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Historical forest condition in and around Kouchibouguac National Park, NB

A recently completed study focused on how the forest has changed after European settlement in Kouchibouguac National Park and surrounding areas of eastern New Brunswick. Present day forest in the area consists primarily of black and white spruce (45%), fir (16%), red maple (10%), aspen (9%), and jack pine (8%) and other species, each representing less than 4% of composition by basal area. This research was more comprehensive than previous attempts to evaluate historical forest conditions in other areas of the province, but general conclusions were similar to those of two previous studies. Four sources of information were used to define a reference condition for the forest approximately 200 years ago.

Written documents, including published and archival anecdotal accounts written by travelers, explorers and early settlers, provided descriptive information on the appearance of the forest. Each mention of a forest attribute was noted and tabulated according to the type of information provided. Each mention of tree species or genus was counted by taxon. Early writers depicted the forest as a continuous expanse of large trees, mostly consisting of long-lived,

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Fig. 1. Study area in eastern New Brunswick, including Kouchibouguac National Park and surrounding region, with riparian zones highlighted, where many of the witness trees and the timber petitions were located.

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shade-tolerant species. Hemlock was mentioned more commonly than any other species.

The second data source also required searching the provincial archives, this time for records of witness trees that were used to mark corners of original land grants given to the settlers approximately 200 years ago, as well as to delimit mill reserves. The surveyors used the metes and bounds system for the land grants, meaning that they blazed the trees at the corners of land parcels, rather than the more common system in eastern US in which two or more "appropriate" trees would be chosen for blazing, within short distances from the corners. The metes and bounds approach results in less potential for bias when the records are used to compare species composition over time. The surveyors recorded the identity of the blazed trees, at least to the genus level, and often by species. There are sufficient numbers of records to estimate historical frequencies of tree species across landscapes that were settled. Information from the witness tree records was digitized and stratified using the province's ecological land classification system for comparison with present day species frequencies based on Forest Development Survey data from the province.

Historical species composition, derived from witness tree data, was very different from modern forest composition. The forest was apparently more diverse 200 years ago, with higher frequencies of late-successional species, such as hemlock, yellow birch, and cedar, and very low frequencies of several early-successional species that are now common, in particular, aspen and jack pine.

Timber petition records provided an additional archival source of information about forest composition. Research focused on the short period of time from 1820 to 1840 when large quantities of square timber were harvested in the area for export to Great Britain. Most of the wood removed during this time was white pine, but yellow birch and red pine were also harvested in small quantities. Records of timber petitions include an approximate area, quantity of wood (in tons), and in the later years, the species. Based on these records, it is apparent that great volumes of large white pine were present in the riparian zones of the study area, and that most of the top quality white pine timber was removed from these zones during the twenty year period.

A mature hemlock stand in New Brunswick.

The fourth approach for describing the historical condition of the forest is ecosystem archeology, conducted by Dr. Elena Ponomarenko from the Museum of Civilization in Ottawa, which generally supported conclusions drawn from the other methods. Ecosystem archeology involves examining soil profiles for charcoal and other identifiable macro-fossils. Soil trenches were examined in areas that had been cleared for farming with the aid of fire over the past 200 years. Charcoal was collected from above and below the plough line. Large quantities of charcoal from above the plough line were identified at least to the genus level and used to determine presence of identifiable taxa at the time of land clearance. Charcoal below the plough layer was dated and used to estimate the average fire interval before European settlement.

The most striking differences between modern and pre-European settlement forest composition were:

- A dramatic shift from mostly late-successional, shade-tolerant species including hemlock, cedar, and yellow birch, to early successional species such as black spruce, jack pine and aspen.
- Forests have become less diverse, with six tree species constituting 95% of contemporary forest, compared to nine species about 200 years ago.
- A decline of white pine and appearance of jack pine, which is now frequent but was not detected by any of the approaches used to define the historical forest condition.
- A loss of the previous dominance of eastern hemlock and reduced cedar frequency, along with a recent increase in frequency of balsam fir and poplar species.
- A historical fire interval estimated to be almost 3000 years before European settlement compared to very frequent fire occurrence since settlement.

