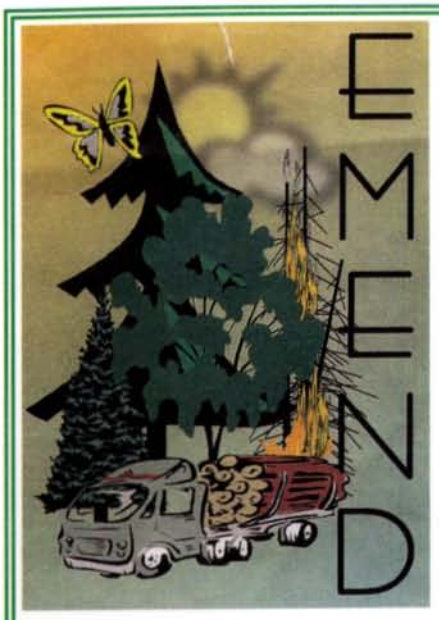


Ecosystem Management Emulating Natural Disturbance

Research Study and Field Guide

EMEND Partners:

Alberta Environment
Alberta Research Council
Canadian Forest Products Ltd.
Canadian Forest Service[1]
Canadian Wildlife Service
Daishowa-Marubeni International Ltd.
Forest Engineering Research Institute of Canada
Forintek Canada Corp.
Laval University
Manning Diversifled Forest Products
Pulp and Paper Research Institute of Canada
Sustainable Forest Management Network
University of Alberta[2]
University of British Columbia
University of Lethbridge
University of Calgary
University of Minnesota
Weyerhaeuser

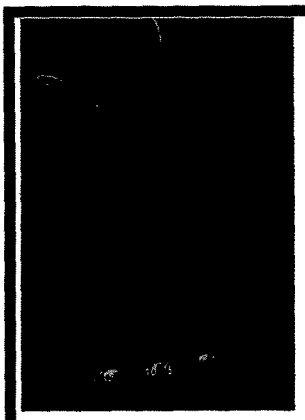
Compiled by:
Derek Sidders[1] and John Spence[2]

SUSTAINABLE FOREST MANAGEMENT NETWORK

RÉSEAU DE GESTION DURABLE DES FORÊTS

Natural Resources Canada
Canadian Forest Service

Ressources naturelles Canada
Service canadien des forêts



Ecosystem Management Emulating Natural Disturbance

Research Study and Field Guide

Table of Contents:

Acknowledgments:

The compilers and Emend Partners would like to thank the following for their contributions to this "Research Study and Field Guide": Chad Grekul, Kim Lambe, Diane Carlsson, Alyssa Bradley, and all the study participants that contributed to the preparation of the research templates..

Ecosystem Management Emulating Natural Disturbance

Research Study and Field Guide

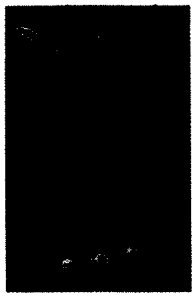
Section 1:

Study Introduction

Study Design and Treatment Matrix

Major Participants by Discipline

Master Map



EMEND:
Ecosystem Management Emulating Natural Disturbance

Basis of Study

Adoption of the "natural disturbance" paradigm for boreal forest management has led away from extensive clear-cutting and toward retention of undisturbed merchantable residuals to leave structure on the landscape. Effects of size and distribution of residual patches have been studied in Alberta. However, the important question of "how much residual is enough to preserve and protect critical aspects of ecosystem function?" has received scant attention. Thus, there is little basis for management of stand structure in forests managed extensively to include fiber production as a goal.

Retention of either standing green-tree or dead residual may have significant impact on forest regeneration and tree growth in addition to promoting other forest values. Therefore, sustainable management depends on linking harvest methods to forest regeneration procedures to promote holistic and ecologically-sensitive silviculture. New silvicultural procedures are required to meet the expanded objectives of sustainable management and to assist with evaluation of their implications for productivity.

The overall objectives of the EMEND project are:

1) to determine which forest harvest and regenerative practices are ecologically sustainable in maintaining biotic communities, spatial patterns of forest structure, and functional ecosystem integrity in comparison with mixed-wood landscapes that have originated through wildfire and other inherent natural disturbances

2) to employ economic and social analyses to evaluate these practices in terms of economic viability and social acceptability.

These objectives are being achieved through work related to a large-scale harvest-silviculture experiment or approached through modeling based on the experimental results and other relevant data.

Overall Experimental Design

The ecological work at EMEND is structured in relation to two main driving variables (cover type and harvest design) in an overall harvesting experiment. Primarily research now focuses on subsequent behavior of response variables, both, without further intervention or with innovative

silvicultural treatments. Silvicultural microsite and regeneration core studies were installed in 0.5 ha subplots within all relevant stand type - harvest treatment combinations.

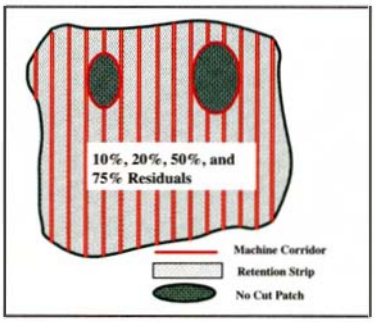
Driving Variables, Controls and Replication

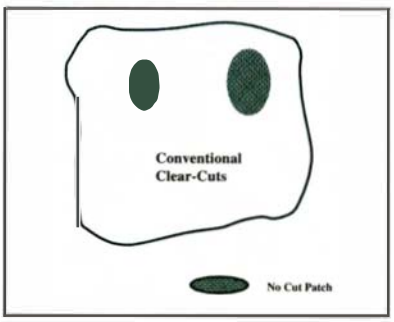
Site Type (SITE). Forest type is partitioned based on canopy composition of stands before harvest as follows: 1) conifer dominated (>70% white spruce); 2) mixed (conifer and deciduous composition each 35-65%); 3) deciduous dominated with coniferous understory extensive and at least 50% of canopy height; 4) deciduous dominated (>70% deciduous). Deciduous stands are a variable mix of trembling aspen and balsam poplar.

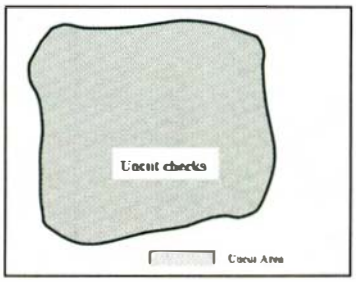
Harvest Prescription (RESIDUAL). Blocks (8-10 ha each) were harvested during winter of 1998-99 in stands of each SITE type, leaving blocks with one of the five following proportions of residual material: 1) 0% (clear-cut); 2) 10%; 3) 20%; 4) 50%; and 5) 75%. Training and site monitoring was completed cooperatively by the Canadian Forest Service, DMI, CanFor and FERIC (Forest Engineering Research Institute of Canada). Analysis of harvesting techniques and their cost are being carried out by E. Philips (FERIC) and D. Sidders (CFS) (see research templates).

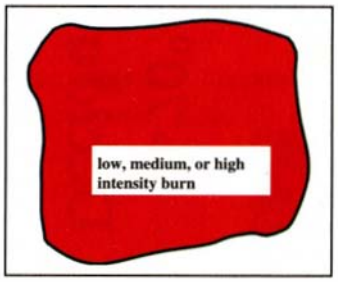
EMEND Harvest Pattern

Candidate Stand ~ 10 Hectares
2 Retained Patches .20 (40X60m) and .46 ha (60X90) - elliptical in shape
10, 20, 50, and 75% retention - evenly distributed within harvest strips
- harvest strips are the 20 m interval between machine corridors (centre to centre)
- machine corridors are 5 m wide
- 25% of compartment-wide removal within machine corridors (only harvest in 75% residual)
- retention strip removal protocol: 1 of 3 trees (50%), 3 of 4 (20%), and 7 of 8 (10%)









EMEND PROJECT

Working Project Design

>70% Deciduous	>70% Deciduous over white spruce	Mixed Forest	>70% White Spruce
no harvest	no harvest	no harvest	no harvest
10% residual	10% residual	10% residual	10% residual
20% residual	20% residual	20% residual	20% residual
50% residual	50% residual	50% residual	50% residual
75% residual	75% residual	75% residual	75% residual
clear cut	clear cut	clear cut	clear cut
burn	burn	burn	burn
X	X	X	X
3 Reps	3 Reps	3 Reps	3 Reps

Treatment effects will be interpreted in relation to two types of "control" treatments, each replicated spatially with harvesting treatments: either uncut blocks, or those burned experimentally in each SITE type. The initial fire application in summer 1999 suggests that we cannot deliver burns of uniform intensity, and thus within burn variation will be used to assess local effects of this sort of variation. Fire treatments are being developed and will be delivered in cooperation with the Province by B. Amiro, B. DeGroot and P. Bothwell (Canadian Forest Service [CFS]). Comparisons of burned and unburned blocks reveal the extent to which harvest/silviculture combinations foster successional trajectories similar to those initiated by natural processes. Comparison to uncut blocks reveal:

1) if any species from a range of indicator groups are threatened by truncation of stand age distribution implicit in a harvest rotation, and/or

2) if residual strips and ellipses are "old-growth" islands that are effective sources for colonists.

Given the size of the experiment (84 blocks, >1000 ha) and its already-coarse ability to estimate variances in response variables, we exclude additional driving variables. Nonetheless, study of other variables, through embedded, focused experiments (as in the approach to fire studies mentioned above), will be essential. For example, effects of variation in coarse woody material might be analyzed with a regression approach, using data about mean natural variation between blocks or, for some questions, data reflecting within-block variation. Such work is under development.

Response Variables

The core of EMEND research is focused on how the various state variables and processes are affected by SITE, TREATMENT and their interaction, and how these effects vary with silvicultural prescription. These state variables include: 1) succession and dynamics of biodiversity; 2) residual structures and nutrient cycling; 3) regenerated structures; 4) site productivity; 5) selected hydrological processes and indicators; and 6) socio-economic indicators (see specific research templates).

The following general results have been achieved to date:

• Reasonably similar stands were selected from a range of candidate stands through a program of active field work during 1997. Not only has this procedure allowed us to control the range of variation within replicates, but the data will also provide a context for wider inferences based on the experiment.

• Permanent sample plots have been established in all treatment blocks and access has been developed.

• Standardized pre-treatment data about biotic and abiotic response variables, especially those related to site productivity and biological diversity, were collected from all blocks to be treated during summer-fall 1998. Post-treatment data about these variables was collected during summer-fall 1999. The information is being developed in the context of an appropriate database

accessible to all EMEND researchers. Summaries will eventually be available on the EMEND Web Site.

• Pre-burn fuel sampling and surface-fire burning prescriptions have been developed. The procedures were tested during 1999 and we hope to apply as many burns as possible during spring-fall 2000 and 2001, depending on weather conditions.

• Individual research projects (see research templates) will be further consolidated and built into an overall framework for EMEND research that includes linkages to other similar work being developed in Canada.

• Socio-economic research has been initiated through a project to consider various approaches to value biological diversity in a northern forestry context.

• A Web Site has been developed (http://www.biology.ualberta.ca/emend/emend.html) to communicate results of EMEND to the scientific and forestry community.

Overview of EMEND Research 1997-1999

Field research within the EMEND project falls under two main categories: 1) experiment-wide data collection, carried out by the Core Crew and covering all 4 forest types, and 2) research conducted by researchers using part of the EMEND project as the basis of their work. Projects by graduate students are included in category 2.

The main areas of research within EMEND are:

Arthropod Diversity
Avian Diversity Vegetation
Fire Ecology
Forest Pathology
Forest Primary Productivity
Genetics
Hydrology and Microclimate
Silviculture
Soils and Nutrient Cycling

Contacts (see templates for specific projects)**:**

•Arthropod Diversity

John Spence, EMEND Project Leader; University of Alberta
- arthropod response to the harvest and fire treatments of EMEND (project wide)
Phone: (780) 492-3003
Email: john.spence@ualberta.ca

Dave Langor; Canadian Forest Service
- population responses of the spruce beetle to the different treatments (project wide)
Phone: (780) 435-7330
Email: dlangor@NRCan.gc.ca

• Avian Diversity

Fiona Schmiegelow; University of Alberta
- avian community diversity before and after the treatments are applied (in all compartments except the high burn treatments)
Phone: (780) 492-0552
Email: fiona.schmiegelow@ualberta.ca

• Bat Diversity and Foraging

Robert Barclay; University of Calgary
- how various harvesting treatment affect use of areas for foraging by bats
Email: barclay@acs.ucalgary.ca

• Economic Issues

Vic Adamowicz; University of Alberta
- valuation of biodiversity
Email: vic.adamowicz@ualberta.ca

• Fire Ecology

B. DeGroot; Canadian Forest Service
- fuel inventory, fire behavior and development of prescribed burn plans
Phone: (780) 435-7312
Email: bdegroot@NRCan.gc.ca

• Forest Pathology

Ken Mallett; Canadian Forest Service
- assessing the extent and incidence of *Armillaria* root disease in the different forest types and treatments before and after the treatments have been applied
Phone: (780) 435-7314
Email: kmallett@NRCan.gc.ca

• Forest Productivity

Jan Volney; Canadian Forest Service
- experiment wide assessment of primary productivity response to treatments
Phone: (780) 435-7329
Email: jvolney@NRCan.gc.ca

• Forest Genetics

Om Rajora; University of Alberta
- effects of forest fires and forest management practices on the genetic diversity of white spruce
Phone: (780) 492-4020
Email: Om.Rajora@ualberta.ca

• Hydrology and Microclimate

Graham Hillman; Canadian Forest Service
- leading a hydrology study at EMEND
Phone: (780) 435-7260
Email: ghillman@NRCan.gc.ca

Rick Hurdle; Canadian Forest Service
- using towers to monitor weather and climate at the EMEND site
Phone: (780) 435-7263 Email: rhurdle@NRCan.gc.ca

• Silviculture

Derek Sidders; Canadian Forest Service
- harvest design and initial layout protocol; EMEND site promotion; coordination of project wide silviculture microsite and regeneration study, windthrow monitoring,
Phone: (780) 435-7355
Email: dsidders@NRCan.gc.ca

Jim Stewart; Canadian Forest Service
- long-term silviculture plot monitoring, white spruce seed rain
Phone: (780) 435-7224
Email: jstewart@NRCan.gc.ca

Vic Lieffers; University of Alberta
Email: vlieffer@forsci.ualberta.ca

Ken Greenway; Alberta Research Council
- deciduous regeneration
Email: ken.greenway@arc.ab.ca

Richard Kabzems; Ministry of Forests, British Columbia
Email: richard.kabzems@mfor01.gov.bc.ca

• Soils and Nutrient Cycling

Barbara Kishchuk; Canadian Forest Service
- soil nutrients, pH, and mass, before and after EMEND treatments (project wide)
Phone: (780) 435-7336
Email: BKishchu@NRCan.gc.ca

Ivor Edwards; Canadian Forest Service
- Soil Scientist
Phone: (780) 435-7235
Email: iedwards@NRCan.gc.ca

•Vegetation and Plant Diversity

Ellen Macdonald; University of Alberta
Phone: (780) 492-3070

Email: ellen.macdonald@ualberta.ca

Derek Johnson and Marty Siltanen; Canadian Forest Service
- monitoring changes in the ground vegetation following the various treatments
Phone: (780) 435-7306 (Derek)/ (780) 435-7378 (Marty)
Email: dejohnso@NRCan.gc.ca / msiltane@NRCan.gc.ca

• **Industry Contacts**

Steve Luchkow, DMI
Phone:(780) 624-7427
Email: sluchkow@PRPDDMI.com

Tim Vinge, CANFOR
Phone: (780) 494-4004
Email: TVinge@Mail.Canfor.ca

J. P. Beilech, Manning Diversified
Email: jpmdfp@telusplanet.net

Pat Wearmouth, Weyerhaeuser Canada
Email: wearmop@wdni.com

EMEND Core Contacts

John Spence: Project Leader
Phone: (780) 492-3003
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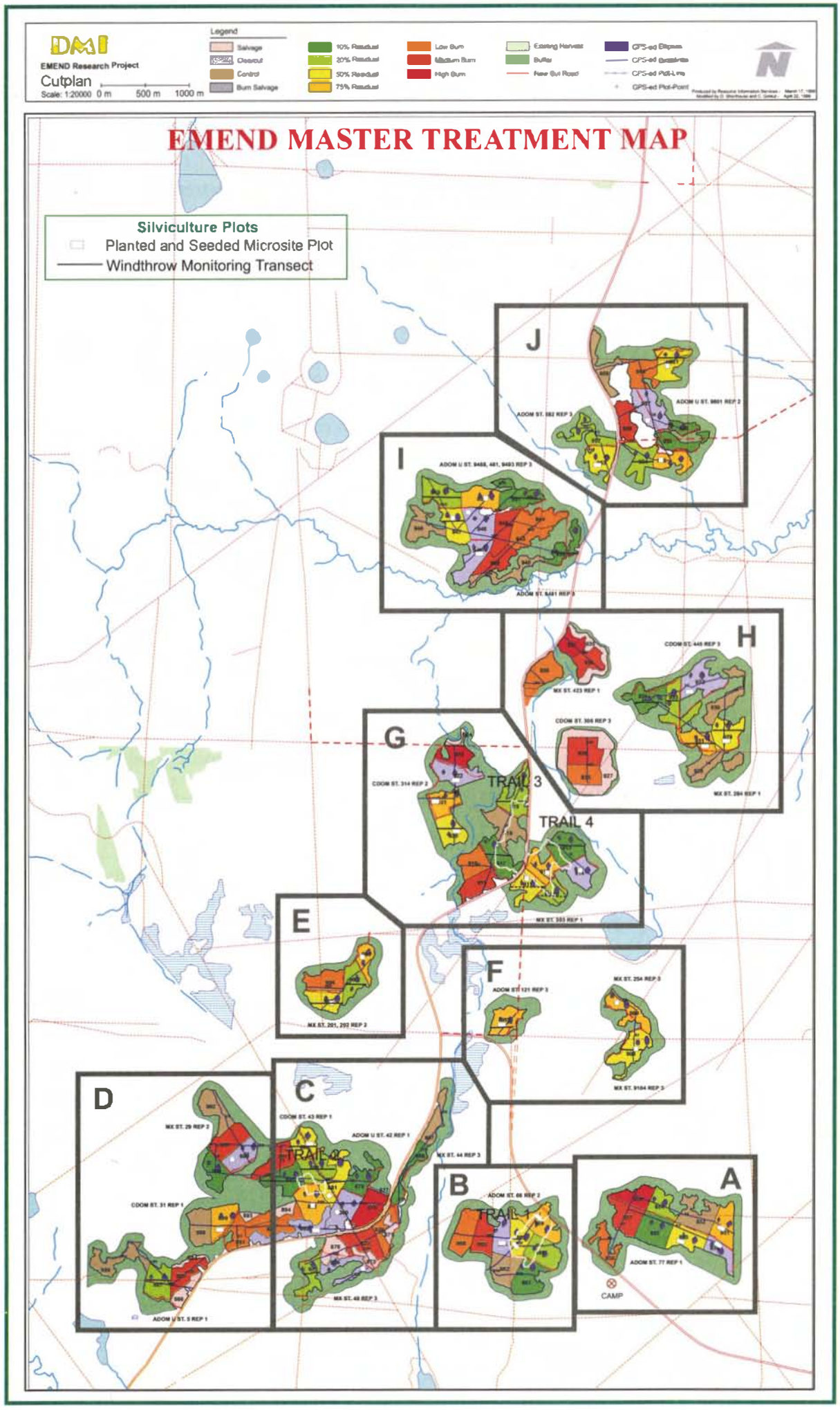
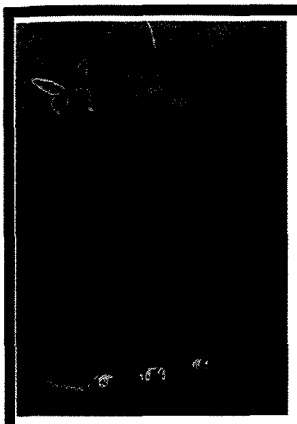
Louis Morneau; 2000 EMEND Field Coordinator:
Phone: (780) 618-3919, Fax: (780) 618-8303

João Sousa; 2000 EMEND Associate Coordinator
Phone: (780) 618-3919, Fax: (780) 618-8303

For additional information, visit the EMEND web-site at: http://www.biology.ualberta.ca/emend/emend.html

For information relating to field tours of the EMEND site, contact Derek Sidders, Canadian Forest Service at:(780) 435-7355.


