-up delay all contribute to a resulting landscape pattern that is more or less similar to natural landscapes created through natural processes (e.g., wildfire, insect outbreaks, gap-phase succession). In Ontario, the Timber Management Guidelines for the Provision of Moose Habitat specify many of these legally binding requirements. The Moose Habitat guidelines were developed under the featured species policy, with the assumption that creating good moose habitat will ensure good habitat for about 75% of the endemic forest vertebrates.

Recently, forest ecologists have argued that the least risky strategy to maintaining endemic biodiversity is to maintain, to a degree that is economically feasible, natural patterns on the landscape. They argue that the entire suite of endemic plants and animals have adapted to these patterns, and therefore the maintenance of natural patterns will have less impact than the creation of artificial patterns. To this end, the province of Ontario is introducing new Fire Simulation Guidelines that will in large part supplant the Moose Habitat Guidelines.

The design of natural landscapes, however, is complex. Virtually all the current policies relating to landscape scale focus on a single scale, the clear cut. Rules define the extent of a clearcut based on the proximity of openings, and from there, define the allowable size, and size distribution of clearcuts. But natural landscapes are hierarchical in structure, with patterns occurring at two or more scales. To faithfully simulate natural disturbance, landscape design rules must incorporate multiscale, spatially explicit guidance, and must be accompanied by similar tools for assessing compliance. The range or tolerance of landscape design compliance then becomes an indicator of overall habitat quality.

In my talk I will present a new approach to assessing landscape design, and our work to define quantitative, spatially explicit models of natural landscape pattern, which I call “landscape signatures”. I argue that these signatures are indicators of habitat sustainability.

Soils in natural disturbance and forest management: Are we out of the rut yet?

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Abstract

Generally those dealing with forest ecosystems ignore the ground that they grow on. Maybe the ignorance is a result of our poor understanding of the processes that occur belowground or the lack of training and education in this area. But soils are important - what happens to them either through natural disturbance processes or from forest management activities can have implications for future ecosystems. In Saskatchewan we are developing a program to monitor forest management effects on forest health and one issue is that of soils. The framework is grounded on using the natural range of variability as one means of determining the kinds of impacts. Is there a way to look at disturbances at a landscape scale to understand the impacts on soil properties? This talk will present a broad overview of soils and some work looking at soil disturbance from management activities and how they might be related to natural disturbance regimes.

What we know about fire in riparian zones – so far

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Abstract

Riparian forests receive special attention in planning and management exercises. Generally, these zones are protected completely or partially from harvesting or other activities based on the assumption that disturbance activities are ecologically harmful. Several authors have noted that the frequency and intensity of wildfire events is lower in riparian zones. However, there is no empirical evidence to suggest that these areas have different disturbance regimes or are differentially affected by disturbance within the Foothills Model Forest. We studied age structure in riparian corridors near Hinton, Alberta in the Upper and Lower Foothills Natural Subregions. We sampled tree ages through cross sections of streams using transects that ran from the upland, through the riparian area and back into the upland. We found that fire burned through the riparian area in 80 % of transects. Fire tended to cross small streams (orders 1 to 3) and streams surrounded by flat topography. When fire did burn through a riparian area, it tended to leave more veterans than in the adjacent upland forest. Our research suggests that the disturbance behaviour in riparian zones is different from behaviour in the adjacent upland and that cultural disturbances in riparian areas should be managed with these differences in mind.

Riparian buffer zones: Small and large scale disturbance paradigms

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Cheryl Smyth, 1422 Sutherland Avenue, North Vancouver, British Columbia, Tel: 604-904-8854 E-mail: cheryl.smyth@home.com

Abstract

In Alberta, the current operating ground rules for forested riparian buffer widths are under review. This talk compares the development and results of two different management philosophies. In most North American jurisdictions, riparian management is based on no or restricted harvest buffer strips. This type of management uses a protection-through-preservation mandate for riparian areas. An examination of the ecological literature indicates that no single buffer width will preserve all ecological functions associated with the riparian areas (except very large widths). Riparian structure, function, and biota are distributed on a probability function with declining impact on riparian areas with increasing distance from streamside. Based on this model, best management practices feature small scale disturbances featuring; variable buffer widths (within block) with a declining intensity of harvest to streamside. An alternative basis for riparian management is the use of a large scale disturbance-succession paradigm. This management philosophy potentially extends the dynamic conditions created by timber harvest in upland areas to riparian areas. Based on a case study of the Notikewin watershed, this would lead to significant amounts of streamside harvest and higher amounts of green tree retention on upland blocks.

Can harvesting be considered an adequate surrogate for fire driven disturbance? Comparison of different harvesting methods using the ecosystem simulation model, FORECAST

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Abstract

The effect of harvesting versus fire on the long-term productivity of forest ecosystems is poorly understood. In the case of natural burns, numerous snags and variable amounts of organic material are often retained and these can serve as a source of nutrient capital for the subsequent stand. Certain types of harvesting, in contrast, usually remove a majority of the aboveground biomass (the future nutrient capital) suggesting that long-term productivity could be depressed. We use the ecosystem simulation model, FORECAST, to explore the consequences of different harvesting systems on stand productivity. Our principal objective is to determine the extent to which harvesting can be used to emulate the disturbance effects created by wildfire. Patterns of natural and harvest disturbance are compared with respect to future stand growth, the retention of coarse woody debris and non-tree species, and their role in nutrient dynamics and total site nutrient capital.

The reality of creating “natural” disturbance events

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Abstract

One of the simplest “patterns” to understand, measure, and integrate into planning is disturbance size. Or is it? Fire history records and maps provide ample evidence that, historically, most fires are very small, but a small number of very large fires are responsible for most of the area disturbed. Closer examination of historical disturbance events reveals that they rarely consist of a single “patch”, but rather a cluster of individual patches of a range of sizes. Further analysis demonstrates that there is a fair to strong relationship between the size and location of these patches, and the pattern of fuel-type on the landscape. For instance, forest fires are sensitive to the amount and spatial arrangement of non-forested areas. Overall then, although disturbance events of a wide range of sizes may be possible anywhere on a given landscape, the same is not necessarily true of disturbance patches – they are largely responding to landscape context. The integration of the concepts of events and patches into forest management create even more restrictions. For example, by confining our disturbance activity to merchantable areas of forest older than some economically-feasible rotation age, our options for creating a range of patch and event sizes diminish considerably. When we add in the social factors limiting patch and event sizes, and specific concerns over special areas such as riparian zones, there is often little room left for debate. These restrictions will be demonstrated using a landscape disturbance simulation model, and their incremental impacts on common landscape metrics tracked relative to “natural” landscape patterns. Alternatives for expanding our options will also be explored and assessed.

Interaction of fire and insects - Management implications

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Abstract

Fires in the western United States last year ignited something of a culture war. Loggers blamed insufficient logging as a cause while environmentalists accused loggers of wanting to destroy the forest in order to save it. Stand structure and species changes are occurring in many of our dry forests, as well as tree encroachment in grassland areas. One debate that is occurring is what combination of factors such as climate change, attempted exclusion of fire, grazing, and past logging practices have lead to tree species composition shifts, denser forests, and loss of grasslands. Another debate is whether current fire and insect problems are related to these factors, with special emphasis on attempted fire exclusion.

Some of the key questions managers would like to have answered in regard to fire and insect interactions are:

1) Are current major outbreaks of insects outside the natural range of variability? Has climate change, attempted fire exclusion (effects on current age class distribution, stand structure, and landscape spatial characteristics), and human disturbances like grazing and logging contributed to these outbreaks?
2) What is the probability of climatic conditions to promote major insect outbreaks occurring at a time when there are large contiguous areas of susceptible hosts in different natural fire regimes?
3) Is there an increase in lightning fire occurrence, size, and intensity after extensive insect induced tree mortality and if so, over what time period does this exist?
4) Can landscape prescribed burning provide direct and indirect control of insect populations in protected areas?

