Fundy Model Forest

~Partners in Sustainability~

Report Title: Potential Forests of the Fundy Model Forest

Author: Vincent F. Zelazny, Hilary Veen, Mark C. Colpitts

Year of project: 1997

Principal contact information: NB DNR
Forest Management Branch

File Name: Soil_and_Water_1997_Zelazny_ Potential Forests of the Fundy Model Forest

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

Natural Resources Canada   Ressources naturelles Canada

Canada

POTENTIAL FORESTS OF

THE FUNDY MODEL FOREST

FUNDY

MODEL FOREST NETWORK

RÉSEAU DE FORÊTS MODÈLES

May 1997

POTENTIAL FORESTS OF THE FUNDY MODEL FOREST

Vincent F. Zelazny[1]
Hilary Veen[1]
Mark C. Colpitts[1]

[1] New Brunswick Department of
Natural Resources and Energy,
Forest Management Branch

This project was funded by the Model Forest Program
Canada's Green Plan

1997

COPIES OF THIS REPORT ARE AVAILABLE FROM:

New Brunswick Department of Natural Resources and Energy,
Forest Management Branch, PO Box 6000, Fredericton, NB, E3B 5H1

Fundy Model Forest
RR #4, Aiton Road, Sussex, NB, E0E 1P0

Digital coverages of the ecosite maps and fire model
are available from the Forest Management Branch

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

Much work has transpired to lay the foundation for this report. Many people contributed time and effort to making this work possible. We would like to acknowledge the special contribution of Martha Gorman, formerly of DNRE, who recognized the potential of ecological land classification in landscape management in New Brunswick and freely shared the resources at her disposal to allow ecosite classification to be completed. Appreciation is extended to the ecosystem classification working group for the Ecological Land Classification, including the ecoregion and ecodistrict levels. Chris Steeves was instrumental in the crucial step of transferring the ecosite algorithms into GIS maps. Finally we extend our thanks to Jim Feltmate who provided ongoing support in the GIS mapping process.

Vince Zelazny
Mark Colpitts
Hilary Veen

OBJECTIVE

The objective of this report is to:

1. provide a description of potential (historically valid) forests of the Fundy Model Forest

2. give practical advice on how to use this information in forest management.

INTRODUCTION

Biodiversity conservation can be addressed through three activities:

1. protection of biological legacies, including rare, threatened, or endangered species and remaining old stands;

2. maintenance of representation of diverse ecosystem types and range of age classes; and

3. achieving an optimal amount and spatial distribution of habitat patches.

This paper will address the second component of this three limbed approach. With respect to maintaining representative ecosystem types, the Canadian Council of Forest Ministers (CCFM, 1995) have identified two indicators:

1. percentage and extent, in area, of forest types relative to historical condition and to total forest area, and

2. percentage and extent of area by forest type and age class.

Definition of *forest type* and of what constitutes historical condition is a significant challenge to the Fundy Model Forest, and of significance to silviculturists, whose role it is to facilitate development of the stands on the ground that will meet the definitions. Potential vegetation is the stand composition and pattern of forest types that would have been there before farming, harvesting, and fire and insect suppression began dominating forest dynamics in the region. This report will provide information that will allow us to quantify the first of these two CCFM criteria. One of the goals of the Fundy Model Forest is to protect native biodiversity. Therefore, we need to know what the native forest condition is, *i.e.* a baseline forest condition to use as a guideline. This report will give descriptions of *a best estimate* of what the potential forest of the Fundy Model Forest area is.

Given predictions about the high probable rate of future climate change, why should we conserve historical forest composition? What the future holds for our forest is difficult to know, partly because regional climate change scenarios are presently not well-understood. Some scientists believe that species that thrive in warmer and drier environments, such as white pine, sugar maple, and beech, will have a natural advantage over species of cold, humid environments, such as spruce and fir, whose present geographic distribution suggests they might retreat towards the north as climate warms (Jacobson, 1987). Others see spruce and fir gaining ground in our area in coming decades and centuries because the variability of winter to early spring temperatures will cause further episodes of dieback in hardwoods, which conifers, for physiological reasons, are less susceptible to (R. Cox, CFS, pers. comm.). Insects and disease outbreaks will continue to affect the forest in ways that are difficult to predict. These factors interact with others, including atmospheric nutrient and acid input, which makes prediction of future trends of natural forest change very difficult and risky.

Human activity in the post-settlement period has resulted in a reduction in the number of tree species of moderate to high shade tolerance in the forest, and an increase in the dominance of shade intolerant hardwood species, and other species readily able to exploit clearcuts, such as balsam fir and red maple. Given the uncertainties associated with future climate change, a reasonable forest objective for the "working" landscape would be to conserve genetic and species diversity of trees in the forest, or to re-introduce species and genetic diversity where its loss is suspected. The principal benefit is the building of forest stability and resilience for an uncertain future by building stand-level diversity of tolerant and moderately tolerant species.

A second benefit of managing for diverse natural regeneration reflecting historical composition is the conservation of microsite variability throughout the forest, which would have positive effects on non-tree species that have limited area requirements, such as many plants, animals and fungi.

This does not mean that every species should be propagated everywhere. Rather*, species should be matched to the sites where they can be expected to thrive*. Natural forest landscape patterns of recent prehistoric and historic time provide clues to how this can be done (see Appendix I for further elaboration of forest change since the last ice age).

Replacement of lost diversity can be attempted by various means, including seeding or planting. Where species and genetic diversity remains intact, harvesting should be conducted so as to maintain species and genetic diversity through natural regeneration. Increased use of tactics such as partial harvesting and limiting opening sizes will provide seed sources and a variety of microsite conditions that will promote diversity at the stand level.

The distribution of forests across the landscape is dependent on an *inherent* pattern and an *induced* pattern. The inherent pattern is the environment on which the forest grows. It is comprised of non-living ecosystem features such as climate, topography, bedrock and soils. Ecological Land Classification (ELC), at the ecosite level was used to describe this inherent pattern.

The induced pattern is caused by natural disturbance regimes such as fire, windstorm, insect and disease attacks and small canopy gaps. After estimates are made of where potential forest would occur based on the inherent pattern, further refinement can be made with a good understanding of the disturbance regimes.

The ELC provided area summaries of forest communities by ecosite. These areas were then adjusted based on photointerpreter error and amount of area in abandoned fields. Information on disturbance regimes, including a fire model, customized for New Brunswick was used to give further information on distribution of forest communities. These descriptions on potential/historical forests can be used in management planning, and suggestions on how to do so are given.

ECOLOGICAL LAND CLASSIFICATION

The Ecological Land Classification Framework

The Fundy Model Forest area is comprised of five ecoregions (approximating climate regions), and eight ecodistricts (approximating areas of similar topography) (DNRE, 1996) (Table 1, Figures 1 and 2). Ecodistricts are nested within Ecoregions (Table 1.) The ecosites, which are nested within ecodistricts, approximate enduring ecosystem types such as a bog, till plain, slope or ridge.

Table 1. Ecoregions and Ecodistricts of Fundy Model Forest

Ecoregion	Ecodistrict Name	Ecodistrict Number
Southern Uplands	Fundy Plateau	12
Fundy Coastal	Fundy Coast	32
Continental Lowlands	Anagance Ridge	29
	Kennebecasis River	31
Eastern Lowlands	Salmon River	16
	Petitcodiac River	30
Grand Lake	Oromocto River	33
	Grand Lake	34

Important predictors of forest community composition include climate, topography, and soil. In addition to these physical factors, natural disturbances such as fire, wind and insect epidemics influence community composition. A finite range of forest communities will occur on a unique combination of climate, elevation, soil fertility and moisture and slope. However, distinguishable forest patterns develop across broader landscapes. Forest types with combinations of physical and climatic features can be considered an ecosystem or *ecosite.*

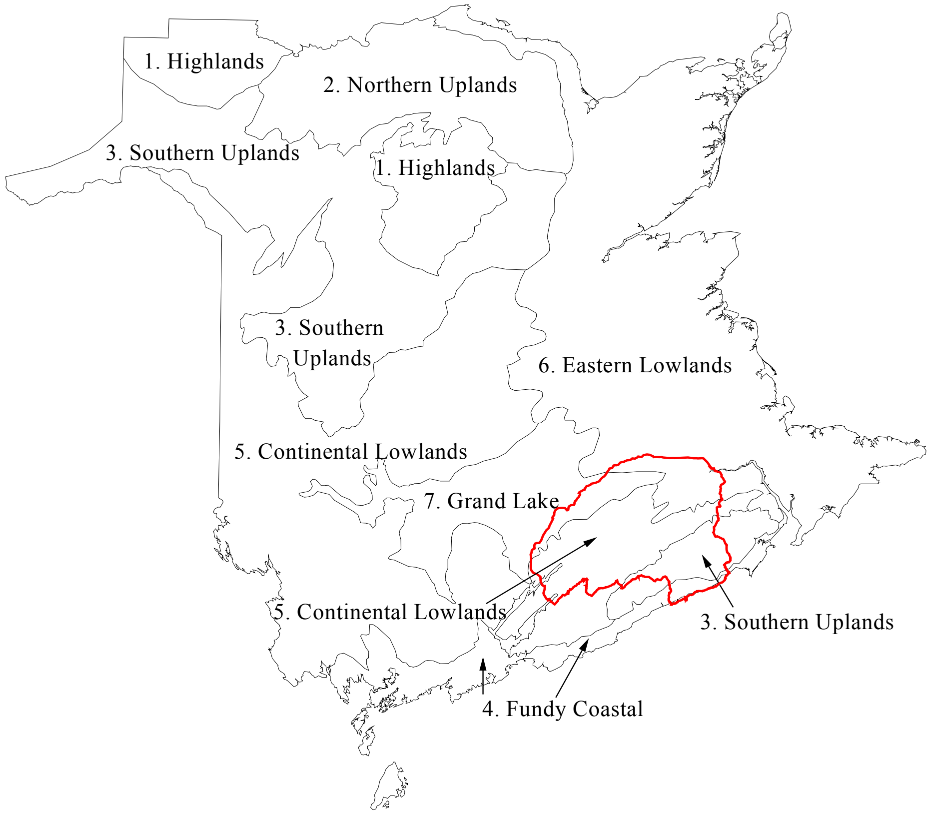

Figure 1. Ecoregions of New Brunswick

Ecosite Delineation

Data assembly

Four geographical information system (GIS) map layers were used in the ecosite delineation process. A separate ecosite analysis was conducted for each ecodistrict of the Ecological Land Classification of New Brunswick (DNRE, 1996). Elevation and slope classes were derived from digital elevation data. Soil type and drainage were obtained from the Forest Soils of New Brunswick (Colpitts *et al.*, 1995). Estimates on forest types as percent cover of major tree species were obtained from the forest inventory. All four layers were merged to provide information on the physical variables of every forest stand in New Brunswick.