DMI
EMEND Research Project
Cutplan
Scale: 1:20000 0 m 500 m 1000 m
Legend
Salvage
Clearcut
Control
Burn Salvage
10% Residual
20% Residual
50% Residual
75% Residual
Low Burn
Medium Burn
High Burn
Existing Harvest
Buffer
New Cut Road
GPS-ed Ellipses
GPS-ed Boundaries
GPS-ed Plot-Lines
GPS-ed Plot-Point
N
EMEND MASTER TREATMENT MAP
Silviculture Plots
Planted and Seeded Microsite Plot
Windthrow Monitoring Transect
J
I
H
G
E
F
D
C
B
A
TRAIL 3
TRAIL 4
TRAIL 2
TRAIL 1
CAMP



Ecosystem Management Emulating Natural Disturbance

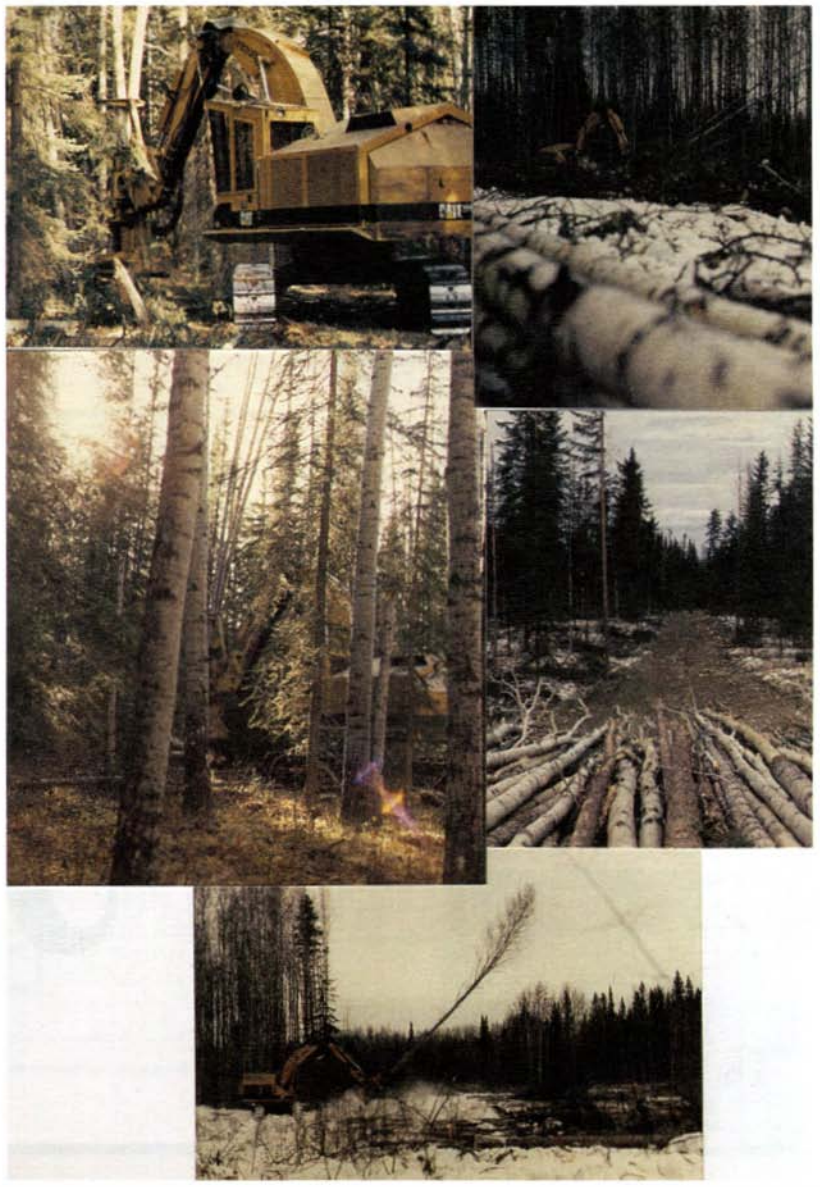
Research Study and Field Guide

Section 2:

Treatment Descriptions:

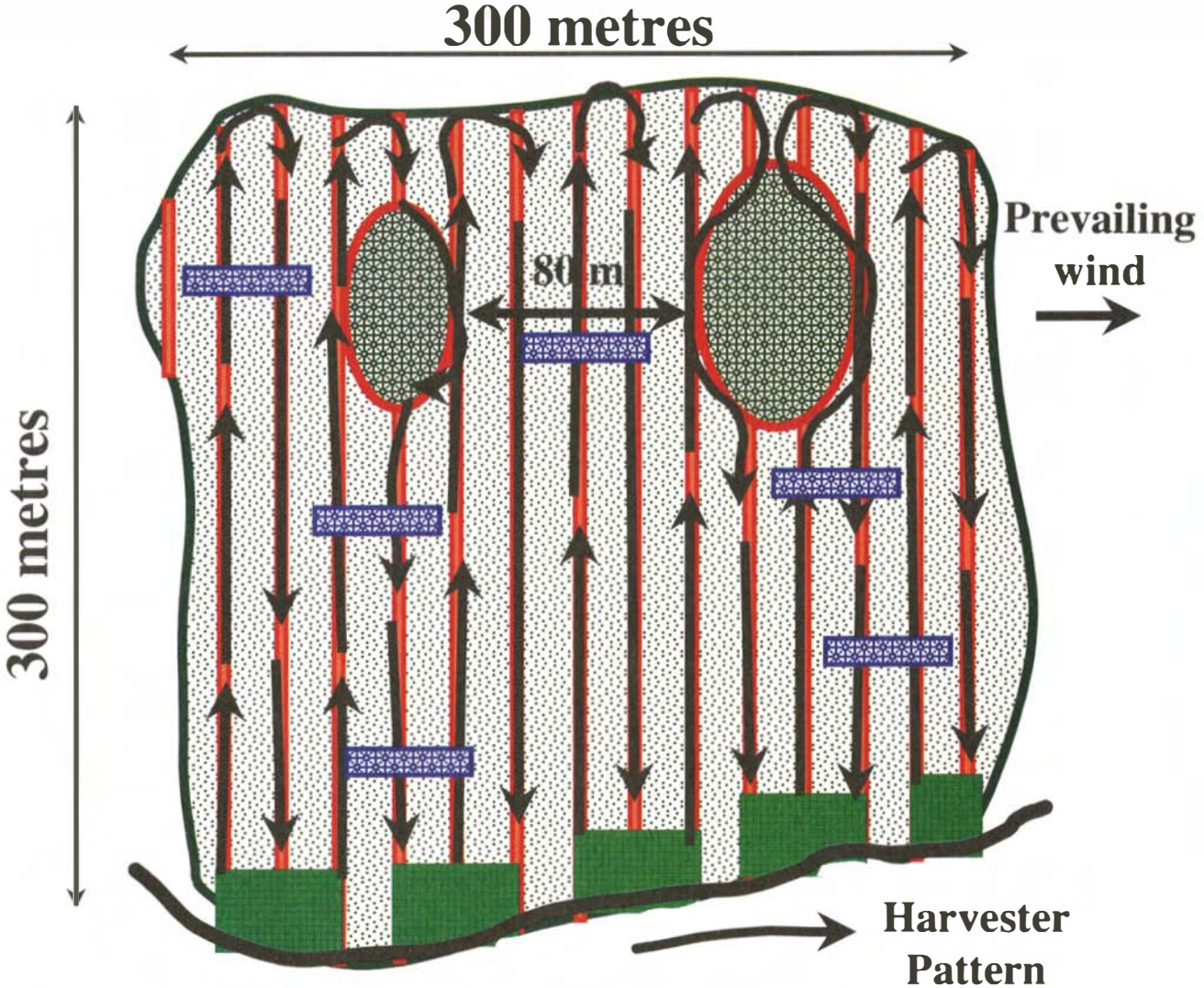
Harvesting
Prescribed Burns
Silviculture

Harvesting Operations Description



EMEND Harvest Pattern

Candidate Stand ~ 10 Hectares
2 Retained Patches .20 (40X60m) and .46 ha(60X90) - elliptical
10, 20, and 50 % retention - evenly distributed
20 m interval between machine corridors (centre to centre) 5 metre wide corridors - 25% removal within machine corridors
-retention strips removal = 1 of 3 (50%), 3 of 4 (20%), and 7 of 8 (10%)



All skidding from the landing backing down the machine corridors.

Haul Road

Landing

Machine Corridor

Retention Strip

No Cut Patch

TREEPlots 2m X 40m

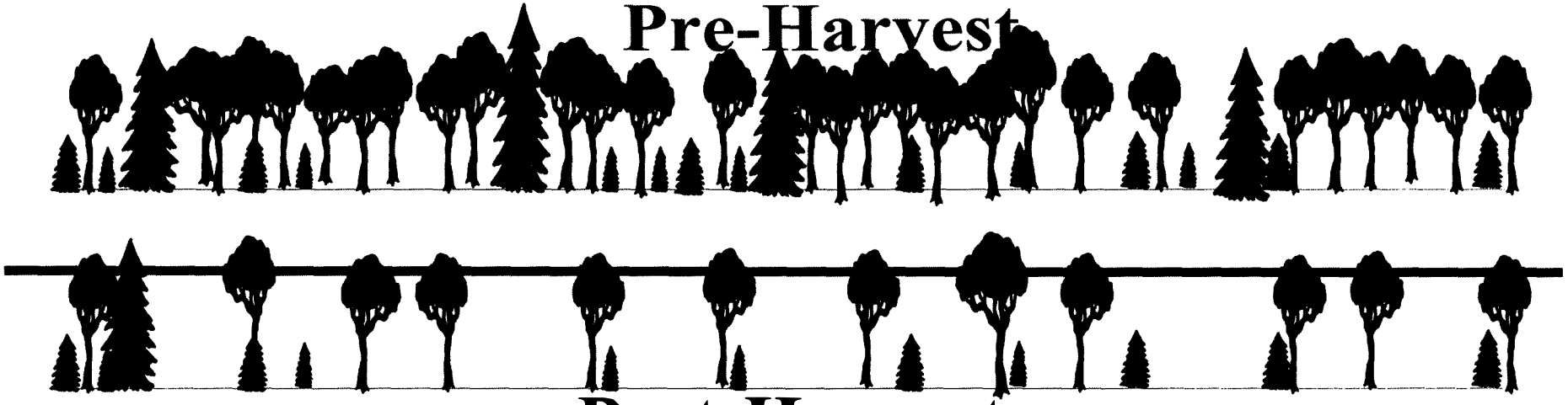
Sidders, D.M., 1999. EMEND Field Guide
Sidders, D.M. and Steve Luchkow, 1998. EMEND Final Harvest Pattern and Extraction Method

EMEND AERIAL VIEW

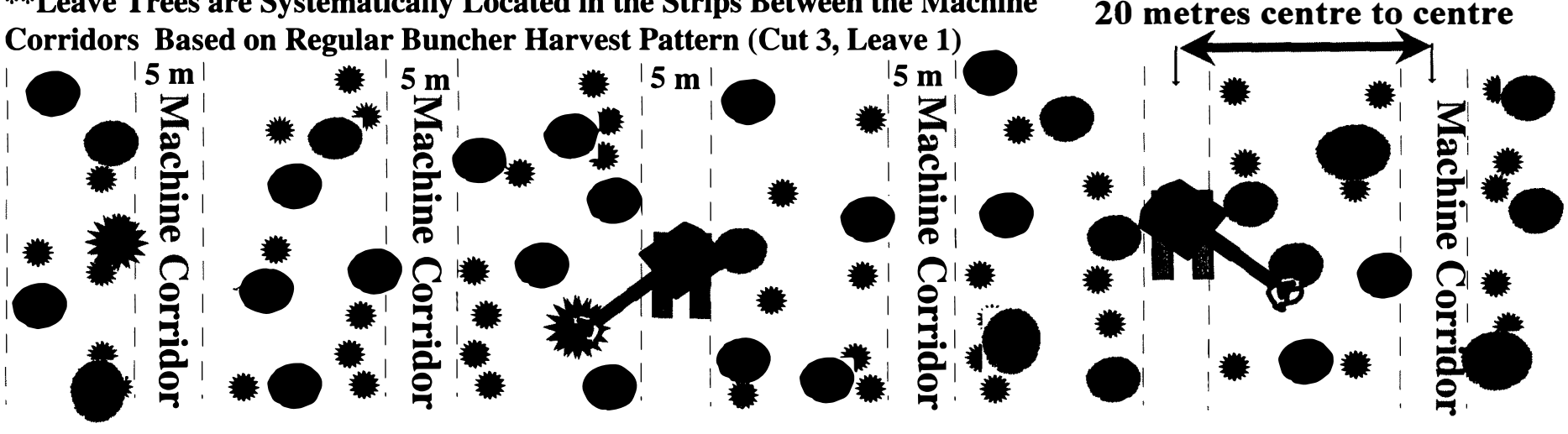
Uniform Shelterwood Harvesting

Systematic Individual Tree Retention with Parallel Machine Corridors at 20 m Centres Spacing: 1 Merchantable Aspen Left every 4 Trees (Cut 3, Leave 1) Resulting Retention Level= 20%.

Wind Direction

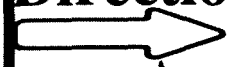


****Leave Trees are Systematically Located in the Strips Between the Machine Corridors Based on Regular Buncher Harvest Pattern (Cut 3, Leave 1)**



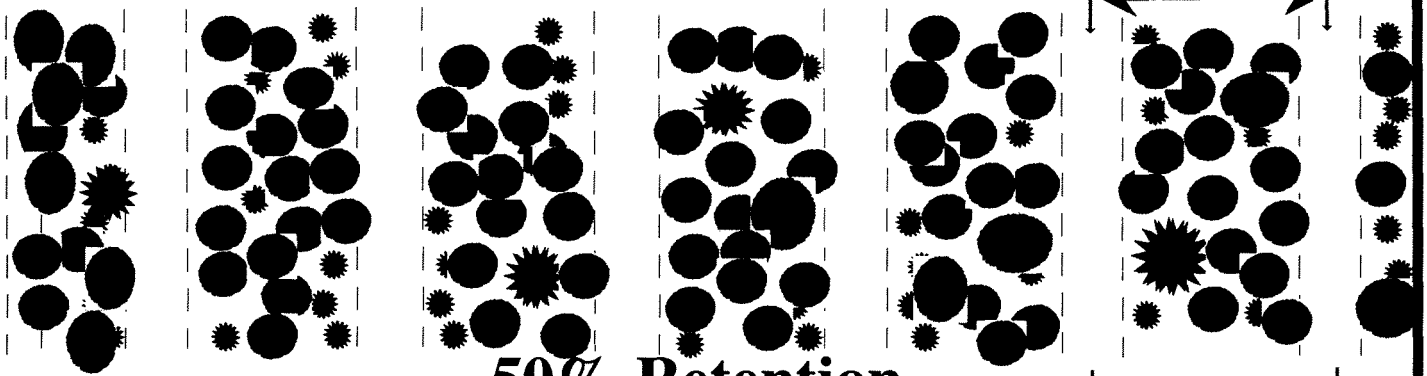
EMEND Harvest
Modified Uniform Shelterwood
75%, 50 %, 20% Retention Profiles

Wind Direction

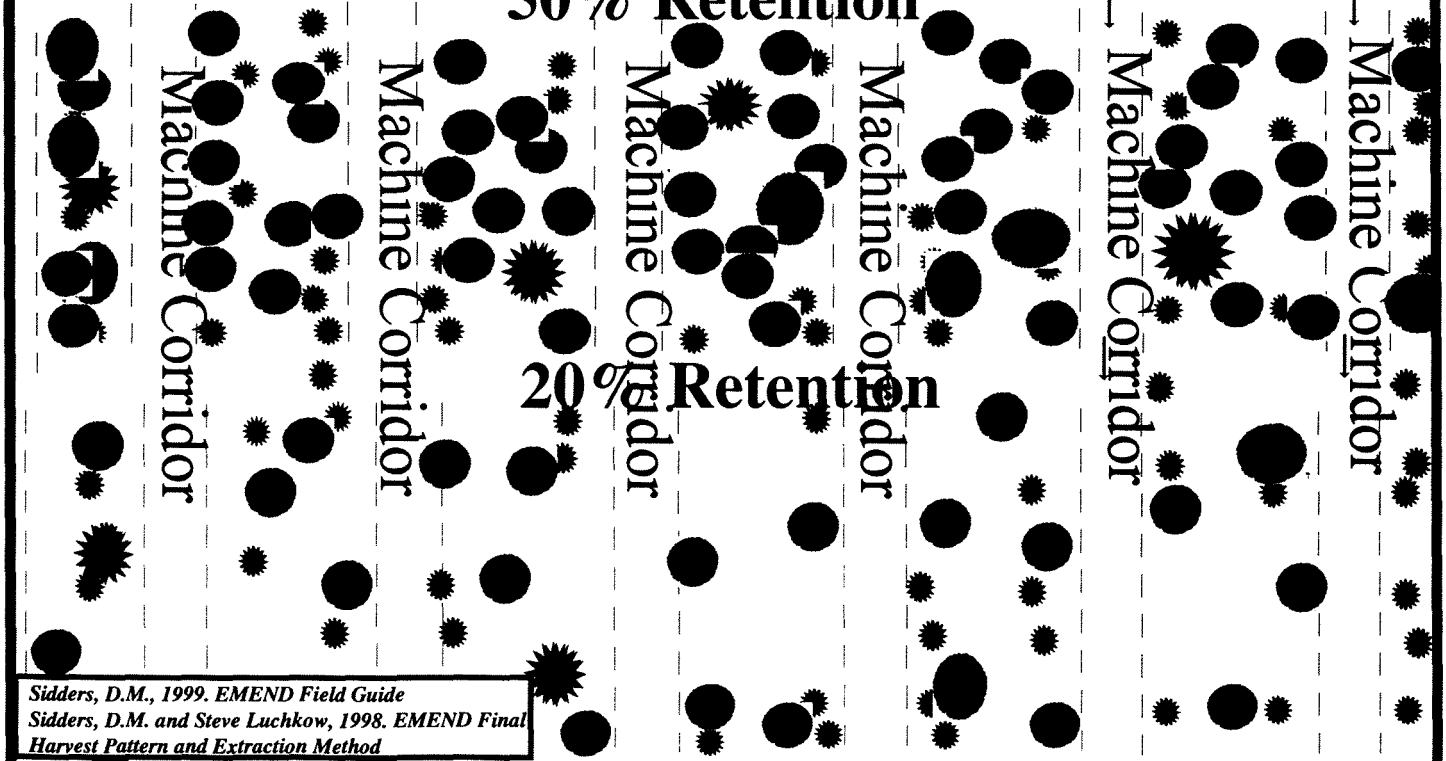


Post-Harvest 75% Retention

20 metres centre to centr



50% Retention



20% Retention

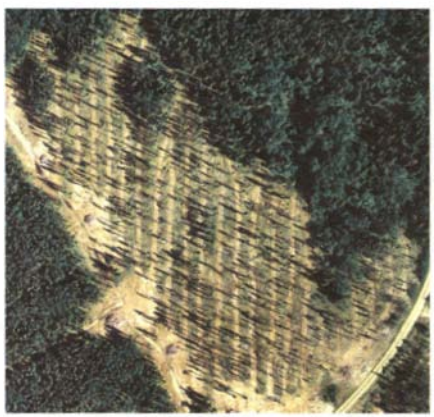
Sidders, D.M., 1999. EMEND Field Guide
Sidders, D.M. and Steve Luchkow, 1998. EMEND Final Harvest Pattern and Extraction Method

Harvesting Treatment Profiles Post-Harvest

Retention Prescription Table

Retention Level	Machine Corridor % of Net Area	Individual Stem Removal Ratio	Retention Strip (% Net Area*)
75%	25%	No Individual Tree Removal	75%
50%	25%	1 removed of 3	75%
20%	25%	3 removed of 4	75%
10%	25%	7 removed of 8	75%

Block 917 10% Conifer Dom.