A review of existing knowledge on fire and insect interactions is presented.

There is a lack of understanding of the potential interaction of fire and insect disturbances and their relation to the past, current, and future state of the forest. The current concept of natural variability could be useful to determine how natural variability, desired future conditions, and current conditions line up. If they don't then more specific discussions could take place among the forest and fire managers, the public, and the government. Natural variability would also be useful in examining if current fire and insect problems are out of their natural range. We have made good progress documenting and understanding the natural role of fire but have made less progress with insects. It seems we are only starting to link the spatial/temporal modelling of fire and insects.

A combination of susceptible host and favourable weather for insect population growth usually results in an outbreak. Prior to logging and fire suppression, the percentage of the landscape in different age classes and species composition varied along with climatic conditions for insect

development such that the susceptible host and good weather conditions for insect development did not always coincide. There is currently a large mountain pine beetle outbreak in British Columbia and previously there was another in the 1980's. The province has vast areas of lodgepole pine susceptible to mountain pine beetle due mainly to attempted fire exclusion and the lack of logging of this tree species prior to the 1970's.

Regardless of the actual factors driving changes in the forest, the forest has changed. An example is a study conducted by Steve Taylor (CFS, Pacific Forestry Centre, Victoria) that documented actual changes in southern B.C. dry forests from 1952 to 1992 and then projected future changes using the Forest Vegetation Simulator. The more dense forest stands have a high proportion of the stems composed of smaller diameter Douglas-fir. The fire behaviour implications of this change is an increase from 7% to 14% of the normal fire season having crown fires with a forty year projection of 29% of the season. The impact on potential insect outbreaks in these dry forests has not been fully assessed but forest managers are dealing with frequent outbreaks of western spruce budworm and Douglas-fir tussock moths.

Fuel changes following insect outbreaks have not commonly been quantified, nor have experimental fire studies to quantify changes in fire behaviour been conducted. The Canadian Forest Service at Great Lakes Forestry Centre did some experimental fires in spruce budworm killed stands and found explosive fire behaviour prior to green up of the understorey vegetation. The influence of insect driven changes in the forest fuel complex on fire incidence has not been investigated widely. A recent study in Ontario by the Canadian Forest Service at Great Lakes Forestry Centre and the Ontario Ministry of Natural Resources has shown an increase in fire incidence a short time after spruce budworm attack.

Landscape prescribed burning has been attempted in Tweedsmuir provincial park in B.C. to control the spread of mountain pine beetle. A high fire intensity is required to kill the beetle under the bark. The burn prescription to achieve the required fire intensity prior to beetle flight occurs primarily in the late spring to early summer period. Burning during this period using a high intensity fire poses a number of challenges including a higher risk of escape, more complete fire control measures needed to limit further fire spread later in the summer and fall, and potential lack of fire management personnel and equipment to conduct the prescribed burn because of other wildfire problems in the province due to the dry and windy weather conditions needed to produce a high fire intensity.

Management implications of this information are discussed. Forest, fire, range, and park managers need to work together, along with the public to find some solutions to the current and future fire and insect problems within the context of the resource management objectives set for different parts of the landscape.

A natural disturbance model based on Mountain Pine Beetle hazard in Alberta

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Abstract

Mountain pine beetle is the most destructive agent of lodgepole pine in western North America. Many mountain pine beetle risk-rating models are based on stand conditions, climate and resident mountain pine beetle populations. In Alberta, mountain pine beetle population are normally nil to extremely low, and infestations are always a result of major infestations in adjacent areas in B.C. or Montana. Mountain pine beetle outbreaks in Alberta, therefore, appear to be predominantly driven by beetle population levels in the adjacent areas, and the climatic factors (notably the minimum winter temperature) rather than biological factors. The current Alberta mountain beetle model is based on the Shore and Safranyik model (1992). This model uses Alberta Vegetation Inventory data, and climatic conditions to rate present or future stand susceptibility to the mountain pine beetle, and the presence of beetles to project beetle hazard rating in a given forest stand. This model, once validated, will provide a useful tool for the forest managers who are interested in beetle-proofing their management units.

Using a timber supply model to predict risk to biodiversity

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Abstract

Timber supply modelling is required to support determination of allowable annual cut (AAC) in every management unit across British Columbia, a process known as the Timber Supply Review (TSR). Until now, the TSR has focused on analyses of timber supply and socio-economic impacts. The BC Ministry Of Environment, Lands & Parks recently undertook to develop methods for analyzing environmental risk in the TSR. An efficient way to model risk to environmental values in TSR is to use the timber supply analysis output to make forecasts for values such as biodiversity. One indicator of biodiversity is seral stage distribution. The measure of risk is the extent to which the area of old forest in an ecological unit varies from the historic natural condition. This approach is based on the assumption that the more managed forests resemble forests that were established after natural disturbances, the greater the probability that biodiversity will be maintained. The methods were developed for the TSR in the Robson Valley Timber Supply Area. Variables used to predict risk to biodiversity were:

a) percent of the management unit that was not available for harvesting,
b) historic range of natural disturbance intervals,
c) the age at which a forest is defined as old forest, and
d) average harvest age.

The analysis showed that current practices were most compatible with historic natural disturbance intervals in one of the ecological units in the Robson Valley Timber Supply Area, but as the mean natural disturbance interval increased current practices were progressively less compatible. It is recommended that more than one indicator be analysed to assess risk to biodiversity. Other indicators that are available and can be forecast using the data available in TSR timber supply analyses are: area in an early seral condition, species composition, and representation of remaining older forests. For each of these factors relative risk is based on comparison with the historic range. By applying this approach to each timber supply analysis a more appropriate understanding of environmental uncertainty can be reached. This can focus attention on relevant research, inventory and policy changes needed in advance of the next AAC determination.

Towards a landscape fire dynamics model

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Abstract

A landscape fire dynamics model is currently being developed at the Northern Forestry Centre. This model emphasizes current knowledge fire research within the Canadian Forest Service in fire occurrence, growth and effects modelling. The fire effects model BORFIRE simulates fire, biomass and tree dynamics at a stand scale. This model will be expanded into a spatial context and incorporate the impact of biophysical parameters on the dynamics. In turn, this model will be combined with Anderson's fire growth and fire occurrence models to produce a spatial landscape fire dynamics/succession model.

Succession of plant communities following combined treatments of fire and harvesting

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Abstract

The natural disturbance model assumes biota have adapted to disturbances such as fire, and will likely be maintained if harvesting practices approximate fire. However, it has been demonstrated that plant communities post-fire and post-harvest remain different at least 60 years into succession, thereby confounding the natural disturbance model.

Because standing dead wood is considered an economic loss to the forest industry, it has become provincial policy to salvage log merchantable burned wood within mapped fire boundaries. The effects of this additive disturbance on the plant community have gone undocumented.

To address these two issues, we examined young (2 years) and old (20 years) stands in each of two treatments: harvested stands that were burned by wildfire (cut/burns), and burned stands that were salvage logged (salvaged). Herbaceous and shrub communities were sampled in nine stands in north-central Alberta. Ordination results indicate 20-year-old plant communities from cut/burns differ from plant communities that were salvage logged. When compared to stands that were burned and harvested individually, plant communities from both treatments (salvage and cut/burns) fell within the successional post-fire trajectory and remain different from the successional post-harvest trajectory. These results provide managers with insight into prescribed burning of cutblocks as a management tool to aid in survival of fire-adapted plant species.