Figure 2. Ecodistricts of New Brunswick

Data analysis

Elevation was divided into forty 20 m elevation classes (800 m being the highest elevation in New Brunswick), and slope into 10 slope classes based on percent slope. Fifty forest soils units and seven drainage classes were used. Forest stands were grouped into up to eight forest communities (depending on Ecodistrict) representing broad coniferous, mixed-wood, and deciduous types. Early successional forest stands that are primarily a reflection of human disturbance (i.e. intolerant hardwood dominated) were removed from the dataset.

Analysis proceeded on an ecodistrict basis. Summaries of percent occurrence of forest communities by elevation class, soil unit, drainage class and slope class were generated. For example, in the Anagance Ridge Ecodistrict, at slope class 2, 19% of the stands are black spruce and 4% are tolerant hardwood. At slope class 9, 1% of stands are black spruce and 19% are tolerant hardwood. Trends of increasing and decreasing percentages of certain stand types with increasing and decreasing slope (elevation, soil or drainage) could be readily detected. Slope classes were grouped depending on striking differences in occurrences of certain stand types at particular slope class "breaks". For example, black spruce stands disappear at a slope class of 6 whereas tolerant hardwood stands markedly increase in the Anagance Ridge Ecodistrict. This is selected as a slope "break" and slope classes above 6 are grouped into a slope class grouping. The same procedure is carried out for the other three physical variables, with usually 3 groupings each for elevation, drainage and slope and from 5-7 soil fertility groupings. Finally all 4 physical variable "groupings" are joined together to become the ecosite based on similarity of site conditions and the frequency of forest types supported. For example, the total area that is dry, (drainage classes 1-2), high fertility (a grouping of higher fertility soil units), steeply sloping (above slope class 6) and 300 m above sea level forms an ecosite.

Ecosite definition

Since a complete description of this combination of physical variables can be quite a mouthful (dry, high fertility, steeply sloping, 300 m above sea level), an edatopic grid (Figure 3.) was used as a framework for naming the ecosites. Forest communities occur across the landscape in response to varying amounts of energy (climate) and moisture. Consequently, a certain combination of soil fertility, soil drainage, slope and slope position can be assigned to a particular position on the grid. For example, wet, low fertility flats are always assigned ecosite "3", whereas moist rich mid-slopes are always “7”. Finally, letter codes are given to specific ecosites that are not covered under this system. For example, the ecosite as described in the previous section for the Anagance Ridge Ecodistrict, would be named “7” for its moist, rich, characteristics, and would be “7c” if the moist, rich slope was on calcareous soils.

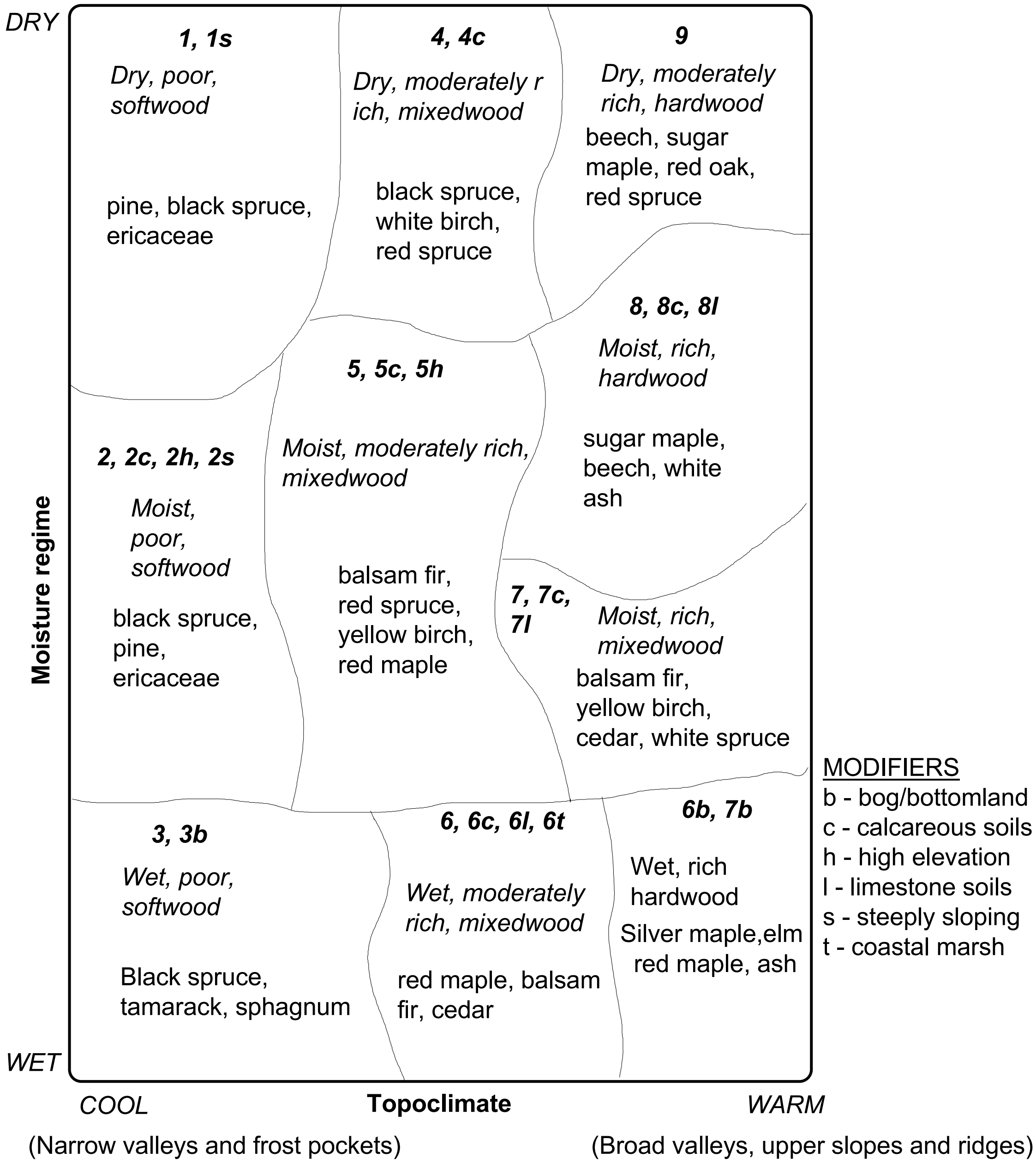

Figure 3. Edatopic Grid and Associated Ecosites

The advantage of indirect measures of ecological classification such as this edatopic grid approach is that it involves environment features that can be mapped (Zelazny et al 1995). In addition to aiding natural value conservation, ecosites can also form the basis for preliminary productivity classes. Preliminary productivity classes can be prioritized at the ecosite level (Figure 3a).

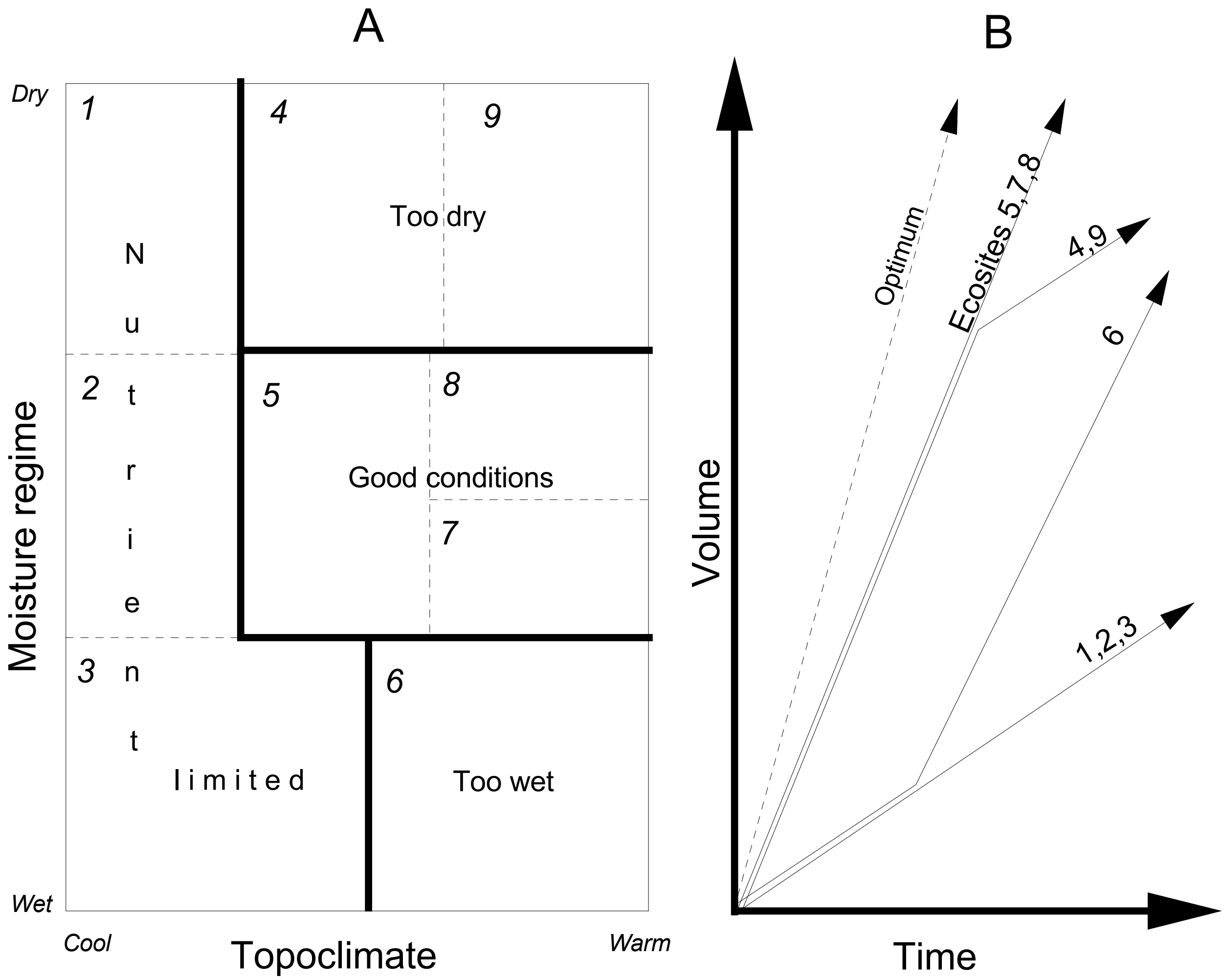

Figure 3a. Ecosites (A) with associated patterns of volume growth (B).
Where soil moisture is excessive, growth limitations may be expected early in stand development but will decrease later (Ecosite 6). If soil moisture is limited, early stand growth may not be restricted, but growth restrictions may develop later (Ecosites 4 and 9).