Understanding how the forest has changed is important in ecosystem management, not to recreate the forests of the past, but to know how human activities have changed the forest dynamics. Such knowledge is important for making informed management decisions because it is important to differentiate between change as a natural process and change that has resulted from human activities.

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Forest Biodiversity Projects Funded under the Ontario Living Legacy Trust

In 1999, the province of Ontario increased its protected areas to about 12% of the provincial land base, under the "Lands for Life" planning initiative. Coincidentally, through the Living Legacy Trust, Ontario funded a research program from 1999-2003 aimed at determining possible effects of increased forest management (FM) on the remaining public lands. Scientists at the Great Lakes Forestry Centre received funding from the Trust to conduct three research projects to better understand the environmental effects of increased FM. Each of these projects involved industrial, government and university partners, resulting in a multi-disciplinary approach to the research problem. Taken together, the programs will provide forest managers with improved information for future FM decisions.

A warbler caught in a mist net, as part of a study to understand use of riparian areas by songbirds.

Impacts of intensive forest management

Increased FM may involve more intensive post-harvest silvicultural techniques, in a certain percentage of the forest, to return forests to conifer-dominated stands earlier than if only natural regeneration occurred after harvest. Such techniques would include increased site preparation, more planting of conifers, especially spruces, and greater use of herbicides to control competing vegetation. Further into the future, we can expect increased use of fertilizers, forest thinning, and drainage of wet sites, as means to increase forest production.

A research project was conducted near Kapuskasing, Ontario - in forests planted between 1965 and 1985 - to assess the possible effects of these kinds of activities on forest structures, especially dead wood, tree species composition, and forest ground covers, and the possible effects of changes in these structures on songbirds, amphibians, small mammals and martens (*Martes americana*). Compared with natural regeneration, intensive FM changed forest tree species from mixedwoods to predominantly conifer stands, and virtually eliminated white birch (*Betula papyrifera*) from the stands. There were also lower densities of standing dead wood in stands where intensive post-harvest silviculture had occurred compared with naturally regenerating stands. Although amounts of dead wood on the ground did not differ, the species of dead wood were different. Scientists found only subtle changes in forest bird, small mammal and amphibian communities in response to intensity of post-harvest silviculture in forests up to 40 years old. However, there was a reduction in numbers of woodpeckers in all intensively managed forests compared with naturally regenerating forests. The woodpeckers were apparently responding to the greater number of dead and moribund trees and live white birch trees in naturally regenerating forests. The scientists also observed very few martens, brown creepers (*Certhis americana*), or boreal chickadees (*Parus hudsonicus*) in all but the older uncut forests on the study area. Recommendations to forest managers will include specific details on amounts of dead wood needed, and that older forests will have to be maintained on the landscape to protect biodiversity.

Bioindicators for assessing forest management effects

The second project was designed to develop a strategy for guiding progress toward sustainability, by using biological indicators - (bioindicators) - to assess the sustainability of FM. The concept is simple enough: if populations of the indicators do not change in response to management over time, then the forest operations may be sustainable. However, there are few examples as yet of the bioindicator approach being used effectively to assess FM, partly because indicators have not been fully tested.

Scientists examined five potential bioindicator groups (forest birds, small mammals, salamanders, carabid beetles, and spiders) in forests

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near White River, ON. All these groups of animals were sensitive to changes in forests through time. Forest bird species were particularly specific in their choice of habitat relative to forest age. The high variability in species counts and relatively high cost of data collection for all the groups suggested that, to develop an efficient and effective bioindicator approach for forest management units, managers will have to change their methods from a trend-monitoring framework, to a computer model-based monitoring framework. Within this proposed framework, computer models based on the ecology of bioindicator species would be used to predict and compare the impacts of alternative FM scenarios on the capacity of the species (or bioindicator) to survive over the long term. One limitation of this approach is that the spatial data needed to create the models are not always available and depend partly on the size of the organisms and, therefore, the scale of the habitat features they choose. Currently, certain habitat supply models are being used to assess the sustainability of forest management, but these rather simple models do not consider population changes, habitat requirements across a landscape, or random events that often occur in wild populations, such as those caused by several years of poor weather. The project also evaluated computer models that linked dynamic landscapes to population models across those landscapes, as an improved alternative to habitat supply models.