Post disturbance stand dynamics: Falldown of residual trees and snags following harvest and wildfire disturbances

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Abstract

Ecosystem-based forest management is becoming more prevalent within Alberta, where natural disturbances, such as wildfire, are being used as a model for harvesting. As an example, some forest companies retain standing residual trees and snags within harvested stands, thereby maintaining some of the structural diversity normally found after wildfire. However, little is known about the fate of residuals in harvested stands, and how their fate compares to residuals in wildfire-disturbed stands. As a result, the ecological and economic impacts of this practice are difficult to determine. We addressed these concerns by developing a long-term study that monitors residual trees and snags within mixedwood stands of the boreal forest, following three disturbance types: structured cutblocks, high intensity burn, and low intensity burn. Our primary objective was to determine falldown rates of residual material and also to determine what factors (i.e. disturbance type, species, wind, and bole diameter) affect falldown rates. This report outlines results from the initial six years following disturbance, a period when the risk of residual falldown may be greatest. Our results indicate that overall falldown rates were not significantly different between structured cutblock (17%) and low intensity burn (19%) stands; however, both were significantly higher than the high intensity burn (12%) stands. Wind and tree morphology strongly influenced residual falldown. Results from this study suggested that structural variability within harvested stands was maintained over the short-term. Long-term trends could not be determined from this study. However, our results provide managers with information needed to effectively plan residual material retention techniques, and increase the likelihood of meeting their long-term management goals.

Keywords:
Boreal mixedwood forest; Falldown; Harvest disturbance; *Picea glauca*; *Populus tremuloides*; Residual trees and snags; Stand structure; Wildfire disturbance

Salvage logging: Does removal of post-fire timber result in the loss of a cavity nesting bird community?

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Abstract

Wildfire is widely regarded as the dominant natural disturbance within boreal forests. Recently burned forests provide critical habitat for post-fire specialist species, and therefore contribute significantly to biodiversity within the boreal forest. However, salvage logging policies in Alberta have failed to address these issues, by encouraging harvest of all merchantable timber within burns. We studied the effects of post-fire salvage logging on bark and wood boring beetles and cavity nesting birds, by establishing 21 research plots in the 1998 Chip Lake Burn (located in the Weyerhaeuser Edson F.M.A.). We found a greater number of woodpeckers and bark/boring beetles in the burned/unharvested forests when compared to burned/harvested forests and unburned/unharvested forests. Our research suggests that the maintenance of standing timber in post-fire forests is critical for several species of cavity nesting birds (specifically *Picoides* woodpeckers) and the bark/boring beetles they feed upon. If provincial policy continues to encourage fire suppression and salvage logging, loss of post-fire forest on the landscape could result. We suggest that policies should consider the importance of maintaining post-fire forests on the landscape, complementary to the governments present philosophy of maintaining biodiversity on the landscape.

Determining a workable signal from historic variability: Can we define forest management targets from natural disturbance regime?

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Abstract

Forest management that is focussed uniquely on sustained fibre yield inevitably results in a simplification of natural forest conditions. Compared to natural disturbance regimes, conventional forest management regimes usually generate narrower ranges in rotation age (or harvest interval), in size of regeneration blocks and in disturbance severity. This situation can even lead to forest conditions that are outside of their reference (historical) variability. In response to what would appear as a threat to forest ecosystem integrity, ecosystem management proposes the use of natural disturbance regimes as a template for defining management targets in order to determine desired future forest conditions within their reference variability. Quantification of variability of disturbance regimes is largely dependent on the temporal and spatial frames of reference retained to characterize them. There are probably few research fields in which time and spatial scales interact as much, with the effect of hiding clear signals or patterns in historic variability. This presentation provides examples of how time period and resolution and spatial extent interact in the characterization of variability of natural disturbance regimes.

The rate of natural disturbance: Implications for forest management and sustainability

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Abstract

The annual area burned by wildfire in the boreal mixedwood forest section is highly variable. In the period 1961-1995, there were many years where a relatively small proportion of the forest burned, and a few years (notably 1980, 1981, 1982, and 1995) that could be characterized as being "extreme" fire years. A statistical characterization of variability in annual area burned has developed and incorporated in a number of different Monte Carlo simulation models exploring different aspects of the relationship between forest management and natural disturbance.

The major findings of these studies are:

1) in a highly variable disturbance regime such as that observed in the study area, precise quantifications of the true "average" annual rate of disturbance cannot be developed,
2) there is no equilibrium age class structure for a forest subject to this disturbance regime, and
3) sustainability of any given level of timber production cannot be treated as a certainty under this disturbance regime: In this system, it is better to think in terms of the probability that a particular level of timber production will be sustainable at a particular point in time.

Examining assumptions about unsalvaged losses in timber supply analysis

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Abstract

In British Columbia, natural disturbances are incorporated in timber supply analyses by estimating the volume of timber killed or damaged by natural causes (e.g. fire, wind, insects and disease) that is not harvested. This volume, known as unsalvaged loss, is estimated on an annual basis from the historical occurrence of natural disturbances in each management unit. Unsalvaged losses are then subtracted from the timber supply forecast before it is reported. We used a landscape simulation model that incorporates natural disturbances as stochastic events to examine the implications of the "unsalvaged loss" method of incorporating natural disturbances in the Robson Valley Timber Supply Area in east central BC. We found that the "unsalvaged loss" method implies some counter-intuitive consequences for both timber supply and natural disturbances. These implications relate to projections of the average susceptibility of the landscape to natural disturbances, the area affected by natural disturbances over time, and the level of the long run sustained yield. We also developed a spatially explicit model of natural disturbances and forest management in which the volume of timber affected by natural disturbances and the volume that is salvaged is an output of the model rather than an input produced by a separate calculation. We compare these two methods of estimating "unsalvaged losses".

Fire, harvesting, and the natural range of variability in the distribution of forest birds

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Abstract

One criterion for evaluating forest management practices is their effect on populations of forest dwelling species. To be meaningful, these effects must be measured in relation to the natural variability of the indicators. Here, we describe the use of FEENIX, an empirically based simulation model of boreal mixedwood dynamics, to quantify the range of natural variability of the distribution and abundance of a suite of forest songbirds on a 300,000 ha study landscape. Natural dynamics are simulated by a stochastic model of fire arrival and spread, parameterized to simulate the pre-suppression fire regime, and by a spatially explicit model of aspen and white spruce stand dynamics. We use Poisson regression models to predict the patch-level abundance of some 20 species of forest birds. The models were developed from 7 years of point count data collected near Calling Lake, Alberta. Using simple patch metrics, we track the amount and configuration of patches of good habitat for each species, as well as mean predicted abundances. The natural range of variability for these indicators was estimated from 100 simulation trials. We then generated similar indicators for a managed forest under current AAC without fire, and under a reduced AAC but with fire rates characteristic of the 1990s.

Our results suggest that under current management practices, the abundances of many forest birds will decline below the minimum expected under natural disturbance. Furthermore, in the harvesting scenarios, patches with high predicted bird abundance will become small and dispersed (more fragmented) relative to the natural fire regime. To the extent that our focal species are sensitive to habitat fragmentation, actual populations may fall below our current predictions. When harvesting and low levels of wildfire are combined, the effects are much more dramatic than when harvesting alone is simulated. Our results suggest that forest managers must move beyond patch or stand-level treatments, and consider the spatial arrangement of residual areas of post-rotation merchantable forest over fairly large areas, if natural patterns of habitat abundance and configuration are to be used as a management template.

Biodiversity assessment of forest management strategies in West-Central Alberta : The use of the NDR for orienting choices

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Abstract

We recently assessed Biodiversity values as part of the strategic forest planning of a publicly owned forest managed by Millar Western Forest Products Ltd. in Alberta, Canada. Our approach was to create and apply a set of models to predict the responses of indicators related to landscape patterns, ecosystem diversity, and wildlife habitat quality resulting from different forest management scenarios. These scenarios differed on silvicultural intensity and cutting spatial layout. Insight into determining favourable behaviour for the biodiversity indicators came from our use of a natural disturbance simulator (LANDIS). We used it to calculate limits of natural variability which define a realm of acceptable behaviour for the biodiversity indicators. Interpretation of the biodiversity assessment results allowed us to identify alternative practices that improve the performance of identified critical indicators and to design a final management-plan option. The paper provides details on our analyses and presents selected results. We conclude by arguing that landscape ecology will have its strongest influence on forest management only if landscape-ecological analysis is embedded directly within a real forest-management planning process.

