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EMEND
Ecosystem Management Emulating Natural Disturbance

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EMEND

ECOSYSTEM MANAGEMENT
EMULATING NATURAL DISTURBANCE

by

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May 1999

ABSTRACT

The EMEND project was established over the two year period of 1997-1999. EMEND research falls into two main categories: 1) collection and analysis of experiment-wide data, mainly by a centrally-administered "Core Crew", and 2) research planned and executed by researchers interested in using a more restricted part of the EMEND experiment as a template for their work. This report deals with work done under category 1 and category 2 activities of the Core Crew that enable graduate student projects (the majority of the SFMN funding). During the summer of 1997 a 5-person, SFMN-supported ($60 K) Core Crew, under the supervision of an industrially funded Project Coordinator, conducted detailed forest surveys through location and measurement of 450 pre-selected plots. This work supported the selection of stands (c. 250 ha) to be used in the experiment representing each of four cover-types characteristic of the northern mixedwood forest. The experiment was laid out on the ground during the winter of 1997-98 to prepare the site for pre-treatment work in summer 1998. The 1997 data suggested that most stands in NW Alberta move along one of two basic successional pathways after their establishment: i) a slow progression from aspen dominated stands, through mixed stands to conifer dominated stands, or ii) a faster progression from aspen stands with concomitantly established spruce understorey to conifer dominated stands. During the summer of 1998 a 7-person, SFMN-assisted ($15K) field team, again under an industrially funded Project Coordinator, collected experiment-wide pre-treatment data through establishment and measurement of 600 permanent sample plots (6 plots in each of the 10-ha experimental compartments). Analysis of these data reveal no inadvertent biases in treatment allocation with respect to basic mensurational characteristics of the stands. Some significant variation in stand density has been effectively dealt with by blocking in the design. Thus, a strong inferential basis for EMEND is assured. Analysis of variation across cover-types suggests that aspen-dominated stands in the area have not yet reached the self-thinning equilibrium.

INTRODUCTION

The EMEND partnership, which has its roots in the initiation of the Sustainable Forest Management Network (SFMN), aims to deliver sustained basic research in support of forest management in NW Alberta. Forestry is changing worldwide, motivated by tangible social pressures, market forces and the desire of the industry to better manage the resource. Thus, the former widespread approach of "sustained-yield" management with predominant focus on fibre generation is giving way to development of new ecologically based management systems. In addition to meeting reasonable fibre production targets, these new management systems will have explicit goals with respect to ecological integrity and conservation of biodiversity. Both the Rio Convention on Biodiversity and the Kyoto Agreement on Carbon, signed by the Canadian government, also favour this direction, and such international commitments have serious implications for the forestry sector and the economic well-being of Canadians. The Canadian forest industry is poised to lead the global move toward innovative management and to fulfill international obligations through research-management partnerships.

Although forest management based on natural disturbance regimes is often touted as the best modern approach to sustainability, there is insufficient basic knowledge on which to base forward looking management (further discussion in Spence *et al.* 1999a). Canadian Forest Products LTD (CANFOR) and Daishowa-Marubeni International LTD (DMI) approached a group of University and Canadian Forest Service (CFS) researchers with this general problem in September 1995, seeking to stimulate research to support management initiatives and planning. They articulated two underlying motivations: i) to develop a sustained basic research environment to provide foundations for long-term management planning based on emulation of critical aspects of natural disturbance, and ii) to ensure that highly qualified personnel would be trained and available to fill anticipated needs for innovative managers in the forestry sector.

Starting in November 1995, a group of Alberta-based researchers initiated meetings with industry personnel to better define research needs and establish shorter-term objectives. Early in the planning process scientists from the Forest Engineering Research Institute of Canada (FERIC) and the Alberta Research Council (ARC), and social scientists from the Department of Rural Economy, UA and the CFS), were invited to participate. Eleven such meetings were held in Edmonton and in northern Alberta during the 18 month period between November 1995 and April 1997. From these lively sessions emerged the basic concept of EMEND ("Ecosystem Management Emulating Natural Disturbance"), which coupled industry needs to a multidisciplinary research project suitable for training graduate students in the basic and applied science and economics required for effective forest management. See Spence *et al.* (1999b) for a more detailed summary of the historical background of the project.

The overall EMEND experiment has been designed to explore the short- and long-term consequences of innovative harvest and silvicultural prescriptions for biodiversity, site productivity, carbon storage, hydrological features, and regional economics (see Volney *et al.* 1999). An important goal is to test the "natural disturbance hypothesis" by asking if ecological features of stands exposed to alternative practices are comparable to the same features in stands originating from experimental burns. Research focuses on the amount and type of residual forest structure required to ensure healthy forest ecosystems capable of meeting sustained multiple-use needs. Within this focus, the overall objectives of the EMEND project are: i) to determine which forest harvest and regenerative practices best maintain biotic communities, spatial patterns of forest structure, functional ecosystem integrity in comparison with mixed-wood landscapes that have arisen through wildfire and other inherent natural disturbances; and ii) to employ economic and social analyses to evaluate these practices in terms of economic viability, sustainability and social acceptability (Spence *et al.* 1999b, Volney *et al.* 1999).