Ecosites were defined by ecodistrict and are therefore unique to a particular ecodistrict (Table 2). Their distribution within the Fundy Model Forest is illustrated in Figure 4. The ecosites can be contrasted with the present day land use configuration of the area represented in Figure 5.

Table 2. Ecosites of the Fundy Model Forest

Ecoregion	Ecodistrict	Ecosites																
Southern Uplands	Fundy Plateau		2		3	3b	4	5						7b		8		9
Fundy Coastal	Fundy Coastal		2	2s	3	3b	4		5h				7		7c			
Eastern Lowlands	Salmon River	1	2		3	3b	4	5		6	6b					8		
	Petitcodiac River		2		3	3b		5					7	7b				
Continental Lowlands	Anagance Ridge	1	2		3		4	5		6					7c	8		9
	Kennebecasis River	1	2		3	3b	4	5			6b		7		7c	8		
	Oromocto River	1					4	5		6	6b	6c		7b	7c		8c	
Grand Lake	Grand Lake	1	2		3	3b	4	5		6			7	7b		8		

FOREST COMMUNITIES

Once the ecosites were delineated, areas of the diverse *forest communities* occupying the physical/climatic ecosites was determined. The forest strata used to estimate potential/historical forest differ ecologically (*i.e.* occupy distinct ecological niches and are comprised of different tree species). They are also practical on a forest management level. The procedure used to assign photointerpreted forest stands to forest communities is given in Appendix II. The seven forest communities are pine, black spruce, spruce/fir, balsam fir, eastern cedar, mixedwood of tolerant species and tolerant hardwood. These will be referred to in this paper as: PINE, BS, SPBF, BF, EC, MXWD, and TH. As the intolerant hardwood community occurs almost anywhere across the landscape (it does not display a strong relationship with environmental variables) and is an early successional community that may mature into a wide range of mature forest types, it is not included as a forest community here.

ADJUSTMENTS BASED ON PHOTINTERPRETER ERROR

Once area summaries of forest communities by ecosite were compiled, they were adjusted to account for photointerpreter error. Stand tally data from 3461 ground plots representing the 8 ecodistricts within the Fundy Model Forest were used. A forest community was assigned to all the ground plots based on the percent basal area of 20 tree species present. The estimated (photointerpreted) frequency of the seven forest communities was compared with the actual frequencies based on ground information from the interpreted stands. Areas of some forest communities were adjusted based on this assessment. If, for example, it was determined that on ecosite 8 in ecodistrict 12, 27% of the plots in the mixedwood photointerpreted community were actually tolerant hardwood based on the ground plots, 27% of the area in mixedwood would be reassigned to tolerant hardwood for that stratum.

ADJUSTMENTS BASED ON OLD FIELDS REVERTING TO FOREST

During the nineteenth and early twentieth century, significant land area was stripped of its original forest cover by settlers and much of this land has reverted to a forest type whose character differs from the original. White Spruce, poplar, balsam fir, alder, and white birch are predominant species on old fields in the Maritimes (Sobey, 1995).

We attempted to separate old fields from "continuous" forest stands. Analysis of sample plots and soil data provided a basis to quantify the effects of past land settlement. A study (Sobey 1995) in Prince Edward Island confirmed forest differences in previously cleared sites that were reverting back to a forested condition. Sobey's analysis identified tree and shrub species that are reliable indicators of old fields, including white spruce (*Picea glauca*), yarrow (*Achillea millefolium*) and common speedwell (*Veronica officinalis*). To soil surveyors, presence of an organic matter-rich brown or black "plow layer" beneath the forest floor, rather than the bleached-looking "eluviated horizon" typical of most undisturbed forest sites in the Maritimes, is another indicator of old fields. With the exception of onshore areas that face the winds from the Bay of Fundy, white spruce is only an occasional component of forests that are not strongly disturbed by the cumulative effects of settlement, clearing, abandonment, and forest reestablishment (Davis, 1966). Sample plots displaying any of these characteristics were flagged as old field.

Based on the plant indicators identified in the Sobey report, the presence of plow layers described by soil surveyors, and the presence of a large proportion (>30% of basal area) of white spruce, we identified among the New Brunswick ground plots those that were likely established on old fields.

Our dataset allowed us to roughly estimate, by ecosite and ecodistrict, the percent area converted to agriculture in the past that has reverted to forest and typical old field vegetation, simply by calculating the percentage of plots in each ecosite and ecodistrict that had old field characteristics, and applying the percentage to the area in the ecosite and ecodistrict stratum. We also made an educated guess, based on forest-environment relations gleaned from the ecosite analysis, what the presettlement forest community might have been, and we adjusted the forest-community-area-by-ecosite graphs accordingly. For example, in ecosite 7 of the Kennebecasis Valley ecodistrict, we estimated that 13% of all plots showed old field characteristics. Because ecosite 7 is typically comprised of mixedwood, and assuming that old fields are conifer-dominated, the percent area of ecosite 7 devoted to mixedwood forest communities was increased, while the percent area in spruce-fir types was decreased accordingly. This process was repeated for all ecodistricts and ecosites for which there was sufficient data. The net effect was to increase the representation of mixedwood and tolerant hardwood stand types in our characterization of the historical forest condition, and to decrease the representation of softwoods. This change is consistent with Lutz's (1997) finding that spruce is more frequent, and maple and birch are less frequent in the Model Forest today than at the time of major immigration from America and Europe in the early 19th century.

THE EFFECT OF DISTURBANCE REGIMES ON THE FOREST

It is widely accepted that tree species have evolved strategies that initiate, promote, exploit or resist disturbances (White, 1979). A variety of natural disturbances play an integral role in the long-term maintenance of virtually all ecosystems (Christensen, 1988). In addition to environmental variation, it is variation in the disturbance regime that provides variation in our landscape and creates the shapes and sizes of stands and the different ages and mix of species. In a monograph describing the history of the red spruce-balsam fir forest of Maine, Seymour (1992) notes that the present red spruce-fir forest may be as young as 1000 years, when it is hypothesized that these species expanded their range as that of beech and hemlock declined (Jacobson *et al.* 1987). He advances the idea, supported by Lorimer (1977), that the red spruce-fir forest of Maine and the southern Maritimes is inherently an uneven aged forest. Based on comparisons of diameter-age relationships of trees sampled in the 1890s, and other, anecdotal evidence, Seymour notes that harvested red spruce sampled from log drives on Maine rivers in the late 19th century were almost entirely older than 125 years. Furthermore, on the basis of age-dbh comparisons with red spruce trees grown in open conditions, he found that trees growing in the 1890's were most often growing in dense shade. Quoting other historical sources, Seymour notes that large fires, blowdown events, or spruce budworm infestations were infrequent in northern Maine before the start of commercial clearcutting in the early 20th century. This view is at odds with the notion that forests of New Brunswick were historically subject to large stand-initiating disturbances caused by insect epidemics, forest fires, and windstorms. In the sections that follow, we'll evaluate this proposal within the specific confines of the Fundy Model Forest. We will also attempt to establish relationships between disturbance regimes and the forest types that occur on the landscape.

Fire

As species such as pines, black spruce, oak, and trembling aspen are dependent on fire for successful regeneration, a study on the distribution of fire across the landscape will yield valuable information on the distribution of fire dependent species such as these as well. A study of present distribution of fire dependent species provides clues on the distribution of natural fires. Natural stands of red and jack pine and red oak do not occur on the Fundy Coast or the Fundy Plateau, because the cool, wet climate precludes wildfires in the area (Power and Matson, 1995). White pine does occur on the few sun-exposed river canyon cliffs edges and slopes (Power and Matson, 1995), where temperatures reach high enough values for germination.

There are many clues in the species composition of the forest, and in the character of local climates, landscapes, and soils, and in the arrangement of these relative to fire breaks that can help us to estimate the historical fire regime (Power and Matson, 1995). Available evidence from the red spruce forests of Maine in the 1800s suggests that even-aged, fire-origin stands of spruce were few in number (Seymour 1992). While this general statement may be true for parts of the Model Forest, including the mixedwood Kennebecasis Valley and Fundy Highlands Ecodistricts, it is likely that fire in prehistoric times varied significantly in frequency by ecoregion because of the range of geomorphologic and climatic conditions found in the area. For example, a relatively dry macroclimate (Dzikowski *et al.* 1984), nutrient-poor soils (Colpitts *et al.* 1995), low relief and a forest cover dominated by fire-dependent species such as jack pine, black spruce, and ericaceous shrubs (Zelazny *et al.* 1989), has led to frequent fires in the Eastern Lowlands Ecoregion of New Brunswick (Wein and Moore 1977).

In a study focused on fire effects in the Fundy Model Forest, Methven and Kendrick (1995) recommended simulation modeling of fire on the landscape to complement their study which focused on historical reconstruction. They noted that it is difficult to separate human effects on fire frequency and size in recent time from purely "natural" fire regimes that existed in earlier periods.

Simulation modelling of fires size and frequency was conducted using **FireNB**, a forest fire simulation model (DNRE 1996) developed by Remsoft Inc. which allows the user to estimate the frequency and size of wildfires over time as a function of fuel type, local climate, and landscape character including topography and the presence of natural firebreaks such as rivers. The graphical simulation of fires on a computer model is an effective exploratory tool. Fires placed by FireNB randomly on the "virtual" landscape will burn depending on topography and fuel type for a randomly sampled day from a weather reporting station assigned to the climate region where the fire "starts".

Topography for New Brunswick was modeled with New Brunswick Geographic Information Corporation topographic data. Weather stations were assigned as follows: Saint John airport was assigned to the Fundy Coast Ecoregion and to the Fundy Plateau Ecodistrict, Moncton airport was assigned to the Continental Lowlands and the Eastern Lowlands Ecoregion, and Fredericton airport was assigned to the Grand Lake Ecoregion.

Because of the strong influence of forest type (fuel type) on model performance, two forest patterns were simulated: the first simulation showed the entire Model Forest covered with mixedwood fueltype (which essentially removed fuel type as a factor influencing rate of spread), and the second simulation used ecosite maps as a proxy for fuel type because of the correspondence between the two. Removing fuel type as a variable in the first simulation highlighted the landscape-level climatic and geomorphologic controls (i.e. fire breaks such as rivers) on fire size in the area. Results of these simulations appear in Figures 6 and 7 and in Tables 3 and 4.

The Fundy Coastal Ecoregion and the Fundy Highland Ecodistrict were infrequently burned in the second simulation, apparently because of the cool, moist climate, and, in the case of the Fundy Plateau, unfavourable fuel type owing to the high frequency of hardwood and mixedwood stands.

The highest frequency of fires of large size occurs in the eastern Grand Lake Ecoregion and in the Eastern Lowlands Ecoregion. High average Fire Weather Indices relative to the Coast and Plateau, favourable spruce-fir and jack pine fuel types and a predominance of ericaceous vegetation associated with nutrient-poor soils (Zelazny *et al.* 1989), plus low relief and few rivers that act as fire breaks have favoured frequent, large fires in this Ecoregion.