Developing and testing wildfire based landscape design and cut-block operating guidelines in eastern Manitoba

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Abstract

Developing and testing wildfire based timber harvest guidelines for eastern Manitoba is the focus of a four year project sponsored by the Manitoba Model Forest and the Tembec Paper Group - Pine Falls Operation. The project has developed guidelines that are intended to approximate the effects of a large wildfire. A large wildfire affects spatial scales that span from a landscape down to a site. The timber harvest analogues for these spatial scales are an operating area and a cut-block within the operating area. This talk describes the landscape design and cut-block operating guidelines developed by this project.

Landscape design guidelines are used to lay out an operating area. The landscape design guidelines implement two principles:

1) place cut-blocks in the same places that a large wildfire usually disturbs and place retention areas in the same places that fire usually skips over, and
2) keep roads and other forms of disturbance out of retention areas.

Fire behavior in six large wildfires with a combined area of 75,000 ha was analyzed and used to establish what a large wildfire usually disturbs and what it leaves.

Operating guidelines address harvesting, site preparation and regeneration in the cut-blocks within the operating area. The goal of the operating guidelines is to regenerate cut-blocks that look, feel and operate like a natural forest as quickly as possible after harvest. Post-fire and post-harvest successional pathways for vegetation, woody material and soils were characterized with data collected from about 800 plots in the area.

These wildfire based guidelines are being tested in two ca. 1500 ha operating areas. Post-harvest ecosystem recovery is being monitored and compared with recovery in a recent wildfire.

Ecosystem management at low cost: Using nature's template to best advantage

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Abstract

A common theme in current forest management policy is that forest harvesting should be designed to achieve the landscape patterns and habitat conditions that are maintained by natural disturbance regimes. I will provide 3 examples from the boreal forest where the use of knowledge of natural disturbance pattern and stand dynamics can lead to more ecologically and economically sustainable forest practices. Forest managers have attempted to reduce variability in harvest block sizes, target stand density and structure, and organic matter removal. Research has demonstrated that patch size, stand density and structure, and disturbance intensity varies considerably within and among natural disturbances and this variability is important to maintain habitat for certain organisms. Identifying situations where changes in forest management can result in increased variability in habitat conditions and reduced management costs will help develop practices that sustain both natural ecosystem function and the forest economy. However, in order to implement these changes we must overcome certain barriers such as a general unwillingness to embrace change and past policies based on incomplete information which have been accepted by the public.

Implementing the natural disturbance paradigm: The Alberta-Pacific experience

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Abstract

Alberta-Pacific Forest Industries attempts to maintain biodiversity by designing harvest operations that emulate fire. An important characteristic of fire is that it leaves patches of live residual material, which contribute to the structural diversity of burned areas. Logging can simulate this structure by retaining residual material in harvested areas. Alberta-Pacific has implemented residual stand structure protocols for all its harvested areas, including fire salvage, since 1993. An average of approximately 5% of merchantable timber is retained in harvested cutblocks, in addition to understorey trees and shrubs where possible. Operator training is a long-term investment by Alberta-Pacific. Operators understand the reasons for leaving structure in harvested blocks, and make the decisions on what residuals to leave and where to leave them. An auditing process has indicated continual improvement in meeting stand structure guidelines. Challenges to the process include properly quantifying residual material in harvested cutblocks, and combining stand structure protocols with new mixedwood management techniques. Ongoing research addresses how we can improve distribution of residual material throughout harvested areas (as individual trees, clumps or arbitrary buffers along watercourses).

From theory to practice: The implementation of the natural disturbance model in Weyerhaeuser Forest Management Areas in Alberta

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Abstract

The "natural disturbance" model is based on the understanding that disturbances have shaped present landscapes and contributed to current complex mosaic of vegetation patches varying in size, composition, age-structure and distribution. Depending on site-specific environmental conditions (e.g. soil, topography, climate), plants and animal species occur in different assemblages (communities) according to the stage of succession, the time-since-disturbance, and the scale (i.e. extent, intensity) of that last disturbance. To some degree, species are adapted to the disturbance regime of the region they inhabit. Hence, it is widely believed that the long term sustainability of the forest ecosystem and the ecological requirements of most species can be addressed by emulating the inherent natural processes of disturbance and succession characteristic of a site and/or a region, that is, by maintaining a variety of stand sizes, seral stages and stand attributes and structures across landscapes, within the range of natural variation in the system.

The landscape structure resulting from a natural disturbance regime is suggested as the model against which existing landscapes can be compared. But defining a "natural regime" is difficult if not impossible. Landscapes are dynamic by nature. They change as a result of changes in physical and ecological conditions, or through stochastic disturbance events (fire, insect outbreaks, etc.). A landscape pattern reflects only the period during which disturbance patterns have left a record. Hence, the current landscape pattern is only a snapshot in time.

Despite the previous considerations, and our limited understanding of forest ecosystems, there is an urgent need for forest management to ensure that current practices do not leave forest ecosystem devoid of structural diversity and in simple, uniform landscapes with truncated age class distribution. It is in this context that current landscapes can provide an initial baseline which may need to be adjusted as we gain a better understanding of the natural range of variation and of historical vegetation trends. Current landscape patterns can act as an initial benchmark to which compare management scenarios where timber requirements, as well as recreational demands and aesthetic consideration are addressed. Monitoring the response of processes (nutrient dynamics, etc.) and of plant and animal communities will provide a measure of success.

Over the last five years, Weyerhaeuser has aggressively adopted new practices aimed at conserving biodiversity across all Forest Management Areas in Alberta. Initially, a pragmatic approach to structure retention in our harvest sites, the creation of a range of patch sizes in operating areas and the maintenance of post rotation mature forest stands were all done within the flexibility of existing Forest Management Plans and consistently with new Government Forest Management policies. Weyerhaeuser approach and practices are now an essential part of new Detailed Forest Management Plans.

Developing a forest management strategy based on natural disturbance dynamics for Northern Abitibi

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Abstract

It is more and more widely recognized that natural disturbance dynamics can be used as a basis for the management of forest ecosystems. Such an approach is currently being developed in collaboration with the QMNR, Tembec Forest Products, and Norbord industries for the black spruce-feathermoss forest of Northern Abitibi. The development of this strategy is based on data obtained through four different projects. The first three projects aim to document the natural disturbance regime of the area, the natural evolution of different forest stands, and the effects of different silvicultural treatments on various forest stand components. The fourth projects aim at the integration of a certain number of these elements at the different levels of forest management planning. So far, the results obtained in this latter project suggest that a management strategy based on the use of several silvicultural treatments (clear-cut, partial cut) is likely to be more successful at maintaining the ecological integrity of the forest ecosystem of this region than a strategy solely based on clear-cut harvesting. However, the applicability of this strategy highly depends on the development of adequate planning tools and guidelines.

Applying results of Foothills Model Forest natural disturbance research to vegetation management in Jasper National Park

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Abstract

Historically, natural disturbances have played a central role in the evolution of Jasper's dynamic and highly diverse ecosystems. Fire, the largest source of disturbance, has largely been excluded from the ecosystem over the last century. Park policy now places great emphasis on natural disturbance processes in the restoration and maintenance of ecological integrity. Much of this is being accomplished through management-ignited prescribed burns.

