

WORKSHOP PROCEEDINGS

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des forêts



Student Workshop
November 2-4, 2000
University of Alberta
Edmonton, Alberta

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Sustainable Forest Management Network
G208 Biological Sciences Building
University of Alberta
Edmonton, Alberta, T6G 2E9
Ph: (780) 492 6659
Fax: (780) 492 8160
<http://www.ualberta.ca/sfm>

ISBN 1-55261-099-3

**Proceedings of the
Sustainable Forest Management Network**

Student Workshop

November 2–4, 2000

**University of Alberta
Edmonton, Alberta**

STUDENT WORKSHOP

November 2-4, 2000

DRAFT AGENDA

Thursday, November 2

Map Room, Lister Hall

11:30 Lunch

12:30 – 1:00 The Sustainable Forest Management Network
(Vic Adamowicz, Program Leader)

1:00 – 2:30 Session I. Regeneration and alternative forest practices – what will the future forest look like?

- Impact of slash loading on soil temperatures and Aspen regeneration (Sarah Liefers, University of Saskatchewan)
- Understory vascular plant regeneration and environmental response with varied canopy removal at the EMEND site, Northern Alberta (Treena Fenniak, University of Alberta)
- The impact of various harvesting practices on the density of ectomycorrhizal fine roots in a boreal forest ecosystem (Lance Lazaruk, University of Alberta)

2:30 – 3:00 Break

3:00 FILS Lecture (Student Union Building)

5:00 – 8:00 Dinner/Social (CW410 Biological Sciences Building)

Friday, November 3

Map Room, Lister Hall

9:30 – 10:30 Session II. Understanding hydrology in the western boreal plains

- Water movement patterns in Gray Luvisolic soil (Ivan Whitson, University of Alberta)
- Isotopic and geochemical estimates of hydrologic parameters and effective contributing areas in peatland dominated catchments, Caribou Mountains, Alberta (Preston McEachern, University of Alberta)

10:30 – 11:00 Break

11:00 – 12:00 Session III. Assessing the impacts of logging on aquatic systems

- Wildfire versus logging: effects on the mercury accumulation by aquatic organisms (Edenise Garcia, Université de Montréal)
- Is green slime affected by watershed logging in Western Canadian Boreal Plains? (Stéphanie Nicopoulos Université de Québec à Montréal)

12:00 – 1:30 Lunch (Map Room) **and Poster Setup** (Banquet Room, Lister Hall)

1:30 – 2:30 Session IV. Technological Solutions – minimizing the footprint of forests products’ production on water quality

- Testing the applicability of one-phase axial dispersion model to describe the performance of Ozone Bubble Columns (Mohamed Gamal El-Din, University of Alberta)
- Colour and Chloride removal from kraft pulp mill effluent by ion-exchange (Gi-yeon Yun, University of Alberta)

2:30 – 3:00 Break

3:00 + SFM Network Open House (Banquet Room, Lister Hall)

Saturday, November 4

Banquet Room, Lister Hall

9:00 – 10:30 Session V. Better understanding of the benchmarks of sustainability.

- Aging discrepancies of white spruce affect the interpretation of recruitment processes in mixedwoods (Vern Peters, University of Alberta)
- Structure and Dynamics of Boreal Forest Stands in the Duck Mountains, Manitoba (Cary Hamel, University of Manitoba)
- An Assessment of a GIS-based habitat model for Canada Lynx in west-central Alberta (Andrea Doucette, Dalhousie University)

10:30 – 11:00 Break

11:00 – 12:00 Session VI. Opportunities for achieving sustainability in boreal forest communities

- Evaluating, comparing, analysing and linking local collaborative forest management outcomes, processes and social capital (Mark Robson, University of Toronto)
- Integrating aboriginal values into forest management planning (Melanie Karjala, University of Northern British Columbia)

12:00 – 1:00 Wrap up, poster take down, lunch

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ORAL PRESENTATIONS

Impact of Slash Loading on Soil Temperatures and Aspen Regeneration

Sarah Lieffers and Ken Van Rees

Department of Soil Science, University of Saskatchewan, Saskatoon, SK

Trembling aspen (*Populus tremuloides* Michx.) is the dominant hardwood tree species harvested in the Canadian prairie provinces. Aspen is able to reproduce asexually and harvested stands are typically regenerated naturally. After apical dominance is removed by cutting, soil temperature becomes the primary factor controlling aspen suckering. Conventional harvest operations in Manitoba involve leaving slash in the cutblock which may influence soil temperature regimes. The objective of this study was to determine the influence of various levels of slash loading on soil temperature regimes and aspen suckering. Twelve harvested blocks (6 summer and 6 winter) in the Duck Mountains, MB were examined. The influence of slash loading on these cutblocks was examined in terms of depth to sucker initiation, influence on soil temperature, and influence on aspen suckering. In order to analyze the relationships between soil temperature, slash loading and regeneration success, three Hobo temperature probes were installed in each block under quantified slash loads. Initial results indicate that increased slash size, loading, and arrangement have a dampening effect on soil temperatures and affect the ability of aspen roots to sucker. Suckers typically initiated from parent roots within the forest floor layer. Increased slash loading and shallow depth to suckering for these sites suggest that harvest operations need to minimize site disturbance and slash loading to ensure adequate aspen suckering.

Understory Vascular Plant Regeneration and Environmental Response with Varied Canopy Removal at the EMEND site, Northern Alberta

Treena Fenniak

Renewable Resources, University of Alberta, Edmonton, AB

Environmental conditions can vary following different types and intensities of disturbance. Partial canopy removal by strip harvesting (intended to mimic natural disturbance) has not experienced widespread use in Alberta, and may provide a unique disturbance type, and therefore unique regeneration niche for the understory community. This study is being conducted at the EMEND site in Northern Alberta to compare changes in environmental factors and species composition before and after different intensities of canopy removal. Measures of stem density, basal area, canopy cover, moisture availability, soil temperature, substrate depth/composition, below ground decomposition rate, nutrient availability, and coarse woody material cover/decay class, understory species percent cover, and richness were taken pre- and post-harvest and analyzed for relationships to harvesting treatment (20% and 75% canopy cover, clearcut and control) and forest type (conifer dominated, deciduous dominated and mixedwood). Pre- and post-harvest measures were analyzed within a general linear model using a nested design (treatment (4) fixed within stands (3) random within community (3) fixed) to study changes in species composition and environmental conditions between treatments and forest types. Results to date suggest that different environmental factors exhibited unique changes related to the various harvesting regimes. Soil temperature, available NH_4^+ , litter type, herb diversity and richness, total vascular richness, and herb, shrub and total vascular plant cover all showed significant variation with relation to harvesting treatments and/or forest type in the first year postharvest. Detrended correspondence analysis and detrended constrained correspondence analysis did not reveal any clustering of treatments or forest types with relation to species distribution postharvest. Further analysis will be required before any conclusions may be reached about these relationships.

The Impact of Various Harvesting Practices on the Density of Ectomycorrhizal Fine Roots in a Boreal Forest Ecosystem

Lance Lazaruk

Department of Renewable Resources, University of Alberta, Edmonton, AB

Ectomycorrhizae facilitate a host of ecological processes, all of which have implications for the productivity, stability and sustainability of forest ecosystems. However, little is known about the ectomycorrhizal (ECM) community in the Canadian boreal forest, let alone the impact harvesting practices (including those designed to emulate natural disturbances) are having on these communities. In order to address these issues a total of 150 soil cores were obtained from a variety of white spruce dominated stands within the Ecosystem Management by Emulating Natural Disturbance (EMEND) research site located in Northwestern Alberta. The total number of ECM fine roots obtained from the soil cores was highly variable within the sites, however, there appeared to be negative correlation between the harvesting intensity (100, 80, 50, 30 and 0 % removal) and the ECM fine root density. Furthermore, the ratio of active:inactive ECM root tips was less variable within the different sites and decreased with increasing harvesting intensity as well. Further research will identify the ECM fungi associated with the active root tips in order to assess the ECM community.