In order to meet the expressed management needs of our industrial partners, EMEND research is being conducted in four cover-types that provide critical focus for management in the successional continuum of the boreal mixedwood forest in NW Alberta. These cover-types are as follows: 1) Aspen-dominated (ADom), >70% of canopy trees as *Populus tremuloides* or *Populus balasmifera*; 2) Aspen-dominated with Spruce understory (ADomU), as in ADom but with understory of *Picea glauca* at least 30% as tall as canopy; 3) Mixed (Mixed), both hardwood and softwood components comprising 40-50% of the canopy trees in the stand; and 4) Conifer-dominated (CDom) >70% of canopy trees as *Picea glauca*. All treatments included in the overall harvesting experiment as defined in our SFMN proposals, except "high-intensity" burns are replicated 3 times in each cover-type. The five harvest treatments (clear-cut, 10%, 20%, 50% and 75% residual green trees) were applied during winter 1998-99 and the three burning treatments are being applied through the summer and autumn of 1999. Each treatment block also contains an uncut check compartment (see Volney *et al.* 1999).

Research comprising the EMEND project falls into two main categories: 1) collection and analysis of experiment-wide data, mainly by the "Core Crew", required to ensure that comparisons of treatments can be made over all four forest cover-types treated in the experiment, and 2) research planned and executed by researchers interested in using a more restricted part of the EMEND experiment as a template for their work. Work done under category 2 is more appropriate for projects by graduate students. The Core Crew has contributed directly to research in category 2 by a) selecting and preparing the EMEND sites for study, and through b) direct assistance with field work under category two during times of peak load for the researchers involved.

This interim report deals with work done under categories 1 and 2a, as defined above. These initial two years of the core EMEND research effort, partially supported by

SFMN funding in 1997-98 ($60K) and 1998-99 ($15K), have delivered excellent "bang for the buck" on SFMN investment (< 20% of what has been required just to support the core activities to date). Core EMEND work has focused on site selection, fine-tuning the experimental design, laying out the experimental compartments and access routes on the ground and collecting pre-treatment data as required for various components of the project. Although frequently misunderstood within the SFMN, the core efforts are **the main vehicle for delivery of crucial research** (focused on the experiment-wide objectives of the EMEND experiment), in addition to ensuring the necessary infrastructure and networking required by a large, multidisciplinary project like EMEND.

This report is delivered with a caveat. From the initiation of work to deliver the EMEND experiment, a 4-year time-frame was planned for initial efforts in three phases: i) stand selection and spatial lay-out for the experiment absorbed year 1 (1997-98); ii) collection of baseline, pre-treatment data absorbed year 2 (1998-99); and iii) collection of post-treatment data about initial effects of the experiment are planned for years 3 (1999-2000) and 4 (2000-01) and longer if required to carefully monitor all experimental burns for two field seasons after application of experimental treatments. In addition, our industrial partners firmly intend to monitor the experiment periodically for a full rotation (60-80 yrs), the time-frame over which forest management must be effective.

We are now at the end of year 2 of the initial EMEND process, as defined above. The core research efforts in years 1 and 2 are described by year below. Some pre-treatment data useful for comparing the cover-types assessing the experimental design have been analysed explicitly for the purposes of this report and these are presented. Of course, given the structure of the experiment, most of the pre-treatment data, by themselves, are of little interest with respect to the main goals of the research program and simply provide no basis for even preliminary conclusions relevant to the objectives of EMEND. The relevant data, analyses and inferences will be presented in the final reports and publications from the initial phase of the project. In ecological work of this scope, victory belongs to those who stay the course.

SUMMARY OF DATA ANALYSIS

Year 1 (1997-98)

Stand selection and characterization

By the time the first SFMN funding was awarded for EMEND, there had already been an extensive period of planning and interaction of forest industry and research personnel, as described above, to develop scientifically rigorous research that would meet industrial needs. By April 1997, we had selected a general site for the study in the P1 Management Zone and planned a basic experiment to explore the impacts of a range of fire and harvest treatments on the four distinct forest cover-types that characterize the mixedwood forest of NW Alberta. The size of the experiment was limited pragmatically by the amount of the coniferous timber that the CANFOR mill at Hines Creek could use in a single year. Given volume estimates available from cruise data, experimental treatments could be replicated in three blocks of stands representing each of the four cover-types with treatment compartment sizes limited to c. 10 ha.

Our first task was to choose the *c.* 250 ha of each cover-type (*i.e.*, total land base of *c.* 1000 ha) to be used for the experiment, from the pool of stands available in the area selected for the study (*c.* 3000 ha). Although not research *per se*, careful site selection is essential in large-scale experiments, which are nonetheless limited with respect to replication. The usefulness of all subsequent research depends directly on careful site selection. Our goal was to select stands that could be blocked in relatively homogeneous replicates in order to maximize our ability to effectively isolate treatment effects from background variation within cover types. We used data in the Phase IV inventory together with spatial considerations about blocking and access to select stands for further study. We aimed to collect detailed data for the most similar stands in each cover-type up to an initial survey area of 400-450 ha .