Block 910 20% Mixed

Block 890 75% Conifer Dom.

Block 853 50% Deciduous Dom.

Block 914 Clearcut Mixed

Prescribed Burn

Treatment Description

Aerial Photo Igniting Block 926, August 1999

Ground Suppression Crew

Prescribed Burn Treatment Description

(level of burns to be determined by post assessment)

Pre-assessment:

•Transect survey for Dead and Downed Woody Debris and placement of Depth of Burn pins is done prior to the burns.

Prescription Criteria:

•For each stand type, upper and lower limits are set for the Fire Weather Index (FWI), Drought Code (DC), Fine Fuel Moisture Code (FFMC) and Duff Moisture Code (DMC). These codes are all part of the Canadian Forest Fire Danger Rating System.

Prerequisite Weather and Fire Indicies:

•The actual indices and codes that exist on the day of burning are used to predict fire behavior and effects.

Fire Control:

• bladed to mineral soil guards have been cleared around the sites to be burned and adequate ground and air resources are present and available "on-site" during and following ignition.

Deciduous Prescription:

(Deciduous Dominant and Deciduous with Understory Spruce)

Deciduous dominant: Burned prior to May 21 (estimated leaf flushing date). No limits on the DC, or FWI. FFMC > 84 and DMC 25-40.

Deciduous with understory: Burned anytime. DC < 300, FWI 4-18, FFMC >84, DMC 25-40.

Coniferous Prescription:

(Coniferous Dominant and Mixed Conifer/Deciduous)

Burned anytime with a DC < 250, FWI 4-18, FFMC > 84, and DMC 25-40.

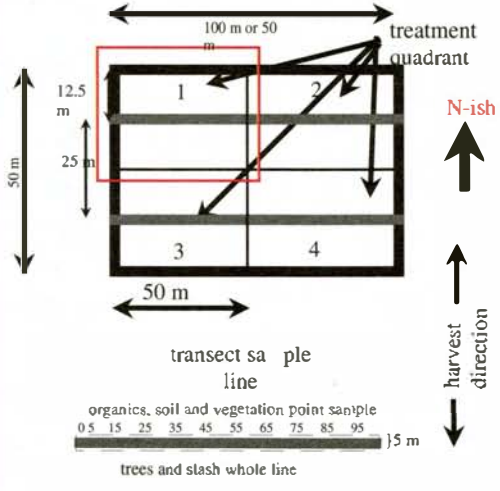
Post Assessment, Classification:

Following the burn, another transect survey of Dead and Downed Woody Debris and measurement of Depth of Burn pins are used to estimate the Total Fuel Consumption. Total Fuel Consumption and Rate of Spread can provide an estimate of the Fire Intensity.

Ecosystem Management Emulating Natural Disturbance

Silviculture Plot Installation

Silviculture Plot Layout



Site Preparation: High-Speed, Horizontal Bed Mixing

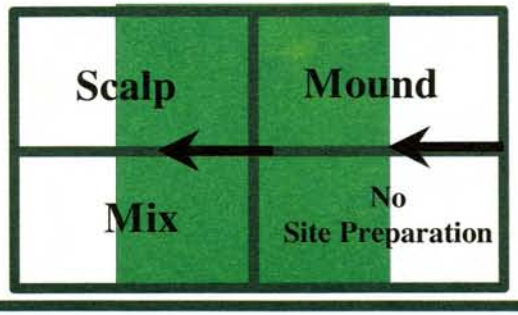
Silviculture Plot in Block 850: Clear Cut - Site Prepared

Site Preparation - Scalp

Planting in Mixed Microsite - July 1999

Planted to 415B White Spruce, July 1999, 100 per Treatment

Seeded with Local White Spruce Seed



EMEND

Site Preparation Treatment Table

1	2
3	4

Block	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4
892	No Treatment	Mounder	Scalp	Meri-Crusher
890	Mounder	Scalp	Meri-Crusher	No Treatment
898	Scalp	No Treatment	Meri-Crusher	Mounder
920	Scalp	Meri-Crusher	Mounder	No Treatment
921	Scalp	Meri-Crusher	No Treatment	Mounder
922	Scalp	No Treatment	Meri-Crusher	Mounder
932	No Treatment	Mounder	Scalp	Meri-Crusher
929	Meri-Crusher	Scalp	No Treatment	Mounder
931	Meri-Crusher	Mounder	Scalp	No Treatment
941	Mounder	Meri-Crusher	Scalp	No Treatment
953	Mounder	No Treatment	Meri-Crusher	Scalp
907	Scalp	No Treatment	Mounder	Meri-Crusher
864	Meri-Crusher	Mounder	No Treatment	Scalp
863	No Treat	Mounder	Meri-Crusher	Scalp
859	Meri-Crusher	No Treatment	Mounder	Scalp
853	Mounder	Meri-Crusher	No Treatment	Scalp
851	Meri-Crusher	No Treatment	Mounder	Scalp
850	Scalp	Mounder	Meri-Crusher	No Treatment

Clearcut, 50% and 75% in Conifer and Deciduous Dominant Stand Types

Ecosystem Management Emulating Natural Disturbance

Research Study and Field Guide

Section 3:

Technology Transfer

Table of Research Studies

Ecosystem Management
Emulating Natural Disturbance

Technical Transfer Activities

Staging Area, Tour 1999

Trail 3 and 4

Individual Research Studies along Trail 3- Softwood Crescent Trail

EMEND Site , RRTC Tour 1999

Silviculture Research Plot on Trail 1 Hardwood Clone Trail

EMEND Research Contact Summary

Main Contact *Alphabetical*	Phone Number	Participants	Organization Only Main	Title	Objective: Short Version	Start Date	End Date
Amiro, Brian	(780) 435-7217	Annette Coderre	Canadian Forest Service	Carbon Flux to the Forest	To measure whole ecosystem carbon fluxes and determine the effect of harvesting on carbon fluxes compared to a mature forest.	1998	indeterminate
Cartar, Ralph	(403) 329-2122	Richard Elhert	University of Lethbridge	Habitat use by bumble bees in response to logging.	This study examines changes to the density of species of understory plants commonly visited by bumble bees, and in the use of these plants by different species and castes of bumble bees, following different levels of logging and burning.	1998	indeterminate
Cuthbertson, Lisa (M.Sc. Candidate)	(780) 435-7308	Ken Mallett, Ellen MacDonald (supervisors)	University of Alberta	Spatial Patterns of *Armillaria*	To describe the pattern of occurrence of *Armillaria* in the soil, on coarse woody debris, and on trees, snags, and stumps.	1999	2001
DeGroot, Bill	(780) 435-7289	Brian Amiro	Canadian Forest Service	Fire Behaviour and Effects in White Spruce-Aspen Forests	To collect critical data on fire spread, fuel consumption and fire intensity over a range of burning conditions to incorporate into the FBP System fire behaviour database.	1999	indeterminate

Main Contact *Alphabetical*	Phone Number	Participants	Organization Only Main	Title	Objective: Short Version	Start Date	End Date
Dunlop, Julia (M.Sc. Candidate)	(780) 492-3080	John Spence and Dave Langor (supervisors)	University of Alberta	Effects of forest harvesting on Spruce Beetle parasitoids	To study Spruce Beetle parasitoid response to control, clear-cut, and 20% and 50% residual harvesting practices.	1998	2000
Dunlop, Julie (M.Sc Cand.) **Morneau, Louis, (M.Sc. Cand.)**	(780) 492-3080	John Spence, Jan Volney, Dave Langor	University of Alberta	Aspen and spruce defoliators' population and their associated parasitoids	To identify defoliators associated with aspen and spruce; To identify their parasitoids and the parasitism rate of a few major forest pests; To link defoliators' population in the canopy with light trapping study	1998	2000
Edwards, Ivor	(780) 435-7235	Ken Greenway (Alberta Research Council)	Canadian Forest Service	Deciduous Regeneration Study	To assess, on a compartment level, the effect of different levels of partial harvest on aspen and balsam poplar regeneration in mixed, and mixed with conifer understory, stands. This protocol may be adapted for other species and stand types.	1998	indeterminate
Fenniak, Treena (M.Sc. Candidate)	(780) 492-3070 (Ellen MacDonald)	Ellen MacDonald (supervisor)	University of Alberta	Understory vascular plant regeneration with reference to site conditions following disturbance	To determine the structure and biodiversity of the understory vascular community before and after disturbance.	1999	2001

Main Contact *Alphabetical*	Phone Number	Participants	Organization Only Main	Title	Objective: Short Version	Start Date	End Date
Frey, Brent (M.Sc. Candidate)	(780) 492-2852 (Vic Leiffers)	Vic Leiffers and Alison Munson (supervisors)	University of Alberta	Effects of forest floor disturbance and canopy removal on soil nutrient dynamics and response of *Calamagrostis canadensis*, *Epilobium angustifolium*, and *Picea glauca* seedlings.	To compare the effects of canopy removal and forest floor disturbance on the growth of *C.canadensis*, *E.angustifolium* and *P.glauca* and on the rates of mineralization.	1999	2001
Gilmore, D.W.	(218) 327-4522	Kathy Haiby	University of Minnesota	Modeling early regeneration processes in mixed-species boreal forests of Alberta	To initiate a long-term record of natural regeneration processes; To assemble the above data into a database that can be used for modeling aspects of forest regeneration for the mixed-species boreal forest of Alberta.	1999	indeterminate
Greenway, Ken		Amar Varma, Dave Kelsberg, Wenonah Fraser	Alberta Research Council	Canopy Analysis	To quantify on a compartment level the amount of visible sky in different levels of partial harvest in deciduous dominant, deciduous with white spruce understory, mixedwood and conifer dominated stands.	1999	indeterminate

Main Contact *Alphabetical*	Phone Number	Participants	Organization Only Main	Title	Objective: Short Version	Start Date	End Date
Harrison, Bruce (M.Sc. Candidate)	(780) 492-0552	Fiona Schmiegelow (supervisor)	University of Alberta	The Response of Boreal Forest Birds to Experimental Harvest and Burning	To compare the effects of harvest and fire on the forest bird community.	1999	2001
Hillman, Graham	(780) 435-7260	Bruce Robson, Cecilia Feng, Greg Taylor	Canadian Forest Service	Effects of Fire and Timber Harvesting on Soil Temperature, Soil Water Content and Evapotranspiration	To determine the effects of fire and different levels of timber harvesting in coniferous stands, on soil temperature and water content and on evapotranspiration; To establish relationships between precipitation, soil water content and evapotranspiration on treed areas and on cutovers and between plant variables and seasonal soil water and temperature conditions.	1998	indeterminate
Hillman, Graham	(780) 435-7260	C.Feng, G.Taylor, J.Roberts	Canadian Forest Service	Effects of timber harvesting, snow accumulation and melt, on seedling survival and growth	To determine patterns of snow accumulation and melt under different levels of timber harvest; To relate seedling survival and growth to snow cover, soil temperature and soil water content.	1999	indeterminate

Main Contact *Alphabetical*	Phone Number	Participants	Organization Only Main	Title	Objective: Short Version	Start Date	End Date
Hurdle, Rick	(780) 435-7263	Ivor Edwards, Graham Hillman, Jim Stewart	Canadian Forest Service	Vegetation -Climate Interaction Studies	To characterize and compare the microclimate and other physical environment impacts of fire and harvest; To extend the short term weather records for the EMEND site into the past by establishing a relationship to longer term records for airport stations in the region.	1998	indeterminate
Johnson, E.A.	(403) 220-3570	M.B. Dickinson	University of Calgary	Fire Behavior and Effects in the Mixedwood Boreal Forest.	To use physically-based models to develop a better understanding of (1) fire behavior and (2) fire effects on trees in the mixed-wood boreal forest.	1999	indeterminate
Johnson, Derek	(780) 435-7306	Marty Siltanen, Joe Crumbaugh, Core crew	Canadian Forest Service	Understory Vegetation Biodiversity Study	To complete an understory vegetation (biodiversity) study post-harvest and pre-treatment of various compartments at the EMEND site.	1998	indeterminate
Kembel, Steven (M.Sc. Candidate)	(780) 492-3289 (Mark Dale)	Mark Dale, Ellen MacDonald (supervisors)	University of Alberta	Spatial patterns of boreal canopies, understory communities and tree regeneration.	To determine how the spatial structure of canopy tree populations affect the fine scale patterns of understory community structure and tree regeneration.	1999	2001

Main Contact *Alphabetical*	Phone Number	Participants	Organization Only Main	Title	Objective: Short Version	Start Date	End Date
Kishchuk, Barb	(780) 435-7336	Paul Christensen, Susan Cassidy, Core crew	Canadian Forest Service	Soil Nitrogen Availability: Buried Bag Incubations	Estimation of net nitrogen mineralization rates over the growing season as an index of Nitrogen availability under different harvesting treatments and cover types.	1998	indeterminate
Kishchuk, Barb	(780) 435-7336	Paul Christensen, Susan Cassidy, Core crew	Canadian Forest Service	Soil Profile Descriptions and Coarse Root Biomass Sampling	To describe and classify soils at the EMEND site; to determine nutrient concentrations and contents from the soil surface to C horizon, and to sample soils for coarse root biomass estimates.	1998	indeterminate
Kishchuk, Barb	(780) 435-7336	Paul Christensen, Susan Cassidy, Core crew	Canadian Forest Service	Changes in Soil Nutrient Capital Under Disturbance	To determine changes in soil nutrient concentration and nutrient content following disturbance.	1998	indeterminate
Langor, Dave	(780) 435-7252 (Daryl Williams)	Jan Volney; Daryl Williams Canadian Forest Service John Spence, Core crew; University of Alberta	Canadian Forest Service	Abundance and Size Distribution of Coarse Woody Debris (CWD) Study	To study the structure of coarse woody debris as a habitat for arthropod communities	1998	indeterminate

Main Contact *Alphabetical*	Phone Number	Participants	Organization Only Main	Title	Objective: Short Version	Start Date	End Date
Langor, Dave	(780) 435-7252 (Daryl Williams)	Daryl Williams, Grant Hammond	Canadian Forest Service	Population Dynamics of Spruce Beetle Study	To study the effects of forest disturbance on the abundance and spatial distribution of the spruce beetle.	1998	indeterminate
Lazaruk, Lance (M.Sc. Candidate)	(780) 492-2922	Damase Khasa and Ellen MacDonald (supervisors)	University of Alberta	The impact of silvicultural practices on the abundance and biodiversity of ectomycorrhizae in a boreal forest ecosystem.	To determine whether alternative harvesting techniques will affect the types and abundance of ECM fungi present and capable of colonizing regenerating white spruce seedlings.	1999	2001
MacDonald, Ellen	(780) 492-3070		University of Alberta	Causes and rates of mortality for understory white spruce, aspen, and balsam fir in a boreal mixedwood forest.	To characterize the seedling mortality of important tree species across the boreal forest through a collaborative effort between different research groups.	1999	2004
Mallett, Ken **Volney, W.J.A.**	(780) 435-7329	J.R.Spence, J.Brant, R.Brett, M.Michaelian, A.Yohannes, H.Gates	Canadian Forest Service	Forest Health Assessments	To determine the health condition of standing trees in all EMEND compartments.	1998	indeterminate

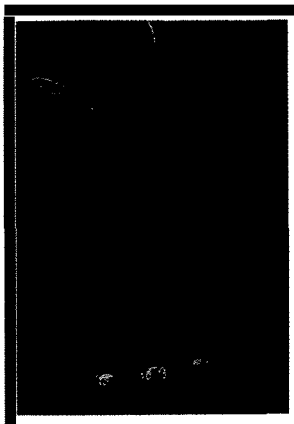
Main Contact *Alphabetical*	Phone Number	Participants	Organization Only Main	Title	Objective: Sbort Version	Start Date	End Date
Martin, René (M.Sc. Candidate)	(604) 822-0501	Pam Krannitz (supervisor)	University of British Columbia	Reproductive responses of bunchberry (*Cornus canadensis*) to disturbance in a managed boreal forest	To study a possible gradient effect occurring on lines running from buffer zones through to harvest treatments (50% and 75%, CDOM) on the reproductive biology of bunchberry (*Cornus canadensis*).	1998	2000
Mills, Suzanne (M.Sc. Candidate)	(780) 492-1899 (Dale Vitt)	Dale Vitt and Ellen MacDonald (supervisors)	University of Alberta	The distribution of bryophyte species diversity in relation to microsite and moisture availability at 2 scales within conifer dominated boreal forests.	Test the link between available substrate and bryophyte species richness. Make predictions about how changes in environmental variables, as a result of forest harvesting, will affect bryophyte species richness.	1999	2001
Morneau, Louis (M.Sc. Candidate)	(780) 492-3080	John Spence and Jan Volney (supervisors)	University of Alberta	Lepidoptera diversity following fire and harvesting	To examine diversity of macrolepidoptera in different undisturbed forest types; To compare the impacts of fire and forest harvest on a boreal lepidopteran community.	1998	2000
Park, Jane (M.Sc. Candidate)	(403) 220-3033 (Mary Reid)	Mary Reid (supervisor)	University of Calgary	Movement and Settlement of Bark Beetles in a Heterogeneous Landscape	To determine the effects of stand type and density on the movement and settlement of bark beetles.	1999	2001

Main Contact *Alphabetical*	Phone Number	Participants	Organization Only Main	Title	Objective: Short Version	Start Date	End Date
Patriquin-Meldrum, Krista (M.Sc. Candidate)	(403) 220-3561	Robert Barclay (supervisor)	University of Calgary	Can human caused disturbances mimic natural disturbances? The impacts of fire and forest harvesting on the foraging ecology of forest dwelling bats.	To experimentally examine the impacts of natural and human caused disturbance on the foraging behavior of bats.	1999	2001
Phillips, Eric			Forest Engineering Research Institute of Canada (FERIC)	Cost and Productivity of Harvesting to Emulate Natural Disturbance	To document the cost and productivity of the harvesting treatments.	1998	indeterminate
Shorthouse, David (PhD Candidate)	(780) 492-3080	John Spence (supervisor), Core crew	University of Alberta	Boreal spiders as bioindicators of forest disturbance and management	How comparable are the spider assemblages during recovery from fire to those found in the harvested treatments?	1999	2002/2003
Sidders, Derek	(780) 435-7355	Rob Taylor, Kim Lambe, Diane Carlsson	Canadian Forest Service	Silviculture Research Study: Regeneration Establishment	To complete the regeneration portion of the silviculture regeneration plots through the planting of white spruce seedlings. Silviculture Studies at EMEND	1997	indeterminate

Main Contact *Alphabetical*	Phone Number	Participants	Organization Only Main	Title	Objective: Short Version	Start Date	End Date
Sidders, Derek	(780) 435-7355	Rob Taylor, Kim Lambe, Diane Carlsson	Canadian Forest Service	Silviculture Research Study: Regeneration on Prepared and Natural Seedbeds in Clear-cut, 50%, and 75% Retention Treatments	To establish and monitor response of seedlings (artificial and natural) on prepared and natural seedbeds within clear-cut, 50% and 75% retention treatments.	1998	indeterminate
Sidders, Derek	(780) 435-7355	Rob Taylor, Kim Lambe, Diane Carlsson	Canadian Forest Service	Silviculture System Wind-Throw Monitoring	To monitor the impact of winds, post-harvest, on the partial-harvest treatments of conifer dominated, mixed wood, and aspen with conifer understory stands and to access blowdown patterns based on stand type and retention levels.	1998	indeterminate
Sidders, Derek	(780) 435-7355	Rob Taylor, Kim Lambe, Diane Carlsson	Canadian Forest Service	Silviculture Research Study: Site Preparation Treatments	To establish various microsites within the silviculture regeneration research plots (hardwood and softwood dominant clear-cut, 50% and 75% retention treatments).	1998	indeterminate

Main Contact *Alphabetical*	Phone Number	Participants	Organization Only Main	Title	Objective: Short Version	Start Date	End Date
Sidders, Derek	(780) 435-7355	Kim Lambe, Diane Carlsson	Canadian Forest Service	Variable Retention Harvest: Microsite Classification and its Receptiveness to Establishment and Growth	To classify and quantify the various microsites resulting from partial harvesting with 25% systematically patterned forest floor disturbance. To categorize the seedbed receptiveness of the various microsites to natural softwood seedling establishment .	2000	indeterminate
Spence, John; University of Alberta **Volney, Jan; Canadian Forest Service**	(780) 492-3003 (780) 435-7329	Ken Mallett; Canadian Forest Service, Core crew; University of Alberta	University of Alberta, Canadian Forest Service	Response of forest net primary productivity to harvesting and fire.	Determine the long-term net primary productivity forest response to treatments	1999	indeterminate
Spence, John	(780) 492-3003	David Langor, Greg Pohl, David Shorthouse, Core crew	University of Alberta; Canadian Forest Service	Arthropod Biodiversity Study	To monitor changes in arthropod communities over time in harvested versus burned stands.	1997	indeterminate