Table 3. Summary fire statistics from FireNB without fuel effects.

Ecodistrict	Total No. Fires	Total Area Burned (ha)	Area of Ecodistrict (ha)	Proportion of Ecodistrict Burned	No. of fires to burn ecodistrict
12	344	401485	140789	2.9	120.6
16	900	1141748	381269	3.0	300.5
22	232	213740	86707	2.5	94.1
25	486	694840	208412	3.3	145.8
26	275	249159	115350	2.2	127.3
29	461	713602	182795	3.9	118.1
30	522	608613	230472	2.6	197.7
31	353	326609	157337	2.1	170.1
32	580	310551	258854	1.2	483.4
33	365	334034	176522	1.9	192.9
34	541	758552	276304	2.7	197.1
Total	5059	5752933	2214810	2.6	1947.7

Table 4. Summary fire statistics from FireNB including fuel effects. Fire cycle assumes a fire rate of 0.45 lightning fires per 1000 km^2 per year (Wein and Moore, 1997).

Ecodistrict	Total No. Fires	Total Area Burned (A)	Area of Ecodistrict (B)	Proportion of Ecodistrict Burned (A/B)	No. of fires to burn ecodistrict	Fire Cycle
12	184	399980	140789	2.8	64.8	102.2
16	420	3229453	381269	8.5	49.6	28.9
22	95	593587	86707	6.8	13.9	35.6
25	246	1110639	208412	5.3	46.2	49.2
26	122	333192	115350	2.9	42.2	81.4
29	221	855861	182795	4.7	47.2	57.4
30	285	1860295	230472	8.1	35.3	34.0
31	158	369447	157337	2.3	67.3	95.0
32	262	413041	258854	1.6	164.2	141.0
33	139	398087	176522	2.3	61.6	77.6
34	261	1293128	276304	4.7	55.8	44.9
Total	2393	10856710	2214810	4.9	648.0	65.0

Intermediate in the frequency of fires of large size is the Continental Lowlands Ecoregion. A predominance of relatively fire-resistant mixedwood forest types on fertile soils, and the presence of significant fire breaks (Belleisle Bay, Washademoak Lake, and the Kennebecasis, Petitcodiac, and Pollet Rivers) limit the size of fires, except on poor soils at the eastern extremity of the Ecoregion where pines are still an important component of today's forest (Power and Matson 1995). As airport weather information was used in the simulation (Fredericton, Saint John and Moncton), fire cycles are higher than expected, as airport weather tends to be dry and windy relative to the forest. The relative proportions of fires between the ecodistricts is of interest, however, and the results are as expected, with ecodistricts in the Eastern Lowlands having the shortest fire cycles and ecodistricts on the coast having the longest.

Seymour's (1992) hypothesis that the forest is inherently uneven-aged does not apply to the Eastern Lowlands ecoregion or to the Grand Lake Ecoregion based on simulated fire regimes.

However, fires appear to be relatively rare in the Continental Lowlands ecoregion and more so on the Fundy Coast.

Insects

The present importance of balsam fir in Maine and the southern Maritimes may be a relatively recent phenomenon, brought about by long-term selective spruce removal, changing utilization standards with the rise of the pulp and paper industry, pesticide spraying to protect balsam fir, and fire protection (Blais 1983; Seymour 1992). Moses Perley's (1846) monograph on the New Brunswick forest tree species reported that balsam fir "does not constitute masses of wood, but is disseminated, in greater or less abundance, among the hemlock and *(sic)* black spruces". Perley did not note any budworm-like defoliating insects in his descriptions, but spruce bark beetle rated mention as the most serious insect pest of spruce. Seymour (1992) noted a similar omission of spruce budworm but inclusion of bark beetles from two other late 19th century accounts of the red spruce forest. The reported effects of bark beetle outbreaks in Maine varied from individual stem mortality to heavy mortality over several townships. It is likely that insect infestation type, frequency, and extent are cyclical on a long time scale. Even researchers who have speculated that large budworm infestations have been frequent for a very long time (at least 300 years, based on ring analysis) suggest that they have occurred more frequently in the last century (Blais 1983). This evidence supports the hypothesis that red spruce is a dominant tree species in the Acadian forest, it can grow to old ages in an all-aged stand structure. To conserve natural forest values, harvesting and silviculture strategies in the Fundy Model Forest area should concentrate on conserving red spruce in the canopy.

Wind

With the exception of the Fundy Coastal Ecoregion, the wind-mediated dynamics of the red spruce-fir ecosystem described by Seymour may be applicable to the forests of central, western, south-central and southwestern New Brunswick, based on climatic similarities and patterns of stand composition and distribution (Dzikowski *et al.* 1984, Keys and Carpenter 1995). Owing to the geographic position of New Brunswick relative to Maine and Nova Scotia, much of the energy of northeast-trending storms and hurricanes is lost over land in Maine or Nova Scotia before reaching the Fundy coast of New Brunswick. The effects of the most damaging windstorm of recent time were seen almost entirely at high elevation (> 650 m above sea level) in the Nepisiguit-Miramichi Ecodistrict (Figure 2), where wind, fire and the spruce budworm would be the principle agents of forest disturbance. However, virtually all of southern New Brunswick lies below 400 m elevation. On the Fundy coast, wind disturbance is probably a more important stand-replacing disturbance than the rest of southern New Brunswick, but the susceptible zone extends less than half a kilometer inland (Davis 1966). For the Continental Lowlands and Fundy Highlands Ecoregions we would apply the findings of Lorimer (1977), who estimated that the average return interval for major blowdown larger than 25 hectares in size, in an area adjacent to western New Brunswick to be more than 1000 years. However, his study revealed small patch or individual-tree blowdown is a relatively frequent occurrence. Therefore, the effects of wind would seem to be chronic, frequent, and small scale in western and central portions of the Fundy Model Forest over late prehistoric and historic time, to the present. It can be concluded that small patch and individual tree blowdown that create small gaps of various sizes in the forest are the most frequent type of disturbance. It would follow that non-clearcut harvesting techniques such as strip cuts, selection cutting and shelterwood would be the most appropriate in these forest situations to best approximate the natural forest condition.

DEVELOPING OBJECTIVES FOR FOREST MANAGEMENT

The ecosite maps encompassing the Fundy Model Forest area are found in figures 8 through 15. Summary data on the area of the various ecosites, and the proportions of seven different potential forest communities that are associated with the ecosites is provided in Figures 8a through 15a. Additional information at the ecoregion level on tree species composition of ecosites in the Model Forest appears in Tables 5 through 9. These tables were developed using forest development survey data sorted by ecosite. Similar constraints were applied to these FDS plots as was applied to photointerpreted stands in the ecosite analysis (stands with greater than 30 percent of basal area in white spruce, or those dominated by intolerant hardwood, were removed from the analysis).

The intention of these maps and charts is to guide the manager in his/her actions on a particular piece of land. Tree species and forest community composition have developed for over 10,000 years in synchrony with the environment and disturbance regime found on specific landscapes. We have attempted to describe a forest stand mosaic that was present in New Brunswick before unprecedented types of disturbance and vegetation changes were introduced by settlers and timber industry. There are at least two biological reasons for wanting to conserve natural forest value. First, species-rich stands of high natural value are probably more resilient in the face of climatic uncertainty and the effects of continuing atmospheric deposition of acids and nutrients from industrial emissions and vehicle exhaust. Secondly, microsite variability of natural stands and the full spectrum of species diversity associated with that diversity is better conserved under silviculture that conserves natural values, especially where catastrophic stand-replacing disturbance has historically been rare. In areas of the landscape where it is impossible to return to this pre-settlement mosaic, we should attempt to maintain the examples that remain.

The combination of Figures 8a through 15a and Tables 5 through 9 provides a characterization of a baseline condition against which progress on maintenance or restoration of forests with high natural value can be measured in forest management planning. Tables 5 through 9 can also be used in silviculture for silviculture selection for natural value for the various ecoregions and ecosites. The remainder of this report contains a preliminary interpretation of Figures 8a through 15a and Tables 5 through 9 for each of the eight ecodistricts found in the Fundy Model Forest.

ECODISTRICT DESCRIPTIONS

Fundy Plateau Ecodistrict

The Fundy Plateau Ecodistrict is a broad, gently rolling upland plateau near the Bay of Fundy in southeastern New Brunswick (Figure 8). Clusters of rounded hills rise to an average elevation of 300 m, and peaks to more than 400 m in areas such as the Kent Hills. Relief ranges from 60-90 m, except along the southern edge of the plateau, where the deeply incised valleys along the Upper Salmon River and Crooked Creek dip more than 270 m in elevation. The high elevations and the climate-moderating influence of the Bay of Fundy result in a cool, wet climate. Annual growing degree days (5°C basis) average 1500-1650, and due to the effects of orographic lifting, the ecodistrict intercepts moisture from marine air masses moving in from the southwest, resulting in an average summer precipitation of more than 500 mm, and over 1400 mm annually, due to frequent winter storms (Dzikowski et al. 1984). The ecodistrict is therefore wetter than the adjacent ecodistricts to the north, which receive 400 mm less precipitation annually because of their location in the rainshadow of the plateau.

Abandoned farmland is found scattered throughout the Fundy Plateau especially along the Shepody Road, which transverses the district from Riverside-Albert to Hammondvale; otherwise the district is mainly forested. The fields are reverting to white spruce and balsam fir over much of the area, however speckled alder is found on the wetter sites.

Well-drained hilltops and upper slopes (ecosite 8) historically support a tolerant hardwood association of sugar maple, yellow birch and beech, often with a red spruce component (Figure 8a). These communities are especially common in the northern part of the ecodistrict away from the cooling influence of the Bay of Fundy, where some white ash and ironwood are also found (Table 5). Mixedwood communities of red spruce, yellow birch, red maple and some balsam fir are typically found on gentle slopes and upland flats (ecosite 5). Valley bottoms and flat areas with impeded drainage are few (ecosites 2 and 3 respectively), and often support pure stands of spruce and balsam fir. Early-successional communities following harvests contain mostly white birch, in mixture with yellow birch, trembling aspen, and balsam fir. The lack of pine, black spruce and the relative scarcity of poplar compared with the adjacent Anagance Ridge Ecodistrict suggests a low fire frequency due to the cool, wet climate.

Sugar maple, red spruce, yellow birch, and white ash are the most valuable timber producing species. Beech is often of poor quality, afflicted with a bark disease caused by the combination of beech scale insect and a *Nectria* fungus. Consequently, beech is a common stand component but is rarely dominant (Table 5). *Nectria*-resistant strains can be conserved and propagated. Beech nuts are, however a valuable wildlife food source, especially for black bear.

