Fundy Model Forest

~Partners in Sustainability~

Report Title: Herbaceous Layer Diversity and Stand Structure in Partial Cuts, Riparian Buffers and Tree Islands

Author: M. Roberts

Year of project: 2002

Principal contact information:
Faculty of Forestry and Environmental Management
University of New Brunswick- Fredericton
P.O. Box 4400
Fredericton, NB, Canada
E3B 5A3
Phone- 506-453-4666

File Name:
Biodiversity_2002_Roberts_Herbaceous_Layer_Diversity_and_Stand_Structure_in_Partial_Cuts_Riparian_Buffers_and_Tree_Islands

The Fundy Model Forest…
…Partners in Sustainability

"The Fundy Model Forest (FMF) is a partnership of 38 organizations that are promoting sustainable forest management practices in the Acadian Forest region."

Atlantic Society of Fish and Wildlife Biologists
Canadian Institute of Forestry
Canadian Forest Service
City of Moncton
Conservation Council of New Brunswick
Fisheries and Oceans Canada
Indian and Northern Affairs Canada
Eel Ground First Nation
Elgin Eco Association
Elmhurst Outdoors
Environment Canada
Fawcett Lumber Company
Fundy Environmental Action Group
Fundy National Park
Greater Fundy Ecosystem Research Group
INFOR, Inc.
J.D. Irving, Limited
KC Irving Chair for Sustainable Development
Maritime College of Forest Technology
NB Department of the Environment and Local Government
NB Department of Natural Resources
NB Federation of Naturalists
New Brunswick Federation of Woodlot Owners
NB Premier's Round Table on the Environment & Economy
New Brunswick School District 2
New Brunswick School District 6
Nova Forest Alliance
Petitcodiac Sportsman's Club
Red Bank First Nation
Remsoft Inc.
Southern New Brunswick Wood Cooperative Limited
Sussex and District Chamber of Commerce
Sussex Fish and Game Association
Town of Sussex
Université de Moncton
University of NB, Fredericton - Faculty of Forestry
University of NB - Saint John Campus
Village of Petitcodiac
Washademoak Environmentalists

HERBACEOUS LAYER DIVERSITY AND STAND STRUCTURE IN PARTIAL CUTS, RIPARIAN BUFFERS, AND TREE ISLANDS

MARK R. ROBERTS

FUNDY MODEL FOREST
YEAR END REPORT
2001-2002

Project Title: Herbaceous Layer Diversity and Stand Structure in Partial Cuts, Riparian Buffers, and Tree Islands

Project Proponent: Mark R. Roberts
Faculty of Forestry and Environmental Management
University of New Brunswick-Fredericton

Abstract

This project was undertaken to provide information on the biodiversity conservation value of leave patches as requested by FMF partners. The objectives for this year were to: 1) delineate new tree islands and provide baseline, pre-harvest data on vegetation, stand structure and the environment of these islands, and 2) assess the size distribution and amount of blowdown in existing islands 1-2 years old. Three new islands, ranging from 0.2ha to 2.2ha in size, were established in proposed cutting blocks at Hayward Brook. A total of 312 $1m^2$ plots and 126 $25m^2$ plots were established on transects running through the islands into the surrounding area to be harvested. Baseline data on herbaceous layer species composition, overstory cover and substrate conditions were collected in June - August, 2001. Relative humidity and temperature at ground level were sampled on representative days in selected plots. Plots were permanently marked for relocation after harvest. Harvesting occurred in August, 2001, and we will resample the plots in summer, 2002. Twenty-six existing islands in 1-2 year-old cuts were sampled for size and blowdown. Most of these islands were < 0.25ha in area. Species composition of the blowdown reflected the island composition. Trees > 5m tall were more susceptible to blowdown. Blowdown was dramatically less in the northeast quadrants of the islands, indicating that this portion of the island is protected from prevailing winds. These preliminary results suggest that some additional wind protection should be provided in the southwest quadrant of tree islands, e.g. by leaving a buffer of wind-firm, smaller trees. Additional work proposed for the 2002-03 fiscal year include resampling permanent plots in the new islands established in 2001, delineating several new islands and collecting baseline data, and expanding the sample of existing islands to include older islands.

Introduction

Leave patches or "tree islands" that are left in clearcuts or variable retention harvest blocks appear to function as refuges for some of the sensitive species of the herbaceous layer (i.e. non-woody plants of the forest floor) and the structural elements upon which they depend (e.g. Ramovs 2001), but we do not know the critical characteristics that these tree islands must have to insure that these species survive and successfully reproduce. Accordingly, the goal of this multi-year project is to assess the functionality of tree islands and other leave patches of varying sizes and shapes as plant refugia and sources of critical elements of stand structure. The results of the first year of the project (fiscal year 2001-02) are reported herein.

During the summer of 2001, we established and monitored permanent plots in three new tree islands that were delineated before harvesting. These stands were harvested later in the summer of 2001. Permanent plots will be left in place so that monitoring can continue in future years. Our previous work (Roberts and Zhu 2002) has shown that some species disappear or decline immediately following harvest, and that species recovery is not complete after 4 years. Accordingly, it is important to continue monitoring at periodic intervals in permanent plots for as many years as possible after treatment. In addition, we also surveyed island size and amount of blowdown in 27 existing islands (1-2 years old).