Water Movement Patterns in Gray Luvisolic Soil

Ivan R. Whitson, Ellie E. Prepas, David S. Chanasyk and Brian Kotak

Biological Sciences, University of Alberta, Edmonton, AB

It is essential to understand the factors that control phosphorus mobility in the landscape if we are to properly manage aquatic ecosystems. In our study of water movement patterns and phosphorus leaching in typical forest soils of northern Alberta (Orthic Gray Luvisolic), we hypothesized that both percolation and interflow would be important mechanisms of subsurface water movement. Luvisolic soils possess physical characteristics that are expected to promote interflow, particularly after logging. We hypothesized that phosphorus is mobilized more effectively by interflow than by percolation. A number of techniques were used to determine patterns of water movement. We measured saturated hydraulic conductivity of A and B horizons, finding only slight differences. We measured soil water content manually and by time domain reflectometry. Upper soil horizons had the widest temporal fluctuation of water content. Bromide was applied in small plots and its movement was monitored for two years. Penetration of the tracer indicated that even during relatively dry periods percolation is important. Soil temperature was measured during the spring snowmelt period.

We used surface and subsurface flow collectors to directly measure both overland flow and interflow. Infiltration occurred during precipitation events, including snowmelt, but only the larger magnitude events changed water content of the soil profile significantly. Most interflow occurred at the time of soil thaw. The lack of runoff during 1998 and 1999 probably reflects very dry weather conditions of this period.

Isotopic and Geochemical Estimates of Hydrologic Parameters and Effective Contributing Areas in Peatland Dominated Catchments, Caribou Mountains Alberta

Preston McEachern, John J. Gibson, Ellie E. Prepas and David Chanasyk

Biological Sciences, University of Alberta, Edmonton, AB

Catchment areas (CA), hydrologic contributing areas (HCA) and effective contributing areas (EA) were calculated for 10 lakes in burnt and 14 lakes in unburnt peatland-conifer watersheds on a boreal sub-arctic plateau. CA was calculated from topography, HCA from isotope composition of lake water and EA from a mass-balance for sodium. CA, HCA and EA divided by lake volume

(V) were used to describe among lake differences in water balance and lake water concentrations of total and dissolved nitrogen (TN, DN), phosphorus (TP, DP), soluble reactive phosphorus (SRP) and dissolved organic carbon (DOC). Water yields from CA averaged 30 mm, half the yield expected from runoff coefficients published for sites off the Plateau. Poor drainage on the Plateau was due to peatlands averaging 66% of CA and catchment slope averaging 2.7%. HCA similarly reflected low water yield averaging 60% of CA. Solutes were delivered from a smaller area than runoff as EA averaged 5.3% of CA. Burnt and reference catchments were not detectably different in CA, HCA or EA ($P > 0.5$). However, water yield from burnt catchments was 1.5-fold higher than in unburnt catchments with the same CA/V ($P = 0.04$). EA/V was the best physical correlate for among lake differences in lake chemistry explaining 30, 60 and 63% of the variance in \log_{10} TN, DN and DOC ($P \ll 0.01$) and 20, 20, and 21% of \log_{10} SRP, TP and DP ($P = 0.03$).

Wildfire versus Logging: Effects on the Mercury Accumulation by Aquatic Organisms

Edenise Garcia and Richard Carignan

Sciences biologiques, Université de Montréal, Montréal, QC

Mercury tends to associate to the organic matter in the upper layer of the soils. As a consequence, watershed disturbances resulting in soil exposure can affect the mobilization and transport of the organic matter linked Hg to lakes. In this study, we determined the levels of methyl mercury (MeHg) in zooplankton and zoobenthos, and of total mercury (Hg) in seven species of fish from 38 lakes. All lakes were located in Quebec and exhibited a clear-cut (N = 9 lakes), burned (N = 9 lakes) or undisturbed (N = 20 lakes) watershed. Because mercury is biomagnified through the food web, the trophic position occupied by a same species in different lakes may be responsible for differences in MeHg and Hg concentrations. Therefore, in order to compare Hg and MeHg levels in organisms from the three groups of lakes, we took into account their trophic position, as defined through stable nitrogen isotope signatures ($\delta^{15}\text{N}$). Our results indicated that Hg and MeHg concentrations tended to be higher in some species of fish (perch and north pike) as well as in zoobenthos and zooplankton from logged lakes. Organisms from burned and reference lakes showed similar Hg and MeHg concentrations.

Is Green Slime Affected by Watershed Logging in Western Canadian Boreal Plains?

S. Nicopoulos, D. Planas, and E.E. Prepas

Sciences biologiques, Université du Québec à Montréal, Montréal, QC

In the recent years, the forestry industry expended extensively in the Western Canadian Boreal Plains. Watershed logging modifies the biogeochemical cycles of nutrients and therefore could change the water quality in Boreal Plain lakes. In these lakes the dominant communities at the base of the food web are the algae attached to aquatic plants. These algae communities are an important food supply for insect larvae and fish. The littoral zone of lakes acts as a buffer between the watershed and the open waters therefore responds quickly to watershed perturbations. Thus, we could expect that nutrient increase associated with harvesting would increased the algal productivity in lakes. However, a paradigm exist on the sources of nutrient for the attached algae: are they take-in nutrients from the water column or from their host (aquatic plants)? Could this controversy be dependent of nutrients availability in the water? This question must be answered before we could predict changes in primary production of lakes relating to logging. The objective of this study is to determine whether nutrient concentrations in the water column is the best predictor of attached algae. The results show that within a certain range of phosphorus (P), there is a linear relationship between P and the attached algae biomass; beyond the maximum P-concentration the relationship became negative. Can my results answer the questions?

Testing the Applicability of One-Phase Axial Dispersion Model to Describe the Performance of Ozone Bubble Columns

Mohamed Gamal El-Din, and Daniel W. Smith

Department of Civil and Environmental Engineering, University of Alberta, Edmonton, AB

When designing ozone bubble columns, two major sources of uncertainties usually exist: the measurement techniques and estimation methods of the various operating parameters; and the application of the pertinent design model. This paper presents a simple and easy to use, yet accurate and reliable design model for describing the performance of ozone bubble columns for water and wastewater treatment. That model is a modified non-isobaric steady-state one-phase axial dispersion model (1P-ADM). The 1P-ADM is composed of a single non-homogeneous second-order linear ordinary differential equation representing the liquid phase. Yet, this liquid-phase differential equation accounts for the countering effects of the gas shrinkage and expansion caused by gas depletion and absorption and reduced liquid hydrostatic head. The differential equation was solved analytically by the method of variation of parameters. Expressing that design model in terms of dimensionless operating parameters and with the available analytical solution of the differential equation, the model predictions of the dissolved and gaseous ozone profiles along the column height were examined using a simple spreadsheet approach. The 1P-ADM was initially tested to evaluate its predictions of the dissolved ozone profiles for water treatment conditions. The model provided excellent predictions of the residual ozone profiles along the bubble column for the co-current and counter-current flow modes.