A number of research projects being conducted under the auspices of the Foothills Model Forest, Natural Disturbance Program have begun to generate information applicable to long term planning and implementation of operational vegetation management programs within Jasper National Park. Studies pertaining to fire history, landscape fire patterns, temporal landscape change, and fire effects are finding applications at scales that include park-wide, ecological regions, watershed and site specific. At the broader scale, natural disturbance research is being used to establish area burned targets for various portions of the park. More specifically, information about aspects of Jasper's historic fire regime is being coupled with other research to better replicate the effects of fire such as burn size, within-burn patterns, and fire intensity/severity during individual prescribed burns. As well, both wildfires and prescribed burns are being used as study sites to learn more about aspects of natural disturbance and the interactions between fire, ungulate browsing and vegetation.

Although natural disturbance patterns are providing the template for vegetation /fire restoration actions, these activities are subject to constraints imposed by the presence of recreational, urban and industrial developments, and by commercial resource values external to the park.

Incorporating natural disturbance in a forest management framework

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Abstract

Using past natural disturbance regimes as a model for forest management requires a management framework guided by localized knowledge about disturbance patterns. Lignum Ltd., a family-owned company, has developed a framework within their Innovative Forest Practices Agreement (IFPA) in interior British Columbia, where management is adapted as knowledge gaps on significant stand- and landscape-level attributes are filled and alternate silvicultural practices are developed. The 610,000 ha IFPA is variable in topography, climate, vegetation (57% interior Douglas-fir, 37% sub-boreal forest), stakeholders and policy (the Landuse Plan, Biodiversity Guidebook). A review of existing research in the area indicated that natural disturbance regimes vary over time and space (e.g., fire intervals were shorter before European settlement, fire refugia in the sub-boreal varied with topography). The review also indicated further understanding of the range of natural variability in disturbance regimes is required. Research has been established to examine fire regimes in the interior Douglas-fir and sub-boreal forests and modelling to explore mountain pine beetle and fire regime patterns. How can forest management incorporate this complexity in disturbance regimes and social environment? A forest manager and a disturbance ecologist will jointly illustrate a possible approach to forest management using results like the following: historic fire intervals in the interior Douglas-fir were on average more frequent than current harvest re-entry, 28% of an unmanaged sub-boreal landscape and 24% of a managed landscape were in patches 250 – 1000 ha.

The importance of communication and education in sustainable forest management research

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Abstract

Strategies like the Canadian Council of Forest Ministers' Criteria and Indicators and the National Forest Strategy recognize the importance of communications and education in the practice and achievement of sustainable forest management. To this end, government, industry and research organizations invest significant time and effort in communications and education. Is this investment paying off? Does the general public believe their forests are being managed in a sustainable manner? Are research and development being used on-the-ground? Are research and development guiding strategic level planning and government policy? The answers to these questions are yes and no, and the good news is communications and education continually improves. There have been successful marketing and communications campaigns for natural resource commodities (*The New Steel – Feel The Strength*) which provide valuable lessons for communicating the sustainable forest management research message to the general public. A similar campaign for forest products (*Be Constructive*) has recently been launched. On an equally important note, communications and education are and will need to be directed at technical audiences and key decision-makers. Advances in research and development need to be implemented, resulting in improvements in forest management. Implementing research and development will play a key role in supporting communication and education efforts targeted at the general public which ultimately should result in a more favourable view of the management of protected and industrial lands.

Using a natural pattern foundation for biodiversity monitoring in Saskatchewan

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Abstract

In April 1999, Saskatchewan announced a new and bold direction for the forest sector in Saskatchewan. It included a significant expansion of the current forest industry. To help ensure this development is sustainable, existing and new industry are being required to develop and implement a program to monitor the effects of their forest management activities on the long-term health of the forest ecosystem. The Forest Effects Monitoring Framework subsequently developed outlines a system of activities that "…*coordinates, assesses, learns from, improves, and communicates the consequences of human activity on the forest landscapes of Saskatchewan for economic, social, or cultural purposes, within an ecologically sustainable context.*" We agreed that the most powerful, objective measure of ecological sustainability is the degree to which the vegetation patterns of our current and future forest ecosystems emulate those of "natural", historical forest ecosystems (NRV). However, we also realize that relying on NRV comparisons alone is naïve, particularly at the outset when our ability to quantify NRV, and our understanding of the relationships between vegetation patterns and ecological responses are both limited. The strategy thus includes many of the more traditional elements of biodiversity monitoring, but within a testable framework based on specific predictions of the relationships between vegetation patterns and ecological responses. This strategy also requires a set of efficient, measurable, and meaningful vegetation indicators that integrate across other indicator types. Finally, in recognition of the fact that monitoring is truly in its' infancy, the framework not only allows for, but rewards active learning towards gaining NRV insight together as we go.

Smoke and mirrors? A critical view on the use of fire history paradigms in forest management

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Abstract

Foresters and land managers have used fire history paradigms in forest management for at least 100 years in western North America. The use of models of fire history or historical models of other disturbance types in forest management has increased dramatically in the last decade. These models often suggest that we have a clear understanding of disturbance history and forest dynamics at multiple spatial and temporal scales. Furthermore, they imply that if we mimic the patterns perceived to originate from natural processes historically then we will be able to sustain biological diversity and many other values in managed landscapes. In this paper, we discuss the limitations of using historical fire regime information in forest management, and examine more specifically the concept of natural range of variability and its value in forest management.

Limitations in reconstructing fire history include the use of unrealistic assumptions, confusing terminology, biased sampling, and extrapolation from small study areas to entire landscapes. In addition to these factors, the rationale for applying fire history or natural disturbance history information to forest management is often weak and largely untested.

Our detailed analysis of dry-belt forests suggests that the wide range of conditions that have occurred in the last 10,000 years, coupled with the uncertainty associated with predicting future conditions, limits the utility of the concept of natural or historic variability. No one point in time should be chosen as the "ecologically correct" reference period and past non-equilibrium disturbance patterns at large spatial and temporal scales illustrate conditions that would seriously compromise our ability to maintain the current range of resource values in forested habitats. “Natural” is synonymous with uncertainty, diversity and an extreme spectrum of impacts; conditions that may not be suitable for or tolerated in the current ecological, economic and social environment.

These factors, along with the lack of experience and virtually no history of managing habitats for biological diversity or ecosystem processes, suggest a cautious approach be taken when prescribing management actions for ecosystem management or ecological restoration purposes. Our “vision” for responsible forest stewardship promotes the maintenance of forested habitat through a strong protected area strategy and through the implementation of a diverse array of silvicultural treatments. A rigorous monitoring program to assess our successes and failures should be implemented.

NVR and other paradigms for a "new forestry"; the role of ecologically-based decision support tools

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Abstract

With 6 billion humans headed towards 12 billion, it is clear that a new relationship must be developed between the world's forests and the world's human population. We cannot continue as we have in the past if we are to sustain desired values for future generations, but neither can we indulge our aesthetic and spiritual sensibilities to the exclusion of a respect for the ecology of those desired values and for the ecological role of ecosystem disturbance. What should the paradigm be for this new relationship: Ecosystem management, Adaptive management, NRV, Zonation or some other approach? Should the achievement of this new approach be by "results-based" forestry or by regulation? How do we balance social values against the desire to sustain the forests within the natural range of variation. These questions will be discussed against a backdrop of the kinds of decision support tools that we will need to plan and implement a new relationship.

What are the critical issues of natural disturbance emulation?

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Abstract

There are many opinions as to critical issues in implementation of the natural disturbance template for sustainable forest management. This paper samples a cross section of these views including those of industry, government, research, environmentalists and academia. A series of questions were presented, allowing simple yes/no type answers. Respondents were also asked to provide further opinion on each question.

Integrating NRV into policy and planning in Alberta

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Abstract

Alberta's provincial boundary overlays the western sedimentary basin which is the source of 75% and 80% of Canada's oil and gas production, respectively. In addition to significant oil and gas developments extensive forestry allocations and grazing allotments result in overlapping tenure rights, which in turn complicates the application of NRV. The challenge is to understand the additive or compensatory impacts of various development activities that either compromise or assist NRV use. Indispensable landscape NRV attributes will be difficult to maintain given the current trends in development without regional scale strategies.