Main Contact *Alphabetical*	Phone Number	Participants	Organization Only Main	Title	Objective: Short Version	Start Date	End Date
Stewart, Jim	(780) 435-7224	Pete Bothwell, Chris Adams, Travis Jones	Canadian Forest Service	Partial Harvest Effects on White Spruce Cone Production and Seed Rain	To quantify the relationships among cone production, residual stand density (degree of exposure), tree condition (preharvest crown class), and seed rain, following partial harvesting.	1999	indeterminate
Stewart, Jim	(780) 435-7224	Pete Bothwell, Chris Adams, Travis Jones	Canadian Forest Service	Regenerating White Spruce in Partial Cut Mixedwood	To quantify the influence of overstory retention and site preparation on microenvironment and relate this to physiology and growth of softwood seedlings; To determine suitability of different site preparation methods for providing receptive seedbeds under partial harvesting regimes; To evaluate the influence of canopy position and degree of release on production of cone crops	1998	indeterminate
Volney, W.J.A.	(780) 435-7329	J.R. Spence, K.I. Mallett, B.E. Kishchuk	Canadian Forest Service	Biomass and Leaf Area Estimators	To determine the most efficient allometric equations to estimate; leaf area index, root biomass, foliage biomass, branch and stem biomass using easily measured measurational tree attributes.	1998	indeterminate



Ecosystem Management Emulating Natural Disturbance

Research Study and Field Guide

Section 4:

Field Trail Sites

Research Templates

Trail 1: Stand 66 Hardwood Clone Trail

Trail 2: Stand 42/43 Loop Trail

Trail 3: Stand 314 Softwood Crescent Trail

Trail 4: Stand 303 Meandering Trail

Research Template Summary

Title of Study	Lead	Affiliation	Trail #
The influence of forest harvesting on habitat use by foraging bats.	Krista Patriquin-Meldrum	University Of Calgary	3
The Response of Boreal Forest Birds to Experimental Harvest and Burning	Bruce Harrison	University Of Alberta	3
Epigacic arthropods as bio-indicators of forest disturbance and management.	David Shorthouse	University Of Alberta	3
Habitat use by bumble bees in response to logging.	Ralph Carter	University Of Lethbridge	4
The dispersal and settlement of bark beetles in a harvested landscape.	Jane Park	University Of Calgary	3
Aspen and spruce defoliators' population and their associated parasitiods.	Julia Dunlop and Louis Morneau	University Of Alberta	3
Lepidoptera Diversity of Residual Forest Stands	Louis Morneau	University Of Alberta	3
Spatial Patterns of Amarillaria	Lisa Cuthbertson	University Of Alberta	3
Biomass and Leaf Area Estimators	W.J.A. Volney	Canadian Forest Service	3
Carbon Flux to Forest	Brian Amiro	Canadian Forest Service	3
Fire Behavior and Effects in White Spruce-Aspen forests	Bill Degroot and Brian Amiro	Canadian Forest Service	3
Forest Health Assessments	K. Mallett and W.J.A Volney	Canadian Forest Service	2
Response of forest net primary productivity to harvesting and fire.	W.J.A. Volney	Canadian Forest Service	3
Partial Harvest Effects on White Spruce Cone Production and Seed Rain	Jim Stewart	Canadian Forest Service	4
Cost and Productivity of Harvesting to Emulate Natural Disturbance	Eric Phillips	Forest Engineering Research Institute of Canada	4
Deciduous Regeneration Study	Ken Greenway and Ivor Edwards	Alberta Research Council	1
Modeling early regeneration processes in mixed-species boreal forests of Alberta.	D.W. Gilmore	University Of Minnesota	4
Regenerating White Spruce in Partial Cut Mixedwoods	Jim Stewart	Canadian Forest Service	1

Research Template Summary

Title of Study	Lead	Affiliation	Trail #
Effects of timber harvesting, snow accumulation and melt on seedling survival and growth.	G. Hillman and J. Stewart	Canadian Forest Service	4
Silviculture Research Study: Regeneration on Prepared and Natural Seedbeds	Derek Sidders	Canadian Forest Service	1
Silviculture Research Study: Site Preparation Treatments	Derek Sidders	Canadian Forest Service	1
Silviculture Research Study: Regeneration Establishment	Derek Sidders	Canadian Forest Service	1
Silviculture System Wind Throw Monitoring	Derek Sidders	Canadian Forest Service	1
Variable Retention Partial Harvest: Seedbed Receptiveness for White Spruce	Derek Sidders	Canadian Forest Service	4
Soil Nitrogen Availability under Disturbance: Buried Bag Incubations	Barbara Kishchuk	Canadian Forest Service	3
Changes in Soil Nutrient Capital Under Disturbance	Barbara Kishchuk	Canadian Forest Service	3
Soil Profile Descriptions and Coarse Root Biomass Sampling	Barbara Kishchuk	Canadian Forest Service	3
Effects of Fire and Timber Harvesting on Soil Temperature, Soil and Water Content	G. Hillman	Canadian Forest Service	3
Effects of forest floor disturbance and canopy removal on soil nutrient dynamics.	Brent Frey	University Of Alberta	2
Understory Vegetation Biodiversity Study	Derek Johnson	Canadian Forest Service	3
Reproductive Responses of Bunchberry to Disturbance in a Managed Boreal Forest	Rene Martin	University Of British Columbia	4
Canopy Analysis	Ken Greenway	Alberta Research Council	1
The impact of silvicultural practices on the abundance and biodiversity of ectomycorrhizae.	Lance Lazaruk	University of Alberta	3
Causes and rates of mortality for understory white spruce, aspen and balsam fir in a boreal forest.	Ellen MacDonald	University of Alberta	4
The distribution of bryophyte species diversity in relation to microsite and moisture availability.	Suzanne Mills	University Of Alberta	3
Spatial patterns of boreal canopies, understory communities and tree regeneration.	Steven Kembel	University Of Alberta	4
Understory vascular plant regeneration with reference to site conditions following disturbance.	Treena Fenniak	University Of Alberta	4

Ecosystem Management Emulating Natural Disturbance

WELCOME: You are entering a large scale forest ecosystem research study area; designed, installed, monitored, and managed through a partnership of forest industry, government and research organizations.

OBJECTIVE: To determine which forest harvest and regeneration practices best maintain natural plant and animal communities when compared to communities resulting from natural disturbances.

EMEND Partners:

Alberta Environment
Alberta Research Council
Canadian Forest Products Ltd.
Canadian Forest Service
Canadian Wildlife Service
Daishowa-Marubeni International Ltd.
Forest Engineering Research Institute of Canada
Forintek Canada Corp.
Laval University
Manning Diversified Forest Products
Pulp and Paper Research Institute of Canada
Sustainable Forest Management Network
University of Alberta
University of British Columbia
University of Calgary
University of Lethbridge
University of Minnesota
Weyerhaeuser

Ecosystem Management
Emulating Natural Disturbance

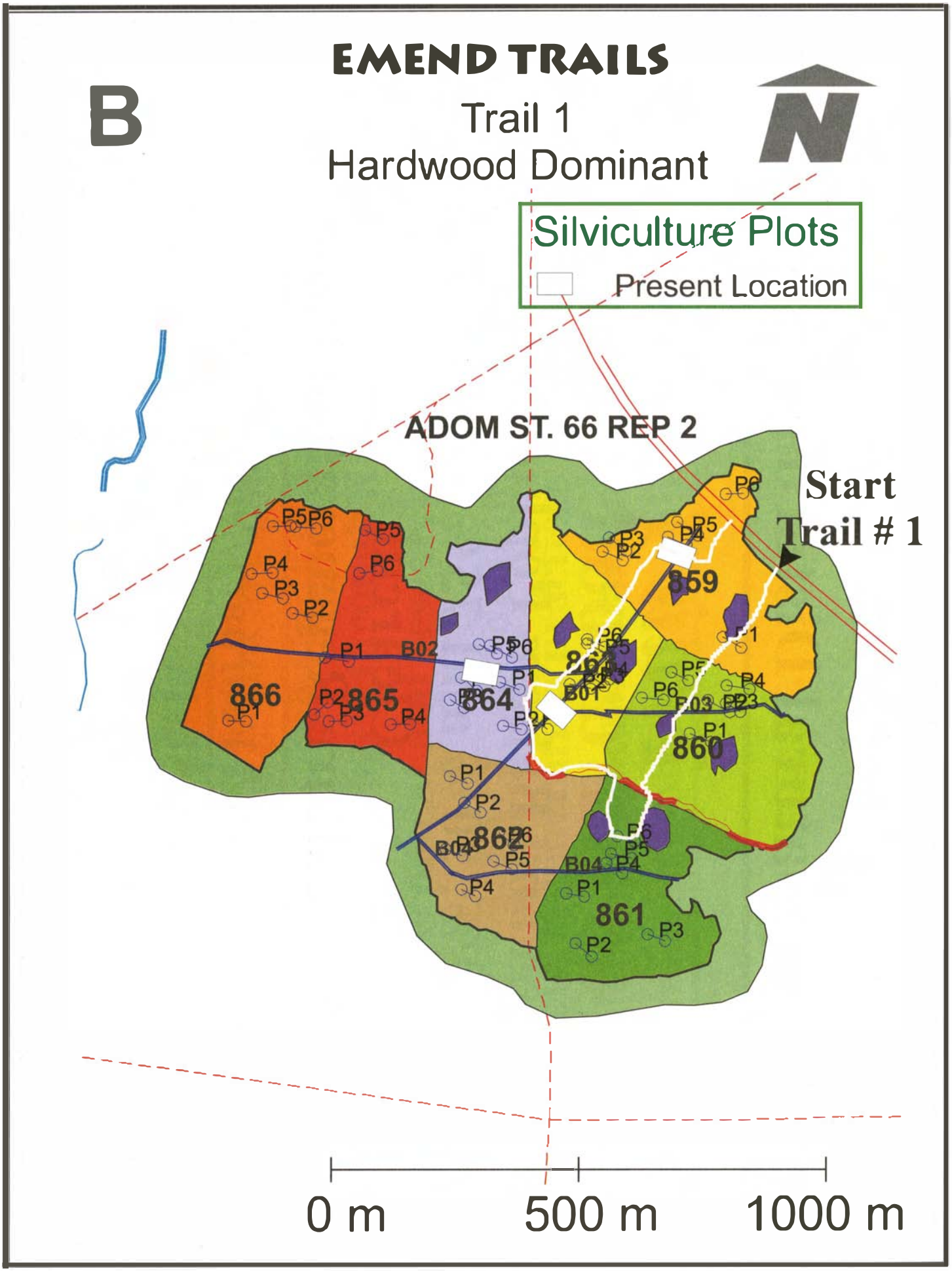
Trail 1
Stand 66 Hardwood Clone Trail

Aspen and Balsam Poplar Dominant
10%, 20%, 50% and 75% Retention, and Clearcut
Silviculture Regeneration Plots

Harvested February/March 1999

Pattern: Uniform Shelterwood with 5 Metre Wide Designated Machine Corridors and 15 Metre Wide Retention Strips

Natural Resources Canada
Canadian Forest Service


EMEND TRAILS
B
Trail 1
Hardwood Dominant
N
Silviculture Plots
Present Location
ADOM ST. 66 REP 2
Start
Trail # 1
866
865
864
862
861
860
859
B01
B02
B03
B04
0 m
500 m
1000 m

EMEND Research Study Template Summary

Title: Canopy Analysis

Participants

Primary Study *Leader:* Ken Greenway

Participants: Amar Varma, Dave Kelsberg, Wenonah Fraser

Alberta Research Council

Objective

To quantify on a compartment level the amount of visible sky in different levels of partial harvest in deciduous dominant, deciduous with white spruce understory, mixedwood, and conifer dominant stands.

Technical Description

Canopy measurements were taken with four LI-C●R-2000 plant canopy analyzers. It was decided that the "percent of the sky visible" was a more relevant measure than 'leaf area index' because conifers violate the instruments operating assumption that foliage is randomly distributed. No valid consistent correction can be made because readings were taken in stands with different relative species mixes. ●ne instrument was set up as a reference base station in a clear cut and the other three were used to take readings under the various canopies. a 180 degree mask was used on all instruments to blockout the south half of the sky. This was done in order to allow us to shade the lenses from direct sunlight and to take readings close to the south boundaries of the compartments. 48 readings were taken per compartment evenly distributed in machine corridors, east third, center third and west third of retention strips. Readings were taken at waist height, at least three tree heights away from west, north and east compartment boundaries and no-cut ellipses.

Hypothesis/Anticipated Results

The amount of sky visible will increase with the amount of trees removed and will decrease with increasing fraction of conifer in the stand composition.

Sampling completed

32 compartments were completed. Readings were taken in repetitions 1 and 2, in 10, 20, 50 and 75% retention treatments of all four stand types. Readings will be taken in rep.3 in summer 2000.

Picture/ Layout Diagram/Design

Boreal Forest Canopy

References and Interpretations

Greenway, K., 1999. Proposal.

EMEND Research Study Template Summary

Title: Deciduous Regeneration Study

Participants

Primary Study *Leaders*:
Ken Greenway[1], Ivor Edwards[2]

Participants: Amar Varma[1]

Alberta Research Council[1]
Canadian Forest Service[2]

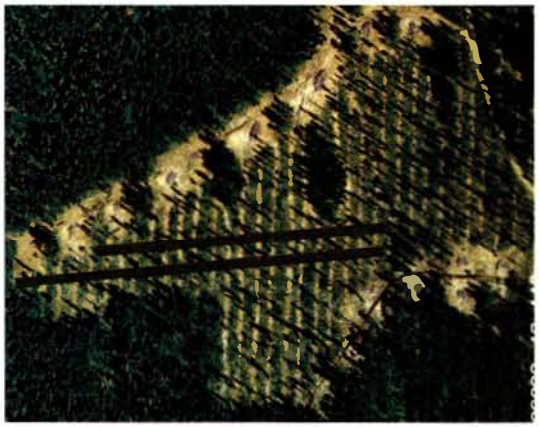
Objective

To assess, on a compartment level, the effect of different levels of partial harvest on aspen and balsam poplar regeneration in deciduous dominant, deciduous with white spruce understory, mixedwood, and conifer dominant stands.

Technical Description

Sample plots were layed out along continuous transects running perpendicular to the harvest pattern which is north-south. The sample intensity is 0.5% of the initial 10 ha block size or 500m^2 per block. Each plot is circular with a radius of 1.26 m totaling 5m^2 and are centred 5 metres apart along the transects. Plots are aligned so that every fourth plot is in a machine corridor which are centred 20 m apart. Where windthrow monitoring transects were installed (see Silviculture Systems Windthrow Monitoring Study Template) the plots were centred along the center line of the transect with additional lines established parallel to the initial transect at 20 m intervals until there were 100 plots. If there were no windthrow transects, the transects were established at the widest part of the block and approximately 30 m south of the ellipses.

Picture/ Layout Diagram/Design



Aspen regeneration transects in
Block 895
Conifer Dominant, 10 % Retention

Technical Description Cont.

The first line was established running east to west and started at least 1 tree height away from block boundary. Each line started with a plot at the centre of a machine corridor and ended with a plot in the centre of a retention strip. The 2nd line was installed from west to east and so on back and forth. The starting point of the line was marked with a post with orange and blue flagging tape and the end with a post with only blue flagging. All 48 harvested blocks, were established including clearcut, 10, 20, and 50% retention treatments.

Sampling Completed: All aspen and poplar suckers were be counted separately within the 1.26m radius plot with the height and damage code recorded for the tallest 4 of each species. Regeneration established before the harvesting was not counted.

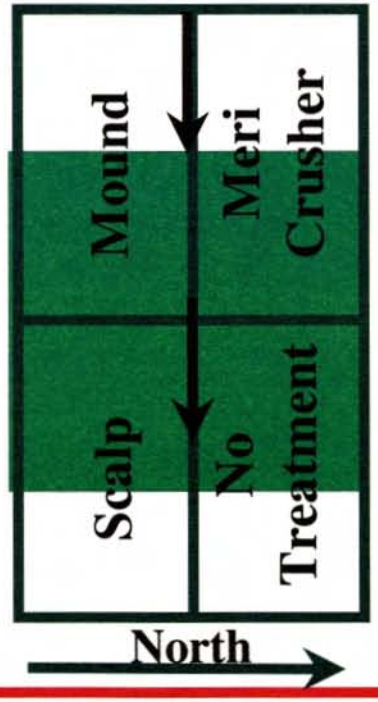
Hypothesis/Anticipated Results

There will be more regeneration in the skid trails than in the retention strips; regeneration will be highest on clearcut blocks and decline as level of tree retention increases.

References and Interpretations

Refer to proposal.

Ecosystem Management
Emulating Natural Disturbance



Block 859
Silviculture Research Plot

Planted in July 1999 with 1-0 415B White Spruce Seedlings

Seeded with White Spruce at 100 Viable Seeds per Microsite

Harvested February 1999

Site Prepared May 1999 with a Cat. 320 Excavator with Attachments

Planted with White Spruce July 1999

Seeded September 1999

Natural Resources Canada
Canadian Forest Service

EMEND Research Study Template Summary

Title: Silviculture Research Study: Regeneration on Prepared and Natural Seedbeds in Clearcut, 50% and 75 % Retention Treatments

Participants

Primary Study *Leader*: Derek Sidders (Tel: 780 435 7355)
Participants: Rob Taylor (Tel: 835 1214); Kim Lambe (Tel: 435 7212)

Canadian Forest Service

Background

Microsites available after major disturbances such as wildfire, windthrow, etc allow for the natural regeneration of both aspen and white spruce seral vegetation species.

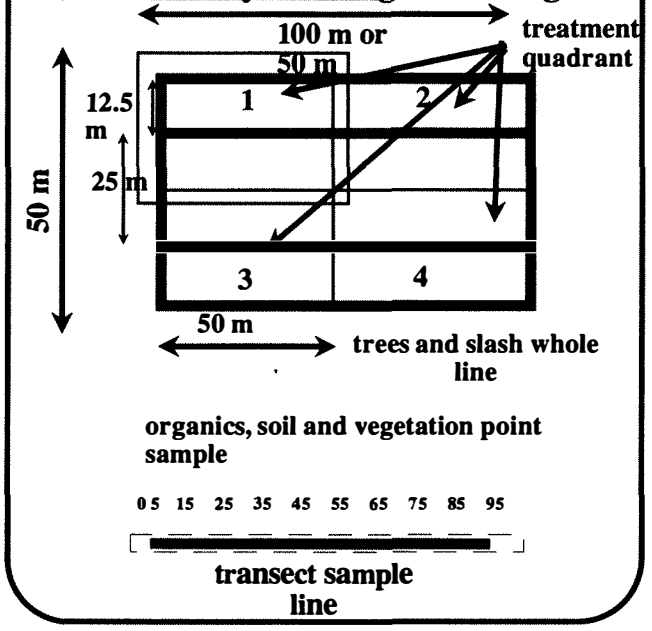
Hypothisis/Anticipated Results

Aspen regeneration from root suckers is expected in each of the forest types with density and vigor relative to tree retention level more than the forest type.

Objective

To establish and monitor response of seedlings (artificial and natural) on prepared and natural seedbeds within clearcut, 50% and 75% retention treatments.

Picture/ Layout Diagram/Design



Technical Description

No artificial site preparation: the two mixedwood forest types and various levels of burns will have 50m by 25m plots established. These will be split into two equal sections to be treated with seed or seedlings. Assessments of pre and post harvest plot characteristics are to be completed to accurately classify ecological and physical ground characteristics.

Artificial Site Preparation: the forest types classed as >70% hardwood and >70% softwood have one half ha plots (100m by 50m) established within each (3 rep's per forest type of the clear-cut, 50% and 75% retention). The 1/2 hectare plots will be divided into 4 quadrants to accommodate the prescribed microsite treatments (scalp, mound, mix and no treatment) and again in 2 sections to allow for the two regeneration treatments, seeding and planting. These plots will be assessed pre and post harvest.