This project was developed in response to the need expressed by FMF partners for better information regarding the benefits of leave patches. Currently, JDI's operational guidelines call for retention of small patches (approx. 50m^2) and tree islands (0.25-0.5ha) in harvest blocks, the number of leave patches depending on block size. This project will provide recommendations concerning the minimum sizes of islands required to maintain habitat for sensitive species of the herbaceous layer.

Objectives

The specific objectives for this first year of the study are to:

1. Establish new islands of varying sizes before harvest in proposed cut blocks to be used for long-term assessments of herbaceous layer response to harvest in the surrounding block
2. Establish a network of permanent sample plots and collect baseline data on vegetation composition, stand structure and local environmental conditions before harvest
3. Determine the size range of existing islands (1-2 years old) and the amount of blowdown that has occurred in these existing islands.

Methods

New Islands

In order to assess herbcaeous layer response, we delineated three new islands before harvesting in June 2001. These tree islands are located in two stands scheduled for harvest in August 2001 the Hayward Brook area near Petitcodiac, N.B. (45°88' N, 65°20' W). Our study design includes before and after monitoring of vegetation and environmental conditions within a network of permanent plots in these islands and the surrounding cutover (see below).

In each island, one transect was established through the island center, parallel to the long axis of the island. One or two additional transects were established perpendicular to the first transect, either through the island center or roughly equidistant from each end of the island. All transects ran through the island and 25 m into the surrounding cutover on either end. Permanent vegetation quadrats ($1m^2$) were established along the transects at 5m intervals except at the edge of the island where 5 contiguous $1m^2$ quadrats were established on each side of the edge (10 contiguous plots total). In the largest island (Island #1), the interval between quadrats was increased from 5m to 10m near the center of the island. The areas of the islands were 2.16 ha, 0.19 ha, and 0.47 ha for Islands #1-3, respectively.

Vegetation and environmental data were sampled during June 13 to July 11, 2001. The percent cover of each species of vascular plant in the herbaceous layer was recorded in each plot, along with coverage of leaf and needle litter, rotten/solid wood, roots or tree trunks, mineral soil or evidence of animals such as scat or animal holes. The microtopography within the vegetation plot was classified as one of the following: level, pit, mound, sloped, or pit and mound. Percent canopy cover was measured in three categories (softwood, hardwood, total) as the average of four measurements in each plot taken with a spherical densiometer (one reading from each corner of the quadrat). Sampling of the canopy occurred from July 12 to July 23, 2001.

At every other sample point, stand structure data was recorded during July 31 to August 15, 2001. Using a $25m^2$ plot, the diameter at breast height (dbh), height, species, and percent live crown of each standing tree ($\geq$ 5cm) were measured. The number of saplings (dbh <5cm) was also recorded by species and dbh class. Coarse woody debris (CWD) and snags were also measured by length or height, dbh, species and state of decomposition.

Using data loggers, temperature and relative humidity were measured at nine different locations along two transects in Island #1 and one transect in Islands #2-3. Table 1 shows the position of each data logger along each transect, as well as the of date of sampling. For each sample date, sampling began at midnight and ran for 48 consecutive hours. A control was placed in an open area along a powerline adjacent to the study site.

Witness tree data were recorded for the four outermost plots (in the area to be cut) at each end of the transects. Compass bearings and distances from selected trees to the corner of the permanent quadrat were measured. To facilitate relocating the witness trees, species and diameter were recorded and the base of each tree was blazed with orange paint. A summary of the number of transects per island and the number of plots per transect is given in Table 2.

Existing Islands

A total of 26 different existing tree islands located near Petitcodiac, N.B., were measured during the months of August to October 2001. The location of these existing tree islands will be referred to by their local community names which are Hayward Brook (45°88' N, 65°15' W), Harper Settlement (45°86' N, 65°34' W), Babcock Brook (45°89' N, 65°02' W) and Goshen Road (45°78' N, 65°21' W).

The objectives for measuring existing tree islands were to examine the size distribution of the islands, as well as the amount of blowdown that has occurred in each island since harvest. Each island was traversed using a compass and length tape. The data were used to map and calculate the areas of each island using an interactive traverse mapping and analysis program (ITMAP). Also, each island was divided along the N-S axis and E-W axis into four quadrants: NE, NW, SE and SW. Table 3 shows a summary of island information.

Blowdown was measured in three of the four areas: Hayward Brook, Babcock Brook and Harper Settlement. Goshen Road was not measured due to time constraints. We propose to complete the sampling during the summer of 2002. No blowdown was encountered at Babcock Brook. Trees ≥5cm dbh that had been blown down since harvest were recorded by species, dbh, and length. The compass bearing of the fallen bole and the quadrant in which it was located were also noted. The type of blowdown was also classified as uprooted, leaning, snapped or uprooted/leaning.