Between May and August 1997, a six-person field team (the "Core Crew") led by Project Coordinator, Lisa Cuthbertson, collected data about these candidate stands, assisted with stand selection and characterized the four cover-types with respect to ecological important features. The SFMN Funding supported the salaries of the five undergraduate assistants, purchase of an additional quad required for Core Crew work, transportation and materials and supplies used by the Core Crew in conducting their assigned duties. Other expenses, including camp costs, safety training, helicopter time and the salary and benefits of Ms. Cuthbertson, were covered mainly by our two industrial partners, CANFOR and DMI.

During May to mid-July the Core Crew located and visited stands in this never-cut forest, with quad access permitted only along the axis provided by the DMI and CANFOR forest roads and a few cut-lines. Each stand was sampled for mensurational characteristics of canopy trees using a system of 50 x 2 cm strip plots, laid out in advance to sample mapped stand polygons at random locations. The following characteristics were measured: species identity, diameter at breast height (DBH), height to live crown (HLC), and spacing of all trees > 9 cm DBH. Also, the first canopy dominant or co-dominant tree on each plot was also cored; the cores were mounted and analysed to establish a representative tree age for each stand. Number of plots was allocated to each stand in proportion to stand area. In all 450 such plots were located, installed and sampled.

Stands to be used for the EMEND experiment were selected by a group of EMEND researchers, based on analysis the mensurational data during late July 1997. In so far as possible, we sought to standardize stand age and volume within replicates and across cover-types by keeping the standard errors (SE) for these parameters within 10% of the mean, while at the same time, achieving a reasonable dispersion of replicates on the landscape. Of course, some trade-offs between stand homogeneity and dispersion were required, and because the distribution of stands was determined by natural processes an ideal dispersion of replicates was not possible to achieve. Nonetheless, we were reasonably successful with stand selection, as described below.

Mean age of poplar canopy trees ranged from 82-97 years with the oldest trees found in CDom and Mixed stands and the youngest trees found in ADom and ADomU stands. In all cases, SEs were <10% of the mean age (Fig. 1) and there was no significant difference across cover types with respect to aspen age (F=1.64, df=3,20, P=0.21). Ages

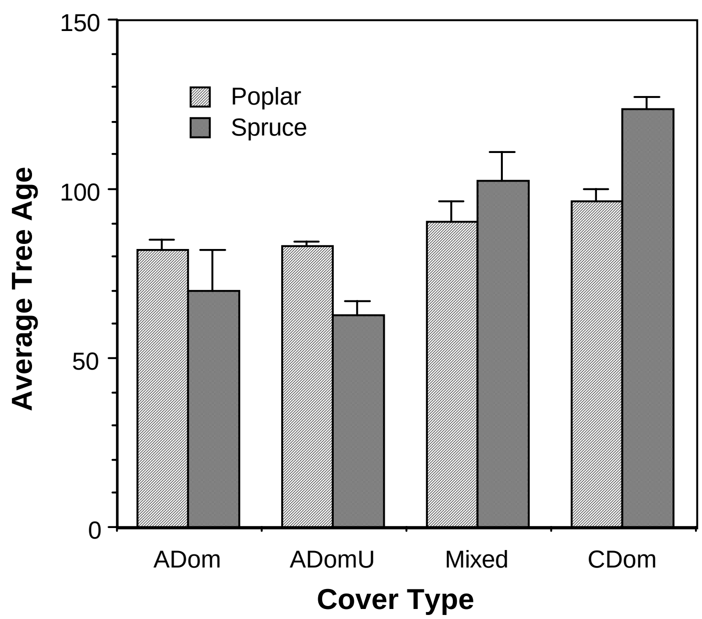

Figure 1. Variation in mean tree age across cover-types at the EMEND site.

of canopy spruce, as expected from knowledge of the prevailing successional sequence, were more variable across cover-types, ranging from 62-124 years, and the differences in age across cover types were highly significant (F=10.47, df=3,17, P=0.0004). For all cover-types, except ADom, however, the stands selected had SEs within 10% of the mean for spruce age as well. Post-hoc comparisons at the 0.05 level using Schéffe's procedure showed that CDom stands had significantly older spruce trees than ADom or ADomU stands, and that spruce in the Mixed stands were significantly older than those in the ADomU stands, but not older than those in the ADom stands.