Scientists studied three possible bioindicators for future monitoring and modeling in detail: brown creeper, red-backed vole (*Clethrionomys gapperi*) and red-backed salamander (*Plethodon cinereus*). These species were selected for more intensive study because they depend on aspects of the forest system that are expected to change as a result of FM, and because they all have different life histories. Modeling results for the brown creeper suggested that the birds were sensitive to differences among management scenarios, indicating that this approach may be useful for assessing and ranking the sustainability of different FM options.

Impacts of harvesting in riparian areas

The goal of the third study, the White River Riparian Harvesting Project, is to determine whether it is possible to harvest timber from streamside riparian buffer strips in a way that is compatible with the protection objectives of the Ontario riparian habitat management guidelines. The study is being conducted in boreal mixedwood forest about 60 km south of White River, ON, which contains small (first to third order), cool water, forest streams. Pre-treatment, baseline data were collected from 2002 to 2004 describing the physical and chemical characteristics (hydrology, soil, and streamwater chemistry); habitat (vegetation community structure, in-stream coarse woody debris, stream bottom substrates); processes (leaf litter decomposition, microbial respiration); and biotic communities (e.g., forest birds, salamanders, flying insects of aquatic and terrestrial origin, stream invertebrates). In the winters of 2004-2005, the upland portions of half the study blocks were harvested normally and the riparian reserves of the same blocks were partially cut. The other three study blocks are controls and will not be cut for the duration of the experiment.

Data will be compared with the baseline data collected to infer impacts in a before and after, controlled-impact experimental design. The project is important because it takes an in-depth, experimental approach to determining the effects of harvesting in riparian reserves, and the ecological relationships that connect the terrestrial and aquatic components of this system. Most previous studies have employed an alternative design, where a relatively small number of indicator species and physical-chemical parameters were measured at sites scattered across the landscape where harvesting was already complete.

Some interesting preliminary results were obtained during the pre-treatment phase of the project. For example, sampling of large woody debris revealed that wood pieces in streams were generally less abundant, smaller, less stable, and consequently, less useful to aquatic life than in other forest regions. These characteristics reflected the small trees in riparian zones in the boreal shield region due to frequent disturbances by fire and insects, and to slower growing rates in the northern climate. Sampling of forest birds by mist-netting revealed that species richness and abundance were greater in riparian areas than in the upland forests, during the breeding season, although there were no differences during spring and fall migration periods. In the breeding season, more insects were captured in traps placed in riparian areas than in upland areas, suggesting that birds were selecting these habitats because they contained more food. More birds were captured in riparian areas than in uplands during fall migration, indicating that riparian areas may function as movement corridors. These initial findings implicate riparian areas as important habitat for breeding and migrating birds and suggest that practices that significantly reduce the supply of riparian habitat could have adverse effects on avifaunal diversity in boreal mixedwood forests.

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American Beech: New Results for Old Invasive Species

American beech (*Fagus grandifolia* Ehrh.) is a familiar component of eastern Canada's hardwood and mixedwood forests. Beech wood could have high value for furniture, as it does in Europe, if the market were to be developed, and if the species were not susceptible to the devastating introduced insect-disease complex known as beech bark disease (BBD). The disease is caused by a fungus (most commonly *Nectria coccinea* var. *faginata* Lohmam Watson and Ayres). Both apparently arrived in the port of Halifax around1890 on infested imported ornamental European beech (*Fagus sylvatica* L). More than 100 years after its introduction, BBD has spread throughout the Maritime provinces and eastern Quebec; south to North Carolina and Tennessee; and as far west as Michigan and parts of Ontario.