The areas for the existing tree islands were summarized into an area frequency histogram. Analysis for the blowdown data included graphs which summarized the data by species, quadrant, diameter class and height class. For all islands, the basal area was also calculated and summarized by species, quadrant, diameter class and height class. Data are presented for Hayward Brook and Harper Settlement (see **Results**).

Table 1: Location of data loggers in the newly established tree islands in Hayward Brook, NB

Island	Sampling Date	Data logger location	Position relative to edge	Distance from edge (m)
1	August 15,16	A1	outside	25
1		A5	outside	5
1		A9-A10	edge	0
1		A14	inside	5
1		centre stake	inside	97
1		A38	inside	5
1		A43-A44	edge	0
1		A47	outside	5
1		A51	outside	25
1		control	-	-
1	August 22, 23	B49	outside	25
1		B47	outside	15
1		B43	edge	0
1		B37	inside	5
1		centre stake	inside	82
1		B14	inside	5
1		B11	edge	0
1		B6	outside	5
1		control	-	-
2	August 12, 13	C34	outside	25
2		C30	outside	5
2		C26	edge	0
2		C21	inside	5
2		C17-C18	inside	25
2		C14	inside	5
2		C9	edge	0
2		C5	outside	5
2		C1	outside	25
2		control	-	-
3	August 18, 19	H1	outside	25
3		H5	outside	5
3		H10	edge	0

3	H14	inside	5
3	H21	inside	50
3	H29	inside	5
3	H33	edge	0
3	H38	outside	5
3	H42	outside	25
3	control	-	-

Table 2: Summary of the number of plots sampled on transects in three new tree islands established before harvesting.

	Island 1		Island 2			Island 3			Totals
	Transect A	Transect B	Transect C	Transect D	Transect E	Transect F	Transect G	Transect H	
compass bearing	182°	260°	360°	360°	110°	037°	038°	130°	----
# vegetation plots ($1m^2$)	52	48	34	29	39	35	33	42	312
# tree plots ($25m^2$)	29	19	12	10	15	13	12	16	126
# data logger plots	9 + control	8+ control	9 + control	----	----	----	----	9 + control	35 + 4 control

Table 3: Summary of the 26 existing tree islands examined for island size and blowdown in southeastern New Brunswick.

	Map# 6052 (Hayward Brook)	Map# 5852 (Harper Settlement)	Map# 6152 (Babcock Brook)			Map# 5954 (Goshen Rd.)	
Stand #	698410	791956	718A	718B	718C	R091014	R091015
# islands	7	5	3	3	2	3	3
total island area (ha)	0.95	0.63	0.34	0.69	0.32	0.5	0.49
# trees blown down	170	30	0	0	0	----	----
BA blowdown (m^2)	1.52	0.39	0	0	0	----	----

Results

New Islands

Three islands, with a total of 312 vegetation plots and 126 stand structure plots, were established in the Hayward Brook area, New Brunswick. The baseline data on vegetation and environments collected in these plots during the summer of 2001 will be compared with post-harvest measurements in 2002 and future years.

Existing Islands

Area distribution of existing tree islands

An area frequency graph shows that majority of the existing tree islands sampled were less than 0.25 ha in area (Figure 1). Five islands of the 26 sampled were ≥ 0.25 ha. One island was > 0.30 ha.

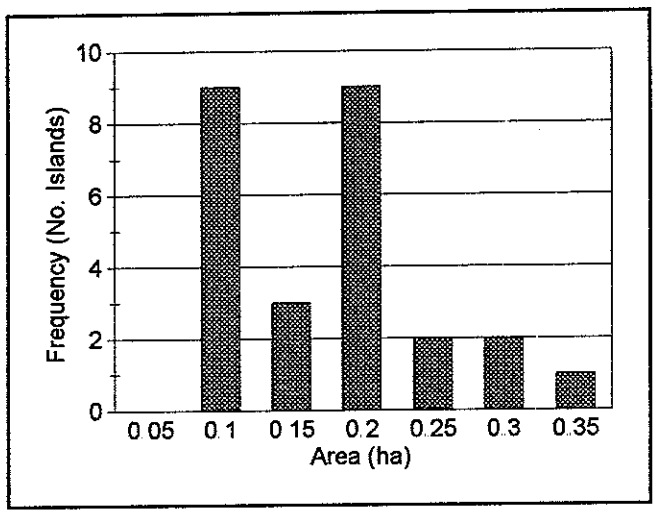


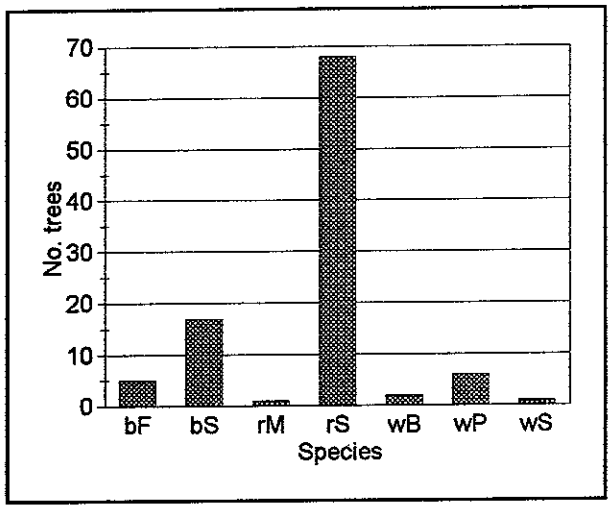
Figure 1: Area frequency graph for the 26 existing tree islands measured during the summer of 2001.

