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White birch deterioration in the Bay of Fundy region, New Brunswick 1979-1988

L.P. Magasi



Information Report M-X-175
Forestry Canada - Maritimes



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**WHITE BIRCH DETERIORATION
IN THE BAY OF FUNDY REGION, NEW BRUNSWICK
1979-1988**

by

L.P. Magasi

Information Report M-X-175

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ABSTRACT

White birch (*Betula papyrifera* Marsh.) has been deteriorating along the Bay of Fundy coast of New Brunswick and Nova Scotia as a result of chronic early leaf browning and premature leaf-fall since the late 1970s. The cause of the condition is unknown but air pollutants are suspected.

RÉSUMÉ

Vers les années 1980, le bouleau blanc (*Betula papyrifera* Marsh.) tout au long de la côte de la Baie de Fundy au Nouveau-Brunswick et de la Nouvelle-Écosse, ont été en état de dégradation progressive à cause d'un brunissement précoce et chronique des feuilles et de la chute prématurée des feuilles. La cause de cette condition est encore inconnue mais on soupçonne les polluants de l'air.

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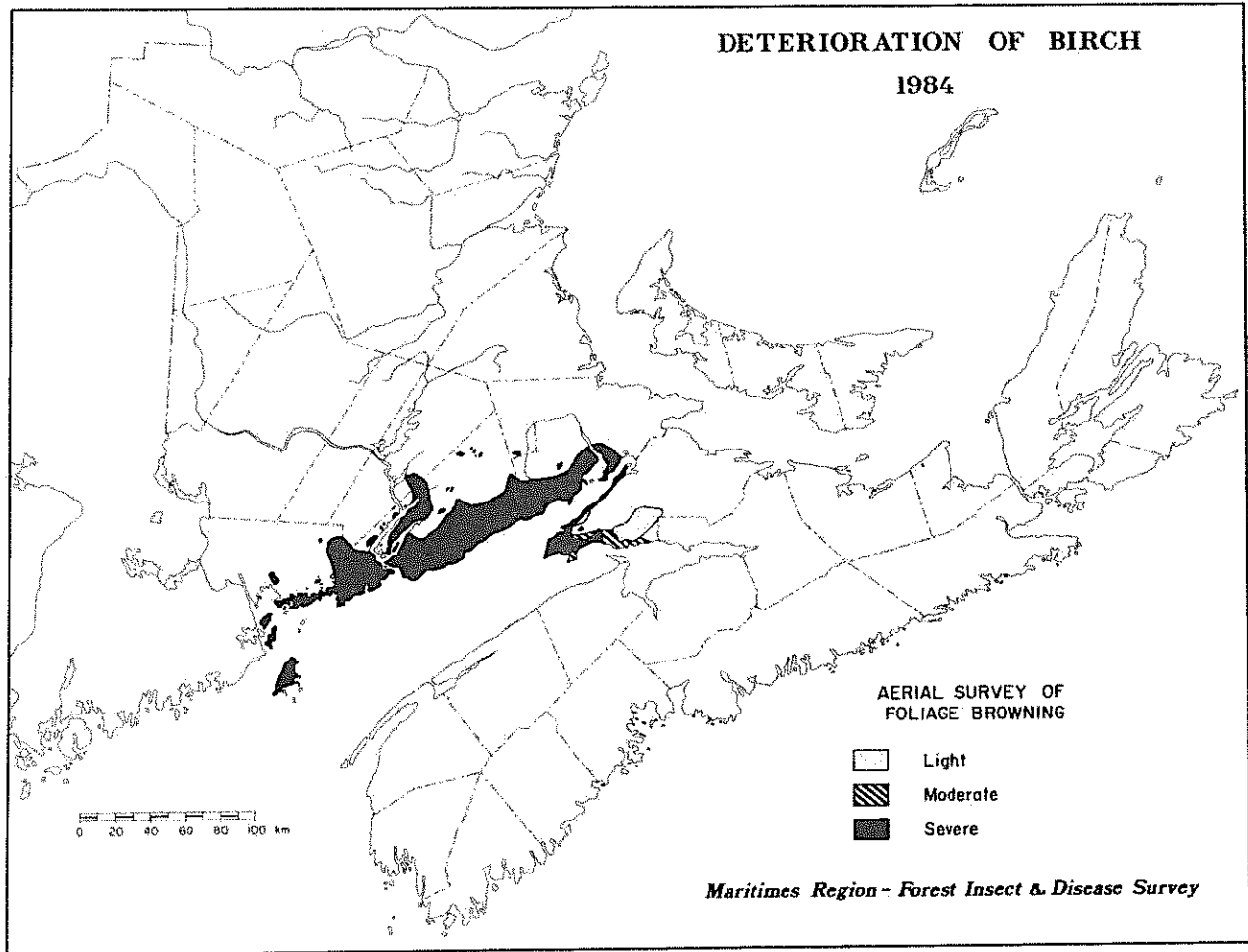


Figure 1

INTRODUCTION

Abnormally early foliage discoloration and premature leaf-fall of white birch (*Betula papyrifera* Marsh.) trees occurred along the Bay of Fundy coast in New Brunswick in 1979 (1). The same condition has occurred each year since then, at varying levels of intensity, in essentially the same general area and has caused deterioration in the condition of birch trees. Twig- and branch-dieback have increased. The situation has been closely monitored by the Forest Insect and Disease Survey (FIDS) of Forestry Canada - Maritimes Region for the past 10 years and observations have been reported in annual FIDS reports. Insects and diseases associated with the condition do not satisfactorily explain the phenomenon, especially since occasionally other vegetation has also been affected. Although the cause of birch deterioration

in this area remains unknown, circumstantial evidence points to air pollution as a possible cause.