Colour and Chloride Removal from Kraft Pulp Mill Effluent by Ion-exchange

Gi-yeon Yun

Department of Civil and Environmental Engineering, University of Alberta, Edmonton, AB

Colour and chloride removal from a pulp mill effluent using various ion-exchange resins was studied in batch mode, bench scale. The tested nine resins involve strong basic anion resins including IRA67 and IRA92 as well as weak basic anion resins including IRA400, IRA402, IRA458, IRA900, IRA958, IRN78 and 4400OH. This batch testing is used for selecting more effective ion-exchange resins for decolourisation and chloride removal and for testing various types of regenerants. According to overnight ion-exchange test results, IRA458, IRA900 and IRA958 in chloride form were the most effective resins to remove colour-causing compounds from the pulp mill effluent. For the chloride removal, IRN78 in free base form and 4400OH in hydroxide form were found to be most effective. NaOH alone and in combination with NaCl were tested as regenerants for these resins. The combination of NaOH and NaCl was found to be the more efficient regenerant. Significant chloride concentration increase was observed during decolourisation using virgin resins in chloride form. Therefore, NaCl addition should be reduced to as little as possible so that the chloride concentration does not significantly increase during ion-exchange using regenerated resins. Further column tests are expected to reveal colour and chloride breakthrough characteristics. Moreover, cyclic exhaustion and regeneration studies will show the optimum conditions for treating the pulp mill effluent with considering the mechanical damage and removal efficiency.

Aging Discrepancies of White Spruce Affect the Interpretation of Recruitment Processes in Mixedwoods

Vern Peters

Biological Sciences, University of Alberta, Edmonton, AB

Post-fire recruitment patterns of white spruce on Mixedwood sites in Alberta are highly variable over time. While previous studies show that some immediate recruitment does occur, most trees appear to recruit between 5-50 years following fire. Uncertainty in recruitment timing may arise from underestimates of true age from ground level disks, and the failure to use crossdating techniques to identify missing rings. Our objective was to determine if age at ground level adequately depicts initial recruitment periods, and to determine if age underestimation increases with time since fire. Spruce were collected from a minimum of two stands per fire, on six fires occurring in most years between 1991-1941. Trees were cut at ground level, and the below ground portion of trees were excavated. Estimates of the true age were obtained by crossdating the below ground portion of trees with skeleton plots and doing ring width analysis with Cofecha. Ground level ages accurately demonstrated that most recruitment occurred in the first year following fire in 7 year old fires; however, a lag in recruitment, and an extended period of recruitment occurred in older stands. Crossdating techniques demonstrated that ground level age underestimates true age by a minimum of 2.1 years, and 9.9 years in 19 and 37 year old stands respectively. We conclude that considerable aging errors on suppressed trees have inaccurately depicted continuous recruitment patterns during early stand development stages. These results present a different picture of white spruce succession in mixedwood forests and have important implications for forest management.

Structure and Dynamics of Boreal Forest Stands in the Duck Mountains, Manitoba

Cary Hamel and Norm Kenkel

Department of Botany, University of Manitoba, Winnipeg, MB

A synoptic overview of the long-term dynamics of forest stands in the Duck Mountains of west-central Manitoba is presented. We reconstructed the initial post-fire composition of 62 stands (minimum 1 ha in size, three 10 x 10 m plots per stand) by enumerating and aging the post-fire canopy cohort, including live, standing dead, and fallen trees. Five fire-initiated stand types were recognized: (1) trembling aspen, $n = 17$; (2) balsam poplar, $n = 11$; (3) white spruce, $n = 14$; (4) jack pine, $n = 13$; (5) black spruce, $n = 7$. For each stand-type, stand dynamics were summarized using age and size-class analyses of individuals in the canopy and advance regeneration layers. Consideration was also given to the autoecology of tree species, and to small-scale natural disturbances such as windthrow, ungulate herbivory, insect pests, pathogens, and beaver activity. We outline stand dynamics of each forest stand-type, and discuss the implications of our findings to the sustainable management of Duck Mountain forests.

An Assessment of a GIS-based Habitat Model for Canada Lynx in west-central Alberta

Andrea Doucette

School for Resource & Environmental Studies, Dalhousie University, Halifax, NS

Modern forest management must consider biodiversity conservation if biological and ecological conditions are to be maintained for future generations. Millar Western Forest Products in Whitecourt, Alberta has initiated a Biodiversity Assessment Project for its Forest Management Agreement area. Models have been developed for assessing spatial patterns, ecosystems, and wildlife habitat relationships within the FMA. The project at hand is to test the Habitat Suitability Index (HSI) model written for the Canada Lynx, which is specific to the Whitecourt area. This

model requires thorough testing to establish model performance and reliability prior to its use in forest management planning.

The project has undergone extensive testing through a specially designed sensitivity analysis and field research. The sensitivity analysis consists of 3 time periods with each period containing a total of 96 sensitivity tests, which investigates the degree of change to projected cover, denning, and food habitat. Field research was conducted from January to March, 2000. Data was collected using a snow-tracking technique and the focus was to explore how the lynx uses the forest for cover habitat. This data, as well as other data available through other sources, has provided the model user to assess whether the predicted cover habitat requirements suggested in the model meet those discovered in the forest.

Evaluating, Comparing, Analysing and Linking Local Collaborative Forest Management Outcomes, Processes and Social Capital

Mark Robson

Faculty of Forestry, University of Toronto, Toronto, ON

After the most comprehensive public hearings ever held on forestry in Canada, Ontario's Environmental Assessment Board and subsequently, Ontario's Crown Forest Sustainability Act, directed the Ministry of Natural Resources (MNR) in 1994 to establish collaboration in forest management planning in the form of Local Citizen's Committees (LCCs). Collaborative and community-based processes are often seen as promising new approaches that can reduce stakeholder conflict, allow ecological, social and economic issues to be addressed simultaneously and result in better natural resource decisions. However, research and early reports suggest collaborative processes are not always successful. The purpose of this research is to determine why this is so by comparing three LCCs representing districts with aboriginal interests in Ontario's boreal forest region. The presentation will outline the methodology that will be used to evaluate, compare, analyse and link LCC outcomes with potential sources of success such as LCC processes and local social capital. By identifying when, where and how LCCs are most successful, the research will enable MNR to achieve some of its objectives for LCCs, help forest managers decide which approaches to use in which circumstances, help policymakers improve the effectiveness of their policies, and contribute to collaborative decision-making theory.

Integrating Aboriginal Values into Forest Management Planning

Melanie Karjala and Stephen Dewhurst

Natural Resources & Environmental Studies, University of Northern British Columbia, Prince George, BC

A process for documenting, translating, and applying local Aboriginal community values into forest management plans has been developed for the 13,000 ha John Prince Research Forest (JPRF) in Central Interior British Columbia. The JPRF is co-managed by the University of Northern British Columbia and Tl'azt'en Nation for research, education and training. Social and ecological criteria and indicators have been identified using social science techniques, and an analytical decision support tool was used to incorporate quantitative, spatial and qualitative indicators into an integrated, long-term management strategy for the forest. A scenario planning approach is used to explore a range of possible management options. Preliminary results and observations will be presented.