Blowdown: tree density

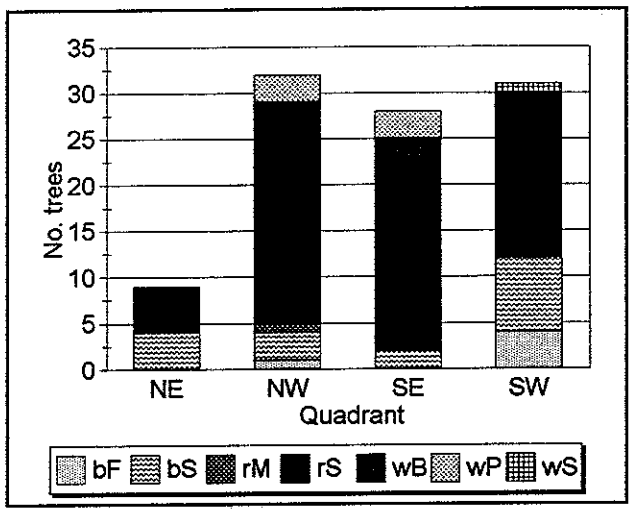
Hayward Brook

The trees that blew down in the islands at Hayward Brook ranged from 5-20 cm in dbh and 0-15 metres in height. The majority of the species blown down were red spruce (*Picea rubens*), ranging from 5-10 cm in dbh and 5-10 metres in height. Blowdown was much less in the northeast quadrant of the islands, with a fairly equal distribution in the other quadrants (Figure 2).

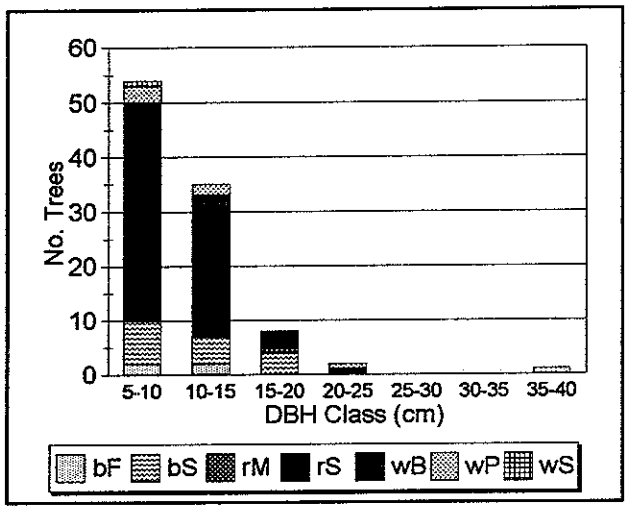
A



B



C



D

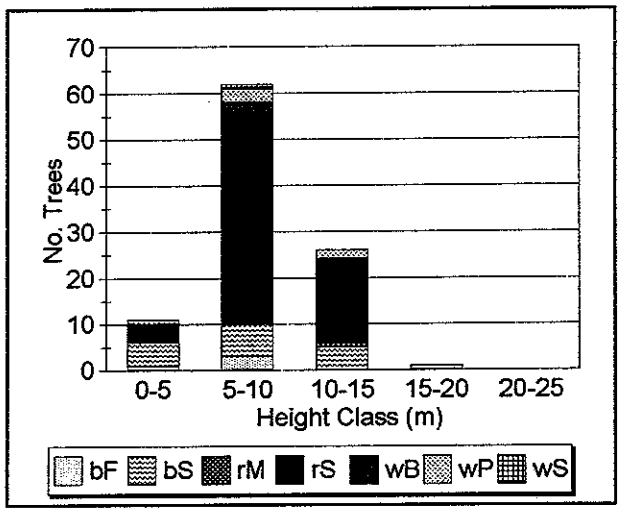


Figure 2: Number of trees blown down in existing islands at Hayward Brook, New Brunswick, by A) species, B) quadrant, C) dbh class, and D) height class. Species codes: bF, balsam fir (*Abies balsamea* (L.) Mill); bS, black spruce (*Picea mariana* (Mill.) BSP); rM, red maple (*Acer rubrum* L.); rS, red spruce (*Picea rubens* Sarg.); wB, white birch (*Betula papyrifera* Marsh); wP, white pine (*Pinus strobus* L.); wS, white spruce (*Picea glauca* (Moench) Voss)

Harper Settlement

Most blowdown was balsam fir (*Abies balsamea*) and red spruce. Balsam fir ranged from 5-15 cm or 20-25 cm in dbh, whereas red spruce was mostly in the 5-10cm and 15-20cm classes. The height of both species ranged from 0-15 metres. There was very little blowdown in the NE quadrant. Overall, the majority of blowdown was in the SE quadrant, 5-10 cm dbh class and 5-10m height class (Figure 3).