Limiting clearcuts on ecosite 8 will favor tolerant hardwoods and red spruce, while shelterwood or group selection systems will promote natural value in red spruce-dominated communities. If pine is part of the management strategy it is recommended for ecosites 4 and 5, however mixedwood communities have historically occupied 40% of these areas (Figure 8a). Red spruce and balsam fir are the preferred species of ecosites 2 (Table 5), while black spruce is best suited to ecosites 3 and 3b. For maximum productivity, silvicultural activities should first be prioritized to ecosites 5 and 8.

Fundy Coastal Ecodistrict

The gently undulating to rugged terrain of the Fundy Coastal Ecodistrict extends along the entire southern coastline of New Brunswick, along the Bay of Fundy from the St. Croix River in the west to the Petitcodiac River in the east, and includes Campobello Island, Deer Island, and Grand Manan Island (Figure 9). The area is generally below 100 m in elevation, except east of St. Martins near Martin Head, where coastal cliffs rise 300 m above the Bay of Fundy. Relief throughout the rest of the ecodistrict varies between 30 and 80 m, with coastal cliffs rarely exceeding 50 m. The climate of the ecodistrict is strongly influenced by the cold marine waters of the Bay of Fundy, which moderates seasonal temperatures and is a source of moisture-laden air masses which provide abundant precipitation (450 mm to >500 mm, May-September) and persistent fog (Dzikowski et al. 1984). Temperatures are often cool in summer and mild in winter (annual growing degree days (5°C basis) average 1500-1650).

Except for the prominence of red spruce, the forest has a boreal nature, due to the cool, wet, climate. In the section west of Alma, the forest consists of almost pure red spruce communities on the higher plateaus (ecosite 5h of Figure 9a) and their associated steep slopes (ecosite 2s). The remainder consists mainly of mixtures of red spruce with white and black spruce, or balsam fir with some red maple, white birch and yellow birch. Moist, gentle slopes (ecosite 2) comprise over 50% of the ecodistrict and are historically dominated by a high proportion (60%) of red spruce communities, with lesser amounts of black spruce, cedar and mixedwood. Cedar is concentrated in the vicinity of Saint John, mostly on areas which have calcareous soils (ecosite 7c). The numerous peat bogs (ecosite 3b) and cool, rocky coastal niches of this ecodistrict support remnant populations of sub-arctic species , such as rose-root (*Sedum roseum* (L.) Scop.). The few tolerant hardwood stands, comprised mostly of yellow birch with small quantities of sugar maple and beech are typically found on dry slopes (ecosites 4) and moist upper slopes (ecosite 7). Heat-loving species such as pine, hemlock, oak, ironwood and ash are virtually absent from the ecodistrict (Table 6). Following harvests, the intolerant hardwood community is mostly white birch combined with red maple and yellow and grey birch.

The Fundy Model Forest encompasses areas dominated by ecosites 5h and 2s. However, harvesting methods favouring red spruce regeneration will promote natural value throughout the ecodistrict. Hardwood management is best suited to ecosites 4 and 7 with proportions approximating 20% of the area (Figure 9a). Black spruce is best suited to wet soils (ecosite 3), while cedar communities have historically occupied 30% of ecosite 7c.

Anagance Ridge Ecodistrict

The Anagance Ridge Ecodistrict is a sequence of northeast-trending ridges and valleys, situated between the high elevations of the Fundy Plateau to the south and the relatively low, flat plain of the Carboniferous basin to the north (Figure 10). Ridges typically rise 150 m, with their crests reaching above 200 m, and the maximum elevation of 320 m occurs in the vicinity of South Branch. The climate is relatively dry (425-450 mm May-September precipitation) and warm (1600-1750 growing degree days, 5°C basis) for the region (Dzikowski et al. 1984). The ecodistrict is protected from the southwesterly storm track by the Fundy.

The area is dotted with agricultural fields (Figure 5), both active and abandoned, which quickly revert to white spruce often mixed with red spruce, balsam fir, and white birch. Jack pine has also been noted to reoccupy old fields on sandy soils (Power and Matson 1995). Harvesting and past fires have also altered the character of the forest, with large areas of the ecodistrict comprised of short-lived, intolerant hardwood species.

Tolerant hardwood stands composed of beech, sugar maple, and yellow birch, with a minor component of white ash and ironwood, are historically common on the higher hills with more fertile, Parleeville-Tobique soils (ecosite 8 of Figure 10a). Softwood stands typically found on moderately, acidic slopes (ecosite 5) and some shallow, exposed sites include red spruce, balsam fir, and white spruce, with eastern hemlock and white pine occurring infrequently (Table 7). White pine, jack pine, and red pine often occur on areas with dry, coarse-textured soils (ecosite 1) and lower, acidic slopes (ecosite 2), suggesting that fires have historically been an important factor in this ecodistrict. Cedar is found dominantly on wet, more fertile soils (ecosite 6). The higher terrain overlooking the valley of the Kennebecasis River has been heavily disturbed by logging. As a result, this large area is dominated by intolerant hardwoods, typically red maple, trembling aspen, large-toothed aspen, white birch, and grey birch. These early successional stands have a beech component on some dry, ridge tops (ecosite 9), suggesting that a beech-dominated climax community will develop on the sandy, nutrient-poor soils.

Limiting clearcutting on ecosites 7c and 8 will favor the longer-lived, more valuable tolerant hardwoods including white ash. Pine management strategies should be restricted to ecosites 4 and 9, however ecosites 1 and 2 are also suitable pine sites. Silviculture to maintain red spruce dominated spruce-fir communities should be concentrated on ecosites 5 and 2, however mixedwood communities have historically occupied 35% of the area in ecosite 5 (Figure 10a).

Kennebecasis River Ecodistrict

The Kennebecasis River Ecodistrict consists of the valleys and lowland areas of the southernmost reaches of the Saint John River, the Bellisle Creek, and the Kennebecasis River as far east as the Elgin area (Figure 11). Elevation rarely exceeds 150 m, and the maximum elevation of 220 m occurs at Raymond Mountain north of Bloomfield. A dry, warm climate dominates the area. Northern sections have more than 1700 annual growing degree days (5°C basis) because of their proximity to the broad valley of the Saint John River (Dzikowski et al. 1984). Summer precipitation (May to September) averages 425-450 mm.

Approximately 60 percent of the land area of the ecodistrict is covered by stands of intolerant hardwood and by active or abandoned agricultural fields (Figure 5). White spruce, tamarack, with lesser amounts of cedar and white birch quickly reoccupy old field sites (Power and Matson, 1995).

Spruce-fir communities of red spruce with lesser amounts of white spruce and balsam fir historically form the dominant softwood cover on less disturbed flats and moist slopes (ecosites 2 and 5 respectively of Figure 11a). Mixedwood communities are more common on dry slopes (ecosite 4) and moderately acidic slopes (ecosite 7). Tolerant hardwood stands composed of beech, sugar maple, red maple, yellow birch, with some red spruce occur on uncleared river slopes and ridge-tops (ecosite 8). White ash, ironwood and some oak are a component of these stands (Table 7). Cedar is locally abundant on wet sites (ecosite 3) and moist rich slopes (ecosite 7 and 7c), while all three pines are frequent on gravelly, sandy soils along rivers and streams (ecosite 1).

For natural value silviculture programs should maintain or increase tolerant hardwoods on ecosites 7, 7c and 8 while maintaining the proportion of red spruce dominated spruce-fir communities on ecosites 2 and 5 (Figure 11a). Special management should be applied to the maintenance of rich bottomland ecosites that contain species (i.e. silver maple, white elm, green ash and butternut) not often found on upland sites (Power and Matson, 1995).

Salmon River Ecodistrict

The Salmon River Ecodistrict is a low, flat plateau in the low-lying Carboniferous basin, forming the height of land between the Northumberland Coast and Grand Lake (Figure 12). The Salmon and Canaan rivers flow southwestward through the district toward the Saint John River, while the Cains River flows northeastward into the Southwest Miramichi River. Peak elevations reach 160 m, and relief rarely exceeds 60 m. The climate is relatively warm and dry (< 425 mm summer precipitation), but soils are poorly drained and of low inherent fertility.

The Fundy Model Forest encompasses only a small area of this ecodistrict south of the Coles Island road. Overall the ecodistrict is heavily forested, with only small areas along the Canaan River previously cleared for agriculture. Fire has been the dominant disturbance regime in this district (Power and Matson, 1995).

Black spruce in association with jack pine is common on all ecosites due to the ecodistrict's strong fire history. Large proportions of these communities occur on moist flats (ecosite 2), dry, valley-bottoms (ecosite 1) and areas of impeded drainage (ecosite 3). These ecosites account for almost 90% of this ecodistrict's total area (Figure 12a) due to the lack of relief and uniform soils. Mixedwood stands occupy the infrequent low ridges (ecosite 5) or dry valley slopes (ecosite 4), and are dominated by red maple, trembling aspen, birch, red spruce, white spruce, and white pine (Table 8). As in all ecodistricts in the Eastern Lowlands, the tolerant hardwood (sugar maple-yellow birch-beech) community is uncommon. Eastern hemlock is not present in stands that have been subject to repeated wildfire, but is gaining prominence in areas that have been protected from fire. These include the private woodlots on the eastern edge of the district, which have roads and fields that function as fire breaks.

Even-aged management strategies (ie. clearcutting) best replicates the disturbance patterns within the entire ecodistrict. However, ecosite 5 historically contains 20% mixedwood communities containing significant proportions of red maple and/or yellow birch.

Petitcodiac River Ecodistrict

The Petitcodiac River Ecodistrict is comprised of the low, gently rolling ridge and valley topography within the broad Petitcodiac River basin (Figure 13). The upper course of the river (North River) flows southwestward to the village of Petitcodiac, where the river turns northeastward, parallel to the structural trend of the bedrock. The river turns southward again at Moncton and empties into Shepody Bay. Elevation is generally less than 75 m, with the exception of a series of ridges, including Steeves, Lutes and Indian mountains, which reach elevations of 120-165 m. The climate of the ecodistrict is moderately warm and dry. Annual growing degree days (5°C basis) exceed 1700 west of Moncton, with only the Grand Lake Basin ecoregion being warmer (>1800 annual growing degree days). Average May - September precipitation ranges from 415-450 mm, as the area lies in transition between the cool-wet Fundy Coast and the dry, warm conditions of the other ecodistricts in the Eastern Lowlands Ecoregion (Dzikowski et al. 1984). Power and Matson (1995) noted a significant moisture deficit in late July and August in this ecoregion.

The Fundy Model Forest only encompasses the area west of Salisbury in this ecodistrict, with much of the well-drained soils cleared for agriculture. A high fire frequency (an average of 7 per year) favor pine, black spruce and intolerant hardwood communities (Wein and Moore, 1977). The low relief in conjunction with poor soil drainage also favor a coniferous forest.