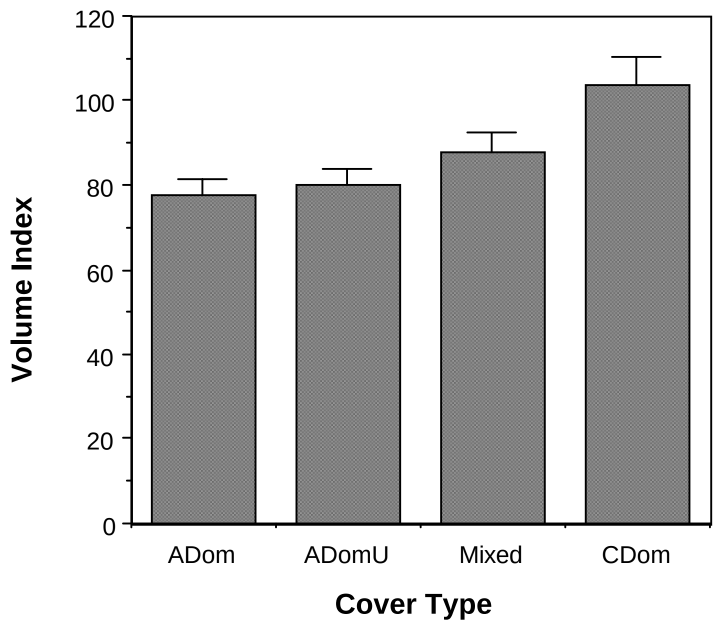

Figure 2. Variation across cover-types in the Volume Index (VI), calculated as described below in equation 1.

We did not calculate rigorous estimates of volume using taper equations for the data collected in 1997. Instead, we calculated a volume index (VI) based on the volume of untapered bole cylinders for plot trees. This index, which is a rough estimate proportional to volume/ha in our stands, was calculated as follows:

$$VI = HLC * (\pi\ ((DBH/2)^2) * 10^3 \qquad [1]$$

Although analysis of the data about VI pooled for all species shows that there are a significant differences in volume across the cover-types (F=3.42, df=3-22, P=0.035, Fig. 2), no pair-wise, post-hoc comparisons showed significant differences according to Schéffe's procedure. Inspection of the data suggest that a 10-20% greater volume in CDom stands is characteristic of the forests in the area chosen for EMEND.

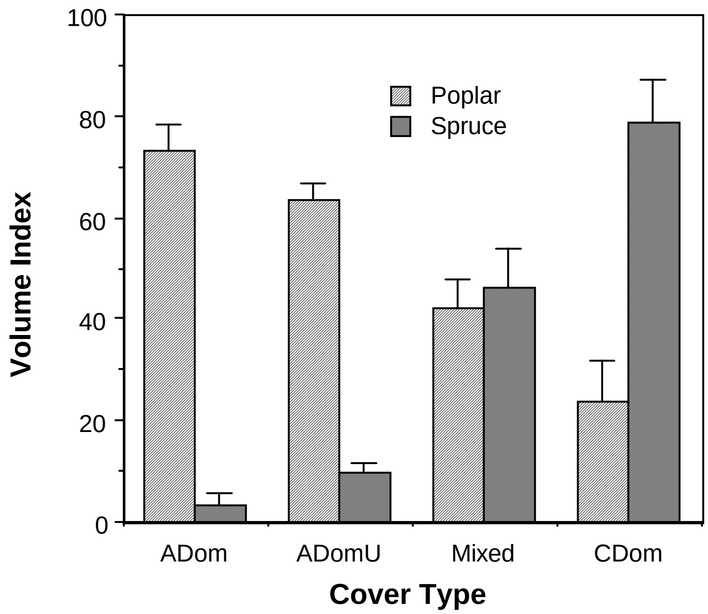

Figure 3. Variation in the Volume Index partitioned by the 4 cover-types used in the EMEND experiment.

When VI is partitioned between spruce and poplar, the results emphasize the "mixedwood" character of the forest at the EMEND site; there is clearly both hardwood and softwood volume in all stands (Fig. 3). Poplar volume increased significantly across the continuum of ADom to CDom stands ($F=12.62$, $df=3, 21$, $P<0.0001$). Application of Schéffe's procedure revealed that there was significantly more poplar volume in ADom stands than in Mixed or CDom stands, and in ADomU stands than in CDom stands. Spruce volume also increased significantly across the successional sequence ($F=23.21$, $df=3, 21$, $P<0.0001$). However, post-hoc tests showed that all pairwise comparisons except Adom-AdomU differed significantly in spruce volume. In general, unstorey spruce were too small to be recorded in the mensurational data, given our 9 cm DBH cut-off for assessment of canopy features.

The above findings suggests that natural regeneration regimes follow two general routes established early in stand development. Along one route, (ADom-Mixed-CDom) stand conversion from hardwood to softwood is slow, with aspen dominated stand perpetuating themselves through several-many cycles of hardwood trees, and moving toward conifer dominance through a process that involves the spatial mosaic of a Mixed stand. If, however, sufficient spruce seed is present at the time of stand initiation, succession toward a CDom stand proceeds rapidly through a different route (ADom-ADomU-CDom). Mixedwood succession probably follows a continuum of sequences between these extremes, and retention of this variability through management may be crucial for maintaining the ecological integrity of this sort of northern forest.