POSTER PRESENTATIONS

Influence of Forest Fire on Methyl Mercury in Food Webs of Boreal Plain Lakes

Erik Allen

Biological Sciences, University of Alberta, Edmonton, AB

Methyl mercury (MeHg) concentrations in fish from remote boreal lakes often exceed the Canadian consumption advisory limit of 0.5 mg/kg. Atmospheric deposition of mercury (Hg) is the primary source of contamination for isolated systems. Following deposition, Hg binds to soil organic matter and is carried into lakes and streams via runoff. Bacteria convert Hg to MeHg, an organic compound that accumulates in biota. Disturbance of a watershed, through forest fire or timber harvest, can expose soils to erosion and may increase Hg inputs to streams and lakes. I propose to examine the influence of forest fire on MeHg in aquatic food webs. I will compare concentrations of MeHg in macroinvertebrates and fish from burned ($n = 5$) and reference (7) catchments in the Boreal Foothills ecoregion, 200 km north-west of Edmonton, Alberta. Lakes were sampled monthly from June-September 2000. Water quality data were collected to assess possible correlations with MeHg in aquatic biota. I collected macroinvertebrates from 4 functional feeding groups (collectors, scrapers, grazers, predators) in order to study the role of food source in MeHg accumulation. As prey of fish and waterfowl, aquatic macroinvertebrates contribute to the MeHg concentrations of commercially important species. My proposed research will be the first comprehensive study to relate watershed disturbance, feeding habit, and water chemistry to MeHg in the aquatic biota of Boreal Plain lakes.

Woodland Caribou Habitat Identification With Landsat TM Imagery

Robert Bechtel¹, Dr. Arturo Sánchez-Azofeifa¹, Dr. Benoit Rivard¹, George Hamilton², John Martin² and Dr. Elston Dzus³

¹ Earth Observation Systems Laboratory (EOSL), Dept. of Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB

² Alberta Environment, Edmonton, AB

³ Alberta-Pacific Forest Industries Inc., Boyle, AB

Woodland caribou habitat mapping in northern Alberta is incomplete and imprecise, as habitat relationships are not fully understood, and land cover mapping is neither consistent nor complete. The spectral reflectance information that can be obtained through remote sensing observations makes possible the identification of woodland caribou habitat over large areas. With the use of Global Positioning System (GPS) collars fitted on the animals, correlations between satellite observations and GPS caribou locations can now be explored. This study examines Landsat 5 TM imagery of the Wabasca region in relation to a dataset containing over 100,000 caribou locations acquired from GPS radio-collars for 36 individuals. The intent has been to determine if reflectance characteristics can be related to caribou selection or avoidance. If so, it should be possible to predict caribou habitat in areas where there are no GPS-collared animals. Reflectance classes preferred by caribou were grouped into three categories. These were preferred, regardless of season (70% of all caribou locations). The first class appears to be dominated by black spruce (*Picea mariana*), which occupies 31.6% of the entire study area and accounts for 47.9% of the caribou locations. The second class is characterized by shrubby fen. It occupies 13.0% of the entire scene and accounts for 15.2% of the caribou locations. The final class is also peatland-related, but it has not yet been characterized by physiography or vegetation type. It makes up only 3.7% of the study area, but accounts for 7.4% of the caribou use. The remaining 30% of the telemetry locations fall within various cover types that were not preferred by caribou. This study demonstrates how remote sensing, Geographic Information Systems techniques, and ecological

information can play a critical role in the implementation of sustainable forest management practices.

Reconstruction of the Presettlement Eastern Lower Boreal Forest in the Rimouski area (Eastern Québec)

Yan Boucher and D. Arseneault

Université du Québec à Rimouski, Département de biologie, Rimouski, QC

During the last 150-200 yrs, logging has dramatically altered forest structure and composition in the eastern mixed woods of Quebec's southern boreal forest. In addition, pest outbreaks and forest fires have had a great impact on the forest. The objective of this study is to reconstruct the evolution of the forest structure and composition during the last two centuries in the Rimouski area (Eastern Québec). A 2,5 km² area was selected in each of the two main forest types in this area: a spruce-aspen-fir forest at a mid elevation (130-200 m asl) and a maple-birch-fir forest at a high elevation site (230-260 m asl). At each location, sampling plots were systematically located using a 100 m X 100 m grid system. At each plot, present day age structure and vertical structure and composition of the forest were described in a 0,04 ha plot. Stump and coarse woody debris were also sampled (disk section) for species identification and dendrochronological analysis. This study is part of aimed at describing the precolonial forest mosaic's key elements, both structural and composition related. This exercise will generate a list of precolonial-equivalent conditions, when met for the most part, should enable us to recreate an environment that is conducive to biodiversity. Each of these elements will become an indicator measured in term of the difference between current conditions (present state of the forest) and optimal conditions (precolonial forest).

The Integration of Forestry and Oil and Gas Policy Regimes: Opportunities and Constraints

Colette Fluet and Norah MacKendrick

Department of Rural Economy, University of Alberta, Edmonton, AB

The northern boreal forest is a region of multiple resource extraction activities, including timber harvesting and oil and gas development. One key factor in the sustainability of this region is the compatibility of these various natural resource policies to the regional context in which they are implemented. In particular, there is a limited understanding of the institutional and political capacity for integrating the management of forestry and oil and gas developments. The Sustainable Forest Management Network is sponsoring a project that will expand knowledge in this area and address the challenge of integrating forest and oil and gas policies for the sustainability of this region. The project will consist of an analysis of the provincial regulatory regimes that pertain to forestry and oil and gas industries, and an assessment of the current areas of conflict. It will also look at the co-ordination and integration between the two industries in forest management in Northern Alberta.

Impacts of Forest Floor Disturbance on Vegetation, Nutrient Dynamics and White Spruce Seedling Growth in Clearcut and Partial-cut Stands

Brent R. Frey, V.J. Lieffers and A. D. Munson

Renewable Resources, University of Alberta, Edmonton, AB

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, NH₄-N, Ca, Mg and K were higher in clearcut stands while NO₃-N was higher in partial-cuts. Within disturbance plots, burns had the highest levels of NH₄-N and NO₃-N in both harvest types, while control plots had the lowest NO₃-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 NH₄-N:NO₃-N was greatest in clearcut stands and lowest in burns suggesting relatively lower rates of nitrification in clearcuts and relatively higher nitrification or reduced NO₃-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.

Assessing the Risk of Vertebrate Extirpation in Ecosystem Management in Northern New Brunswick

J.W. Higdon¹, D.A. MacLean¹, J.M. Hagan² and J.M. Reed³

¹ Faculty of Forestry and Environmental Management, University of New Brunswick, Fredericton, NB

² Division of Conservation, Manomet Center, Brunswick, ME

³ Department of Biology, Tufts University, Medford, MA

An important goal of ecosystem management is to maintain biodiversity in managed forest landscapes. Several methods have been developed and used to provide an index of biotic integrity, and these have come with varying levels of success. The species sorting algorithm presents a new, more comprehensive, method of assessing biotic integrity. It assesses the potential ability of a landscape to support all terrestrial vertebrate species. This coarse-filtered, spatially explicit modeling tool best 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. This 190,000 ha management district represents some of the most intensively managed forest lands in Canada. The project began in September 2000 with an anticipated completion date of September, 2002. A natural disturbance model is being developed as a companion project to this risk assessment. Landscapes that will be used to assess the biotic integrity of forest management activities include: 1) the 1950, pre-intensive silviculture and harvesting forest, derived from interpretation and digitizing of late 1940's aerial photos of the forest; 2) the present forest; 3) a simulated current forest based upon simulation of natural (but no anthropogenic) disturbances applied to the 1950's forest; and 4) the projected forest in year 2025, based upon planned management actions.