Mixedwood stands dominated by red spruce, in mixture with red maple, and balsam fir, historically occur on the well-drained slopes (ecosite 5) while black spruce communities are more prominent on the moist and wet flats (ecosite 2 and 3). Intolerant hardwoods, tamarack, eastern hemlock, and white pine are common associates in these communities depending on disturbance. Jack pine commonly occurs in scattered patches, across all ecosites (Figure 13a) indicating fire-origin, while cedar is typical on the bogs (ecosite 3b). Tolerant hardwoods (sugar maple, beech, and yellow birch) are typically found on some of the less disturbed, upper slopes (ecosite 7), especially on soils that are slightly calcareous (Table 8). The large area of aspen-dominated stands occupying disturbed sites is a reflection of the long history of settlement along the Petitcodiac River. The 10,000 ha Tantramar coastal marsh (ecosite 6t) at Sackville and additional tidal deposits along the lower stretches of the Memramcook and Petitcodiac rivers are non-forested, however dyked sites revert to spruce communities.

Management activities should be focused around maintaining or increasing the proportion of spruce-fir communities through less intensive harvesting practices. Shelterwood harvesting systems will help maintain red spruce regeneration. Mixedwood communities have historically occupied approximately 30% of the area on ecosite 5, with the hardwood component dominated by red maple with lesser amounts of yellow birch and sugar maple. Black spruce is best suited to the wet ecosites (3,3b and 6), however productivity is lower than on the better drained sites. The area occupied by cedar communities should be maintained or increased and special management be applied to protect the natural value of stands having a red oak or hemlock component.

Oromocto River Ecodistrict

The Oromocto River Ecodistrict in south-central New Brunswick consists of the broad, low-lying valleys of the Saint John and Oromocto rivers (Figure 14). Only a small area, near Wickham in the extreme southeast of the district, lies within the Fundy Model Forest. East of Fredericton, the terrain is less than 100 m in elevation and has relief of less than 30 m, while to the west, the narrow valleys are incised as deep as 150 m into the upland surface. Climate is strongly influenced by the volume of water flow through the river basins, which act as a heat source and sink and thereby extend the length of the frost-free period (Dzikowski et al. 1984). Average annual growing degree days (5°C basis) increase from 1650 in the west near Hoyt, to 1800 in the east along the Saint John River. The area is partially in the rainshadow of the Appalachian Mountains further west, and receives only 425 to 450 mm of summer precipitation (May-September).

Many of the broad, valley slopes and fertile bottomlands have been cleared for agriculture (Figure 5), with heat-loving vegetables and apples being the dominant cash crops that take advantage of the prolonged growing season.

This ecodistrict supports forest which is more characteristic of warmer parts of the continent. Silver maple, white elm, butternut, bur oak and green ash occur on the seasonally flooded lands of the Saint John River, especially the islands in the vicinity of Douglas and Jemseg (ecosites 6b, 7b). Red oak and white ash are historically common on raised, sandy beaches along the shores of Grand Lake and the Saint John River, and infrequently on more upland sites. White pine dominates on glaciofluvial deposits which are not subject to flooding (ecosite 1). Sugar maple and white ash, with the occasional red maple, beech, yellow birch, ironwood, and basswood are typical on moist, calcareous soils (ecosites 7c, 8c). Black cherry is also found uncommonly throughout. Cedar is prevalent on moist to wet sites, especially seepage slopes underlain by calcareous bedrock (ecosite 6c of Figure 14a). The original forest has been strongly altered by agriculture on the interval soils and by forest harvesting on the valley slopes and on flat, poorly-drained land at the periphery of the district. Stands of red maple, white birch, grey birch, and trembling aspen are common in disturbed areas around settlements. The remaining forest on moist, acidic slopes (ecosite 5) is a combination of red spruce, balsam fir and red maple with significant amounts of white pine and hemlock and infrequently red oak and white ash (Table 9).

For natural value, management strategies to promote the more valuable hardwoods (sugar maple, white ash, red oak, black cherry and butternut) is recommended in this ecodistrict. Less intensive harvesting practices (selective harvest) to promote the natural regeneration of these species should be favored. Red spruce dominated spruce-fir communities should be maintained using a shelterwood or group selection harvesting system. White pine occurs across all ecosites and its proportion should be maintained or increased especially on moist, deep sands of ecosite 1.

Grand Lake Ecodistrict

Nearly all of the low-lying, flat basin of the Grand Lake Ecodistrict is under 120 m in elevation, and the terrain slopes gently downward from the periphery toward Grand Lake (Figure 15). Only the area southeast of the Canaan river system lies within the Fundy Model Forest. Relief is less than 30 m except in some locations where streams cut as much as 70 m into the surface of the basin. The large volume of water in Grand Lake and the lower Saint John River prolongs the frost-free period by acting as a heat reservoir (Dzikowski et al.1984). This ecodistrict has the warmest climate in the province, with and average of 1700-1800 annual degree-days (5°C basis), and is moderately dry, receiving an average of 425-450 mm of summer precipitation (May-September).

Agricultural land use is less prominent than in the preceding district due to lower amounts of fertile, interval soils, however farmlands line the edges of Grand Lake and Washademoak Lake.

As this ecodistrict is in the warmest ecoregion, tree species such bur oak, green ash, butternut and silver maple are found, especially on interval soils (ecosite 7b of Figure 15a). On low-elevation sites which are flooded less frequently, sugar maple, red maple, basswood, ironwood, white ash, and red oak stands are typically found, and sandy shorelines are often dominated by red oak and white ash. Mixed-wood stands of red spruce, hemlock, in association with red maple, white birch, and trembling aspen are historically common on the better-drained, upland acidic slopes (ecosite 5 of Table 9). Black spruce, which is rare in the Oromocto River Ecodistrict to the west, is an important species on the wet, acid, poorly-drained upland soils (ecosite 3) and on the numerous bogs (ecosite 3b) such as Bull Pasture bog east of Minto. White pine is a common associate in many stands and has been historically dominant on ecosites 1 and 2. Jack pine is most abundant toward the ecoregion boundary to the east, where fire has historically been a strong influence on the forest. Only a few examples of the sugar maple - yellow birch - beech association remain on ecosites 4 and 8, generally on the higher elevations bordering the Anagance Ridge Ecodistrict to the south and the Southwest Miramichi Ecodistrict to the north. Disturbances associated with settlement, particularly agriculture and forestry, have altered the original forest considerably, resulting in numerous stands of red maple, gray birch, white birch, and trembling aspen, with scattered spruce and fir.

Special management considerations should be given to the maintenance of bottomland sites supporting hardwood communities. In addition tolerant hardwood and mixedwood communities should be favored on higher elevations, especially in the vicinity of Havelock where butternut was once a component of these communities. Outside of these areas, even-aged black spruce and pine management best reflects the natural fire disturbance pattern.

Table 5. Potential tree species frequency by ecosite in the Southern Uplands Ecoregion- Fundy Plateau Ecodistrict

Ecosite	1	1s	2	2c	3	3b	4	5	6	6l	7	7b	7c	7l	8	8l	9
BS	3/1	1/1	3/2		4/3		1/+	2/1	4/3		1/+	3/3	1		1/+		
WS	6/1	4/+	3/1	9	2/+	9	5/1	4/+	5/1	3	4/+	7	6/1	5	3/1	7	
RS	8/3	9/6	7/5	8	7/4	5	5/1	8/4	6/2	9/3	7/3	7	2	9/5	5/1	6	9/9
BF	9/3	9/3	9/3	8/6	9/3	9/5	9/4	9/3	9/4	9/5	9/4	9/7	8/5	9	7/2	9/4	9
WP	1	4	2		2		+/	2	2		1	3			+/		
JP		1/+	+/					+/+	+/						+/+		
RP								+/							+/		
EC	6/3	2/+	4/1	6/4	4/1	9/5	3/1	4/1	6/2	9/8	2/+		3/1	9/5	1/+	2/1	
EH		+/	+/+		+/+		+/+	+/+	1		+/				+/		
TL	1/1	/	+/	4	+/		+/	+/	1/+	3	+/				+/		
RM	5	7/1	5/+	2	5/+	9	6/1	7/1	4/1	3	7/1		4	5	5/1	8/2	9
SM	1	2	1/+	2	1/+		4/2	2/1	1/1	3	4/2		5/5		6/4	3/2	
YB	3	5	2/+	2	3	9	6/1	5/+	3	5/3	7/+		6		8/1	8	
BE		2/+	+/+		1/+		3/1	2/+	1/+		4/1		3/2		5/1	2/1	
IR					+/		+/	+/							+/		
OK							+/	+/	+/		+/				+/		
WA		+/	+/		+/	9	+/	+/	+/		+/				+/+		
WB	5	7	7/+	6	5	9/5	7/+	7/+	6	5	7/+	3	3	5	5/+	7	9
TA	6	+/	2/+	8	1		4/1	2/+	2/+		2/+			5	2/+	3	
No. Plots	**8**	49	108	**5**	112	**2**	176	439	59	**4**	241	**3**	13	**2**	448	10	**1**

The number on the left of the slash indicates percent frequency class of the species in stands, and the number on the right is the percent frequency of stands where the species comprises at least 30% of the basal area. Classes as follows: blank : species absent; +: less than 5%; 1: 5 to 14%; 2: 15 to 24%; 3: 25 to 34%; 4: 35 to 44%; 5: 45 to 54%; 6: 55 to 64%; 7: 65 to 74%; 8: 75 to 84% 9: 85 to 100%.

Table 6. Potential tree species frequency by ecosite in the Fundy Coastal Ecoregion / Ecodistrict

Ecosite	2	2s	3	3b	4	5h	7	7c
BS	2/1	2/1	6/5	4/4	+/+	1/+		
WS	2	1	2		1	2	1	
RS	8/4	8/8	6/3	8/2	9/6	9/7	8/6	9
BF	7/1	5	5/1	6/2	7/+	4	9	9
WP	2	+/	2/+		1	2/1	1	3
JP	+/+	+/				1		
RP	+/+		+/			1/+		
EC	4/2		2/1	2/2	4/1	1	3/2	
EH	+/			2/2	+/		1	3
TL	2/+	+/	4/+	4	1	+/+		
RM	5/1	5/+	3/+	4/2	7/1	8/+	7/3	9/7
SM	1/+	+/	+/	2	1/+	2	2/1	3
YB	2/+	5/+	1		6/1	5	4/2	3
BE	+/+	+/		2	2/1	+/	2	
IR				2				
OK	+/							
WA	1			2	+/			
WB	6/1	5	5/1	9/2	9/1	7/+	8	7
TA	1/+	1	1	2	1	2		7
No. Plots	113	22	42	**5**	29	21	**9**	**3**

The number on the left of the slash indicates percent frequency class of the species in stands, and the number on the right is the percent frequency of stands where the species comprises at least 30% of the basal area. Classes as follows: blank : species absent; +: less than 5%; 1: 5 to 14%; 2: 15 to 24%; 3: 25 to 34%; 4: 35 to 44%; 5: 45 to 54%; 6: 55 to 64%; 7: 65 to 74%; 8: 75 to 84% 9: 85 to 100%.