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12. Spatial and temporal patterns of natural disturbance in northern New Brunswick
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    Cheryl Smith and Jim Schieck

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    Paula Vera and Michael Feller

15. The effect of alternative harvesting practices on long-term ecosystem productivity and carbon sequestration was investigated with the ecosystem simulation model, FORECAST
    Clive Welham

Spatial and temporal variation in fire cycle across Ontario

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Abstract

Estimates of the disturbance rate by wildfire enter into calculations of predicted wood and habitat supply used in Ontario's forest management planning process. Inaccurate estimates compromise our ability to manage in a sustainable way and to predict sustainable harvest levels. Current estimates used by forest managers come from non-spatial data sets. Here, more accurate estimates are made using spatial data that just recently became available in Ontario and more rigorous analysis techniques. Spatial patterns show a trend from shorter fire cycles in the northwestern part of the province to longer fire cycles in the northeastern and southern parts. The trend matches well with known climate and fragmentation trends across Ontario and into Quebec. The length of time period over which to estimate the fire cycle is also examined. Fire cycles are estimated by drawing data from a single, homogeneous time-since-fire distribution that spans the period from 1921 to 1995. This is a much longer period than has been used previously and produces estimates with considerably less variability between management units than shorter periods.

Impacts of forest floor disturbance on vegetation, nutrient dynamics and white spruce seedling growth in clearcut and partial-cut stands

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Abstract

This study examines the effects of site disturbance on vegetation, nutrient dynamics and white spruce seedling growth in clearcut and partial-cut stands in the boreal mixedwood of northwestern Alberta. Disturbance plots consisting of burn, mix, mound, scalp and control (no forest floor disturbance) treatments were installed within partial-cut and clearcut white spruce stands. A general increase in nutrient availability was noted with increased tree removal, although this varied with site disturbance. Overall, NH_4-N, Ca, Mg and K were higher in clearcut stands while NO_3-N was higher in partial-cuts. Within disturbance plots, burns had the highest levels of NH_4-N and NO_3-N in both harvest types, while control plots had the lowest NO_3-N levels in both harvest types. Ca and Mg were highest, but K lowest, in the scalp treatments in both harvest types. The ratio of NH_4-N:NO_3-N was greatest in clearcut stands and lowest in burns suggesting relatively lower rates of nitrification in clearcuts and relatively higher nitrification or reduced NO_3-N uptake in burns. Vegetation response was evaluated by identifying species, percent cover and height for all shrubs, *Populus spp*. and *Epilobium angustifolium*. Burn plots were dominated by *E. angustifolium* whereas scalps were dominated by *Populus spp*. Mix plots in clearcuts, and mix and mound plots in the partial-cuts were most effective in suppressing vegetation growth in the first season after harvesting and site disturbance. Variation in vegetation and nutrient availability among treatments suggests harvest intensity and site disturbance will interact to affect white spruce seedling growth.

Pre-settlement boreal forest – aspen parkland ecotone structure derived from soil anthracology in Elk Island National Park, Alberta

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Abstract

A study was conducted within the Boreal Forest - Aspen Parkland ecotone in Elk Island National Park, Alberta to investigate the structure and composition of the pre-settlement vegetation and to examine changes after a century fire suppression and reduced herbivory.
The last intensive fire in this region was in 1895, leaving behind a distinctive charcoal horizon. As charcoal retains the microstructure of the parent plant tissue, the analysis of large charcoal fragments (pedoanthracology) from this horizon provided the data to examine specific changes to the landscape after a century of fire suppression and reduced herbivory.

This project was designed to test the effectiveness of the pedoanthracology method in recreating the characteristics of the Boreal-Aspen Parkland ecotone prior to settlement and to determine whether this method is capable of providing a spatially precise, high-resolution palaeovegetation map.

Results of stratigraphic sampling showed that aspen establishment was initially topographically controlled with aspen on north and east exposures in 1895, expanding to blanket the modern landscape.

A comparison of the pre-settlement with the modern vegetation consociation reveals significant changes to the ecotone including aspen invasion of the grasslands and the decline in spruce stands. The mean area of aspen increased from 46-86%; an average of 0.82% per year. Spruce stands are presently half of the pre-settlement area, presumed to be a function of the slow establishment and growth of spruce in the shade of the rapidly growing aspen.

Ecological land classification of the mid-boreal forest utilising remote sensing and G.I.S., Duck Mountain, Manitoba

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Abstract

The purpose of this research is to utilise digital remote sensing image analysis and GIS to classify a portion of the Duck Mountain upland region in west central Manitoba into ecosites. This research will contribute to an understanding of the regions historic disturbance regime through the digital mapping of forest ecosites and the spatial analysis of physical controls on the distribution of forest ecosystems. The ecosite classification and digital database will result in a high-resolution spatial model of the forest ecosystems and a framework for scaling up models of biophysical processes and associated ecological data. An assemblage of ecosites is the geographic expression of biophysical activity over time scales that are longer than the diurnal and seasonal variability of ecological processes and closer to the time frame for forest management and planning. This research will provide a framework for the spatial integration of various SFMN studies of natural disturbance, planning and implementation of forest management practices that emulate the natural disturbance, and for the spatial variability of boreal forest ecosystems, at appropriate spatial and temporal scales, using natural patterns as a guide for forest and ecosystem management.

Using natural disturbance modeling in assessing vertebrate species risk in Northwestern New Brunswick, Canada

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Abstract

An important goal of ecosystem management is to maintain the integrity of managed forest landscapes. An ecosystem has integrity when it is deemed to be in a state of "well-being". A common strategy for maintaining integrity involves emulating natural disturbance regimes (e.g. size, frequency, intensity and spatial distribution of natural disturbance events) by modifying harvest techniques to most closely match the natural disturbance regime. The philosophy behind this strategy is that species will be maintained because the managed landscape closely resembles the natural system under which species evolved. Several key assumptions are made: 1) forest management can mimic nature to a high enough degree to be effective, and 2) mimicking nature is the most effective way to maintain native species viability.

The species-sorting algorithm (SSA) assesses the potential ability of a landscape to support *all* terrestrial vertebrate species. This coarse-filtered, spatially explicit modeling tool complements a natural disturbance emulation approach to ecosystem management, by allowing an evaluation of the ecological value of alternative landscape management scenarios. This method is currently being used to assess the risk of vertebrate extirpation at J.D. Irving Ltd.'s Black Brook Forest District in northwestern New Brunswick. A natural disturbance model is being developed as a companion project to this risk assessment (A. Smith, UNB). We will use the SSA in conjunction with natural disturbance modelling to assess the biotic integrity of forest management activities by comparing changes in species risk between the current, intensively managed forest and a hypothetical current forest based upon simulation of natural (but no anthropogenic) disturbances applied to the 1950's (pre-Irving) forest.

Methods for delineating historical fire size using Geographic Information Systems

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Abstract

Managing forests sustainably requires knowledge of both spatial and temporal variation in historical disturbance regimes, such as fire, at landscape scales. This approach to forest management attempts to mimic the parameters of historical disturbances, such as frequency, severity and size, when planning harvesting and other human disturbances. Most fire-scar based studies reconstruct frequency for individual stands, however a few spatially explicit fire histories now provide critical information on historical variation in fire size. Furthermore, although historical reconstructions of fire are acknowledged to contain uncertainty, that uncertainty is rarely quantified. We report here on reconstructing variation in the size of low-severity fires and attempts to quantify uncertainty, using a geographic information system. We used Voronoi polygons, based on triangular irregular networks formed from fire histories sampled at a grid of points (≈1 ha) over landscape scales (7000 ha) in the Stein Valley, BC, Canada. We assessed uncertainty in the location of fire boundaries with fuzzy set theory, which has been used previously to delineate urban/rural boundaries. Comparing these methods to quantify the spatial extent of fire regimes is expected to contribute to improved sustainable forest management with better understanding of both the spatio-temporal variation and uncertainty of fire regimes.