As the disease spreads into new areas, it is preceded by heavy infestation of woolly beech scale, which predisposes the trees to *Nectria* attack. The subsequent massive beech mortality (85% of the trees may die in this first wave) is known as the "killing front." Beech stands north of Toronto are exhibiting signs of the infestation levels followed by the killing front. Dying trees readily produce root suckers, and seedlings are released by the rapidly thinning canopy in dying beech stands. The resulting suckers and saplings, known as "aftermath forest," also become infected by BBD. The disease is endemic. Canker-deformed trees grow poorly, but produce new suckers before they eventually die. The cankered trees have lost their potential value for cabinet making and for seed production, thus reducing the availability of beech nuts to wildlife, especially black bears. The cycle continues, posing serious forest management challenges because the shade-tolerant, vigorous beech suckers out-compete other species, only to fall victim to the disease again. The management solution is often to attempt to eliminate beech and replace it with higher value species. This strategy, although it makes good economic sense, removes healthy trees along with diseased ones, thus reducing the potential for eventual restoration. A group at the Atlantic Forestry Centre (AFC) has followed up on work initiated by Dave Houston (retired scientist with the USDA Forest Service) to better understand the disease, and determine the feasibility of restoring healthy beech to Canada's forests. In almost all heavily infested stands that we have examined, there are a few healthy beech trees showing no signs of the insect or the fungus. Sometimes disease-free trees are found in clumps, surrounded by diseased trees, indicating a probable clonal origin and suggesting genetically based resistance to the disease. Early reports by Houston indicated a high probability of relatedness among trees in such clumps. They also indicated that the apparent resistance was to the scale insect. If trees do not become infested by the scale, they are not susceptible to the *Nectria* fungus.

Pollination bags protect beech flowers used for controlled breeding to produce scale resistant seedlings.

The AFC group, in collaboration with Marek Krasowski at the University of New Brunswick, has identified, tested, and attempted to vegetatively propagate more than 20 putatively resistant beech trees in southern New Brunswick. The most successful vegetative propagation method was grafting, which provided a useful set of material for screening genotypes for resistance to the scale insect. If true genetic resistance to the scale insect can be proven using grafted material from putatively resistant

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trees, it would provide an opportunity to increase the proportion of disease-free genotypes by mass-propagating resistant genotypes and reintroducing them into beech stands.

To screen trees for resistance to the scale insect, experiments were conducted to challenge the trees for resistance using scions from putatively resistant trees that were grafted on wild rootstock and inoculated with eggs of the scale insect. Two years of challenge testing confirmed the existence of genetic resistance to the scale insect. The insect appeared incapable of establishing at all on a few of the clones, whereas there were low numbers of surviving adult insects on other clones. All of the known susceptible genotypes developed healthy scale colonies, including production of eggs one year after inoculation, as did one putatively resistant clone. After closer examination, it was apparent that the putatively resistant tree had branch cankers, although its stem appeared healthy. No eggs were observed with the scale colonies on clones showing intermediate resistance, so these colonies may not be viable.

Vegetative propagation of American beech has proved to be very difficult. Among the different propagation methods attempted, including tissue culture, rooting of stem cuttings, and grafting, a level of success has been achieved only with grafting. Micropropagation has encountered many difficulties, including high initial contamination of tissue cultures, low rooting success, and failure of plantlets to establish after transferring from sterile culture to the soil. Few stem cuttings rooted successfully, and even those that did failed to survive beyond a few months.

Work is continuing on the resistance of American beech to BBD. Current activities focus on controlled breeding and challenging the progeny obtained from controlled crossings with different combinations of resistant and diseased trees. The research aims at elucidating the mode of inheritance, understanding the nature of the resistance, and finding molecular markers for the resistance. In the meantime, it is important to improve silvicultural approaches, preventing the loss of resistant genotypes from our forests.

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Forest Health and Biodiversity Readership Survey

The Canadian Forest Service and Natural Resources Canada are conducting this study to gain insights into its readers' opinions, attitudes, and viewpoints towards our publication *Forest Health and Biodiversity News* (FHBN).