Blowdown: Basal Area

Hayward Brook

The total basal area of all blowdown was 1.5158 m^2, with red spruce comprising 0.5639 m^2. Most of the basal area for red spruce was in the NW, SW and SE quadrants, 5-10 and 10 -15 cm dbh classes, and 5-10 and 10-15 m height classes. Overall, the majority of the basal area of blowdown was in the NW quadrant, 10-15 cm dbh class, and 5-10 and 10-15 m height classes (Figure 4).

Harper Settlement

The total basal area of all blowdown was 0.4212 m^2, with balsam fir and large tooth aspen (*Populus grandidentata* Michx.) comprising the majority at 0.1103 m^2 and 0.1064 m^2, respectively. Balsam fir that blew down was mostly in the NW quadrant and 5-10 m height class. The basal area of balsam fir was distributed in three dbh classes: 5-10 cm, 10-15 cm and 20-25 cm. Large tooth aspen blowdown was in the NW quadrant, 35-40 cm dbh class and 15-20 m height class. Overall, most of the basal area was in the NW quadrant, 20-25 cm and 35-40 cm dbh classes, and 10-15 m and 15-20 m height classes (Figure 5).

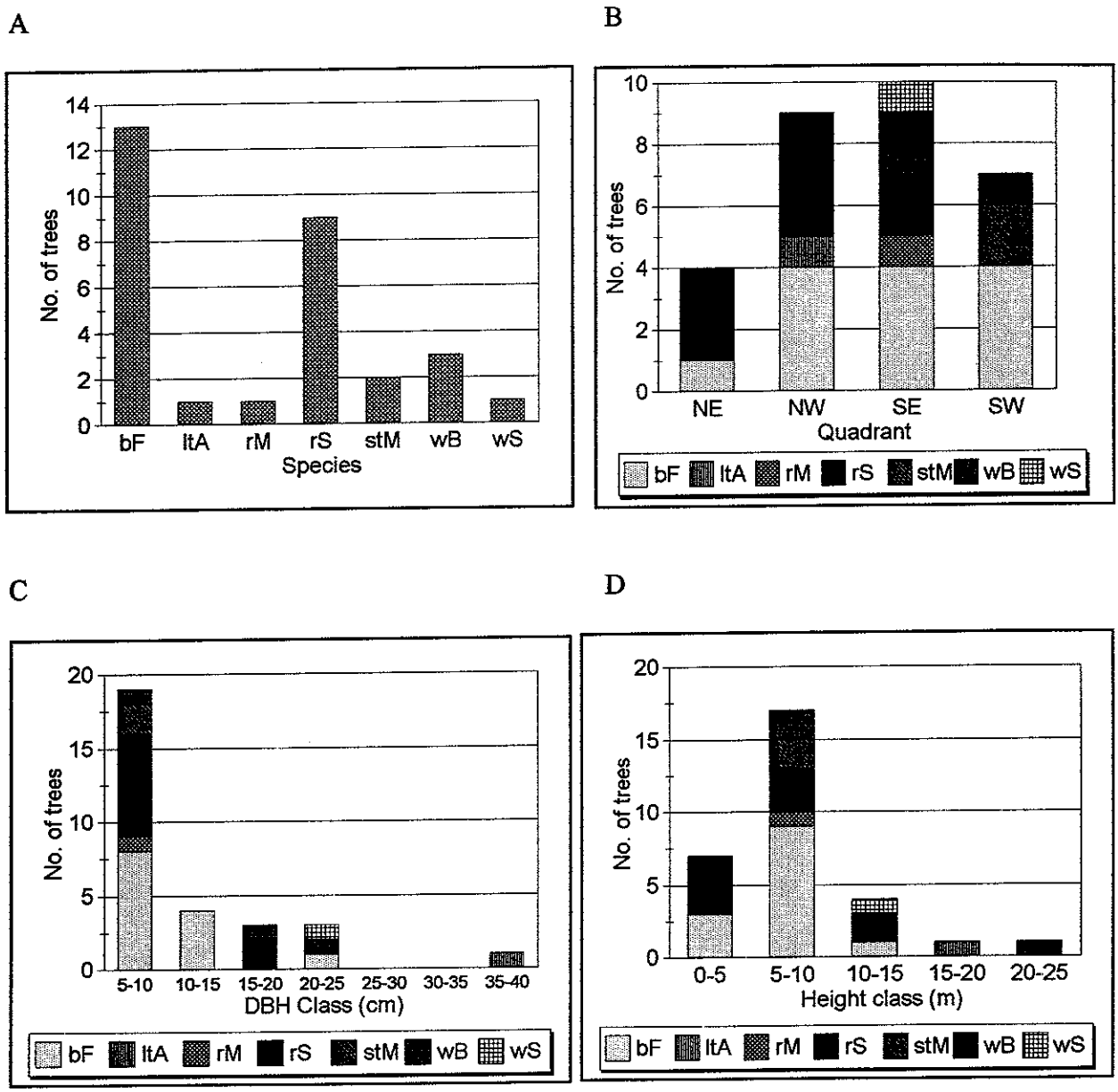


Figure 3: Number of trees blown down in existing islands at Harper Settlement, New Brunswick A) by species B) by quadrant C) by dbh class and D) by height class Species codes: bF, balsam fir (*Abies balsamea* (L.) Mill.); ltA, largetooth aspen (*Populus grandidentata* Michx.); rM, red maple (*Acer rubrum* L.); rS, red spruce (*Picea rubens* Sarg.); stM, striped maple (*Acer pensylvanicum* L.); wB, white birch (*Betula papyrifera* Marsh.); wS, white spruce (*Picea glauca* (Moench) Voss)

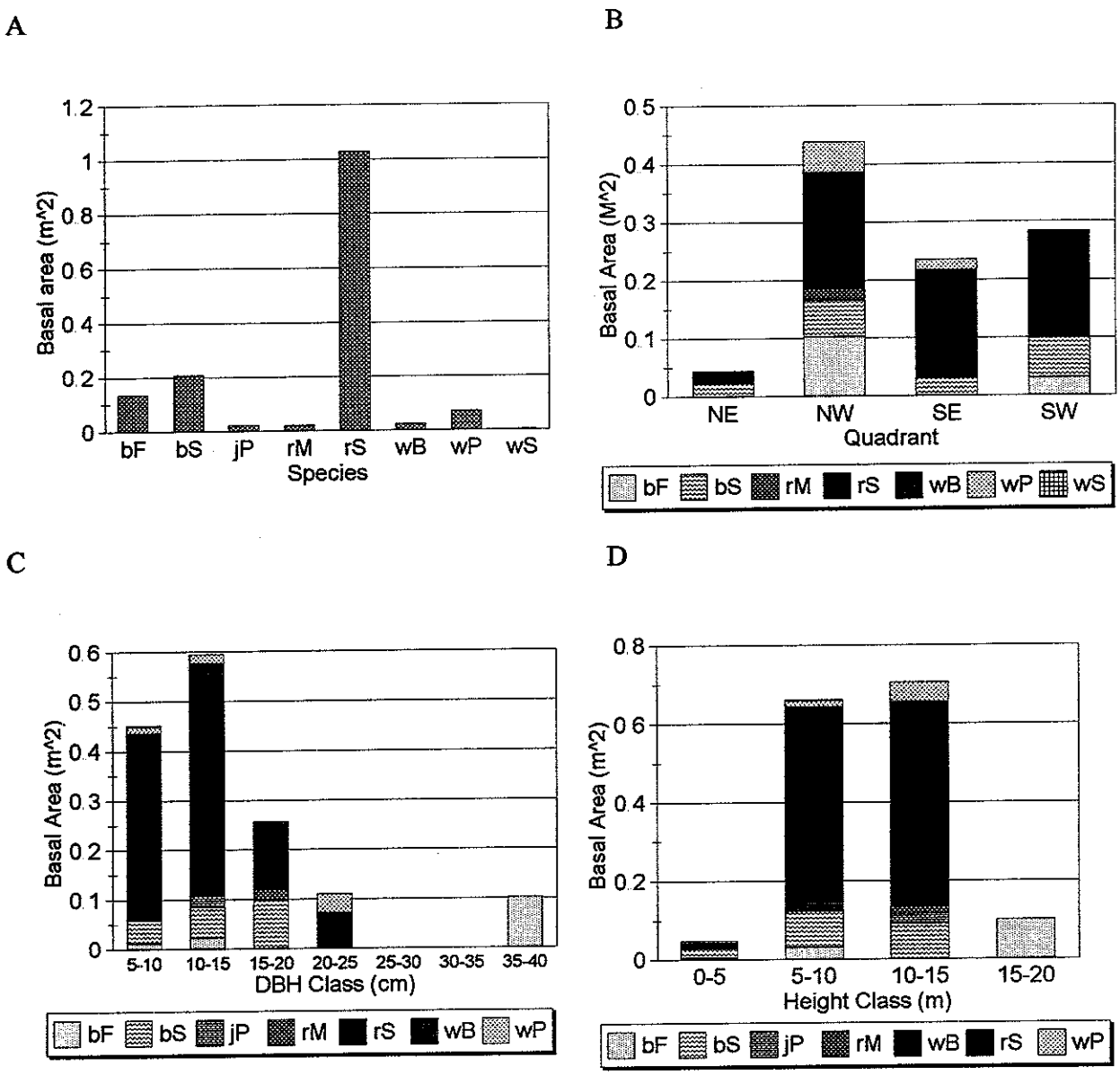
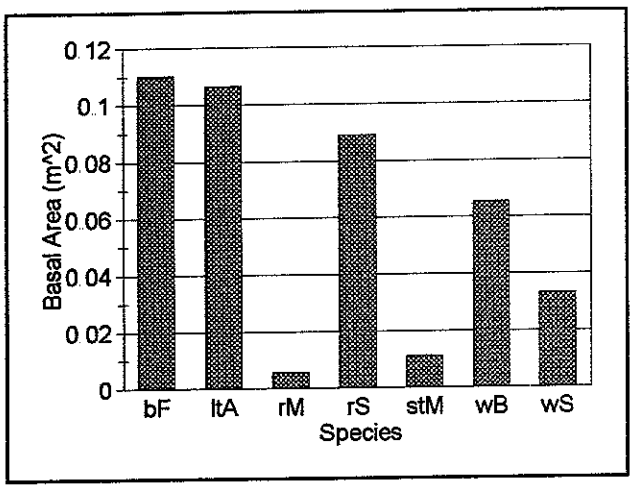
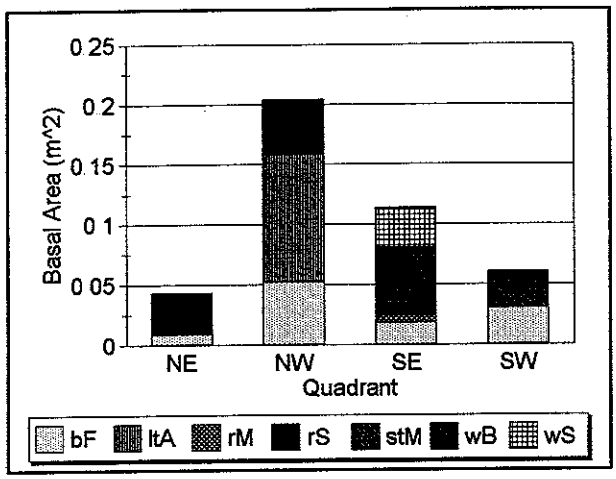