Evolution of the experimental design

The design of the EMEND experiment has evolved through three rather distinct phases (Spence *et al.* 1999b). During the winter of 1997-98, two blocks were cut to prescriptions outlined by phase 2. Inspection of the results and subsequent discussions among researchers, provincial foresters and forest industry personnel led to development of the phase 3 design, which has now been laid out on the ground. The advantages of this optimal impact design are fully discussed by Volney *et al.* (1999).

Other initiatives

During the month of August the Core Crew carried out ecosite classifications for a subset of these stands, chosen to assist with spatial aspects of blocking. They also conducted on-site tests of alternative protocols for collection of data about coarse woody debris (CWD), as good data about this component is regarded as essential to an experiment focused on the development and fate of residual structures after harvest and wildfire. In the context of work on CWD, the Core Crew collected detailed data about fuel loading from compartments initially designated for fire treatments in case spring burns might be possible in 1998. However, because of high-risk fire conditions in Spring 1998 and because there was extensive spatial reorganization of burn compartments subsequent to application of risk minimization criteria during winter 1997-98, no burns were conducted in 1998. Nonetheless, the data about fuel loading proved useful in planning the burns that are scheduled for 1999 and assisted us with the development of effective protocols employed by the Core Crew to collect pre-treatment data about CWD during 1998.

An EMEND project website was established during 1997 by Core Crew member Louis Morneau. It may be located at the following URL:

http://www.biology.ualberta.ca/emend/emend.html

The website is an effective tool for communication among EMEND workers and for communication between the project and other scientists who may be interested. The SFMN agreement prevents us from making the raw data available but some data summaries are posted along with more detailed descriptions of the project goals, design and personnel. Although Mr. Morneau has become an EMEND MSc student sponsored by an NSERC-Industrial Fellowship and under the supervision of Drs. John Spence (UA) and Jan Volney (CFS), he continues to fill the role of EMEND Webmaster.

Year 2 (1998-99)

Core research activities

Between May and August 1998 an 8-person Core Crew, once again led by Project Coordinator Lisa Cuthbertson, carried out research activities at the EMEND site. In order to collect the full range of pre-treatment data desired, a 4-person Core Crew remained at the EMEND site collecting data during September and October. The $15K investment from the SFMN was used to pay the summer salaries of *c.* 2.4 of the Core Crew. Our industrial partners met the other direct expenses associated with core research activity during 1998-99; these amounted to >$165K.

In addition to the Core Crew, >70 researchers and their assistants used the EMEND camp facilities during the past summer. Fifteen of these people (those identified as Core Crew, plus D. Langor, V. Lieffers, E. Macdonald, D. Sidders, J. Spence, J. Volney and M. Weber) contributed mainly or significantly to the experiment-wide research activities of the Core Crew. The remaining researchers fall mainly into category 2, as explained above. When considering the extent of SFMN investment in EMEND, it must be remembered that our partners bear the full camp costs of researchers in category 2; these are $75-90/person-day, depending on the number of people in camp.

In addition to the experiment-wide research activities outlined below, the Core Crew provided significant assistance to researchers in category 2 in the following ways during 1998:

- periodic collection and sorting of samples for studies of biodiversity;
- assistance with compartment-specific assessments of forest health;
- collection of material for studies of forest genetics;
- pre-burn collection about fuel loading essential for fire studies;
- descriptions of soils across the entire EMEND landscape; and
- erection of meteorological towers and equipment.

These duties and the data that resulted will not be further discussed in this interim report, but will be reflected in the subsequent reports of researchers working in category 2, and in the overall EMEND summaries. The important point is that the Core Crew has played a significant role in providing direct and efficient research assistance to scientists in category 2, and in so doing, have contributed to the integration of work at the EMEND site.

The experiment-wide work conducted by the Core Crew during the past summer included establishing access routes to each compartment through a series of "baselines" and laying out and mapping the two residual ellipses to be left in each harvested compartment under the phase 3 design (see Volney *et al.* 1999). In addition, 600 permanent 40 x 2 m strip plots were established (6 per compartment) and data about mensurational characteristics and coarse woody material were collected between May and August. The size of strip plots was altered in 1998 to best sample harvested blocks, which are now patterned with 5m machine corridors between 15m thinned strips. Plots are oriented at 90° to the grain of the harvesting so that each plot samples exactly two completely harvested machine corridors and two thinned strips. The Core Crew also made regular collections of epigaeic arthropods and flying insects from all stands to serve as pre-treatment data for an experiment-wide analysis of treatment effects. Data about the biomass and composition of shrub understory and about site classifications were collected during September and October. All strip plots and ellipses were located with GPS and a permanent record of location was established.

We emphasize that the above work is essential to the long-term *research* objectives in the EMEND experiment. Although we refer to this team as the "Core Crew", it represents serious misunderstanding to equate the experiment-wide research strictly with non-research infrastructure activity.