We have designed this 20 question survey to be completed in approximately 7-10 minutes. Please take your time in responding to each question. Your opinions, habits, and preferences are very important to us and the success of this study.

As a valued reader of *Forest Health and Biodiversity News*, please be assured that your name will not be revealed and your responses will only be used when grouped with those of the other people taking part in this study. All information will be held strictly confidential.

You can also do this survey online at:

www.atl.cfs.nrcan.gc.ca/FHBN-SBFN

Question 1: Do you regularly read *Forest Health and Biodiversity News*? Please choose one answer.

- ☐ Yes
- ☐ No

Question 2: If you are not a regular reader of FHBN, please indicate why. Check all that apply.

- ☐ Plan to read but haven't had the time
- ☐ Never received a copy
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- ☐ The articles don't apply to my job
- ☐ The appearance and layout do not appeal to me
- ☐ Other: ____________________

Question 3: When you read FHBN, how much do you usually read? Please choose one answer.

- ☐ All or almost all the articles
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Question 4: In terms of overall quality, how would you rate FHBN? Please choose one answer.

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Excellent

Question 5: How many people share your copy of FHBN?

- ☐ I don't share my copy of FHBN
- ☐ 1 to 2 people
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Question 6: Please rate the quality of FHBN on the following:

a. Diversity of issues covered

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- ☐ Fair
- ☐ Good
- ☐ Excellent

b. Regional coverage

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Excellent

c. National coverage

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Excellent

d. Credibility of information

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Excellent

e. Objectivity and fairness

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Excellent

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- ☐ Poor
- ☐ Fair
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- ☐ Excellent

g. Enjoyability

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Excellent

Question 7: What information would you like to read about in FHBN? Check all that apply.

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- ☐ Upcoming Events
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Question 8: Overall, how would you rate the timeliness of articles in FHBN? Please choose one answer.

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Excellent

Question 9: Are you aware that FHBN is available online? Please choose one answer.

- ☐ Yes
- ☐ No

Continues on next page

Question 10: Would you prefer to receive FHBN in an electronic format instead of a paper copy?
Please choose one answer.

- ☐ Yes
- ☐ No

Question 11: If we began offering FHBN in an electronic format only, which statement below best describes your preferred method of access?
Please choose one answer.

- ☐ PDF version attached to message
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Question 12: How would you rate the length of the articles?
Please choose one answer.

- ☐ Long, stopped reading part way through
- ☐ Long, but of interest to keep me reading
- ☐ Just right
- ☐ Too short

Question 13: How would you rate the technical level of FHBN?
Please choose one answer.

- ☐ Not scientific enough
- ☐ About right
- ☐ Too scientific

Question 14: How would you rate the language level of FHBN?
Please choose one answer.

- ☐ Too simple
- ☐ Just right
- ☐ Too complex

Question 15: Please indicate your opinion on the following statements:

a. FHBN is easy to read from a visual standpoint.

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

b. The current format of 8 ½" x 13" is appropriate.

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

c. The print size is appropriate.

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

d. FHBN is well designed in terms of visual appearance.

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

Question 16: How often would you like to receive FHBN?
Please choose one answer.

- ☐ Less frequently
- ☐ Current practice of twice a year is my preference
- ☐ More frequently

Question 17: How do you typically obtain a copy of FHBN?
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- ☐ Government - municipal
- ☐ Industry
- ☐ Non-governmental organization
- ☐ Media
- ☐ Other: ____________________

Question 19: What is your occupation; that is, in what kind of work do you spend the major portion of your time?

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Question 20: Which of the following categories best corresponds with your last completed year in school?
Please choose one answer.

- ☐ Some High School
- ☐ Completed High School
- ☐ Some university / college
- ☐ Completed university / college
- ☐ Graduate studies or degree
- ☐ Post-graduate studies or advanced degree

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The survey is now complete.

Thank you for taking the time to complete this survey on the Canadian Forest Service's *Forest Health and Biodiversity News*. Your time and opinions are greatly appreciated.

Check back in the next issue of *Forest Health and Biodiversity News* for the results.

Please return this survey by May 31, 2007 to:

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