Figure 4: Basal area of trees blown down in existing islands at Hayward Brook, New Brunswick. A) by species B) by quadrant, C) by dbh class and D) by height class.

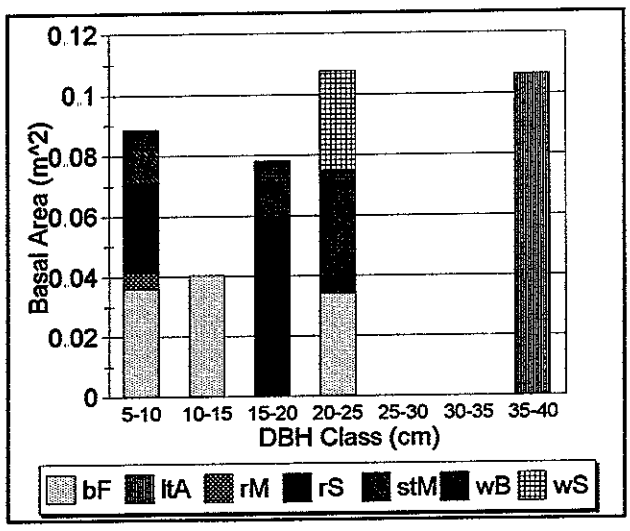
A



B



C



D

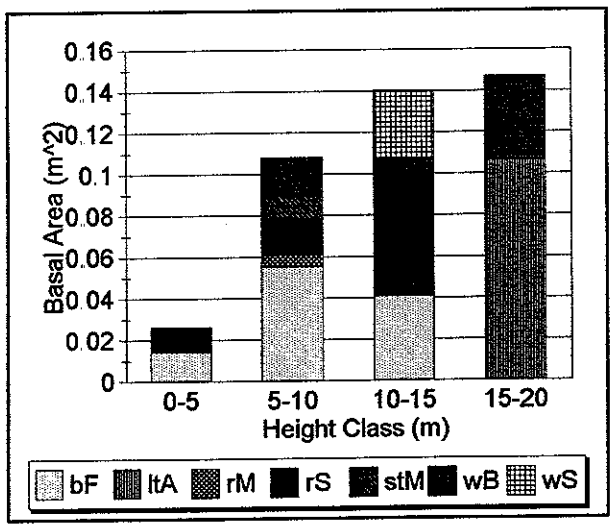


Figure 5: Basal area of trees blown down in existing islands at Harper Settlement, New Brunswick. A) by species B) by quadrant C) by dbh class and D) by height class

Discussion

New Islands

Vegetation and environmental data have been converted to digital format and error-checked. Spreadsheets have been designed for use with post-harvest data to be collected in 2002. Pre-harvest (2001) and post-harvest (2002) data will be compared to determine changes in vegetation and environment as a function of island size, distance from the island edge (either direction from the edge), and edge orientation (e.g. N edge versus S edge). Pre-harvest data will also be analyzed to determine the degree to which the plant species composition within the islands is representative of composition in the cutover portion of the block (to test whether islands are being placed in unrepresentative habitats in harvest blocks).

Existing Islands: Area Distribution

The size of most islands, at least in the four geographic areas sampled, fell below the minimum size of 0.25ha recommended in JDI's operational guidelines. Although we believe that these sizes are representative of all islands within the FMF, we will continue to sample additional islands during the summer of 2002.