References and Interpretations

Sidders, D., 1999. EMEND proposal and Site Preparation - Silviculture Research study: Operational Description.

EMEND Research Study Template Summary

Title: Silviculture Research Study: Site Preparation Treatments

Participants:

Primary Study *Leader*: Derek Sidders (Tel: 780 435 7355)

Participants: Rob Taylor (Tel: 835 1214); Kim Lambe (Tel: 435 7212)

Canadian Forest Service

Background

The layout is a 100m wide (E-W) by a 50m long (N-S) block within the EMEND softwood and hardwood dominant harvest blocks. The site preparation blocks are divided into 50m by 25m quadrants and randomly identified for treatment type. All blocks have a different treatment arrangement. The four treatments are: 1. mound, 2. mixing, 3. scalping, and 4. no treatment. Dimensions of the microsites are as follows: 1) mound - 80cm wide mineral soil cap, 100cm long mineral soil cap, 10-15cm deep at center: 2) scalp - 100em by 100cm wide, exposed mineral soil: 3) mix - 140cm wide (size of meri crusher), 100cm long, 12-18cm deep mix, scrape aside slash only, 4) no treatment. Treated blocks include 892,922,932,850,864,941 (clearcuts), 898, 929, 920, 853,863,953 (50% retention), and 890, 931,921,851, 859,907 (75% retention).

Objective

To establish various microsites within the silviculture regeneration research plots (hardwood and softwood dominant clearcut, 50% and 75% retention treatments).

Picture/ Layout Diagram/Design

Meri-Crushed site

Technical Description

All machine travel will be limited to the skid trails on the 50% and the 75% retention blocks. One entry and exit trail will be used on the clear cuts to minimize ground disturbance. On retention blocks, the excavator will prepare the retention strips by reaching from the skid trails and will only complete the skid trails when the machine no longer needs to travel on it. Trees adjacent to the skid trails should not be damaged by boom or tail swing. On the clearcut blocks the excavator will enter the treatment block and complete the preparation from the center to the outside edge. No travel will be permitted on the no treatment quadrant. A 5 meter area along the border of the site prep. block can be used to finish treatment blocks and traverse around them. The operator will attempt to align the microsites, regardless of the treatment, in a regular pattern. Microsite assessments will be completed pre and post site preparation treatment.

References and Interpretations

Sidders, D., 1999. EMEND proposal and Site Preparation - Silviculture Research study: Operational Description.

EMEND Research Study Template Summary

Title: Silviculture Research Study: Regeneration Establishment

Participants:

Primary Study *Leader*: Derek Sidders (Tel: 780 435 7355)
Participants: Rob Taylor (Tel: 835 1214); Kim Lambe (Tel: 435 7212)

Canadian Forest Service

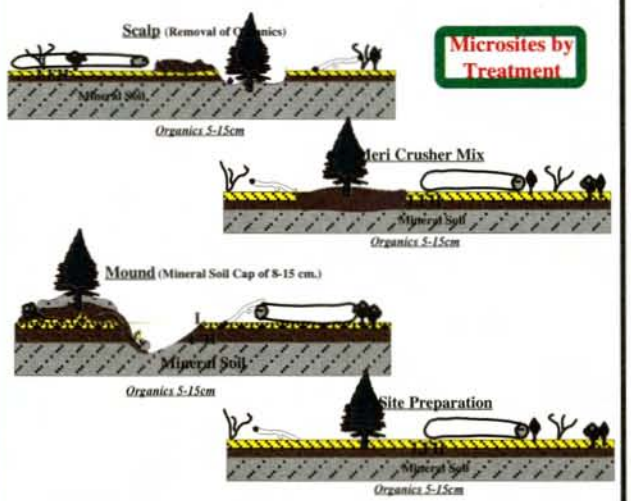
Background

Boreal forest sites similar to the EMEND are regenerated under present management applications through site preparation and planting. To naturally regenerate white spruce it is necessary to have an acceptable microsite and seed source. Site prepared and non site prepared harvested sites were planted and seeded to evaluate regeneration options in the various treatment areas.

Objective

To complete the regeneration portion of the silviculture regeneration plots through the planting of white spruce seedlings.

Picture/ Layout Diagram/Design



Technical Description

White spruce seedlings were planted in all silviculture plots, both site prepared (7200 trees) and non site prepared (1200 trees) between the time of the 22nd and 31st of July. The stock number was 1-0, 415 B's. There were 400 trees (100 each treatment) planted in the prepared sites and 100 in the non prepared sites. The northern portion of these non prepared sites were planted while the south will be seeded in September. When planting an L slit was used and seedlings were placed 1-2cm below the surface.

Planted areas include, for the treated blocks, 892, 922, 932, 850, 864, 941 (clearcut), 898, 921, 920, 853, 863, 953 (50% retention), and 890, 931, 929, 851, 859, 907 (75% retention) and the non treated blocks 899,906, 903, 911, 912, 914, 947, 950,961, 957, 955, 881, 882, 880, 874,908, 909, 946, 961, 957,955.

Monitoring of the annual survival and growth response will be completed on all blocks.

References and Interpretations:

Sidders, D., 1999. EMEND Silviculture Installation Plan.

EMEND Research Study Template Summary

Title: Regenerating White Spruce in Partial Cut Mixedwood

Participants

Primary Study *Leader*: Jim Stewart

Participants: Rick Hurdle, Derek Sidders, Rob Taylor, Travis Jones, Jessica Roberts

Canadian Forest Service

Background

Existence of residual canopy modifies microclimate and competitive environment on forest floor and on disturbed sites.

Hypothesis/Anticipated Results

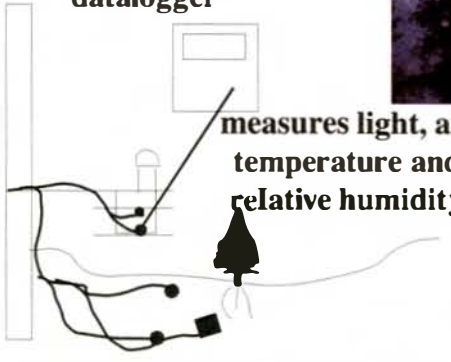
Residual canopy moderates microclimate; differences among site preparation treatments under canopies will be less as compared to the more extreme conditions in the clearcut.

Objective

To quantify the influence of overstory retention and site preparation on microenvironment and relate this to physiology and growth of softwood seedlings; to determine suitability of different site preparation methods for providing receptive seedbeds under partial harvesting regimes; to evaluate the survival and growth of white spruce seeding from natural seed rain and; to assess the longevity of viable seedbed produced by the different mechanical site preparation and harvest combinations by seeding in alternate years and annual survival evaluations.

Picture/ Layout Diagram/Design

Relates to mesoscale and microclimate monitoring network →



Technical Description

Microclimate: continuous time series measured in mound, mix, scalp and control microsites, in one replication of aspen dominant and conifer dominant clearcut, 50% and 75% retention. Periodic spot measurements in all 3 replications.
Annual growth and physiology measurements of planted 415B white spruce seedlings.
Operational seeding in September 1999. Seedbed duration assessed by seeding in alternate years; annual survival evaluations.

References and Interpretations

Stewart,J., 1998. White Spruce Regeneration in Mixedwood Forests of the EMEND Project-Proposal.

Ecosystem Management
Emulating Natural Disturbance

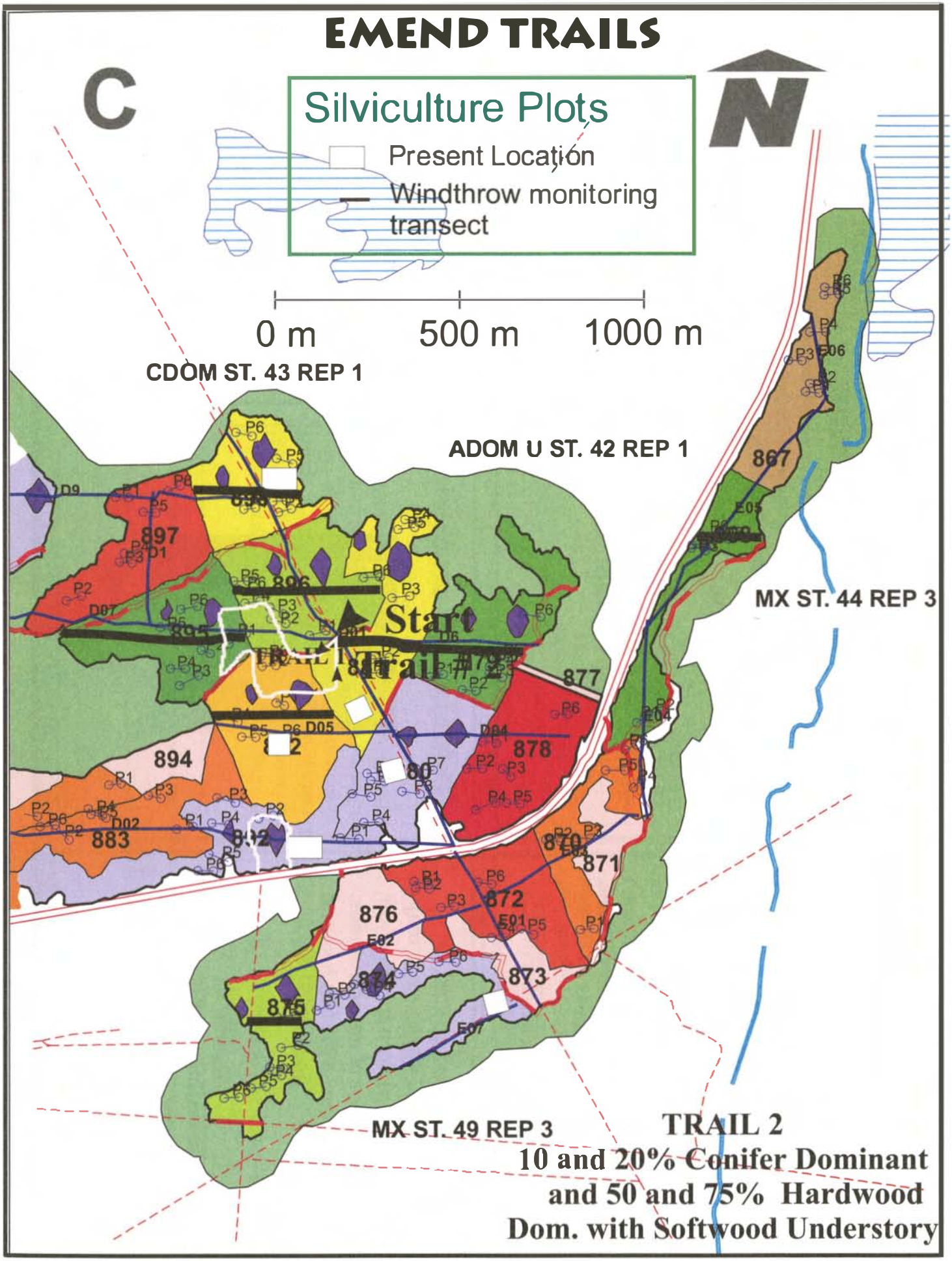
Trail 2
Stand 42/43 Loop Trail

10% and 20 % Retention, Softwood Dominant
50% and 75 % Hardwood Dominant with Softwood Understory

Harvested January 1999

Pattern: Uniform Shelterwood with 5 Metre Wide Designated Machine Corridors and 15 Metre Wide Retention Strips

Natural Resources Canada
Canadian Forest Service


EMEND TRAILS
C
Silviculture Plots
Present Location
Windthrow monitoring transect
N
0 m
500 m
1000 m
CDOM ST. 43 REP 1
ADOM U ST. 42 REP 1
MX ST. 44 REP 3
MX ST. 49 REP 3
Start
Trail
TRAIL 2
10 and 20% Conifer Dominant
and 50 and 75% Hardwood
Dom. with Softwood Understory

EMEND Research Study Template Summary

Title: Forest Health Assessments

Participants

Primary Study Leaders: K. Mallett, W.J.A. Volney

Participants: J.R. Spence, J. Brant, R. Brett, M. Michaelian, A. Yohannes, H. Gates.

Canadian Forest Service
University of Alberta

Background

Insect and diseases are major natural determinants of the structure of natural stands. They cause growth loss and mortality.

Hypothesis

Harvesting treatments will differentially not affect insect and disease impacts in managed stands.

Objective

To determine the health condition of standing trees in all EMEND compartments.

Picture/Layout Diagram/Design

Fungus stump

Technical Description

All trees in the 2mx40m productivity plots were examined. Preharvest trees were assessed for general health condition (healthy, declining, dead) and for agents or symptoms of damage. Incidences of healthy or declining trees were determined. Incidences of pest damage and their cause were also calculated. Follow up assessments will he conducted to determine differential effects of the treatments on forest health.

References and Interpretations

Refer to proposal.

EMEND Research Study Template Summary

Title: Effects of forest floor disturbance and canopy removal on soil nutrient dynamics and response of Calamagrostis canadensis, Epilobium angustifolium, and Picea glauca seedlings.

Participants

Primary Study *Leader*: Brent Frey

Participants: Vic Lieffers, Allison Munson

University of Alberta
Forest Science

Objective

To compare the impacts of canopy removal and forest floor disturbance on the growth of C.canadensis, E.angustifolium and P.glauca; to compare the impacts of canopy removal and forest floor disturbance on soil nutrient dynamics; to relate nutrient availability to vegetation response.

Technical Description

2 canopy levels:50% (3 reps)
clearcut (3 reps)
5 forest floor disturbance levels: mix, mound, scalp, low intensity burn, control

Design: Split plot with canopy level as main plot factor and forest floor disturbance as the subplot factor. Each canopy replicate (3 for 50% and 3 for clearcut) has a block of forest floor disturbance plots (see diagram). These plots are generally located adjacent to the silviculture plots.

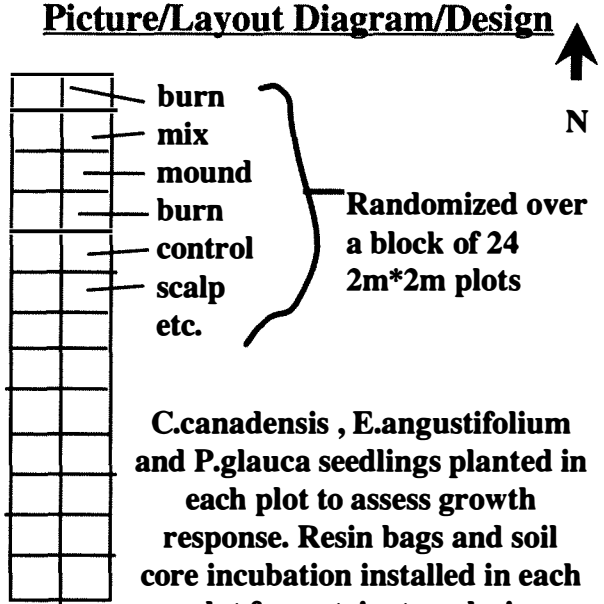
Background

C.canadensis & E.augustifolium are adapted to disturbed environments and affect regeneration of P.glauca and have significant impacts on vegetation and nutrient dynamics. It is important to determine how different disturbance types and intensities will affect nutrient dynamics and vegetation response.

Hypothesis/Anticipated Results

50% canopy removal should reduce growth of C. canadensis and E.augustifolium but not P.glauca and should show lower rates of mineralization relative to clearcuts. The scalped and burned areas should favor growth of E.augustifolium over C.canadensis.

Picture/Layout Diagram/Design



C.canadensis , E.angustifolium and P.glauca seedlings planted in each plot to assess growth response. Resin bags and soil core incubation installed in each plot for nutrient analysis.

References and Interpretations

Frey, B., 1999. Proposal.

Ecosystem Management Emulating Natural Disturbance

Trail 3

Stand 314 Softwood Crescent Trail

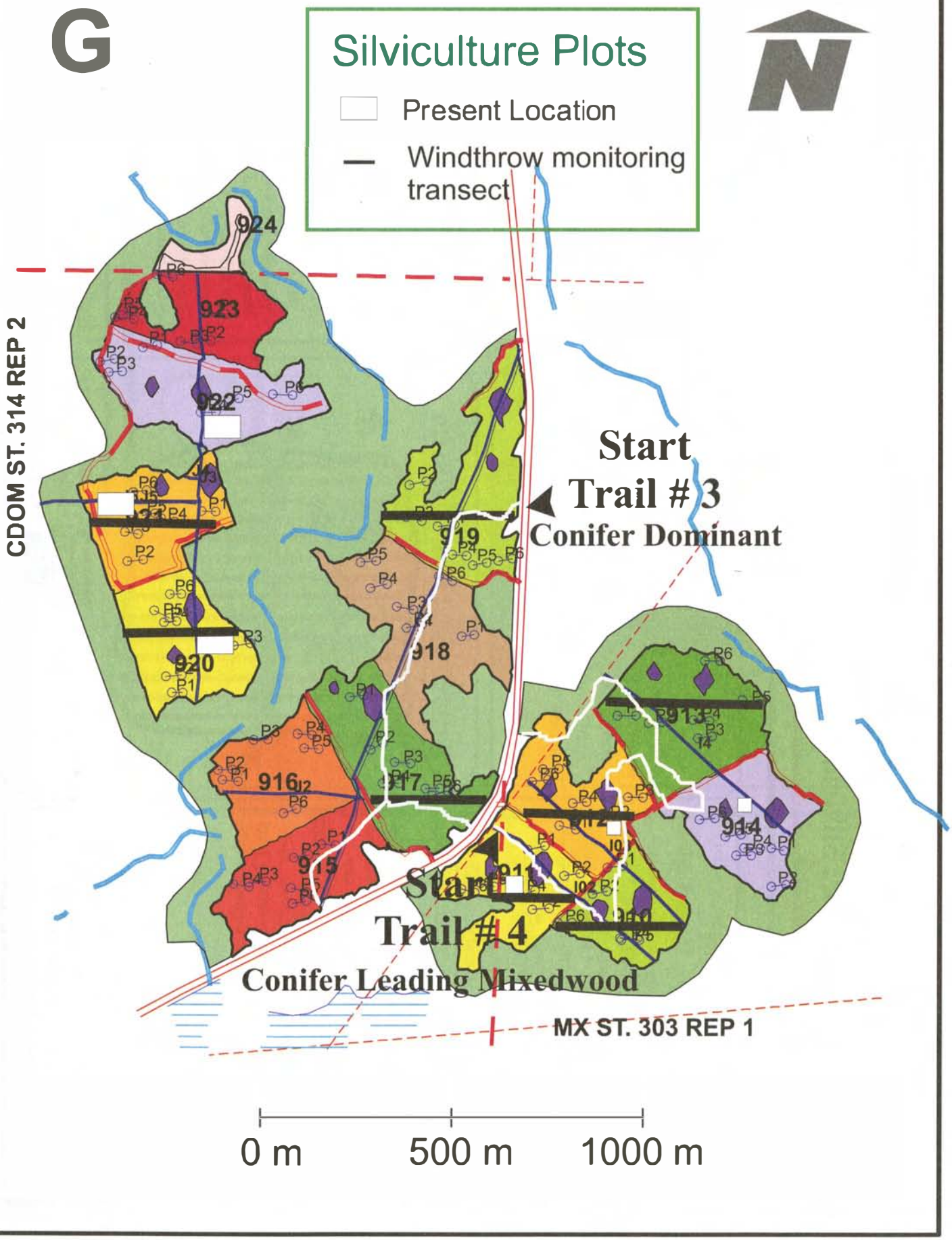
10% and 20 % Retention and Control (No Harvest), Softwood Dominant

Harvested February 1999

Pattern: Uniform Shelterwood with 5 Metre Wide Designated Machine Corridors and 15 Metre Wide Retention Strips

Natural Resources Canada
Canadian Forest Service

EMEND TRAILS



EMEND Research Study Template Summary

Title: Silviculture System Wind-throw Monitoring

Participants

Primary Study *Leader*: Derek Sidders

Participants: Kim Lambe and Diane Carlsson

Canadian Forest Service

Background

The various retention levels established on the EMEND site will be impacted by post harvest winds in different ways, based on site conditions (topography and soil moisture), stand type and slenderness coefficient (diameter to height ratio) . Pre-harvest, each block was classified by wind vulnerability level based on the above. This study will monitor the blowdown on each block to quantify the effects of the various silviculture systems or stand and retention levels.