During the period November 1998 - March 1999, Chad Grekul was hired to replace Lisa Cuthbertson as Project Coordinator. Ms. Cuthbertson resigned at the end of the year to take up a graduate program at EMEND, sponsored by an NSERC-Industrial Fellowship and under the supervision of Drs. Ellen Macdonald (UA) and Ken Mallett (CFS). Two core crew members, Alyssa Bradley and Tom Patochka, worked with us over the winter to mount and analyze tree core data from the 600 EMEND plots and to enter and check the experiment wide data. Reliable SAS databases for much of the pre-treatment data are now established. Ms. Bradley will stay on, through December 1999 and beyond, depending on availability of funding, as the Data Manager for EMEND. Such full-time assistance is required if the experiment-wide data are to be organized and analysed in a timely manner.

Preliminary analysis of mensurational data

For the purposes of this report we have undertaken an analysis of the basic mensurational data collected by the Core Crew during 1998. These analyses permit us to elaborate the comparison of cover types for the pre-cut EMEND forest, and to check whether we've actually met reasonable goals in site selection. For these preliminary analyses we've considered three response variables: Number of living stems (NLS), Total plot volume (TPV) and Plot basal area (PBA). The ALFS taper equations for NW Alberta (Huang 1994) were applied to estimate actual plot volumes.

We first subjected each of the response variables to ANOVA with the main effects of Treatment [harvest (5 levels), burn (3 levels), uncut check (1 level)], Cover-type and Replicate in the model (Table 1). The results are generally comforting, although because of some ambiguities about coding in the data base, 13 plots were omitted in the analyses presented here; these problems will be corrected by plot visits during the upcoming summer. For all three variables, there are strongly significant effects of Cover-type, however, there are no statistically significant effects of Treatment. Thus, it appears that the allocation of Treatments to compartments within Replicates, which could not be strictly randomized because of pragmatic considerations about fire control, can be safely treated as randomized in subsequent analyses of the EMEND data. The analyses reveal a significant effect of Replicate for NLS but no other systematic variation.

Table 1. Results of GLM ANOVA for three mensurational variables. Note all F-values calculated using a denominator mean square with 574 df. Ranges are given on a per plot (i.e., 80 sq-m) basis. Thus, to convert to a per hectare estimate, multiply by 125.

Variable & Effect	Range of Plot Means	F	df	P .
No. Living Stems				
Treatment	7.13-8.59	1.52	8	0.146
Cover-Type	6.24-10.50	28.16	3	0.0001
Replicate	6.03-9.04	22.17	2	0.0001
Plot Basal Area				
Treatment	0.324-0.383	0.51	8	0.845
Cover-Type	0.292-0.372	11.92	3	0.0001
Replicate	0.329-0.367	1.95	2	0.14
Total Plot Volume				
Treatment	2.947-3.549	0.52	8	0.849
Cover-Type	2.627-3.601	7.26	3	0.0001
Replicate	3.202-3.530	2.27	2	0.104

Differences in stand density among cover-types were driven primarily by a nearly 40% greater number of stems per plot in ADomU stands, as compared to the other cover types (Fig. 4). There could be significant block effects in response to the EMEND treatments based on this pre-cut difference in stand density, but fortunately, these can be partitioned in the blocked design. Standard errors in NLS within cover-types is less than 10% of the mean in all cases.

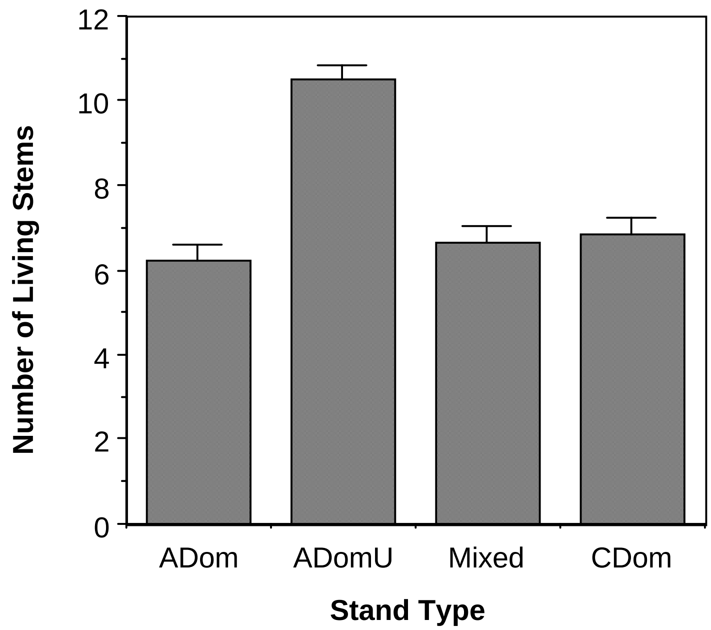

Figure 4. Variation in number of living stems per plot across cover-types.