Existing Islands: Blowdown

The species, diameters and heights of blowdown probably reflect the composition of the islands. One or two large diameter white pine or largetooth aspen accounted for a relatively large proportion of blowdown basal area at Hayward Brook and Harper Settlement, respectively. Otherwise, most blowdown basal area was spread across the 5 to 25cm dhb classes. Trees >5m in height appeared to be more likely to blow down.

There was consistently less blowdown in the northeast quadrant of islands at both Hayward Brook and Harper Settlement. This quadrant offers some protection from southwest winds which follow the predominant storm tracks in this region (Loucks 1962).

During the summer of 2002, we will expand our sampling to older islands (possibly up to 8 years old) to obtain better estimates of how blowdown develops over time in tree islands. In particular, we will develop island shrinkage rates which will allow us to make improved recommendations of minimum island sizes.

Expenditures

A total project budget of $37,212 was estimated for the 2001-02 fiscal year (see Application for Research Grant for fiscal year 2001). $14,339 was requested from FMF and $12,470 was awarded. Some adjustments in the project budget were necessary because of the reduced funding from FMF and Sir James Dunn Wildlife Research Centre, unsuccessful proposal to Mtn. Equipment Coop, and additional award from UNB Work-Study Program. In addition, Ms. Abby Pond, the graduate student working on the project, was forced to take sick leave for one year in September, 2001. Ms. Tanya Borgal was hired in her place to assist with data analysis during the academic year with support from the UNB Work-Study Program. The actual budget for fiscal year 2001 is outlined below.

Expenses

Graduate student salary (Ms. Abby Pond)	$ 4,800
Student summer salaries (Ms. Tanya Borgal)	4,839
Student Academic year salaries (Ms. Tanya Borgal)	1,776
Field accommodations and meal subsidy	1,900
Transportation (vehicle rental, gas, insurance)	5,800
Presentation materials (e.g. photographs, poster)	750
Equipment and supplies (temp./humidity sensors)	2,984
Total	$ 22,849

Collaborative Funding

Agency	Cash	In-kind
SEED	$ 2,175	
Summer Career Placement	$ 1,248	
UNB Work-Study	$ 1,376	
UNB Faculty of Forestry & EM (salary of PI)		$ 15,000
UNB Fac. Forestry & EM (lab, computer, printer)		$ 2,000
Sir J. Dunn Wildlife Res. Cen. UNB	$ 3,000	
UNB Fac. Forestry & EM (dataloggers, sensors)		$ 10,000
UNB Fac. Forestry & EM	$ 2,580	
Fundy Model Forest	$12,470	
Total	$22,849	

Deliverables

1. Measures of herbaceous layer composition and diversity and stand structural features under different management scenarios and functionality of buffer strips and uncut patches
2. Recommendations for partial harvesting scenarios to maintain herbaceous layer diversity and stand structure
3. Management recommendations concerning size, shape and structure of buffer strips and uncut patches

The assessment of different management scenarios, e.g. partial harvesting and buffer strips, was abandoned because of limited funding and a shift of emphasis toward tree islands by the members of the Biodiversity Committee. Accordingly, the deliverables have been reoriented toward measuring herbaceous layer composition and diversity, stand structure, and functionality of uncut patches (tree islands) in harvest blocks, as well as making recommendations concerning the size, shape and structure of these patches. After this first year, we are able to make preliminary recommendations relating to minimum sizes and protecting the islands from blowdown. More detailed recommendations based on analysis of vegetation and environment response data will follow next year.

Summary

Our work to date has focused on identifying herbaceous layer (vascular plants and bryophytes) species that are at risk to clearcut harvesting and plantation management practices in the Acadian Forest. FMF partners have expressed the need to assess modified harvesting practices, particularly the use of leave patches ("tree islands") in harvest blocks, in terms of their value in maintaining herbaceous layer diversity. To address this need, we initiated a two-year study in 2001 to evaluate the value of leave patches of varying sizes and shapes as plant refugia and sources of stand structure. Our design includes pre- and post-harvest sampling in permanent plots established before harvest in tree islands last year and sampling in a chronosequence of existing islands 1-8 years-old Three islands (0.2-2.2ha) were delineated and permanent plots were measured before harvesting in the summer of 2001. Post-harvest remeasurements and establishment of additional new islands will be done in the summer of 2002. Sampling is conducted on transects through the islands into the surrounding cutover to allow us to assess the degree of edge effects in relation to island size, shape and orientation. Species composition of the herbaceous layer (vascular plants and bryophytes), stand structure (tree sizes and densities, coarse woody debris and snags), and microclimatic characteristics (solar radiation, relative humidity and temperature) are measured along the transects. In addition, the amount of blowdown in existing islands is being assessed as a function of time since harvest. 26 existing islands were assessed in 2001 and additional islands up to 8 years old will be sampled in 2002. This work will enhance managers' knowledge of the ecological role of leave patches, especially in maintaining habitats for sensitive species, and will provide guidelines for managing such patches.