Table 7. Potential tree species frequency by ecosite in the Continental Lowlands Ecoregion/ Anagance Ridge; Kennebecasis River Ecodistricts

Ecosite	1	2	3	3b	4	5	6	6b	6c	6l	7	7c	7l	8	8c	8l	9
BS	2/1	3/2	6/5	5/4	1/1	1/1	4/3	5/5	3	4/+	1/1	1/+	1/+	1/+	1		1/1
WS	2	2	1	+/	2	2	2			5	2	2	3	2	2	2	2
RS	9/6	8/5	6/3	7/4	8/5	8/4	7/3	5/5	5/3	4	8/3	7/2	3/+	6/2	8/2	2/1	8/4
BF	7/1	6/1	5/+	5	5/+	7/1	8/1	9	9	8/+	9/1	9/1	8/1	7/+	9/1	8/2	4
WP	5/+	5/+	3/+	3/+	3/+	3/+	3		3	+/	2	1/+	+/	1/+	+/	+/	3/+
JP	1/+	+/+	+/	+/	1/+	+/+								+/+			2/+
RP	1/+	1/+	+/	+/	+/+	+/+	+/+				+/+	+/		+/			1/+
EC	2/+	3/1	4/2	4/2	3/1	4/2	6/3		9/5	9/7	6/2	6/3	6/4	3/1	4/1	4/1	1/+
EH	2	1/+	1	2	2/+	3/+	2			1	2	3/+	1	2/+	4	1	+/
TL	1/+	2/+	3/+	3/+	1	1/+	2/+	5		5/1	+/+	1/+	2/1	+/		1/1	+/
RM	6/+	7/+	5/+	6	7/+	7/+	6/+	5	8	4	7/+	6	4/+	5/+	6	5	6/+
SM	2/+	1/+	+/+		3/1	2/1	1/+	5	5/3	2/1	3/1	4/2	5/4	7/4	8/4	8/6	4/2
YB	3/+	3/+	1	+/	5/1	5/+	3	5	3	3	5/+	6/+	7	7/+	9	5/+	5/1
BE	3/1	1/+	+/+	+/	2/1	3/1	1/+		3		2/+	3/1	3/1	7/2	8/4	6/2	3/1
IR	1	+/	+/		1	+/+	+/			+/	1	1/+	3	2	2	2	+/
OK		+/				+/						+/	+/		+/		+/
WA	1	+/	+/	1	1	2/+	+/	5		2	1	3/+	4	3/+	3	2	1
WB	5	6/+	3/+	4/1	6/+	5/+	4/+	9	3	3	5/+	3	2	3	1	2	6/+
TA	4/+	2/+	1/+	2	3/+	3/+	2/+	5	3	5	2	3/+	5/+	3/+	1/+	6/1	3
No. Plots	78	232	192	29	157	473	189	**2**	**4**	28	101	197	1+2	263	60	33	48

The number on the left of the slash indicates percent frequency class of the species in stands, and the number on the right is the percent frequency of stands where the species comprises at least 30% of the basal area. Classes as follows: blank : species absent; +: less than 5%; 1: 5 to 14%; 2: 15 to 24%; 3: 25 to 34%; 4: 35 to 44%; 5: 45 to 54%; 6: 55 to 64%; 7: 65 to 74%; 8: 75 to 84% 9: 85 to 100%.

Table 8. Potential tree species frequency by ecosite in the Eastern Lowlands Ecoregion/ Salmon River; Petitcodiac River Ecodistricts

Ecosite	1	2	2c	3	3b	4	5	5c	6	6b	7	7c	8
BS	4/3	5/3	2	7/6	8/7	4/3	3/2		6/4	9/9	2/2		3/1
WS	3	3	2	2	1	3	4	6	2	3	4	8	4
RS	7/3	7/2	4	5/2	5/+	7/3	6/2	6	6/1	7	6/3	6/1	6/1
BF	7/1	7/1	9/4	5/1	4/+	7/+	8/2	9/1	8/1	3	7/1	9	9/1
WP	4/+	3/+	2	3/+	4	4/1	3/+	3	4		3	3	1
JP	3/1	2/1		3/1	3/1	3/1	1/+		1/+		1/+		
RP	1/+	+/		+/	+/	1	+/		+/		+/		
EC	3/1	2/1	9/6	2/1	2/1	2/1	2/1	9/6	5/3		4/1	6/4	4/1
EH	2/+	1/+		+/		2/+	2/+		1/+		1		3
TL	2/+	2/+	2	2/+	4/+	1	1/+		3/+		+/	1	+/
RM	5/1	7/2	8	5/1	4/1	7/1	8/2	9	7/1		8/1	8	9/1
SM	1/+	1/+		+/+	+/+	1/+	2/+	1	+/+		4/1	6/1	5/1
YB	2	2/+	2	1/+	1	3	3/+	6	2		4	5	8
BE	1	1/+		+/	+/	3/+	2/+		+/+		4/1	3	4/2
IR		+/				+/	+/				+/		1
OK	+/	+/+		+/			+/				+/		
WA	+/	+/+	2	+/		1	1/+		1		1	1	3
WB	4/+	5/+	8	3/+	3/+	4/+	5/+	9	4		6	6	4
TA	3/+	4/+	4	2/+	2	3/+	4/+	4/1	3/+		4/+	8	3/+
No. Plots	191	1313	**5**	811	52	58	415	**7**	118	**3**	44	**8**	28

The number on the left of the slash indicates percent frequency class of the species in stands, and the number on the right is the percent frequency of stands where the species comprises at least 30% of the basal area. Classes as follows: blank : species absent; +: less than 5%; 1: 5 to 14%; 2: 15 to 24%; 3: 25 to 34%; 4: 35 to 44%; 5: 45 to 54%; 6: 55 to 64%; 7: 65 to 74%; 8: 75 to 84% 9: 85 to 100%.

Table 9. Potential tree species frequency by ecosite in the Grand Lake Ecoregion/ Oromocto River; Grand Lake Ecodistricts

Ecosite	1	1m	2	3	3b	4	4c	5	6	6b	6c	7	7b	7c	8	8c
BS	3/3		4/3	7/5	7/7	1/+		2/1	2/1		2	2/2	1	1/1	1/1	
WS	1		1	1	/	3		3	1	3	5	2	3	3	1	7
RS	8/2	9/3	7/3	6/2	3	7/1	9	8/2	6/2	3/3	5	8/2	3/2	8/1	9/1	3/3
BF	7/1	9	7/1	5/+	3	8/1	9	8/1	7/2	7/3	9	6	8/3	8	4	7
WP	6/+		3/+	1	7	3	3	5/+	4/+	7	2	2	3	1	3	3
JP	+/+		2/+	1		+/+		1/+	+/+		/	2/2				
RP	+/+		1	1	3	+/		+/	1		/			1		
EC	5/1		2/+	2/+		2/+	5/3	2/+	3/1	3	8/5		4/1	7/4	1	3
EH	4/1		1	1		3/+	8	2/+	2/1		8/3		1	7/1		3
TL	3		3/+	3/+		1/+		2/+	3/+	3/3	3/2		2		1	
RM	8/1	9/7	8/2	5/1	7/3	9/3	5/3	9/3	8/3	7/3	5	8/2	8/2	8/1	9/4	7
SM	+/		+/	1		2	3/3	1/+	1/+		3	4/2	3	3	1	7/3
YB	1/+		1	1		3/+	8	1/+	1	3	5	6	3	6	7/1	3
BE	1		+/	1/+		3/+	3	1/+	+/		3/2	4/2		4	6	7/3
IR	+/			+/		1	3	+/				2		2		
OK	+/		+/			1		+/	+/+				1	1		
WA	+/		+/	1		2/+	5	+/+	1	3	3	2	5/1	4		3
WB	6	9	5/+	3	3	8	9	6/+	5/+	7/3	5	6	3	6	3/1	3
TA	5	7/3	5/+	3	3/3	5/1	8	5/+	5/1	3	2	4	3/2	4	3	7
No. Plots	24	**3**	110	50	**3**	61	**4**	209	96	**3**	**6**	**5**	12	18	**7**	**3**

The number on the left of the slash indicates percent of plots where the tree species is present, and the number on the right is the percent of plots where the species comprises at least 30% of the basal area. Classes as follows: blank : species absent; +: less than 5%; 1: 5 to 14%; 2: 15 to 24%; 3: 25 to 34%; 4: 35 to 44%; 5: 45 to 54%; 6: 55 to 64%; 7: 65 to 74%; 8: 75 to 84% 9: 85 to 100%.

LITERATURE CITED

Blais, J.R. 1983. Trends in the frequency, extent, and severity of spruce budworm outbreaks in eastern Canada. Can. J. For. Res. 13:539-547.

CCFM. 1995. Defining sustainable forest management. A Canadian approach to criteria and indicators. Canadian Council of Forest Ministers, Ottawa. ISBN 1-896408-04-4.

Christensen, N.L. 1988. Succession and natural disturbance: paradigms, problems, and preservation of natural ecosystems. U. of Wash. Press.

Colpitts, M.C.; Fahmy, S.H.; MacDougall, J.E.; Ng, T.T.M.; McInnis,B.G.; and V.F. Zelazny. 1995. Forest Soils of New Brunswick.

Davis, R.B. 1966. Spruce-fir forests of the coast of Maine. Ecol. Monogr. 36:79-94

Department of Natural Resources and Energy; Ecosystem Classification Working Group. 1996. An ecological land classification system for New Brunswick. DRAFT.

Dzikowski, P.A.; Kirby, G.; Read, G. and W.G. Richards. 1984. The climate for agriculture in Atlantic Canada. Agriculture Canada. ACA 84-2-5.

Jacobson, G.L. Jr.; Webb, T. and E.C. Grimm. 1987. Patterns and rates of vegetation change during the deglaciation of eastern North America. p. 277-288 *in* Ruddiman, W.F. and H.E. Wright, Jr. Eds. The geology of North America, v. K-3. North America and adjacent oceans during the last glaciation. Geol. Soc. Amer., Boulder, CO.

Keys, J.E. and Carpenter,C.A. eds. 1995. Ecological units of the eastern United States: first approximation. USDA For. Serv.

Lorimer, C. 1977. The presettlement forest and natural disturbance cycle of northeastern Maine Ecology 58:139-148.

Lutz, S. 1997. Pre-European settlement and present forest composition in King's County, New Brunswick, Canada. Masters Thesis, in Prep.