The more accurate volume estimation procedures employed with the 1998 data (Fig. 5) present a rather different picture from the data based on VI plotted from 1997 (Fig. 2). The compartment specific data from last year suggest that the significant differences in volume across cover-type flow mainly from somewhat lower mean volumes in the ADom stands. This same rather simple trend is mirrored in the data about plot basal area (Fig. 6), corroborating our hypothesis that ADom stands are younger and not fully developed, perhaps still growing to meet the self-thinning equilibrium. Understanding these relationships is central to a knowledge of carbon dynamics in these stands. Standard errors for both TPV and PBA are within 10% of the means for each cover-type.

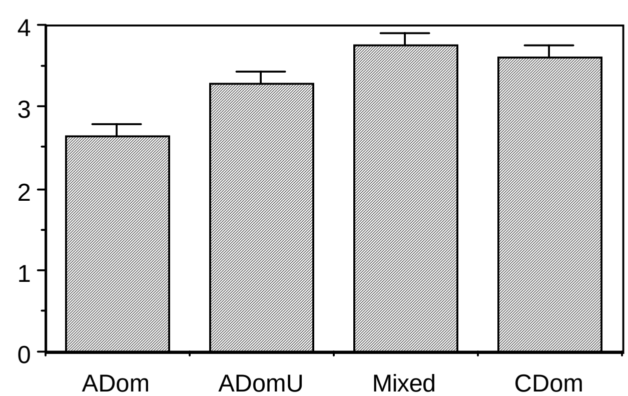

Figure 5. Plot volumes across the cover-types based on the EMEND plots.

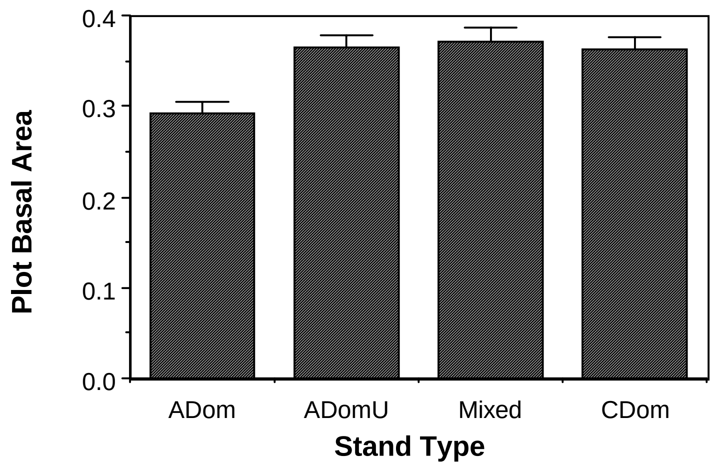

Figure 6. Plot mean basal areas across the cover-types based on the EMEND plots.

A total of eight tree species were recorded on the EMEND plots, including three deciduous species (*Populus tremuloides, P. balsamifera* and *Betula papyrifera*) and 5 conifers (*Abies balsamea, Larix laricina, Picea glauca,*
Picea mariana and *Pinus contorta*). All but the two poplars and two spruces are minor elements, rarely accounting for more than 2% of the trees encountered in any stand (Fig. 7). Clearly, as also seen in the data from 1997, the proportion of white spruce increases steadily and that of trembling aspen fall across the sequence ADom-ADomU-Mixed-CDom. Interestingly, the proportion of balsam poplar in the deciduous component of these stands also falls across this successional sequence. Furthermore, black spruce was entirely absent from compartments in the ADomU stands, suggesting that these afford generally drier sites on the EMEND landscape.

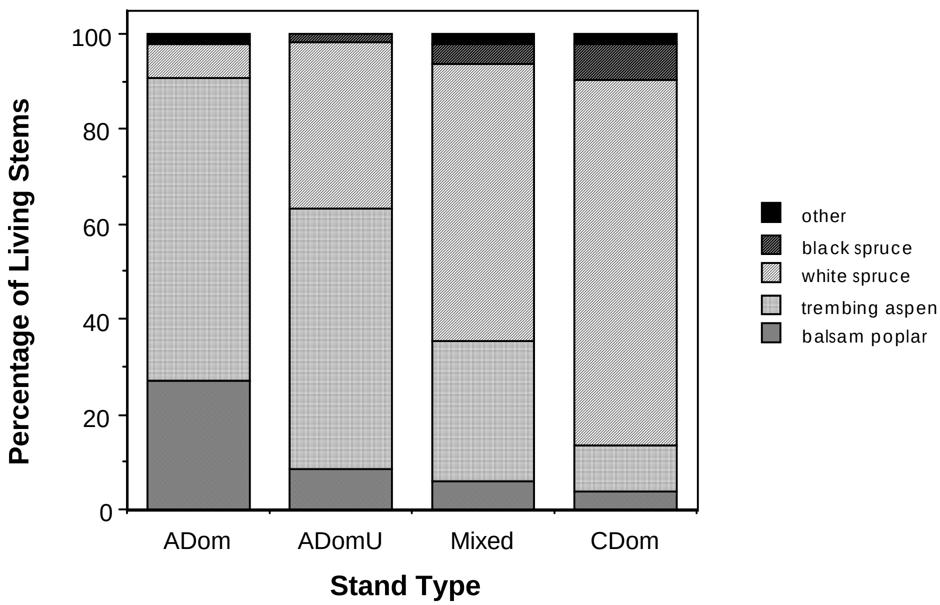

Figure 7. Percentage of living stems partitioned by species across the EMEND cover types.