The effects of hydrological processes on nutrient availability and transportation in a western boreal forested wetland

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Abstract

Wetlands affect the nutrient status and productivity of aquatic ecosystems. However, few studies have examined wetlands hydro-biogiochemical interactions in the complex hydrologic settings commonly found in the western Boreal Forest. We report on the hydrology and nutrient dynamics of a forested wetland in north-central Alberta for the duration of the hydrological year ending May 2000. We show that:

1) patterns of drying and re-wetting affect concentrations and flushing processes of NO_3 and NH;
2) following successive dry years, wetlands may act as sources of nitrate rather than sinks;
3) wetlands have a greater potential to contribute nutrients and surface runoff than surrounding hill slopes, during springmelt, and
4) considering the above, managers should incorporate and assess wetlands connectivity to aquatic systems to better understand the effects of disturbance on nutrient dynamics in the western boreal ecozone.

Managing for residual material

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Abstract

All disturbances leave material within them, including standing dead trees, standing live trees and coarse woody debris. Residual material plays important roles in ecosystem processes such as tree regeneration and nutrient cycling and provides habitat for wildlife. The purpose of this study is to quantify the amount, types and pattern of material left within disturbances. We hope to be able to follow the change in structural variables on these sites over time to identify temporal patterns.

Currently, a study is underway on patterns of residual material left by complete and partial burns in the Virginia Hills Fire, northwest of Whitecourt, Alberta. This is the first year of a two year study. Data is being collected on various structural variables, including number of live and dead trees by size class, species of live and dead trees and amount, location and size of coarse woody debris

Preliminary results show that most pieces of coarse woody debris are small but the size varies, that most pieces of coarse woody debris are on the ground but some are suspended and that residual trees in partial burns tend to be trembling aspen while residual trees in complete burns tend to be black spruce and lodgepole pine.

This data and future findings on the amount and types of material left by natural disturbances will be used by Foothills Model Forest partners to guide the retention of these structural variables in cultural disturbances.

Disturbance frequency and intensity dictate patterns of tree species replacement: Results from the ecosystem simulation model, FORECAST

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Abstract

Natural disturbance events are highly variable with respect to their frequency of occurrence, and intensity. Wildfires, for example, can burn with an intensity sufficient to remove almost the entire complement of organic material or, in the case of a crown fire, simply kill the dominant trees while leaving the understory largely intact. Using the ecosystem simulation model, FORECAST, we varied the intensity and frequency of disturbance and examined its effect upon the subsequent development of a stand containing three potential tree species, trembling aspen, white spruce, and lodgepole pine. Results suggest that disturbance type, in conjunction with the autecological features of the resident trees, are critical in determining patterns of species recruitment and persistence (and thus, stand development). As a technique for emulating natural disturbance, harvesting frequency and intensity should be given careful consideration if management objectives include the maintenance or creation of particular stand types.

Keystone processes regulate white spruce recruitment: The masting cycle and fire history connection

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Abstract

White spruce is typically regarded as a late succession species in Mixedwood forest. While immediate post-fire recruitment does occur, the importance of this period to spruce succession may depend on mast years (periodic years of high cone crops) occurring while burned seedbeds are still suitable for germination. Our objective was to determine whether the timing of fire relative to mast years affects the density and timing of white spruce recruitment. Historic fires which occurred between 1941-1994 during mast years, as well as 1, 2, and 3 years prior to mast years, were chosen. The density and timing of spruce establishment were determined on each fire. Trees were carefully aged by crossdating the below ground portion of trees with skeleton plots and doing ring width analysis with Cofecha. Preliminary results indicate that significantly more recruitment occurs on mast year burns than sites with a two or three year delay before a mast year. These differences persisted in stands even after 60 years. We also found that standard aging techniques underestimate the true age of spruce by as much as 16 years in 38-year old trees. It now appears that the first mast year cohort following fire provides the majority of recruits in many mixedwood stands. These results demonstrate that masting is a keystone process that interacts with natural disturbance regimes to shape Mixedwood stand composition. Our results also demonstrate the importance of regeneration practices that rely on the success of initial establishment periods, as well as the need for more realistic growth and yield projections for white spruce.

EMEND, "Ecosystem management emulating natural disturbance

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Abstract

The EMEND project established between 1998 and 1999 is a large scale, multi-discipline forest ecosystem research study to determine which forest harvesting and regeneration practices best maintain natural plant and animal communities when compared to communities resulting from natural disturbances. This study, one of the largest in the world, was designed, installed, and is managed and reported through a partnership of forest industry, government and research agencies.

This poster and the associated research study and field guide (available for participants) describes the EMEND study objectives, design, layout of treatments, treatment technical descriptions and post-installation landscape patterns. Also included are descriptions all of the research activities and research contacts within the study, acknowledging all participants.

Spatial and temporal patterns of natural disturbance in northern New Brunswick

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Abstract

A goal of ecosystem management is to guide harvesting and silviculture practices by the natural variability in stand structures and forest landscape patterns found through natural disturbance regimes. Individual stand structures make up the forest patterns that can be described by species composition, age class distribution, patch size, and shape. Natural disturbance regimes, including the type, frequency, extent, and severity of disturbance, influence the development of vegetative patterns across the landscape. Understanding natural disturbance effects on forest vegetation is an important step in developing forest ecosystem management strategies. We are defining natural disturbance attributes and quantitatively characterizing the forest, in order to specify disturbance regimes for vegetation communities on the 190 000 ha J.D. Irving Ltd. Black Brook District in northwestern New Brunswick. Natural disturbance modeling tools are being used to simulate effects of disturbance regimes on stand structures and forest patterns, and to analyze the effects on species composition, patch size and shape, and age class distribution. Comparisons are being made between natural and harvest disturbances.

Pattern of small residuals in mixedwood stands affected by fire

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Abstract

One hundred and sixty-eight mixedwood stands, from seven fires in the boreal forest of northern Alberta, were mapped and digitized from post-fire aerial photographs. Mixedwood stands within the fires were classified as small (<10 ha), medium (10-60 ha), or large (>60 ha) stands. We described distribution of live residual trees (single trees and unburned and partially burned islands of live trees) within these mixedwood stands and their position relative to water features and large fire skips. There was proportionally more residual live tree area in large stands compared to medium stands, which in turn had proportionally more residual live tree area than small stands. The proportion of partially burned island area was greater in large stands compared to small stands. In general for all stand sizes, a few large residual islands accounted for most of the residual live trees that were present. Few residual live trees and live tree islands were found close to large fire skips. However, many partially burned islands of live trees were found close to large fire skips. There was a slight tendency for live tree residuals (single live trees and non-burned islands of live trees) to be less abundant within 100 metres of water features than further from water.

Unburned patches within lodgepole pine dominated forests in central British Columbia

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Abstract

When a fire burns a substantial area of forest, it often leaves patches unburned. No published study appears to have addressed the question of whether or not there are patches that have never been burned by fires within the last few hundred years in British Columbia. Published studies have only partially addressed the question of whether or not there are some landscape factors which prevented fire from killing trees within the unburned patches.

To address these questions, a research program commenced in 1999 with 2 main objectives – To determine:

1) if there are some forest patches within lodgepole pine forests in central B.C. that have not burned during the last 200-300 years, and
2) if forest patches within lodgepole pine forests in central B.C. that did not burn at the time when the surrounding forests were most recently burned, have some characteristics that caused them not to burn.

The objectives are being addressed by studying lodgepole pine in 2 different climatic regimes – drier and moister climates.

To date, measurements have been completed in a drier climate region – the Sub Boreal Pine Spruce biogeoclimatic zone in B.C.'s Cariboo Forest Region. Preliminary analysis of the data suggests that all patches that escaped burning during the most recent fire did in fact burn during a preceding fire, so that there are no patches that did not burn within the last 200 years.