Methven, I.R. and M. Kendriks. 1995. A disturbance history analysis of the Fundy Model Forest area.

Perley, M.H. 1846. Report on the forest trees of New Brunswick. Simmonds Colonial Magazine and Foreign Miscellany (London) XI 129-55, 314-24, 412-29.

Power, R.G. and Matson, B.E. 1995. Ecological land classification of southeastern New Brunswick. New Brunswick Department of Natural Resources. Fundy Model Forest

Seymour, R.S. 1992. The red spruce-balsam fir forest of Maine: Evolution of silvicultural practice in response to stand development patterns and disturbances *in* The ecology and silviculture of mixed-species forests, 217-244. Kluwer Academic Publishers.

Sobey, D.G. 1995. Analysis of the ground flora and other data collected during the 1991 Prince Edward Island forest inventory. III A comparison of the vegetation and environmental factors of pre-1935 and post-1935 forested sites. Institute of Island Studies, University of Prince Edward Island, Charlottetown, P.E.I. Canada.

Wein, R.W. and J.M. Moore. 1977. Fire history and rotations in the New Brunswick Acadian Forest. Can. J. For. Res. 7:285-294.

White, P.S. 1979. Pattern, process, and natural disturbance in vegetation. Bot. Rev. 45(3): 229-299.

Zelazny, V.F.; Ng, T.T.M.; Hayter, M.G.; Bowling, C.L.; and D.A. Bewick. 1989. Field guide to forest classification in New Brunswick.

APPENDIX I: VEGETATION CHANGE OVER RECENT GEOLOGIC TIME

Vegetation Change over Recent Geologic Time

If we were to take some point in the past as a baseline point in time for establishment of a vegetation standard to emulate, we'd have to choose carefully. If we chose 13 thousand years ago, then we'd challenge ourselves to recreate a landscape of retreating glaciers, tundra, and advancing early successional forests. Mastodons, wooly mammoths, and a host of other North American mammals would soon go extinct due to hunting pressure and climate change (Pielou 1991). The bones and teeth of mammoths and mastodons are still being hauled up in fishermen's nets. There was no forest as we know it today; fossilized pollen layers show that areas of coastland not covered by ice supported an Arctic tundra of sedges, grasses, shrubs, dwarf willows and birches. With the passage of a further 5 thousand years we'd see enormous changes in the character of terrestrial ecosystems, as closed forest of roughly the same complement of tree species that we see today dominates the landscape. In New Brunswick, vegetation would advance farther north, following the Appalachian mountains migration corridor, than vegetation in the centre of the continent, where huge inland seas blocked northward migration for many years. Today, New Brunswick has higher tree species diversity than Ontario or Quebec at this latitude. Tree species range expansion is still taking place: hemlock reached the Great Lakes 5000 years ago and reached the western shore of Lake Superior only 1000 years ago, and beech, a slow-migrating, heavy-seeded species, is still migrating westward from its current range-boundary in the middle of the Upper Peninsula of Michigan.

High sea levels caused by the release of water from the melted ice sheets would cause salt water to lap against shores as far inland as present-day Boiestown, New Brunswick. Marine fossils and other archaeological evidence reveal that much of what is now Maine was under the sea until, released from the weight of glaciers, the earth's crust rebounded slowly upward and pushed the sea out to its present location, followed closely by advancing vegetation and other organisms. By 12,000 BP the coastline from Cape Cod to the Bay of Fundy looked much as it does now. Tree species invading from the south left evidence in the form of pollen preserved in lake sediments: poplar was first, followed by spruce, balsam fir and white birch, then the less cold-hardy oak, maple, white pine, and hemlock, in that order. No doubt the colonization of the landscape by hardier trees permitted the eventual establishment by the less hardy, but fire also played an important role. Charcoal layers in the sediments of lake-bottoms show that fire frequency change was concurrent with changes in species dominance.

As the climate gradually warmed, forests slowly advanced northward from the latitude of Long Island, replacing tundra. Many plant species of present-day Nova Scotia descended from ancestors whose glacial refuges were on land now submerged. This has resulted in disjunct present-day populations (*e.g.*, catbrier, skunk cabbage) which are present in Nova Scotia and in southern New England, but are absent from northern Maine and New Brunswick (Pielou 1991).

Fossil and palynological evidence from our area demonstrates that the major changes in the both species composition of communities and the geographic distribution of plant communities has been the norm over recent geologic time (Pielou 1991). The composition and distribution of plant communities has changed periodically in response to large and small climatic changes, from glaciations (shorter periods of intense cold during glacial or "ice" ages) to interglacials, through alternations of the climate from cool-wet to warm-dry, and each change was of sufficient duration to lend the appearance of "permanence" to ecosystems, at least from the human perspective of time (Sprugel 1991). Communities changed because species migrated at different rates in response to the movements of the ice sheets, and because species harboured in different refugia moved in from different directions during interglacials (Botkin 1990). Pathogens have an effect on forest composition that is often overlooked; 4800 years ago a pathogen caused a sharp decline in eastern hemlock populations throughout the species' range (Davis 1981).

Are New Brunswick's remaining old-growth forests examples of evolutionary, tightly-integrated webs of life, or simply collections of more-or-less individualistic species that have come and gone with winds of climate change and chance events? Given the ups and downs of species fortunes with climate change since glaciation, most ecologists today subscribe to the latter view of temperate and boreal forests. Theorists have put forward the idea that evolutionarily, it pays for a species to be "uncommitted" to others in all but the most stable environments. Although examples of mutualistic species associations are known from our ecosystem, such as the mycorrhizal associations between tree roots and fungi, the numbers of such associations pales in our forest (which in world terms is relatively well-studied) in comparison to humid tropical rainforests, for example. In eastern North America the biodiversity value of old growth lies in the possibility that remnant populations of disturbance sensitive species - "biological legacies"- may be surviving there, and this is one of the strongest biological rationales for conserving old growth. Claims for the possibility of "ecosystem collapse", of sudden and significant loss of ecosystem function, dramatized by the use of analogies of aircraft in flight, losing rivets one by one until the inevitable crash - are not supported by the evidence, which demonstrates the remarkable resilience of ecosystem function, and the remarkable diversity of past configurations of biota associated with the enduring landscape ecosystems in this part of the world.

Literature Cited

Botkin, 1990. Discordant harmonies. A new ecology for the twenty-first century. Oxford University Press. ISBN 0-19-507469-6

Davis, M.B. 1981. Outbreaks of forest pathogens in Quaternary history. Proc. Int. Palynol. Conf., Lucknow, India. 3, 216-27.

Pielou, E.C. 1991. After the ice age. The return of life to glaciated North America. University of Chicago Press. Chicago. Pp. 366.

Sprugel, D.G. 1991. Disturbance, equilibrium, and environmental variability: what is ‘natural’ vegetation in a changing environment? Biol. Cons. 58:1-18.

APPENDIX II: PROCEDURE TO DEFINE FOREST COMMUNITIES

Procedure to Define Forest Communities

The following procedure was executed to define forest communities for each ecoregion. *Each forest community is statistically significantly different with respect to basal area of at least one tree species*. The ecoregion level was chosen on the basis of data availability.

1. The 1986 photointerpreted forest as digitized on the Geographic Information System was used. The two dominant tree species, as interpreted for each forest stand, were concatenated to become the name of each CLASS and the area in each CLASS was summarized.

2. A collection of *digitized* ground plots that contained basal area data by tree species was used. (Forest Development Survey, Permanent Sample Plots, and various other studies). An ArcInfo procedure was carried out to attach the photointerpreted attributes to every ground plot. The CLASSES which contained ground plots were used in the analysis.

3. A preliminary grouping procedure reduced the initial number of CLASSES to 25.

a) Mean percent basal area of tree species was generated for all CLASSES that contained ground plots.

b) CLASSES that represented the smallest percent of the area and secondly contained the smallest number of ground plots were grouped. To aid in grouping, the tables of mean basal area of tree species were used throughout the process. Names were assigned to grouped classes according to a "Priority List". The priority list emphasizes infrequent or longer-lived species in the following order - EH, RP, EC, TL, WP, JP, BS, TH, SP, BF, IH, (*i.e.* WPRP → RP; BSEC → EC; EHEC → EH).

c) Grouping continued until the set of CLASSES was less than or equal to 25.

4. A table of means of percent basal area for all tree species was generated for the new set of CLASSES (*i.e.* "grouped CLASSES").

5. A series of oneway analyses of variance and multiple range tests was conducted to detect differences between grouped CLASSES with regard to the mean percent basal area of tree species.

6. Grouped CLASSES that did not differ significantly were further grouped together.

7. The final set of grouped CLASSES are called Forest Communities. Each forest community is significantly different from the others with respect to average basal area percent of at least one tree species.

8. The final set of VEGCOMMS ranges from 9 (Fundy Coast) to 25 (Eastern Lowlands). It should be noted that although each community indicates a distinct association of tree species, a majority each comprise a small area, *e.g.* in the Eastern Lowlands, 22 of the 25 communities are each less than 5 percent of the area. It follows from this that a grouping of forest communities would be beneficial in many applications. An algorithm exists to group all forest communities into 8 larger groupings, called GROUPCOM's, that correspond to locations on an ecological gradient (poor to

rich). These are: PINE, BS, SPBF, BF, EC, MXWD, and TH (Table 1). In addition, the grouped community IHSW exists to represent the early successional community. It is foreseeable that groupings of forest communities could take other forms depending on the application.

Table 1. Grouping of forest communities within GROUPCOM's

GROUPCOM	Forest Community						
	1 Highlands	2 Northern	3 Southern	4 Fundy	5 Continental	6 Lowlands	7 Grand Lake
PI	BSJP BSWP	BSJP BSWP	JPSP SPWP	PINE	JP RP SPWP	BSJP BSWP JP SPWP	BSJP SPWP WP
BS	BS BSBF SP	BSBF SP	BSBF	BS BSBF	BS BSBF SP (21)	BS BSBF BSIH BSTL SP TL	BS BSIH BSTL SP (34) TL
SPBF	SPBF	SPBF SPIH	SPBF	SP SPIH SPTL	EH SPBF SPIH SP SPTL TLEC SPEC	EH SPBF SPIH SPTL	EH SPBF SPIH SP
BF	BF BFBS BFIH	BFSP	BFSP	BFSP	BFSP	BFSP	BFSP
EC	SPEC	EC ECBF ECBS SPEC	ECSP	ECSP	EC ECSP	EC ECBS ECTL SPEC	EC SPEC
MXWD	BFTH THBF THSP	BFTH THBF THIH	BFTH SPTH THBF THIH THSP	THSP	SPTH THBF THSP	BFTH SPTH THIH	THIH THSW
TH	TH	TH	TH	TH	TH THIH	TH	TH
IHSW	IHSW	IH IHSW	IH IHSW	IH IHSW	IH IHSW	IH IHSW	IH IHSW