Species and Stand Dynamics after Fire in the Coniferous Boreal Forest of North-Western Quebec

Nicolas Lecomte

URDFAT, Université du Québec en Abitibi-Témiscamingue, Rouyn-Noranda, QC

In the eastern boreal forest, burnt areas are usually recolonized by stands dominated either by black spruce, jack pine or trembling aspen. The regenerative capacity after fire of these species (serotinous or semi serotinous cones and root systems that survive fires) favour a post-fire composition similar to the pre-fire composition. Therefore, when the fire cycle is shorter than the life span of the dominant species, arboreal vegetation dynamics is reduced to understanding the

population dynamics between fires with the fire behavior acting as the filter between one generation of trees to the next. However, recent studies in the boreal forests of Ontario and Quebec have demonstrated a large variability in the fire frequency (50-500 yrs) and in forest composition during the Holocene. Furthermore, dendrochronological reconstructions have shown a dramatic decrease in fire frequencies since the mid-nineteenth century, which corresponds to a decrease in the frequency of dry periods during the fire season since the end of the Little Ice Age (1850). Since, the fire cycle appears to be increasing in conjunction with global climate change, it is important to understand the chronology of stand dynamics after fire in the long-term (>250 yrs) to better predict and hence mitigate the ecological effects associated with global climate change. The primary objective of this study is to reconstruct the long-term compositional and structural evolution of the three different post-fire stands. We will utilize three methodologies to attain our objective: a dendroecological stand reconstruction approach, a description of the stratigraphy of organic profiles and a detailed analysis of a chronosequence of stands.

Fouling Control Strategies for Membrane Filtration in Water/Wastewater Treatment

Warren Martin

Dept. of Engineering, University of Guelph, Guelph, ON

Increased public and government pressure have led to stricter water and wastewater treatment standards. In some instances, current technologies are not able to meet these new standards and new treatment processes have to be developed. Membrane filtration is a developing treatment technology that has been proven successful in meeting these enhanced treatment standards. However, the design of membrane filtration systems is still largely empirical since the fundamental processes governing the flux decline, or fouling, are not well understood. Therefore, a considerable amount of research is currently being directed to understanding the membrane fouling mechanisms and developing new fouling control strategies.

The objective of this project is to study specific membrane fouling mechanisms and devise new control strategies using theoretical and empirical analyses. Specifically, this project will use Computation Fluid Dynamics (CFD) to predict the micro and macro scale hydrodynamic interactions between submerged, circular membrane tubes and water. It is hoped that a greater understanding of the hydrodynamic forces acting on the membrane system will enable improved membrane fouling control strategies to be developed. New fouling control strategies will then be tested under different conditions using an experimental apparatus to determine their actual efficiency in reducing membrane fouling.

Towards a Typology of Forest-Based Social Values. The Point of View of a Forest Dependent Community: The Haut-St-Maurice (Quebec)

Catherine Martineau-Delisle

Forestry and Geomatics, Laval University, Quebec, QC

Forest managers are increasingly required to consider public values and policy preferences in their decisions. This study aimed to understand and describe the views of rural residents of the surrounding forest and the meanings that they attached to it. Research results illustrate that the first step in incorporating people relationships to the forest into public land management is to identify and legitimate the diversity of stakeholders and of values. This constitutes an essential step to enable forest managers to manage resources in ways which are socially acceptable. The primary objective of the study was to use empirical data to develop a typology of forest values based on relationships between residents of a forest-dependent community and the forest. Using non-probability sample techniques, qualitative data were collected from 32 personal interviews and analyzed using a qualitative inductive approach. This approach attempts to recognize nuances of attitudes that might escape researchers using methods that emphasize deduction and

quantification. The analysis of meaning of place as described by the respondents resulted in a typology describing six different relations between residents and the forest : industrial; ecological; amenity recreo-tourism; wild recreo-tourism; amenity leisure; and wildlife leisure. The typology is based on dimensions or categories that were distilled from the respondents discourse: the forest attributes and qualities that are valued; the type of forest attachment (economic, affective, ecosystemic) and the strength of attachment; and the forest management activities that are considered acceptable. Our results reveal great diversity and complexity in regard to the forest-based social values held by stakeholders in forest dependent communities.

Characterizing Historical Forest Structure and Species Composition to Determine Criteria and Indicators for Forest Restoration in a Working Forest

Michelle McGregor

Department of Forestry, University of Northern British Columbia, Prince George, BC

Restoration ecology involves restoring the structure and function of a damaged system to some prior point in time by accelerating natural ecological processes within the system (Hobbs and Norton 1996). The study area is a 13, 000 ha landbase located 50 km north of Fort St. James in the central interior of British Columbia. It is hypothesized that the stand structure and species composition of the John Prince Research Forest has been altered from historical norms due to the interaction of natural processes, fire suppression, and timber harvesting activities. To characterize historical stand structure and species composition on the Research Forest we will analyze historical records of harvesting and management activities, and interview experiential knowledge holders. This information will be compared with a comprehensive forest inventory to evaluate change in the Research Forest from the time of timber harvesting to the present. From this information will develop criteria and indicators for purposes of designing a management scenario for forest ecosystem restoration on the Research Forest. The target state to restore to has been defined as the forest state prior to the commencement of harvesting activities; and we will design a management scenario which, combined with natural processes, will accelerate the natural processes to reach this target using active forest management.

Developing Sustainable non-timber forest products in the Gwich'in Settlement Area

Gordon Murray

Rural Economy, University of Alberta, Edmonton, AB

Introduction

For many northern communities the boreal forest may not be suitable for the production of traditional fibre forest products such as sawlogs and pulp. In these communities, the forest may offer the ability of individuals to generate subsistence benefits through the collection of bush foods, trapping and clothing. In pursuing economic development opportunities it is fair to ask whether these subsistence activities can be further developed to generate income for the community. This poster/project involved the examination of the potential for some income earning non-timber forest products in the Gwich'in Settlement Area to be incorporated into a sustainable forest management plan. This research concentrated on foods, primarily berries, fungi, and other edible plants.

Methodology

For the 2000 field season, the various fruit bearing plants which grow in the area were identified and examined in order to find their levels of production and abundance of fruits. During the month of June, 24 transects were placed between the of Inuvik and Fort McPherson in forest areas along the Dempster highway. The transects were located in white spruce, black spruce, and paper birch stands, as well as peat/bog areas. After full leaf expansion the areal cover of each plant species was estimated on various plots at 5m intervals. During the last week of July and the

first part of August each site was revisited to derive the estimates of the actual quantities of berries. On six, 1m squared plots the percent cover of the berry plants and all berries were collected. Samples of the berries were collected and dried to determine the water content and dry weight.

Conclusion

It was found that the sites with the highest diversity of berry species was the white spruce and black spruce stands (with 7 species) followed by the paper birch stands and finally the peat/bog areas (with 4 species). However the sites with the highest productivity levels was that of the peat/bog sites, followed by black spruce sites, white spruce sites and finally the paper birch sites.