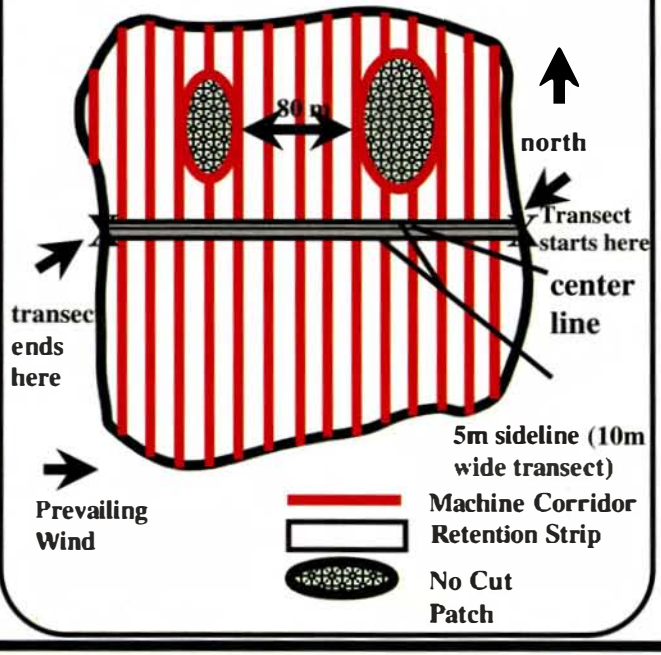
Hypothesis/Anticipated Results

Blowdown will increase as retention levels decrease; there will be more blowdown of conifer stems than deciduous and sites with more ground moisture are more vulnerable than those with less.

Objective

To monitor the impact of winds, post-harvest, on the partial-harvest treatments of conifer dominated, mixed wood, and aspen with conifer understory stands and to access blowdown patterns based on stand type and retention levels.

Picture/Layout Diagram/Design



Technical Description

10 metre wide continuous transects were established in each of the blocks identified below running from east to west and perpendicular to the harvest pattern. Sample blocks: 898, 896, 895, 881, 875,900, 887, 907,905, 903, 908, 920, 919, 917, 913, 934, 933, 931, 929, 951, 950,949,947, 939, 961, 939, 961, 954. Along the transects all trees within 5 m of each side of the centreline is marked with an orange X and tagged with a number. Trees over 2m will be measured with the exception of understory hardwoods. Each of the tags are placed on the tree at breast height/where the diameter of the tree was taken.

The following information will be collected for each tree:

tree number/species, tree diameter, tree location, tree height, harvest damage class (bark removal, branch removal, leaning, etc...) and health classification (healthy, blown over, standing dead).

Post establishment sampling will take place after major wind events and in the spring just after thaw of each season up to year 5.

References and Interpretations

Sidders, D., 1999. Wind-throw Monitoring Guide.

EMEND Research Study Template Summary

Title: Lepidoptera diversity of residual forest stands

Participants

Primary Study *Leader*: Louis Morneau
Participants: Christine Decker, Sam Price
University of Alberta

Background

Moths and butterflies (Order Lepidoptera) play key functional roles in the ecosystem, such as vegetation consumers in their larval stage, food source for birds, bats, mammals and other insects, and they act as pollinators. They are good indicators to study biodiversity as they are taxonomically well described, well studied ecologically, numerous, easily sampled and most importantly, sensitive to disturbance.

Hypothesis/Anticipated Results

Species assemblages will differ between undisturbed forest types in terms of both species presence and relative abundance. It is reasonable to expect that the lepidopteran community will reflect changes in ecosystem integrity following disturbance. Environmental modifications (temperature, light, wind cover) and small-scale forest fragmentation will affect the use of the habitat by different species. Thus, specialist species should be more negatively affected than generalist species.

Objective

To compare diversity of macrolepidoptera, including significant forest pests, in different undisturbed forest types;
To compare the impacts of fire and forest harvest on a boreal lepidopteran community.

Picture/Layout Diagram/Design

Light trap

Technical Description

Light trapping is conducted in 24 sites (8 in each forest stand type) every 9-10 days in the control, 20% and 50% residuals and the low intensity burn compartments. Light traps (UV light) are setup on 2m high tripods and run on 12V batteries. Collected moths are then sorted and identified in the lab. So far about 300 species of moths have been found, the majority of them being habitat use generalists.

References and Interpretations

Morneau, L., 1999. Proposal

EMEND Research Study Template Summary

Title: The Response of Boreal Forest Birds to Experimental Harvest and Burning: A Test of the Natural Disturbance Model

Participants

Study *Leader*: Bruce Harrison
Participants: Fiona Schmiegelow (supervisor)

University of Alberta

Background

Among vertebrates, birds represent the most diverse taxa in the boreal forest, and in general they are good indicators of forest condition. Also, their enhanced mobility should allow them to respond more rapidly than other vertebrates to disturbances.

Much recent research on boreal songbirds has focused on the northeast portion of boreal Alberta, but it is not clear to what degree these results can be extrapolated to northwest Alberta, and to date there have been few studies of the relative effects of harvest and fire.

Objectives

To monitor the immediate response of forest birds (at the community and species levels) to varying levels of harvest and intensities of fire;
to study the distribution, characteristics and use of wildlife trees;
to document the pattern of colonisation/recolonisation of disturbed areas by forest birds (settlement patterns may be used to infer habitat quality);
to explore potential mechanisms for bird community response using data from other EMEND researchers on vegetation and invertebrate response.

Picture/Layout Diagram/Design

Black Throated Green Warbler

Technical Description

Pre-disturbance data was collected in 1998 by establishing point count stations in the various treatments and controls. During each visit, observers recorded all birds seen or heard within a 50 and 100 meter radius around the station, during a 5 minute sampling interval. Some data on the vegetation immediately surrounding each point count station was also collected. In 1999, stations were revisited for post-treatment sampling. An assessment of wildlife tree occurrence was introduced in selected site types to study species such as woodpeckers, which are difficult to monitor using point count surveys. In 2000, a second year of post-treatment point count sampling will be conducted and in a new approach, we plan to monitor breeding behaviors in selected sites as a measure of habitat quality.

References and Interpretations

Schmiegelow, F.K.A., Machtans, C.S. and S.J. Hannon, 1997. Are boreal birds resilient to forest fragmentation? An experimental study of short-term community responses. Ecology 78: 1914-1938.

EMEND Research Study Template Summary

Title: Changes in Soil Nutrient Capital Under Disturbance

Participants

Primary Study *Leader*: Barbara Kishchuk

Participants: Paul Christensen, Susan Cassidy

Canadian Forest Service

Objective

To determine changes in soil nutrient concentration and nutrient content following disturbance.

Technical Description

Soil nutrient concentrations and soil mass are being determined at six locations in each compartment (600 locations). Sampling for nutrient concentrations and soil mass are done at three depths: 1) forest floor (L,F,H), 2). 0-7cm mineral soil, and 3). 10-17cm mineral soil. A 15cm by 15cm quadrant is used for determining forest floor mass and a 500cm soil core is used for determining mineral soil mass. Nutrient concentrations and soil mass will be used to determine soil nutrient content (kg/ha) as an estimate of site soil nutrient capital.

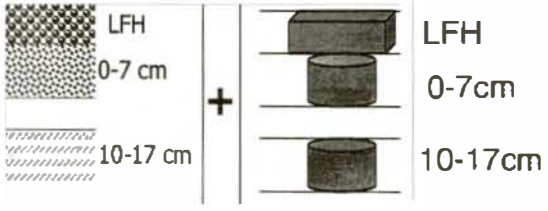
Background

Changes in soil nutrient availability following disturbance may affect long-term site productivity. Nutrient availability is controlled by nutrient capital (the amount of nutrients on the site) and the rate of nutrient turnover.

Hypothesis/Anticipated Results

In this study we are following changes in nutrient capital under full tree harvesting where litter inputs are reduced; and under burning where biomass and forest floor losses are occurring.

Picture/Layout Diagram/Design



Nutrient Analysis

Soil mass/bulk density

= Nutrient Content (kg/ha)

References and Interpretations

Kishchuk, B. , 1999. Nutrient Dynamics Under Disturbance at the EMEND site. Canadian Forest Service

EMEND Research Study Template Summary

Title: Soil Profile Descriptions and Coarse Root Biomass Sampling

Participants

Primary Study *Leader*: Barbara Kishchuk

Participants: Paul Christensen, Susan Cassidy, EMEND Core crew

Canadian Forest Service

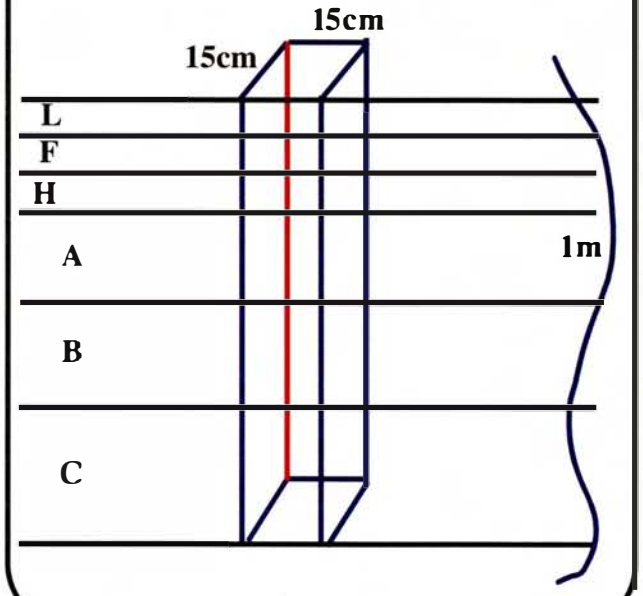
Background

Description and chemical analysis of soils in representative stands will provide information about the variability of soils, parent materials, soil forming processes, and drainage across the EMEND study area. This information will be used in the interpretation of above ground vegetation and other site attributes. Coarse root distribution and biomass will be used in determining below ground carbon pools.

Objective

To described and classify soil at the EMEND site; to determine nutrient concentrations and contents from the soil surface to C horizon; and to sample soils for coarse root biomass estimates.

Picture/Layout Diagram/Design



Technical Description

Soils in $1m^3$ soil pits were described and sampled by horizon in each stand across the study area (total 25). Soil chemical and physical properties are being used to classify the soil to Subgroup level. Coarse root distribution in a 15cm wide x 1m deep section was mapped in each soil pit. A 15cm x 15cm x 1m monolith was removed from each soil pit for estimates of coarse root biomass. Four soil pits are being maintained for demonstration purposes.

References and Interpretations

Kishchuk, B., 1999. Nutrient Dynamics Under Disturbance at the EMEND site. Canadian Forest Service

EMEND Research Study Template Summary

Title: Epigacic Arthropods as Bioindicators of Forest Disturbance and Management

Participants

Study *Leader*: David Shorthouse

Participants: John Spence, Dave Langer, Jan Volney, Greg Pohl

University of Alberta

Background

Barnes (1953) wrote, "Spiders constitute one of the best indexes for the investigation of community structure, stratification, and succession." First, spiders, carabids and staphylinids are generally abundant in terrestrial communities ensuring large enough samples for numerical analyses. Second, they have a variety of forms to fulfill a variety of ecological niches. And third, the order is small enough so that a working knowledge of the taxonomy is not beyond the capabilities of a single worker. Spiders have been studied in relation to clear-cutting, fire , managed forests , and succession. However, integrated experimental studies tying all these processes together have not been published.

Objectives

How comparable are ground-dwelling spider and beetle assemblages before and after disturbance? How comparable are these assemblages during recovery from fire to those found in the harvested treatments? What species or groups of species show measurable population responses to disturbance and what species or groups of species are the best indicators of disturbance and recovery? What habitat characteristics of harvested and burned stands are most tightly linked to the structure of epigaerc assemblages?

Picture/Layout Diagram/Design

Figure 1. Cross-section of pitfall trap, sunk into the ground with lip flush to the surface of the ground.

Technical Description

Prior to harvesting and burning, spiders and beetles were pitfall trapped at the stand level throughout summer 1998. In 1999, a total of 703 pitfall traps were installed in tree plots within the 100 EMEND compartments and emptied of their contents once every three weeks from May to August. All four stand types (ADOM, ADOMU, MX and CDOM) and harvest/burn treatments were sampled. Results from biodiversity analyses will answer my broad questions 2nd and 3rd (see Objectives). Biodiversity data will be linked to compartment dendometry, such as coarse woody debris, tree diameter, and tree height. These results will answer my broad question 4th (see above) and may contribute to forest management decisions.

References and Interpretations

Barnes, R.D. 1953. Ecological Monographs 23 (4): 315-337. Spence, J.R. and Niemelä, J.K. 1994. The Canadian Entomologist 126: 881-894.

EMEND Research Study Template Summary

Title: The dispersal and settlement of bark beetles in a harvested landscape.

Participants

Primary Study *Leader*: Jane Park
Dr. Mary Reid

Participants: Mike Logan

University of Calgary

Objective

To determine the effects of stand type and density on the movement and settlement of bark beetles.

Technical Description

Two 12-funnel Lindgren traps (baited) will be placed in each of 48 compartments . The compartments include all replicates of the four EMEND stand types as well as the 10%,20%, 50%, and control compartments to assess the propensity of beetles to fly through compartments of differing stand type and density. Additional traps will be placed in 75% blocks to assess the use of machine corridors as areas of movement. All beetles caught in traps will be identified and counted. Habitat availability will be determined with full compartment surveys where suitable habitat will be examined for habitat quality (diameter and tree species) and the density of colonizing beetles. Reproductive success of beetles will also be quantified.

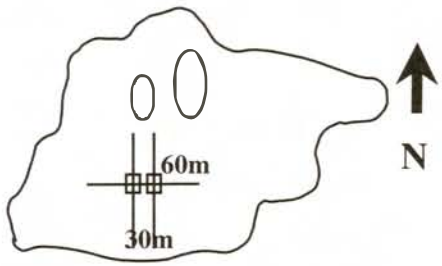
Background

The dispersal and habitat selection by bark beetles is largely influenced by habitat availability, stand composition and density. The need for improved forest management requires that beetle outbreaks be monitored in order to estimate the biological and economic impacts of infestations .

Hypothesis/Anticipated Results

Beetles may be found to disperse through thinner stands (due to ease of flight) and stands with more suitable habitat (CDOM). Dispersal and settlement is expected to be influenced by site characteristics as well as the abundance of suitable habitat.

Picture/ Layout Diagram/Design



☐ 12-funnel Lindgren trap

References and Interpretations

Bartos, D.L. & G.D. Booth, 1994. Effects of thinning on temperature dynamics: Mountain Pine Beetle activity on a lodgepole pine stand. Res. Pap. INT.RP-479. Ogden. UT, USDA Forest Service, Intermountain Research Station.
Gustafson, E.J. & R.H. Gardner, 1996. The effect of landscape heterogeneity on the probability of patch colonization. Ecology 77:94-107.

EMEND Research Study Template Summary

Title: Aspen and Spruce Defoliators' Population and Their Associated Parasitoids

Participants

Study *Leaders:* Julia Dunlop, Louis Morneau
Participants: John Spence, Jan Volney, Dave Langor
University of Alberta

Background

Defoliators (caterpillars, sawfly larvae) play an important role in the forest's natural processes (nutrient cycling, decrease in wood fiber production etc.). However, their diversity and population numbers are still unclear. Also parasitoids, which are believed to keep defoliators population at a non-epidemic level by killing their host, are poorly known. Impacts of partial harvesting on those two organisms are investigated on the two major tree species in northern Alberta: trembling aspen and white spruce.

Hypothesis/Anticipated Results

Assemblages of species will largely differ between aspen and spruce. The parasitoid community is mostly unknown but will comprise both generalist and specialist species.

Objective

Identify defoliators associated with aspen and spruce at EMEND; Identify their parasitoids and the parasitism rate of a few major forest pests; Link defoliators' population in the canopy with light trapping study

Picture/Layout Diagram/Design

Collection of Defoliators

Technical Description

Aspen and white spruce are felled on a tarp laid on the forest ground to collect defoliators. Larvae are then reared in a field laboratory on fresh foliage to obtain adults or parasitoids. Each species is photographed to build a reference guide. Vegetation data is also taken on every tree to establish relationships about larval density, parasitoid population and foliage quantity in the canopy. Aspen and white spruce defoliators collected and reared in the laboratory link the summers of 1998 and 1999. Sorting and identification of the specimens from both years are almost done.

References and Interpretations

M.Sc. Proposals of Julia Dunlop and Louis Morneau.

EMEND Research Study Template Summary

Title: The impact of silvicultural practices on the abundance and biodiversity of ectomycorrhizae in a boreal forest ecosystem.

Participants

Primary Study *Leader*: Lance Lazaruk
Participants: Ellen Macdonald and Damase Khasa

University of Alberta

Background

The high incidence of failure when late-successional conifer species such as white spruce (*Picea glauca*) are replanted in disturbed forest sites is a considerable problem and may be linked to the reduced ectomycorrhizal (ECM) inoculum present in disturbed forest soils. Past research has shown that the diversity of ECM fungi is significantly lower in clear-cut sites compared to unharvested control sites.

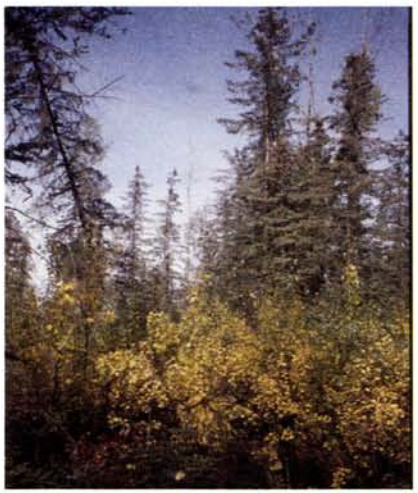
Hypothesis/Anticipated Results

As the level of disturbance is increased there should be a corresponding decrease in the diversity and abundance of ectomycorrhizae as the ECM fungal community becomes dominated by "early stage" ectomycorrhizae.

Objective

To quantify the impact of various silvicultural practices on the biodiversity of ectomycorrhizae; to determine whether alternative harvesting techniques will affect the types and abundance of ECM fungi present and capable of colonizing regenerating white spruce seedlings.

Picture/Layout Diagram/Design



Boreal Forest Ecosystem

Technical Description

In the conifer dominated stands a total of 360 sampling locations will be located throughout the control, clear-cut, 20%, 50%, and 75% residual, and medium burn sites. At each of the sampling locations a soil core (4cm diameter x 30 cm deep) will be obtained (to assess the ECM fungal community present in the forest soils) and a non-mycorrhizal white spruce seedling will be outplanted (to determine what types of ectomycorrhizae are capable of colonizing the regenerating seedlings). The sampling locations were established and the 1st year post harvest soil cores were obtained for analysis (winter 99/00).

References and Interpretations

Hagerman, S.M. *et al.*, 1999 Canadian Journal of Forest Research 29:124-134

EMEND Research Study Template Summary

Title: Spatial Patterns of Armillaria

Participants

Primary Study *Leader*: Lisa Cuthbertson

Participants: *Ken Mallett, Ellen MacDonald, Jacqueline Polland

University of Alberta
*Canadian Forest Service

Background

Armillaria is a common forest pathogen that can cause significant loss of merchantable timber by weakening the butt of trees and making them susceptible to windthrow.

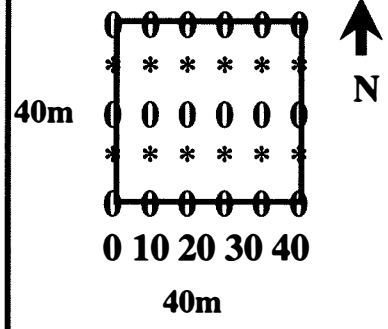
Hypothesis/Anticipated Results

It is expected to find areas of high concentration of disease in a clumped pattern on the landscape.

Objective

To describe the pattern of occurrence of Armillaria in the soil, on coarse woody debris and on trees, snags and stumps in mixedwood stands.