The effect of alternative harvesting practices on long-term ecosystem productivity and carbon sequestration was investigated with the ecosystem simulation model, FORECAST.

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Abstract
Three tree species, white spruce (*Picea glauca*), trembling aspen (*Populus tremuloides*), and lodgepole pine (*Pinus contorta* var. *latifolia*), were each used in combination with different rotation lengths. An additional run was conducted to investigate the effect of nitrogen addition to aspen. Results were also compared with a natural disturbance scenario in which a mixedwood stand composed of all three species was subjected to a catastrophic wildfire, on a 150-year fire cycle. All simulations included an understory grass competitor, *Calamagrostis canadensis*, and the total simulation length for each scenario was 300 years.

Carbon stored in soil represented a large, relatively stable pool and showed only minor long-term responses to harvesting activities. Tree biomass and litter pools, in contrast, fluctuated widely in concert with the harvest cycle. *Calamagrostis* was relatively unimportant as a carbon pool.

Total ecosystem carbon increased with rotation length regardless of species, and this was attributable largely to changes in the biomass pool. A 150-year pine, and a 200-year spruce rotation, were the only scenarios in which average total carbon storage exceeded that in the natural disturbance scenario. For equivalent rotation lengths, total carbon storage was greatest in aspen, followed by pine and spruce, respectively. Application of nitrogen fertilizer to aspen increased average total carbon storage by 13%. This increase was attributable primarily to the storage in wood products and biomass pools.

The proportion of total carbon stored in the soil pool increased as harvest frequency declined (i.e., at longer rotation lengths), while the proportion stored in litter pools was roughly equivalent among all scenarios. However, there was a consistent decline in soil carbon across the 300-year simulation period for managed stands. The natural disturbance scenario, in contrast, showed an increase in soil carbon over the same period.
Species-specific biomass accumulation rates (an index of ecosystem productivity) were maximal in the shortest rotations for aspen, but in mid-length rotations for pine and spruce. Short-rotation scenarios showed a marked drop in site productivity over subsequent rotations. The application of nitrogen fertilizer reduced the relative drop in site productivity for aspen.

Our results suggest a trade-off between ecosystem storage capacity and timber production. By selecting the appropriate tree species and rotation length, however, it is possible to balance these competing demands.

Foothills Model Forest Publications

A–5 Assessing age data in Foothills and Mountain landscapes of Alberta: Laying the groundwork for natural disturbance research. Alberrta Foothills Disturbance Ecology Researach Series Resport No. 1. Foothills Model Forest, Hinton, Alberta.
Andison, D.W. 1999.

A – 6 Understanding and Applying Natural Disturbance Patterns on Front Range Landscapes (A Foothills Model Forest Workshop). March 29-30 1999.
David Andison, Bandaloop Landscape-Ecosystem Services and Foothills Model Forest Natural Disturbance Activity Team. (Website)

A – 7 Foothills Model Forest Natural Disturbance Program Two Year Review Long Term Research Plan: Annual Work Plan 1998/1999. February 1999.
David Andison, Bandaloop Landscape-Ecosystem Services. Dan Farr, Foothills Model Forest. Don Harrison, Alberta Lands and Forests. Hugh Lougheed, Weldwood of Canada. Alan Westhaver, Jasper National Park. (website).

A – 8 Landscape Fire Behaviour Patterns in the Foothills Model Forest
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A – 9 Foothills Model Forest Natural Disturbance Workshop. November 24, 1999.
Dave Andison, FMF Natural Disturbance Activity Team.

A – 10 Landscape-Level Fire Activity on Foothills and Mountain Landscapes of Alberta. Alberta Foothills Disturbance Ecology Research Series Report No. 2.
D.W. Andison, Bandaloop Landscape-Ecosystem Services. Belcarra, British Columbia. July 2000.

R - 3 Detailed Disturbance History Mapping of the Montane, Jasper National Part 1997-1998. 1999.
Marie-Pierre Rogeau M.Sc.

R - 4 Landscape Disturbance Project Stand Origin Mapping. 1996.
Marie-Pierre Rogeau Consultant in Wildland Disturbances.

Island remnants within fires in the Foothills and Rocky Mountain natural regions of Alberta: Part 1. Methodology.
MacLean K., D. Farr, and D. Andison. 1998.

Workshop. Natural Disturbance as a template for forest management in Alberta. December 9-10, 1997, Hinton, Alberta.

Assessing Forest Age Data in Foothills and Mountain Landscapes of Alberta Laying the Foundation for Natural Disturbance Research
D.W. Andison. Bandaloop Landscape-Ecosystem Services. Coal Creek Canyon, Colorado. October, 1999.

Integrating Natural Pattern Knowledge into Management: Issues and Opportunities
Dr. David. W. Andison, Bandaloop Landscape-Ecosystem Services, On behalf of Foothills Model Forest, Alberta. Paper given at the COFE-CWF Conference, September 11-13, 2000, Kelowna, British Columbia.

Foothills Model Forest Publications Quick Notes

QuickNote No. 1 – Fire Cycles and Disturbance Rates
Quicknote No. 2 – Natural Sub-regions: Are They Meaningful?
Quicknote No. 3 – Fire Control Impacts: Real of Imagined?
Quicknote No. 4 – Historical Fire Sizes. Easy one… Right?
Quicknote No. 5 – Ages, Inventories, and Pattern
Quicknote No. 6 – The "Even-Aged" Boreal Forest

Publications are available at the Foothills Model Forest web site at:
http://www.fmf.ab.ca/p2.html
or by calling the Foothills Model Forest at 780-865-8330

Sustainable Forest Management Network Publications

Working Papers

1999-24 The forest fire induced impacts on phosphorus, nitrogen and chlorophyll *a* concentrations in boreal sub-arctic lakes of northern Alberta
P. McEachern, E.E. Prepas, John J. Gibson, and P. Dinsmore

1999–12 Compositional analysis of wildfire in the Alberta boreal mixedwood: What do fires burn?
S.G. Cumming

1998–11 Using forest fire hazard modelling in multiple use forest management planning
William Thompson, Ilan Vertinsky, Hans Schrier and Bruce Blackwell

1998–6 Silvicultural practices and forest management strategies that emulate natural disturbance / Pactiques sylicoles et strategies d'aménegement qui s'inspirent des perturbations naturelles
Yves Bergeron, Brian Harvey, Alain Leduc and Sylvie Gauthier

P&P-1(SES-2) Natural disturbance management: Timber supply implications
Glen Armstrong, Steve Cumming and Vic Adamowicz

EBS – 1 Natural fire regime: A guide for sustainable forest management of the boreal forest
Yves Bergeron, Brian Harvey and Alain Leduc

Project Reports

1999-35 Comparative impacts of fire and forest harvesting on water quality in boreal shield lakes
Richard Carignan, Pierre D'Arcy, and Sébastian Lamontagne

1999-32 Comparative impact of natural fires and forest logging on zooplankton communities of boreal lakes
Bernadette Pinel-Alloul and Alain Patoine

1999-27 Genetic diversity of black spruce populations regenerated after fire or harvesting with pre-established regeneration protection
Jean Bousquet and Daniel J. Perry

1999-20 Understanding how fire behaviour characteristics shape tree population dynamics, diversity and forest patterns
E.A. Johnson, D.F. Greene and K. Miyanishi

1999-19 Comparison of the effects of fires and logging on algal productivity, quality and biodiversity in boreal shield lakes
Dolors Planas

1999-3 Natural disturbance analysis and planning tools
Robert S. Rempel

SES – 3 The incorporation of fire and price risk in regional forest resource accounts
M.K. Haener and W.L. Adamowicz

Publications are available at the Sustainable Forest Management Network website at http://www.ualberta.ca/sfm or by calling (780) 492-9060 or by email glarkin@gpu.srv.ualberta.ca.

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