Effects of Slash Loadings and Site Conditions on the Regeneration Dynamics of Harvested Aspen Stands

S. Murray and N.C. Kenkel

Department of Botany, University of Manitoba, Winnipeg, MB

The objectives of this study are: (1) to evaluate the impacts of harvesting on plant biodiversity and community structure, and (2) to determine the factors controlling regeneration patterns after harvest. Our survey compared the understory vegetation of harvested, edge and intact aspen dominated forest in Duck Mountain Provincial Forest Reserve, Manitoba. Sampling was restricted to hardwood stands dominated by aspen (> 60% cover) harvested between the summer of 1996 and the winter of 1998-1999. A stratified random sampling design was used, dividing each cut block into three strata. A transect was randomly located in each strata, along which three 10m x 10m plots were located: (1) harvested plot, located at least 40m from cut edges or residual forest; (2) unharvested forest edge; (3) unharvested plot, located at least 50m from the cut edges. Biotic variables recorded within each plot included: (1) density, cover and height of shrub species and saplings; (2) sapling age; (3) herb species cover; (4) age, basal diameter and cover of canopy trees. Abiotic variables included: (1) slash loadings and decay class; (2) soil identification, texture, pH and conductivity; (3) slope and aspect. A total of 34 cutblocks were enumerated in 1999 and 2000. Preliminary results summarizing the response of understory species diversity and community structure (herb and shrub species) to aspen harvesting are presented.

Optimization-Based Forest Planning Tools for Sustainable Forest Management

David Nanang

Department of Rural Economy, University of Alberta, Edmonton, AB

The purpose of this research is to formulate and solve three related forest management planning models: 1) forest scheduling with access constraints; 2) analyzing the costs of regulatory constraints; and 3) forest scheduling with access and non-timber benefits. The first paper models long-term timber supply on two Weyerhaeuser Forest Management Agreement (FMA) areas with explicit consideration of access and its effects on strategic timber supply analysis. Secondly, the costs of regulatory constraints of overlapping tenures in Alberta are analyzed. The objective of this paper is to investigate the costs of implied constraints due to overlapping tenures on two Weyerhaeuser FMAs in Edson and Drayton Valley in Alberta. The third paper deals with the incorporation of human choice models into forest scheduling problems. Specifically, the benefits of hunting moose in the study area will be incorporated into the scheduling problem to examine the effects of non-timber values on long-term timber supply. The solution technique used to solve all three models is a decomposition method introduced by Hoganson and Rose (1984). This method combines the advantages of simulation models with optimization approaches and is based on stand level economic analysis and price adjustment procedures. It is hoped that results of this study will among other things, provide insights into how integrated forest products companies can develop management plans given the forest-planning environment in Alberta and also

information that may be useful for formulating forest management policies especially related to overlapping tenures in Alberta.

The Distribution of Bark Beetles in a Harvested Landscape

Jane Park

Department of Biological Sciences-Ecology Division, University of Calgary, Calgary, AB

Heterogeneity in landscapes is expected to affect the distribution of animals in terms of both habitat availability and movement between habitats. In the case of bark beetles (Scolytidae) differences in stand composition may also affect flight preferences based on the probability of finding a suitable host tree. Decreased tree density may also influence where bark beetles fly, due to changes in microclimate, ability to detect host tree chemicals and ease of movement. In this study, at the EMEND study site, we examined the distribution of dispersing bark beetles in four stand types and four harvest levels (90% harvest, 80% harvest, 50% harvest and uncut control) with three replicates of each combination.

Baited 12-funnel Lindgren traps were used to trap bark beetles as they dispersed over the EMEND landscape. *T. lineatum* was examined to determine the effects of harvest on the distribution of *T. lineatum*, as well as the effect habitat availability and probability of finding suitable habitat on the dispersal

T. lineatum. Data from 1998 (pre harvest) was analyzed and it was determined that there was a relatively even distribution of *T. lineatum* on the landscape prior to harvest. When these data were compared to post harvest data, they showed that there was a spatial redistribution of *T. lineatum* upon the application of harvest treatments, with a significant increase in *T. lineatum* where harvest had occurred ($p=0.0001$).

If *T. lineatum* are able to estimate the probability of finding suitable habitat in a stand, then we may expect them to avoid stands with few conifers. Statistical analyses (regression analyses) showed that numbers of *T. lineatum* were positively correlated with the proportion of coniferous trees found in a stand ($p=0.04$). When the effect of harvest treatment (habitat availability i.e. number of spruce stumps) was examined, it was found that there was no effect of harvest on the dispersal of *T. lineatum* ($p=0.001$). These results suggest that the movement of *T. lineatum* across the landscape is influenced by habitat availability as well as the probability of finding suitable habitat.

Combining Scientific and First Nation Knowledge for the Management and Harvest of Traditional and Commercial Non-Timber Forest Products

Tracy Ruta¹ and Brennan Wapioke²

¹Natural Resources Institute, University of Manitoba, Winnipeg, MB

²Shoal Lake Resource Institute, Iskatewizaagegan Independent No.39 First Nation

Non-timber forest products (NTFPs) are any products, other than timber, harvested from a forest ecosystem. NTFPs are now recognized as an important vehicle for including local people in forest management, ensuring there is a sharing of benefits, and decreasing pressure on the forest ecosystem from timber harvesting. The poster outlines a project that has as its purpose the development of a model for cooperative research between First Nation harvesters and scientific researchers in order to build sustainable rural livelihoods through traditional and commercial harvesting of non-timber forest products. To achieve this, a case study is being undertaken in the Shoal Lake watershed, Northwestern Ontario. Cooperation between a First Nation community and university researchers is an integral component of this project. The poster describes this working relationship through outlining the data collection approaches used in the summer of 2000 as part of field work that considered the distribution and abundance of NTFPs in relation to disturbance (such as fire and logging).

Conducting Forestry Research in First Nation Communities: Notes from the Field

Tanja Schramm, Leslie Treseder, and Naomi T. Krogman
Renewable Resources, University of Alberta, Edmonton, AB

Our poster presentation draws from our field experiences conducting research with the Little Red River Cree Nation and the Tallcree First Nation in Northern Alberta. The poster intends to communicate some of our experiences and lessons learned during the different phases of planning and conducting our fieldwork. Research in Aboriginal/First Nation communities differs in some ways from related research in mainstream Western societies. Issues of patience, cultural awareness, and knowledge of the proper protocol make a significant difference in the success of a project. Generally, this type of research requires a lot of time, both in the planning and in the fieldwork stage. Our presentation will primarily focus on issues of planning and logistics.

Objectives include:

- To describe our experiences doing social science research in / with Aboriginal communities.
- To inform other academics and potential funders of the considerations involved in funding and conducting this kind of research.
- To offer some suggestions for facilitating and supporting this kind of research.

Consequences of Increased Tree Vigour through Commercial Thinning on Bark Beetle Reproduction

Colleen M. Simpson and Mary L Reid
Department of Biological Sciences, University of Calgary, Calgary, AB

Intensive forest management strategies are becoming an increasingly common means of maximizing timber production, mainly through increasing the rate at which trees grow. However the biological and ecological consequences of such manipulations remain unknown. Of particular concern are the consequences of increased tree vigour on herbivores, since some herbivores may benefit from enhanced tree vigour and diminish the yields from intensive forest management.