Picture/Layout Diagram/Design



0 = trap logs (aspen stakes)
*= soil sample for moisture, ph and pressure of rhizomorphs.
As well, resin bags are in the ground to measure available nitrogen .

All trees, snags, and stumps are mapped and permanently marked with orange flagging and a tree tag marker.

Technical Description

There are 9, 40m by 40m plots in the control and burn.
The tree composition for the plot ranges from pure aspen, aspen with white spruce understory, aspen and spruce, and pure spruce.

blocks include 948, 958, 928, 918, 930, 904, 856, 937 and 938

References and Interpretations

Cuthbertson, L., 1999. Proposal.

EMEND Research Study Template Summary

Title: Biomass and Leaf Area Estimators

Participants

Primary Study Leader:
W.J.A.Volney

Participants: J.R. Spence, K.I. Mallett, B.E. Kishchuk

Canadian Forest Service
University of Alberta

Objective

To determine the most efficient allometric equations to estimate leaf area index, root biomass, foliage biomass, branch and stem biomass using easily measured tree attributes.

Technical Description

Sample trees selected to represent the range of variation in morphology were sectioned to obtain total foliage, current foliage production, twigs, branch and stem biomass. Roots and stumps will be removed and weighed. These variables will be examined for their dependence on dbh, height and sapwood area. These estimators combined with measured data from tree productivity plots, can be used to make area wide estimates of productivity and biomass.

Background

Techniques are required to estimate biomass and leaf area in each compartment. These must rely on easily measured attributes such as tree height and sapwood basal area.

Hypothesis

Regression estimators for foliage, branch, stem and root biomass can be derived using dbh, height and sapwood basal area as independent variables.

Picture/Layout Diagram/Design

Student holding disc stained to reveal sapwood. Stack of discs from one white spruce tree.

References and Interpretations

We expect sapwood basal area to be correlated with productivity but dbh and height to be strongly related with total tree biomass.

EMEND Research Study Template Summary

Title: Response of Forest Net Primary Productivity to Harvesting and Fire

Participants

Primary Study *Leader*: W.J.A. Volney

Participants: J.R. Spence*, K.I. Mallett, B.E. Kishchuk

Canadian Forest Service
*University of Alberta

Background

Net primary productivity is one component of forest sustainability.

Hypothesis/Anticipated Results

Net primary productivity over the long-term should be unaffected by treatments. Over time the productivity of treated areas should converge to that of the untreated areas.

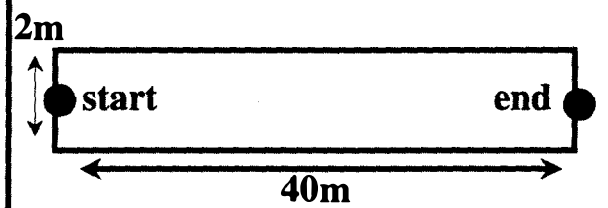
Objective

To determine the long-term net primary productivity forest response to treatments.

Picture/Layout Diagram/Design

N

6 - 2m by 40m plots per compartment



Start and end points marked with a wooden stake wrapped in pink and blue flagging tape.

Technical Description

Biomass of standing vegetation is being determined using tree plots and allometric relationships - linking tree dimensions to foliage, branches, stems and root. Heights of trees, shrub and litter layer biomass will be determined by clipping and weighing components.

There are 6 randomly placed plots in each of the 100 compartments that make up the EMEND study sites. Each individual plot is 2mby 40m (see diagram). These plots were visited before the treatments were applied and will be visited periodically after treatment. Assessments include coarse woody debris, tree height, DBH, and health and plant productivity.

References and Interpretations

Regrowth of forest stands after burning is compared to stands cut at different retention levels. Refer to proposal.

EMEND Research Study Template Summary

Title: Carbon Flux to the Forest

Participants

Primary Study *Leader*: Brian Amiro

Participants: Annette Coderre, Mike Hobbs

Canadian Forest Service

Objective

To measure whole ecosystem carbon fluxes and determine the effect of harvesting on carbon fluxes compared to a mature forest.

Technical Description

Towers are placed in control and harvested stands. The carbon flux is measured using a covariance technique which involves measuring vertical wind velocity and carbon dioxide concentration above the forest, at a high sampling frequency. Half-hour average fluxes are computed and compared simultaneously between sites. Typically data is collected for one week.

Background

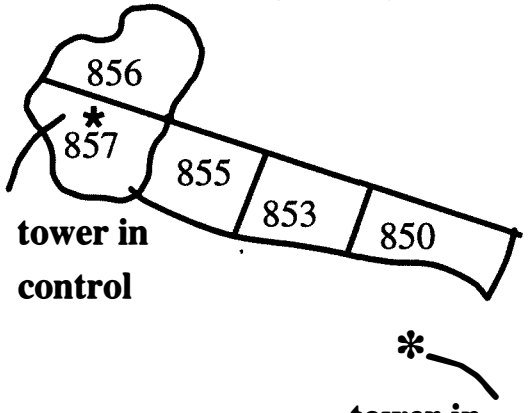
Present mathematical models estimate that carbon is released from ecosystems for many years following harvesting.

Hypothesis/Anticipated Results

To directly measure the difference in carbon flux between harvested and mature sites.

Picture/Layout Diagram/Design

Compartment A - Aspen dominated



References and Interpretations

This is part of a larger study on the effect of disturbance on the forest floor. Refer to proposal.

EMEND Research Study Template Summary

Title: The distribution of bryophyte species diversity in relation to microsite and moisture availability at 2 scales within conifer dominated boreal forests.

Participants

Primary Study *Leader*: Suzanne Mills

Participants: Dr. Ellen MacDonald, Dr. Dale Vitt (supervisors) and John Dale, Athena Cormer (assistants)

University of Alberta
Biological Science

Background

Habitat is the likely key determinant of bryophyte species diversity (Wetson, 1980, Soderstrom, 1988, Vitt et al., 1995).Many bryophyte species require specialized substrates such as logs, large tree bases or disturbed soils. Bryophytes are also vulnerable to water stress which is dependent on light, topography, temperature, and relative humidity. The combined effect of these habitat factors on bryophyte species richness has not been explored.

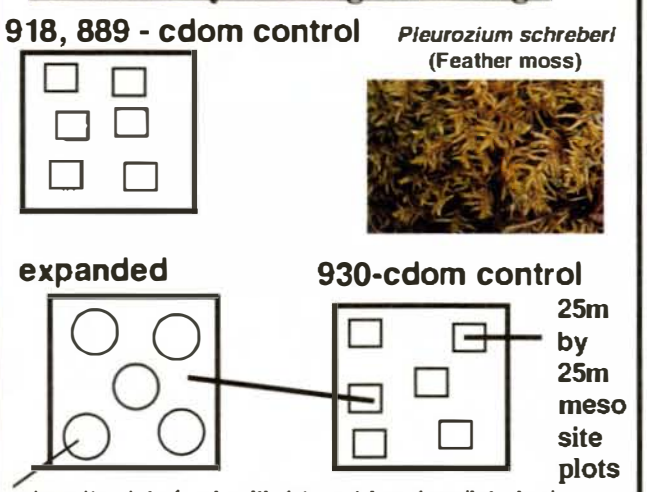
Hypothesis/Anticipated Results

Bryophyte species richness is positively related to microsite availability and moisture regime within the stand.

Objective

To test the link between available substrate and bryophyte species richness.
Is this link dependent on environmental factors (light, temperature and moisture)?
At what light, temperature and moisture levels do we begin to see a decrease in bryophyte species richness?
From this we can make predictions about how changes in these environmental variables, as a result of forest harvesting, will affect bryophyte species richness.

Picture/ Layout Diagram/Design



Technical Description

Within each of the 3 stands and mesosites, plots were randomly placed.
In each of these, 5 microsite plots were selected randomly.
Within these, the area of available substrates types was determined and environmental variables were measured (light and moisture).
Sucrose vials were placed at logs, trees, and disturbed/ undisturbed patches within the microsite plots to measure temperature.
Data loggers were placed at each mesosite to measure relative humidity and temperature.
Species richness at the microsite, mesosite and stand levels will be determined, as well as the relationship between species richness and environmental conditions.

References and Interpretations

Soderstron, L.,1988. The occurrence of epixylic bryophyte and lichen species in an old, natural and managed forest stand in NE Sweden. Nord. J. Bot. 8:89-97.

Watson, M.A.,1980. Patterns of habitat occupation in mosses-reference to considerations of the niche. Bull. Torrey Bot. Arb1007 (3):346-372.

Vitt, D.H.Y.L., and R.Bellard, 1995.Patterns of bryophyte diversity in peatlands at continental western Canada. The Bryologist 98 :218-227.

EMEND Research Study Template Summary

Title: The influence of forest harvesting on habitat use by foraging insectivorous bats.

Participants

Primary Study *Leader*: Krista Patriquin-Meldrum

Participants: Dr. Robert Barclay (supervisor)

University of Calgary

Background

Bats play an integral role in forest dynamics, as they are major predators of nocturnal, flying insects. Prey (insects) availability, risk of predation and the ability to fly in an area, dictate the foraging behavior of bats. These factors are in turn influenced by forest stand structure, which is clearly influenced by fire and logging.

Hypothesis/Anticipated Results

I predict that foraging activity by bats will be highest along edges of openings, whether natural or human caused, and decrease as the percentage of residual trees increases. The converse will be true of foraging activity in the center of compartments. However, due to morphological differences between species of bats, they will be affected differently by the harvest treatments.

Objective

Although the impact of logging on bats has recently received considerable attention, most studies are anecdotal, few studies have approached this question experimentally. Therefore, the objective of this study is to experimentally examine the impacts of natural and human caused disturbances on the foraging behavior of bats. The species of bats present in the boreal forest as well as their reproductive chronology will be documented, as very little is known about bats in the northern regions.

Picture/Layout Diagram/Design

Various levels of edge effect, relating to the foraging activity of bats.

Technical Description

Between May and September 10, 1999 and 2000, I will measure relative foraging activity of bats in 0, 20, 50, and 100% residual compartments in each of the aspen and conifer dominated and mixedwood stands. I will measure foraging activity using Anabat II bat detectors, which will convert the ultrasonic calls produced by the bats into audible and visual displays. Each species of bat produces a specific call pattern, which will allow for the determination of which species are foraging in the treatments. Samples will be taken in the edge of the buffer and thinned compartment, and the center of each compartment. With the aid of mist nets and harp traps, bats will be captured for species identification. As well, reproductive chronology, such as timing of pregnancy, lactation and post lactation, will be assessed.

References and Interpretations

Barclay and Brigham (eds) 1996. Bats and Forests. Symposium

Barclay *et al.*1991.Can.J.Zool.69:1853-1856

Brigham *et al.*1997. Can.J.Zool.75:131-136.

Fenton *et al.*1994. Anim.Behav.48:9-18

Grindal, 1996. In ref.6

Kalcounis and Brigham,1995. Can.J.Zool.73:89-95

EMEND Research Study Template Summary

Title: Soil Nitrogen Availability under Disturbance: Buried Bag Incubations

Participants

Primary Study *Leader*: Barbara Kishchuk

Participants: Paul Christensen, Susan Cassidy

Canadian Forest Service

Objective

Estimation of net nitrogen mineralization rates over the growing season as an index of nitrogen availability under different disturbance types, disturbance intensity and cover types.

Technical Description

Intact cores of forest floor and mineral soil were placed in plastic bags that allow gas exchange but no loss of soil solution. The cores were replaced in the soil for the growing season. Extractable NH_4 and NO_3 is determined at the beginning and end of the incubation period. The difference between the initial and final N values is an estimate of the net N mineralization rate of these soils. Incubations will be established at six locations in each compartment (600 locations).

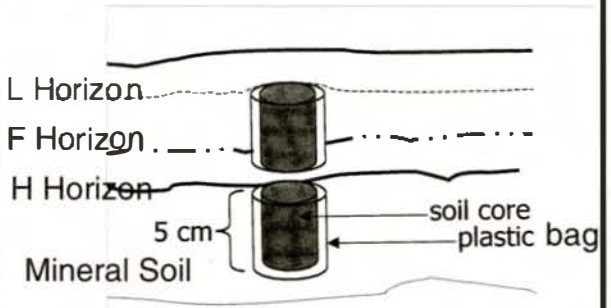
Background

Soil nitrogen availability is a factor in stand productivity. We are looking at relationships among nitrogen availability, foliar nutrition, and productivity across all disturbance types in all stands.

Hypothesis/Anticipated Results

Soil nitrogen availability is expected to change following disturbance. It is not known (1). at which level of canopy removal measurable changes in soil nitrogen availability will occur and (2). whether similar changes in nitrogen availability will occur under harvesting and fire.

Picture/Layout Diagram/Design



Soil Nitrogen Availability: Buried Bag Incubations

References and Interpretations

Kishchuk, B., 1999. Nutrient Dynamics Under Disturbance at the EMEND site. Canadian Forest Service

EMEND Research Study Template Summary

Title: Fire Behavior and Effects in White Spruce-Aspen Forests

Participants

Study *Leaders*: Bill DeGroot and Brian Amiro, Pete Bothwell

Participants: Mike Hobbs

Canadian Forest Service

Background

The CFS is currently in the process of developing a national fire effects module to complement the current Fire Weather Index (FWI) and Fire Behavior Prediction (FBP) Systems of the Canadian Forest Fire Danger Rating System (CFFDRS). This requires collection of postfire mortality and recruitment data for major Canadian tree species and establishing relationships to fire behavior. The EMEND Project will provide the opportunity to collect valuable fire behavior and fire effects data in support of CFS fire research initiatives.

Objective

To collect data on fire spread, fuel consumption and fire intensity in white spruce, aspen and mixedwood stands;

To collect postfire data on tree mortality and seedling recruitment of white spruce and aspen, and sprouting of aspen for comparison with other EMEND treatments;

To correlate tree mortality and regeneration with fire behavior characteristics to develop fire effects models for white spruce and aspen.

Picture/Layout Diagram/Design

Natural Wildfire

Technical Description

Burn prescriptions estimating fuel consumption, fire intensity and flame lengths for each burn compartment were calculated using fuels data (collected at the EMEND site in 1998 and 1999), and FWI System criteria.

Pre-burn photos will be made along several fuel lines in each compartment for later comparison with post-burn photos. Weather conditions, flame lengths and rate of fire spread will be recorded during the burns; depth of burn and surface fuel consumption will be measured after each burn is completed. Tree mortality, seedling recruitment and suckering will be surveyed along the original fuel lines. A fire weather station was set up at the EMEND camp to record local burning conditions through the 1999 field season. One compartment (926) was burned on Aug. 4, 1999.

EMEND Research Study Template Summary

Title: Effects of Fire and Timber Harvesting on Soil Temperature, Soil Water Content and Evapotranspiration

Participants

Primary Study *Leader*: G. Hillman

Participants: Cecilia Feng, Bruce Robson, Greg Taylor, Rick Hurdle

Canadian Forest Service

Objective

To determine the effects of fire and different levels of timber harvesting in coniferous stands, on soil temperature and water content and on evapotranspiration;
To establish relationships between precipitation, soil water content and evapotranspiration on treed areas and on cutovers and between plant variables and seasonal soil water and temperature conditions.

Technical Description

Instrumentation was installed on the treed and cutover areas on the control, clearcut, 10%, 20%, 50% and 75% residual sites. Each of these instrument stations consists of a datalogger connected to eight thermistors and eight soil moisture sensors, which will provide duplicates or triplicates per treatment (i.e., cutover and treed areas). A similar installation will be established on the medium burn following treatment.

Background

Information of the effects of fire and timber harvest on soil temperature, soil water content and evapotranspiration in the boreal forest is generally lacking. We propose to evaluate these effects at the EMEND project site.

Hypothesis/Anticipated Results

For both soil temperature and soil water content:clearcut>10%>20%>50%>75%>control.

Picture/ Layout Diagram/Design

thermistors and soil moisture sensors

References and Interpretations

Hillman, G., P.A. Hurdle, C.C.,Feng, 1998. Effects of Timber Harvesting and Subsequent Re-Growth on Season Soil Water Content, Soil Temperature and Evapotranspiration-Progress Report.

EMEND Research Study Template Summary

Title: Understory Vegetation Biodiversity Study

Participants

Primary Study *Leader*: D Johnson
Participants: M. Siltanen, J. Crumbaugh

Canadian Forest Service

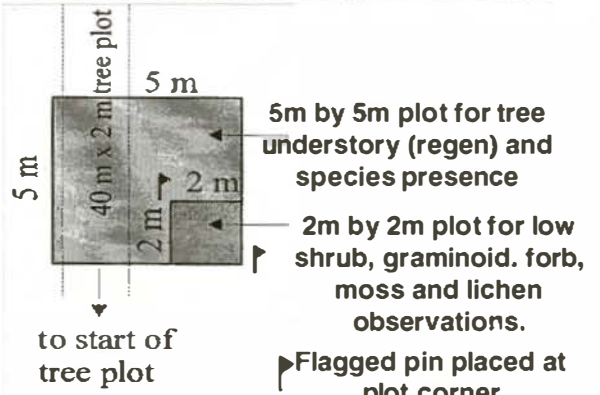
Background

All treatments and compartments at the EMEND site have been measured in terms of the understory vegetation. The total number of compartments is 100 and the total number of plots (at 6 plots per compartment) is 600.

Objective

To complete an understory vegetation (biodiversity) study post-harvest and pre-treatment of various compartments at the EMEND site.

Picture/Layout Diagram/Design



Beginning of vegetation plot is 17.5m from start of 40m tree plot.

Technical Description

A 5m by 5m tree/tall shrub plot with a nested 2m by 2m low shrub/graminoid/forb/moss/lichen plot was laid out at the midpoint of the 40m length of the 2m by 4m CFS-Forest Health plot.

In each plot, species were assessed for percent ground cover; 5m by 5m plot for trees and tall shrubs (over 1.5m tall); 2m by 2m plot for low shrubs (less than 1.5m tall), graminoids, forbs, mosses and lichens. If species absent from the 2m by 2m plot were found in the 5m by 5m plot a presence value of P was given.

Tall and low shrubs were also assessed for average height. A count of understory tree regeneration was completed in the 5m by 5m plot species. Collections of species were made for identification and verification.

Plots will be monitored over time to assess the direction and rate of change following the various treatments, as well as the long term impacts on species biodiversity.

Plots in the harvested compartments were assessed for disturbance (summer 1999) using a 5-point scale based on the area of the 2m by 2m plot that had been damaged by harvesting activities.

Ecosystem Management Emulating Natural Disturbance

Trail 4
Stand 303 Meandering Trail

Softwood Leading Mixedwood

10%, 20 %, 50%, and 75% Retention and Clearcut

Harvested February 1999

Pattern: Uniform Shelterwood with 5 Metre Wide Designated Machine Corridors and 15 Metre Wide Retention Strips

Natural Resources Canada
Canadian Forest Service

EMEND Research Study Template Summary

Title: Modeling Early Regeneration Processes in Mixed-species Boreal Forests of Alberta

Participants:

Study *Leader*: D.W. Gilmore

Participants: K. L. Haiby (research technician), C.A. Becker (Msc candidate)

University of Minnesota
Dept. Forest Resources

Background

Although much is known about securing regeneration of desirable species, few predictive tools currently exist to deal with observed annual variation in seed crop, seed predation, germination success, early survival, and seedling growth. Even when a conscious decision is made to impose treatments conducive to regeneration of target species, the composition and density of the realized seedling community often departs from expectation. Without better understanding of early regeneration processes, our future forest will occur by default rather then by plan.

Objective

To initiate a long-term record of natural regeneration processes; to assemble the above data into a database that can be used for modeling aspects of forest regeneration for the mixed-species boreal forest of Alberta.

Picture/ Layout Diagram/Design

Seed collection trap

Technical Description

Initial installations focused on establishment of seed collection traps in unharvested control and partially harvested mixedwood stands (table 1).

Table 1. Cover type and treatment in which seed collection traps were installed during July 1999.

Cover Type	Treatment	# Site	# Traps
Aspen dominated	control	3	17
Mixedwood	control	2	12
Mixedwood	50% retention	1	6
Mixedwood	75% retention	1	6
Conifer dominated	control	2	12

References and Interpretations

Gilmore, D.W., 1999. Modeling early regeneration processes in mixed-species boreal forest of Alberta.. MDFP99/1, Progress Report.