A partition of volume by species shows a similar pattern across cover-types (Fig. 8). The only notable differences from the pattern based on number of stems is that the volume accounted for by black spruce and the 'other' category is less significant, except perhaps in the Mixed stands. However, even in the Mixed cover-type these two strata account for only about 5% of the overall volume. The contribution of trembling aspen to stand volume is somewhat more significant in CDom stands.

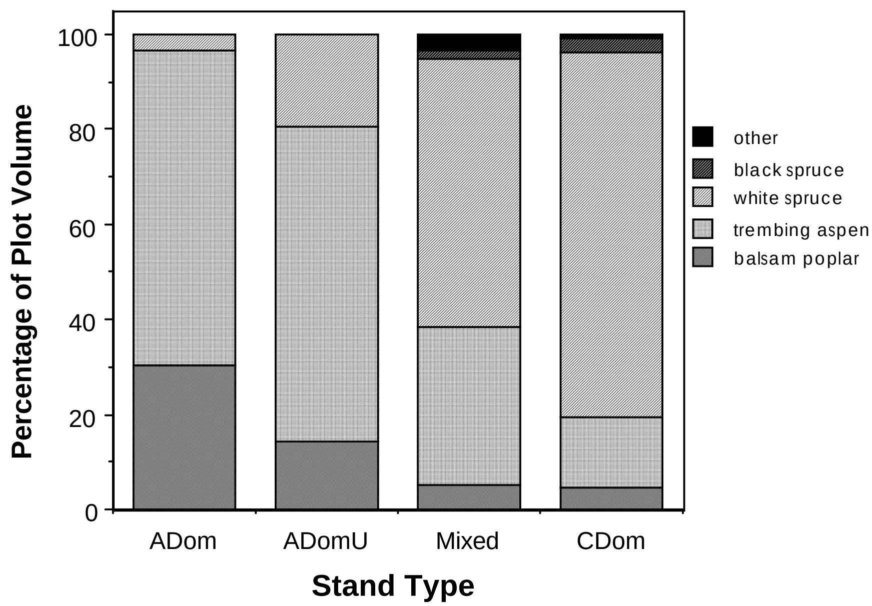

Figure 8. Percentage of volume partitioned by tree species across the EMEND cover types.

MANAGEMENT APPLICATIONS

Because no post-treatment data had been collected by 31 March 1999, we have no basis for making management recommendations in this interim report that flow from analysis of the EMEND experiment itself. The past two years have been invested in designing and establishing the large-scale field experiment central to the EMEND project and in building a multi-disciplinary research team. We have endeavored to set the experiment out as carefully as possible so that it may be of long-term, lasting value. We sought explicitly to establish replicates that are as homogenous as possible, with respect to the stand features of direct interest to foresters. Given the large variance that characterizes the boreal forest, even in NW Alberta, one year was absorbed simply selecting sites and a second field season was required to collect a full range of pre-treatment data. The data presented in this report suggest that interpretation of the experiment will not be unduly confounded by features not considered in the design. Thus, we hold that results of the EMEND experiment will be valuable for managers.

The pre-treatment and stand selection data presented in this report help to define the general character of the mixedwood forest in NW Alberta. They suggest that most stands follow one of two main successional routes after establishment, either ADom-ADomU-CDom or ADom-Mixed-CDom. The initial post-treatment data, to be collected over the next 2-3 years, will reveal how stands can be best harvested and regenerated to move them onto one or the other pathway.

The data presesented in this report are valuable in an of themselves. For example, CANFOR has been using our mensurational data to check on their coarser estimates of stand volumes based on timber cruise data. Some discrepancies have been noted and over the next year we will be trying to get to the bottom of these. Comparing the mensurational data together with data collected by FERIC during the experimental harvests should allow us to resolve the matter; *i.e.*, we can check our estimates of what was there against what actually came off the land during harvest. Thus, even the early pre-treatment data will have implications for managers in allowing us to better judge the quality of volume estimation as presently employed by industrial foresters.

CONCLUSIONS

Unlike much research in forestry, the EMEND project developed through an intimate interaction between foresters and researchers explicitly managed to provide long-term focus relevant to industrial planning. The experiment wide research work conducted by the Core Crew is crucial to the success of the EMEND project. The experiment-wide data about forest state, growth and productivity will connect the experiment to the central currencies of the forest industry. No management optimization is possible for any land base without simultaneous knowledge of both traditional and new data. To the extent that forestry is a long-term enterprise, a legacy of carefully collected data about forest responses to various management regimes under controlled, experimental conditions is certain to be valuable. Such data are uncommon at least partly because research priorities are driven by short term 'product oriented' objectives. The significance of long term, multi-disciplinary projects like EMEND cannot be properly evaluated until the data are in, but we judge the probable significance to be great.

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