I will evaluate the effects of commercial thinning on bark beetles (Scolytidae). Commercial thinning is a forest management practice in which mature trees are thinned to enhance the vigour and growth of the remaining trees for future harvest. The study system consists of thinned and unthinned mature lodgepole pine stands near Whitecourt, AB, with pine engraver beetles (*Ips pini*) as the primary bark beetle. Thinning may affect the nutritional quality of phloem (inner bark) in terms of both nutrients and defences, thereby directly affecting the reproductive success of bark beetles. Preliminary results from my study site indicate that phloem sampled from trees in thinned stands have increased levels of nitrogen, compared to phloem from unthinned stands. Future chemical analyses will examine the effects of thinning on defensive chemicals. My research will focus on the response of breeding bark beetles to these changes in host plant quality in both live and freshly fallen trees. The *Ips*/lodgepole pine system is ideal for the study of such interactions because once a log is colonized it can be considered a closed system where a number of beetle life history traits can be quantified with relative ease. Through the use of felled trees derived from thinned and unthinned stands whose logs are placed in each stand type, I will be able to compare various fitness and life history traits of pine engravers and attribute them to either host tree quality or indirect stand effects (e.g. on temperature). These results for individual bark beetles will be linked to data on population sizes that are monitored concurrently with funnel traps; trapping over the past 5 years has indicated higher numbers of pine engravers in thinned than in unthinned stands. Experimental implantation of beetles can also be used to achieve a more controlled picture of reproductive behaviours in selected logs. Thus, this study will link increased tree vigour to its nutritional quality for a primary herbivore, thereby elucidating a key ecological relationship resulting from intensive forest management.

Spatial and Temporal Patterns of Natural Disturbance in Northern New Brunswick

Amanda Smith¹, David A. MacLean¹, Ian Methven³, and Kevin Porter⁴

¹ Faculty of Forestry and Environmental Management, University of New Brunswick, Fredericton, NB

² Centre for Property Studies, University of New Brunswick, Fredericton, NB

³ Canadian Forest Service, Atlantic, Forestry Centre, Fredericton, NB

It is currently accepted that forest dynamics are largely shaped by natural disturbances. It is with this logic that Pickett and White (1985) suggested that temporal and spatial scale of management should be based on natural disturbance regimes. In order for this to occur, natural disturbance regimes need to be defined quantitatively in terms of disturbance agent, severity, frequency, and extent for particular regions. This will require development of forest characterization that can be measured in time and space, as well as defining forest and stand disturbance responses. This will allow an analysis of the effects of disturbance on stand structures and forest patterns.

The objectives of this project are two-fold: 1) to define natural disturbance regimes and to quantitatively characterize the forest, in order to specify disturbance regimes for each vegetation community; and 2) to develop and use natural disturbance modeling tools to simulate stand structures and forest patterns, to analyze effects on species composition, patch size, and age class distribution. This project will be based on a case study in northwest New Brunswick on the 190,000 ha JD Irving Black Brook District. Related studies will determine spatial and temporal patterns of human-caused disturbance (silviculture and harvesting) from the late 1940's to the present, and the risk of extirpation of vertebrate species based on actual and simulated landscape patterns. The project began in September 2000 and the anticipated completion date is 2002.

Pickett, S.T.A. and White, P.S. 1985. The ecology of natural disturbance and patch dynamics. Academic Press. London.

Examining the Bacterial Community Structure within a Pulp Mill Effluent Treatment System

Nancy Smith

Microbiology, University of British Columbia, Vancouver, BC

The temporal stability of the bacterial community in a UNOX activated sludge system for treatment of pulp mill effluent was examined. Bacterial communities can now be elucidated by methods other than traditional cultivation techniques, which is particularly important since approximately 99% of bacteria are estimated to not be culturable by liquid enrichment or by plating on solid media. In this study, the ribosomal intergenic spacer (RIS), located between the 16S and the 23S rRNA genes, was amplified. The length polymorphism (LP) profile of the RIS for each sample was determined. LP profiles compared among samples taken on Day 1 of the study with samples taken four weeks later, during the mill's annual shutdown and one week post start-up (after the annual shutdown) displayed changes, which suggest that there are temporal changes in the microbial community structure. The change in the LP profile of the Shutdown sample relative to the Post Start-up sample appeared to be more drastic compared to the change of the Shutdown sample relative to Pre-shutdown and Day 1 samples. The RIS fragments from selected samples were cloned and classified according to restriction fragment length polymorphisms (RFLP). Phlotypes were defined by unique RIS-RFLP patterns. Between the Day 1 samples and the samples taken four weeks later, phlotype overlaps occurred; however, unique phlotypes were also observed between the two samples. The Shutdown sample had the lowest phlotype abundance compared with the other sampling times. This study suggests that the bacterial community in a UNOX pulp mill effluent treatment system is dynamic with its composition constantly changing over the operation of the mill. It was determined that more clones need to be analyzed to provide data that better represented the system studied. The most

abundant phylotypes were phylogenetically identified on the basis of partial 16S rRNA gene sequences.

Modelling the Light Environment in Mixed-Species Boreal Forest Stands

Kenneth J. Stadt and Victor J. Lieffers

Renewable Resources, University of Alberta, Edmonton, AB

Alternative silvicultural systems require innovative models to predict the growth of regenerating species. Light is the limiting factor for growth in the understory of aspen-spruce mixedwoods, uneven-aged and partial-cut forests. To better predict tree growth in these environments, we developed and calibrated a model to predict the light received in the understory of any mixture and spacing of the common boreal tree species. This model, MIXLIGHT, takes a list of tree species and diameters, estimates their leaf area, and calculates instantaneous or seasonal light transmission through their canopy. Light levels can be estimated to the microsite level if tree positions are known, otherwise stand-level estimates can be generated. In this poster, we present the structure and flexibility of MIXLIGHT, demonstrate its effectiveness on the stand scale, and outline our current work on microsite-scale validation.

An Integrated Forest Management Strategy

Pia Wilkinson-Chapman

Canadian Circumpolar Institute, University of Alberta, Edmonton, AB

The poster outlines the goal of the partnership between Alexis First Nation (AFN) Millar Western Forest Products (MWFP) and the University of Alberta (Canadian Circumpolar Institute) to achieve four primary objectives: 1) the application of aboriginal knowledge (temporal/spatial) in industrial forest management; 2) provide a source of training and capacity building at the community level to enable Aboriginal communities to participate equitably in forest management; 3) to provide an additional increment of Aboriginal, industry and university cooperation to further indicate the viability of partnerships in land use planning and socio-economic development; 4) to establish a framework for First Nation – industry cooperation through continued monitoring and evaluation.

The poster will outline the strategies, research and training that is hoped to lead to the development and implementation of capacity-building programs in cultural, natural resource and business management that will further enhance the long-term involvement of the AFN in forest management.

Incremental to the project is Millar Western's long-term commitment to promote the economic development of the AFN through their enhanced involvement in all phases of woodland operations. The goal of Millar Western is to increase employment opportunities for Alexis band members in all phases of operation, from planning to production. The aim of the project then is to establish a parallel management structure to work cooperatively with Millar Western in meeting the objectives.