EMEND Research Study Template Summary

Title: Partial Harvest Effects on White Spruce Cone Production and Seed Rain

Participants

Study *Leader:* Jim Stewart

Participants: Dan Gilmore (U of Minnesota), Kathy Haiby (U of Minnesota), Jessica Roberts, Travis Jones

Canadian Forest Service

Objective

To quantify the relationships among cone production, residual stand density (degree of exposure), tree condition (preharvest crown class), and seed rain, following partial harvesting.

Technical Description

Use windthrow monitoring transects (and tree plots in control compartments);
rate cone crop density and crown density, and measure of total live crown length and of cone-bearing crown length;
calibrate rating system with binocular-aided estimates of cone numbers from the ground, and with counts of cones from felled trees;
test a photographic image analysis system for measuring cone crops in the future;
place seed traps in silviculture plots to measure cumulative seed rain during early fall and late fall/winter.

Hypothesis/Anticipated Results

Cone production per tree will increase as residual density decreases;
cone production will be greatest in dominants, least in suppressed trees (crown class before harvest);
cone production will increase as live crown length increases;
cone production will differ more among crown classes as residual density increases;
seed rain will increase as residual density increases.

Picture/Layout Diagram/Design

Cone Production

Seed Trap

References and Interpretations

Stewart, J., 1998. Partial Harvest Effects on White Spruce Cone Production and Seed Rain-Proposal.

EMEND Research Study Template Summary

Title: Effects of timber harvesting, snow accumulation and melt, on seedling survival and growth.

Participants

Primary Study Leaders:
G.Hillman and J. Stewart
Participants: C. Feng, G. Taylor, J. Roberts
Canadian Forest Service

Background

Timber harvesting can greatly affect snow accumulation and melt by reducing precipitation interception and changing the aerodynamic structure of the forest. Deep snow can protect young seedlings from animal browsing and insulate them from extreme low temperatures. On the other hand, seedlings may be attacked by snow mold or smothered by accumulations of snow and grass. Some cutting patterns may prolong the snowpack in the spring.

Hypothesis

Prolonging the snowpack in the spring can inhibit seedling growth.

Objective

To determine patterns of snow accumulation and melt under different levels of timber harvest; to relate seedling survival and growth to snow cover, soil temperature and soil water content.

Picture/Layout Diagram/Design

Snow accumulation in an aspen dominated with white spruce understory stand

Technical Description

Snow survey and seedling transects will be established perpendicular to the machine corridors in five treatments (0, 20, 50, 75 and 100% residuals) applied to coniferous stands on the EMEND project area. White spruce seedling plots will be circular, 5m^2 in area, spaced at 5m intervals and correspond to the snow survey plots. Each year, snow measurements (depth and snow water content) will be taken, close to, but outside and north or south of the seedling plots. Snow sampling will be done at maximum snow pack, and on 3 or 4 occasions between maximum snowpack and disappearance of the snow.

References and Interpretations

Refer to proposal.

EMEND Research Study Template Summary

Title: Cost and Productivity of Harvesting to Emulate Natural Disturbance

Participants

Study *Leader:* Eric Phillips
Participants: Craig Evans, Ernst Stjernberg

Forest Engineering Research Institute of Canada (FERIC)

Background

The EMEND study prescribed various levels of partial-retention harvesting to determine the amount of retention required for maintenance of functional ecosystems. FERIC's project explores the impacts these harvesting strategies have on the cost and productivity of conventional, forest-harvesting equipment. The goal is to ensure that forestry carried out in the northern mixedwood land-base is both economically viable and ecologically sustainable.

Hypothesis/Anticipated Results

Harvesting logistics and the resulting costs will be impacted by the differing retention levels.

Objective

To document the cost and productivity of the harvesting treatments.

Picture/Layout Diagram/Design

Harvesting at EMEND.

Technical Description

The EMEND project provided the opportunity to study the effect of residual stand density and stand type on the performance variation of conventional forest harvesting equipment.
Harvesting activities were monitored both on a cycle by cycle ("detailed timing") and shift level basis, by harvesting phase. The detailed timing results will be used to compare individual cycle-time elements between treatments to determine the effect of different levels of removal and differing stand types. Shift level monitoring results will be used with FERIC's costing model to calculate the cost per hour and per cubic meter, by treatment.

References and Interpretations

Phillips, E.J., 1997. Working plan for FERIC Project #3558: Cost and Productivity of Harvesting to Emulate Natural Disturbance

EMEND Research Study Template Summary

Title: Reproductive Responses of Bunchberry (*Cornus canadensis*) to Disturbance in a Managed Boreal Forest

Participants

Study *Leader*: René Martin

Participants: Pam Krannitz, Chris Smit,
Joanna Murdoch

University of British Columbia

Background

In order to help and understand any gradient effects that might be occurring along the forest floor, running from the interior of an unharvested buffer zone to the interior of a harvested (50% or 75% retention) area located in a conifer-dominated stand. These gradient effects may manifest as differences along the gradient that result in differences in reproductive success of bunchberry (e.g. fruit set). Understanding these gradient effects may help to understand the impact harvesting has on the understory both in harvested and adjoining unharvested forests.

Objective

To study a possible gradient effect occurring along lines running from the interior of buffer zones to the interior of harvest treatments (50% and 75%) on the reproductive biology of bunchberry (*Cornus canadensis*) located in conifer dominated forests.

Picture/Layout Diagram/Design

Bunchberry (*Cornus canadensis*)

Technical Description

The following measurements were taken at each plot: a) insect visitation rates; b) types of insects visiting bunchberry; c) number of inflorescences/plot; d) number of rammets/plot; e) number of flowers/inflorescence; f) amount of pollen deposited by insects/flower; g) amount of initiated fruits/inflorescence; h) amount of mature fruits/inflorescence; i) weight of fruits/inflorescence. The following microclimatic measurements were taken at each plot as well: a) below canopy light levels; b) ambient temperature; c) vegetation type and cover class for all species within the plot; d) surrounding tree measurements of height, dbh and distance from plot; e) soil moisture.

References and Interpretations

Barrett, S.C.H. and K. Helenurm. 1987. The reproductive biology of boreal forest herbs. I. Breeding systems and pollination. Canadian Journal of Botany. 65: 2036-2046.

EMEND Research Study Template Summary

Title: Habitat use by bumble bees in response to logging.

Participants

Primary Study *Leader:* Ralph Carter

Participants: Richard Elhert, Brent Magnan

University of Lethbridge

Background

Logging and burning change the structure of boreal forests, presumably including the understory plant community and its pollinators, of which bumble bees are a major component.

Objective

This study examines changes to the density of species of understory plants commonly visited by bumble bees, and in the use of these plants by different species and castes of bumble bees, following different levels of logging and burning.

Picture/Layout Diagram/Design

Ground Vegetation

Technical Description

Between June and August 1998 and 1999, we studied the densities of bumble bees, and of their floral resources, in all of the ADOM and ADOM-U stands (n=8) at the EMEND site. All of the baseline transects, in each of the stands, were surveyed by walking slowly along each, two to three times during the summer. In each survey, bumble bees were counted and identified to species and sex, and the number of open flowers (for plant species visited by bumble bees) were counted over a 2m wide band along the baseline. Flower counts can be converted into an estimate of nectar profitability by estimating 24 h nectar production rates in a sample of flowers of each species. As long as the baseline transects are identifiable over the years, censusing them in a similar manner will allow a quantitative evaluation of how long logging and burning affected the pollination community.

References and Interpretations

These data have 2 primary applications: they will allow an among-stand comparison of bumble bee use of available floral resources, and they will provide a short-term comparison with 1998 baseline data for effects of habitat manipulations on the pollination community.

EMEND Research Study Template Summary

Title: Causes and rates of mortality for understory white spruce, aspen, and balsam fir in a boreal mixedwood forest.

Participants

Primary Study *Leader*: Ellen MacDonald

University of Alberta

Background

An understanding of mortality in juvenile trees is essential for developing models of forest succession and growth and yield. Little is known about mortality in juvenile trees in the understory - either the rates or the underlying causes. The study will provide a mechanistic understanding and a quantification of mortality of major commercial boreal forest trees in the understory. The results will contribute to development of stand level succession and growth and yield models. Results will also be interpreted to provide information on the likely success of stand-level silvicultural manipulations (e.g. understory protection, uneven-aged management systems, shelterwoods, underplanting).

Objective

The objective of this project is to characterize the seedling mortality of important tree species across the boreal forest through a collaborative effort between different research groups. A five-year monitoring of naturally regenerated seedlings will permit comparisons of mortality between geographic regions, soil types, light levels and (possibly) stem heights.

Picture/ Layout Diagram/Design

Understory White Spruce

Technical Description

In the summer of 1999, 500 trees of each of the three species (aspen, white spruce, balsam fir) were tagged in each of two light conditions (high light, low light). The variation in light levels was the result of selecting trees growing in the understory along with those growing along natural edges and openings or gaps in the forest. Further measures of morphology and the surrounding environment will be made on these trees over the next five years. Mortality will be monitored annually. Data will be combined with five other researchers from across Canada to provide a comprehensive understanding of mortality of understory trees in the boreal forest.

References and Interpretations

Refer to Proposal

EMEND Research Study Template Summary

Title: Variable Retention Partial Harvest:
Seedbed Microsite Classification and its Receptiveness to White Spruce Establishment and Growth

Participants:

Primary Study *Leader*: Derek Sidders
(Tel: 780435 7355)
Participants: Kim Lambe, Diane Carlsson and Dr. Ivor Edwards

Canadian Forest Service

Background Justification

Natural regeneration of softwoods in mixed boreal forests have been reported in the past by numerous researchers from the perspective of seedling densities and stocking over time. The newly evolving movement to more ecologically sensitive prescriptions and management practices has resulting in mixedwood partial harvest systems specific to a certain management objectives. If natural softwood regeneration is going to be part of the prescription there is a need to develop a seedbed microsite receptiveness classification system that relate it to the new practices. Several EMEND studies (see references) are assessing natural softwood seed availability and seed germination and establishment under various created microsites and climatic conditions. This study will classify receptive seedbed types and quantify the distribution and area based coverage % of those created as a result of partial harvest systems employed on the EMEND site.

Hypothesis/Anticipated Results

Natural seeding of softwoods (primarily white spruce) will establish along disturbed harvest machine corridors and within retention strips where a compactible and moist rooting environment is available. The 1999 seed crop (Sw) was heavy and should result in a good catch in 2000 on appropriate microsites.

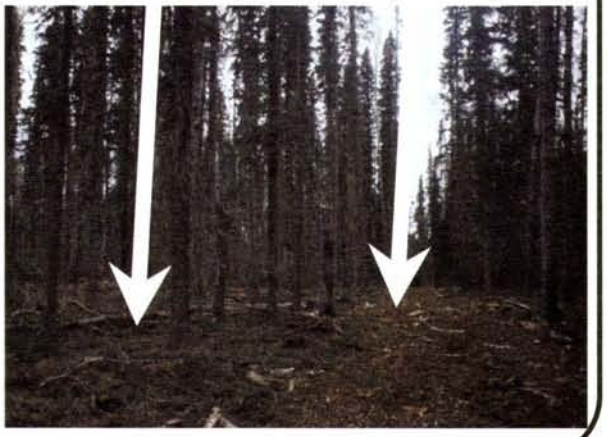
Objective

To classify and quantify the various microsites resulting from partial harvesting with 25% systematically patterned forest floor disturbance. To categorize the seedbed receptiveness of the various microsites to natural softwood seedling establishment .

Picture/ Layout Diagram/Design

Minimal Ground Disturbance Retention Strip (Poor Seedbed)

Ground Disturbed Machine Corridor (Potential Seedbed)



Technical Description

Assessments will be completed in the spring of 2000 on clearcut, no cut controls and 10, 20 and 50% retention treatments on conifer dominant, mixed and deciduous dominant will softwood understory stand types. All reps (3) will be assessed. This totals 45 blocks. METHODS: The windthrow monitoring transect centrelines (see Windthrow Monitoring Template) will be used as the sampling nucleus with 2 metre wide continuous belts (1 m on either side of the centreline) incremented in 20 metre segments considered a plot. Microsite classification with be completed in area based percentages using categories developed into an assessment guide in cooperation with the CFS vegetation research group. Microsite classifications will be categorized based on perceived seedbed receptiveness under normal climatic conditions. A second assessment will be completed in the early fall of 2000 to determine actual seed catch on the various seedbeds classified in the spring. Annual assessment will be completed to monitor seedling establishment survival over time.

References and Interpretations:

Numerous CFS reports and Gilmore, Stewart and Hillman EMEND Templates

EMEND Research Study Template Summary

Title: Understory Vascular Plant Regeneration with Reference to Site Conditions following Disturbance

Participants

Primary Study *Leader*: Treena Fenniak
Participants: S.E. Macdonald (Supervisor)

University of Alberta

Background

Immediately following disturbance, harvesting and fire provide different site conditions for plant establishment. Establishment occurs with respect to production, dispersal and successful germination of seed or other reproductive organs. The regeneration niche provided by site conditions determines which plant may establish and succeed on a given site. This niche could be extremely influential in succession, since early establishment may be more important than competitive ability in determining community history. Since understory plants are the first to establish, and their presence can be strongly linked to subsequent forest composition, studying early post disturbance conditions and understory regrowth could provide a unique perspective on succession.

Objective

My objectives are to determine a) what site conditions exist following various types of disturbance, including soil temperature, nutrient and moisture availability, surface soil disturbance, removal of organic matter, residual live and dead canopy, and creation of litter and downed coarse woody material; and b) the structure and biodiversity of the understory vascular community before and following disturbance. Results will be used to elucidate relationships between post-disturbance site conditions and vascular plant regeneration in its earliest stages.

Layout Diagram/Design

Sampling will focus on conifer- and aspen-dominated and mixedwood forest types, with the following treatments: clear-cut, 20% residual, 75% residual, and burn. Plots were selected using a stratified random sampling design, placing them in leave strips and in the residual ellipses, a minimum of 100m away from the edge of the block. Twelve plots were selected in each partially thinned stand, 8 in thinned areas and 4 in ellipses, while 8 randomly placed plots were selected within clearcut and burned stands.

Technical Description

Preharvest data was collected in the summer and fall of 1998; post-disturbance data will be collected for two consecutive years, in the summers of 1999 and 2000. Environmental parameters investigated will include surrounding snag and live tree cover, soil temperature at 10cm and 30cm, moisture and nutrient availability, rate of decomposition, disturbance intensity, and germination substrate. In both shrub and herb plots, vascular plant species cover will be recorded.

References and Interpretations

Black, R.A. & L.C. Bliss. 1978. Canada. Can. J. Bot. 56: 2020-2030. Carleton, T.J., Jones, R.K. & G. Pierpoint. 1985. Can. J. For. Res. 15: 1099-1108. Carleton, T.J. & P. MacLellan. 1994. Ecoscience. 2: 141-152. Carleton, T.J. & P.F. Maycock. 1980. Ecology. 61: 1199-1212. Clements, F.E. 1916. Succession. Carnegie Institution, Washington. Connell, J.H. & R.O. Slatyer. 1977. Am. Nat. 111: 1119-1144. DeGrandpré, L., Gagnon, D. & Y. Bergeron. 1993. J. Veg. Sci. 4: 803-810.

EMEND Research Study Template Summary

Title: Spatial Patterns of Boreal Canopies, Understory Communities and Tree Regeneration

Participants

Primary Study *Leader*: Steven Kembel

Participants: M.R.T. Dale (Supervisor); John Dale, Erin Flynn, Carmen Gibbs (Field Assistants)

University of Alberta

Background

Canopy gaps provide increased light to the understory and influence temperature, moisture and nutrient availability. Canopy structure is known to influence understory communities and tree regeneration patterns in many forest types, but studies of canopy influence on small scale patterns of understory vegetation/tree regeneration are generally lacking in the boreal forest.

Objective

To determine how the spatial structure of canopy tree populations affect the fine scale patterns of understory community structure and tree regeneration in boreal mixedwood forests.

Picture/Layout Diagram/Design

Boreal Forest Canopy

Technical Description

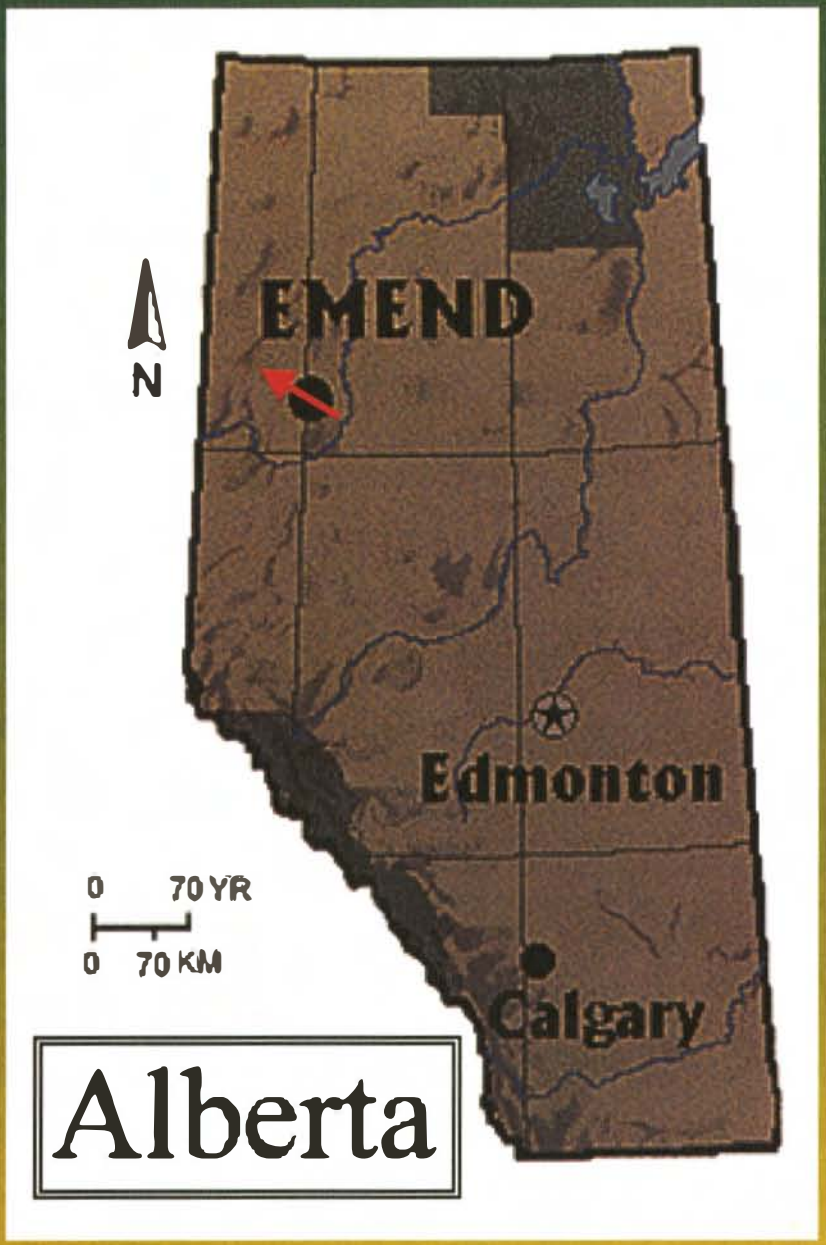
Seven 70m x 70m plots in EMEND control/burn forests (2 ADOM/2 MX/3 CDOM), 10 m buffer around a 50m x 50m 'core area'. In each plot: map location, DBH, and canopy height/width information was recorded for all trees (seedling to canopy) in the entire plot using surveying equipment. All fireweed stems in 50m x 50m core area were mapped. A grid of 121 quadrats (spaced 5m apart in a 11x11 grid) in a core area - measured understory composition (50cm x 50cm quadrat) and PAR light availability at each grid point.

Four 50m transects (100 contiguous 50cm x 50cm quadrats) were randomly placed in the core area.

References and Interpretations

Kembel, S. 1999. EMEND Research Proposal.

Kuuluvainen, T. *et al*. 1993. Can. J. For. Res. 23:2101-2109.



The EMEND research study site is located in the Upper Boreal - Cordilleran Ecoregion of Alberta, approximately 90 km north-west of Peace River. The forest stands are comprised of various mixtures of white and black spruce, trembling aspen, and balsam poplar.