LIST OF PARTICIPANTS

Erik Allen
University of Alberta
Biological Sciences
Biological Sciences Bldg
Edmonton, AB T6G 2E9
Ph: 780-492-6304
ewallen@ualberta.ca

Robert Bechtel
University of Alberta
Earth & Atmospheric Sciences
1-26 Earth Sciences Building
Edmonton, AB T6G 2E9
Ph: 780-492-3265
Fax: 780-492-2030
rbechtel@ualberta.ca

Yan Boucher
Université du Québec à Rimouski
Biology
308, rue du Bourgeois, apt. 317
Rimouski, QC G5L 7P9
Ph: 418-724-0788
Fax: 418-724-1849
yanb33@hotmail.com

Andrea Doucette
Dalhousie University
School of Resource & Environmental
Studies
1312 Robie St
Halifax, NS B3H 3J5
Ph: 902-494-1364
Fax: 902-494-3728
amdoucet@is2.dal.ca

Treana Fenniak
University of Alberta
Renewable Resources
4-42 Earth Sciences Bldg
Edmonton, AB
Ph: 780-481-2326
tfenniak@ualberta.ca

Colette Fluet
University of Alberta
Rural Economy
#203, 10101 Saskatchewan Drive
Edmonton, AB T6E 4R6
Ph: 780-435-9985
cfluet@ualberta.ca

Brent Frey
University of Alberta
Renewable Resources
4-42 Earth Sciences Bldg
Edmonton, AB T6G 2E3
Ph: 780-492-2409
Fax: 780-492-1767
brent.frey@yahoo.com

Edenise Garcia
Université de Montréal
Sciences biologiques
5730A Wilderton
Montréal, QC H3S 2K7
Ph: 514-739-9021
Fax: 514-739-9330
garciae@ere.umontreal.ca

Mohamed G. El-Din
University of Alberta
Civil & Environmental Engineering
304 Environmental Engineering Bldg
Edmonton, AB T6G 2M8
Ph: 780-492-9094
Fax: 780-492-8289
mgg1@ualberta.ca

Cary Hamel
University of Manitoba
Botany
435 Buller Bldg
Winnipeg, MB R3T 2N2
Ph: 204-474-9525
caryhamel@canada.com

Jeffrey Higdon
University of New Brunswick
Forestry & Environmental Mgmt
P.O. Box 44555
Fredericton, NB E3B 6C2
Ph: 506-447-3339
Fax: 506-453-3538
f7brd@unb.ca

Mélanie Karjala
University of Northern BC
Forestry
3333 University Way
Prince George, BC V2M 2T8
Ph: 250-960-5741
Fax: 250-960-5539
karjala@unbc.ca

Lance Lazaruk
University of Alberta
Renewable Resources
4-42 Earth Sciences Bldg
Edmonton, AB T6G 2E3
Ph: 780-492-5597
Fax: 780-492-1767
llazaruk@ualberta.ca

Nicolas Lecomte
Université du Québec en Abitibi-
Témiscamingue
URDFAT
445 boul. de l'Université
Rouyn-Noranda, QC J9X 5E4
Ph: 819-762-0971
Fax: 819-797-4727
npylecomte@hotmail.com

Sarah Lieffers
University of Saskatchewan
Soil Science
51 Campus Drive
Saskatoon, SK S7N 5A8
Ph: 306-966-6882
Fax: 306-966-6881
sm1127@usask.ca

Michelle MacGregor
University of Northern BC
Forestry
3333 University Way
Prince George, BC V2M 2T8
Ph: 250-960-5677
Fax: 250-960-5839
macgregm@unbc.ca

Norah MacKendrick
University of Alberta
Rural Economy
515 General Services Bldg
Edmonton, AB T6G 2H1
Ph: 780-437-2069
Fax: 780-492-0268
nmackend@ualberta.ca

Warren Martin
University of Guelph
Engineering
P.O. Box 31104
Guelph, ON N1H 8K1
Ph: 519-827-0477
wmartin@uoguelph.ca

Catherine Martineau-Delisle
Université Laval
Faculté de foresterie et géomatique
1520 Garnier, #3
Quebec, QC G1S 2T5
Ph: (418) 688-5589
cmartineaud@hotmail.com

Preston McEachern
University of Alberta
Biological Sciences
CW405 Bio Sci
Edmonton, AB T6G 2E9
Ph: 780-492-6304
preston@gpu.srv.ualberta.ca

Steffen Mueller
University of Alberta
Renewable Resources
515 General Services Bldg
Edmonton, AB T6G 2H1
Ph: 780-492-8743
mueller@ualberta.ca

Gordon Murray
University of Alberta
Rural Economy
515 General Services Bldg
Edmonton, AB T6G 2H1
Ph: 780-454-6425
gmurray@ualberta.ca

Samantha Murray
University of Manitoba
Botany
435 Bullet Bldg
Winnipeg, MB R3T 2N2
Ph: 204-474-9525
Fax: 204-474-7601
ummurras@cc.umanitoba.ca

David Nanang
University of Alberta
Rural Economy
515 General Services Bldg
Edmonton, AB T6G 2H1
Ph: 780-438-3314
Fax: 780-492-0268
dnanang@gpu.srv.ualberta.ca

Stéphanie Nicopoulos
Université du Québec à Montréal
UQAM-GEOTOP
C.P. 8888, Succ. Centre-ville
Montréal, QC H3C 3P8
Ph: 514-987-3000 x 1582
Fax: 514-987-3635
m207315@er.uqam.ca

Gunnilla Nilsson
University of Alberta
Rural Economy
515 General Services Bldg
Edmonton, AB
gunnillanilsson@hotmail.com

Jane Park
University of Calgary
Biological Sciences
2500 University Dr. NW
Calgary, AB T2N 1N4
Ph: 403-220-7930
jshpark@ucalgary.ca

Vernon Peters
University of Alberta
Biological Sciences
CW405 Bio Sci
Edmonton, AB T6G 2E9
Ph: 780-492-0079
Fax: 780-492-9234
vspeters@gpu.srv.ualberta.ca

Mark Robson
University of Toronto
Forestry
33 Willcocks St.
Toronto, ON M5S 3B3
Ph: 416-946-7023
Fax: 416-978-3834
mark.robson@utoronto.ca

Tracy Ruta
University of Manitoba
Natural Resources Institute
Box 166
Dugald, MB R0E 0K0
Ph: 204-853-7932
tracyruta@hotmail.com

Tanja Schramm
University of Alberta
Renewable Resources
751 General Services Bldg
Edmonton, AB T6G 2H1
Ph: 780-492-2111
Fax: 780-492-4323
tschramm@gpu.srv.ualberta.ca

Colleen Simpson
University of Calgary
Biological Sciences
2500 University Dr.
Calgary, AB T2N 1N4
Ph: 403-220-7930
simpsonc@ucalgary.ca

Amanda Smith
University of New Brunswick
Forestry & Environmental Mgmt
P.O. Box 44555
Fredericton, NB E3B 6C2
Ph: 506-447-3339
Fax: 506-453-3538
d0wp@unb.ca

Nancy Smith
University of British Columbia
Microbiology
#300-6174 University Blvd.
Vancouver, BC V6T 1Z3
Ph: 604-822-4285
Fax: 604-822-6041
nansmit@yahoo.com

Giyeon Yun
University of Alberta
Civil & Environmental Engineering
#1514, 8515-112 St
Edmonton, AB T6G 1K7
Ph: 780-429-3245
Fax: 780-429-3245
yungiyeon@hotmail.com

Kenneth Stadt
University of Alberta
Renewable Resources
Earth Sciences 442
Edmonton, AB
Ph: 780-492-6827
kstadt@ualberta.ca

Brennan Wapioke
Shoal Lake Resource Institute
Iskatewizaagegan Independent No. 39 First
Nation
Kejick Post Office
Shoal Lake, ON P0X 1E0
Ph: 807-733-2560
Fax: 807-733-3106
iifn@voyageur.ca

Ivan Whitson
University of Alberta
Biological Sciences
CW405 Bio Sci
Edmonton, AB T6G 2E9
Ph: 780-492-1295
iwhitson@ualberta.ca

Pia Wilkinson-Chapman
University of Alberta
Canadian Circumpolar Institute (CCI)
8820-112 St (Old St Stephen's College)
Edmonton, AB T6G 2E2
Ph: 780-492-4512
Fax: 780-492-1153
pia_wilkinson@yahoo.com