The purpose of this report is to describe the problem, chronicle the events, and summarize 10 years of observations on the deterioration of birch along the Bay of Fundy coast, in a single document.

DESCRIPTION OF THE PROBLEM

Tree species affected

The species of birch affected has been consistently referred to as white birch in all FIDS reports. However, according to Cox (pers. comm.), at least some of the white birch trees affected are of the variety mountain paper birch (*Betula papyrifera* var. *cordifolia* (Reg.) Fern.). As separation of the variety, especially from the air, is extremely difficult,

the species affected will be referred to as white birch, mainly to distinguish it from yellow birch (*Betula alleghaniensis* Britt.). This distinction is important, partly because yellow birch in the area is not affected and partly because the current condition should not be confused with the yellow birch dieback (2), a still unexplained phenomenon which virtually eliminated yellow birch as an economic species over extensive areas in the 1930s and 1940s (3).

Although the foliage browning has been mainly a recurring condition of white birch, similar symptoms have been observed on other deciduous trees and on ground vegetation in those years when birch browning was particularly severe. Tree species affected, other than birch, were: alder (*Alnus rugosa* (DuRoi) Spreng.), mountain ash (*Sorbus americana* Marsh.), mountain maple (*Acer spicatum* Lam.), largetooth aspen (*Populus grandidentata* Michx.), and trembling aspen (*Populus tremuloides* Michx.).

Area affected

The area affected by leaf browning has varied somewhat from year to year. However, the condition generally occurred along the Bay of Fundy coast in New Brunswick and in Nova Scotia. Symptoms have been observed in a coastal strip of 1 to 15 km, except in low lying areas where leaf browning extended inland as far as 30 km. Birch on Campobello, Deer and Grand Manan islands in the Bay of Fundy has also been affected. The situation in 1984 typifies the extent of the problem (Fig. 1).

Foliage symptoms on birch

Leaf discoloration on birch starts either as browning at the leaf margins or as spotting on the leaf surface. The browning develops and spreads rapidly and is characterized by chocolate-brown discoloration and a scorched-like appearance, which at times is restricted to leaf margins. Severely affected leaves curl and start dropping as early as mid-August. Symptoms have appeared as early as mid-July in some years and, in those cases, leaves that developed in the latter part of the season often remained green while older leaves on the same twigs turned brown.

HISTORY OF FOLIAGE DISCOLORATION, 1979-1988

Premature foliage discoloration of birch on Campobello Island and along coastal areas of southern New Brunswick was first noticed in 1977 during regular surveys (unpublished FIDS records).

FIDS personnel often encounter forest conditions during regular reconnaissance surveys without the presence of insects or diseases, and the cause is classified as 'unknown'. These areas of concern are assigned for re-examination and are placed under more intensive observation. If a condition of undetermined cause persists, it then becomes a reportable item in annual FIDS reports.

The birch browning condition persisted and it was first reported in 1979 as follows:

"Widespread browning and loss of foliage of white birch occurred in New Brunswick on Campobello, Deer, and Grand Manan islands, and in a coastal strip from west of Saint John to east of the Fundy National Park. A similar condition occurred in Nova Scotia, west of Parrsboro in Cumberland County and white birch trees lost their leaves unusually early in 1979" (3).

FIDS efforts to monitor the situation have gradually increased during the 1979-1988 period, due partly to the interest in the effects of chronic foliage loss on tree condition in the area (discussed below) and partly to the increasing circumstantial evidence that air pollution may be involved. General surveys to assess insect and disease conditions in the area have been supplemented by specific observations on the condition of foliage (discoloration, loss) on birch and other hardwoods. In addition, specific monthly visits have been instituted to selected permanent observation points to collect insect, disease, and foliage condition data. In 1984, one of 17 ARNEWS (Acid Rain National Early Warning System (4)) plots was established within the affected area at St. Martins (5). In 1985, bi-weekly observations were carried out from early June to mid-September along the mainland New Brunswick portion of the affected area to collect foliage, insect, and disease samples, and to establish the dates and chronological order of events in symptom development and the patterns of discoloration in the forest. Since 1986, FIDS observations have been supplemented by those of other Forestry Canada personnel working on the relationship between air pollution and birch deterioration in the area. Aerial surveys have been conducted annually, at a time when the extent and intensity of foliage discoloration was deemed to have fully developed. The area affected was sketch-mapped from the air using standard Forestry Canada foliage discoloration or defoliation categories (nil; trace up to 5%; light 6-29%; moderate 30-69%; severe 70-100%).

Although some degree of foliage browning occurred within the affected area each year between 1979 and 1988, differences were recorded in: (1) the intensity of foliage discoloration, (2) the pattern of discoloration in the forest over both large areas and small stands, (3) the time of the season when symptoms first appeared, (4) the time when full symptom-expression was reached, and (5) whether or not vegetation other than white birch was also affected.

Following the severe foliage discoloration in 1979, leaf browning was generally severe again in 1980, with patches of various sizes of moderate or light discoloration interspersed within the affected area. The degree of browning often varied among individual trees at the same location. On some shoots, younger leaves remained green while older leaves exhibited severe symptoms. Other hardwood species were also affected in some areas of severe birch browning but the degree of discoloration on these was generally light (6). Conditions in 1981 were very similar to those found the previous year (7).

Conditions were much improved in 1982 after several years of severe or moderate discoloration. Although leaf browning occurred in essentially the same areas, only trace or light discoloration was observed (8). Severe discoloration occurred again in 1983 and conditions were similar to those observed prior to 1982, except that the most severely affected areas were further east than in previous years and, although severe, the general intensity of browning was lower than that observed in 1981 (i.e., the degree of browning was towards the lower end of the severe discoloration category) (9). The conditions in 1984 were essentially a repeat of those found the year before (10).

In 1985, discoloration was light in the western part of the affected area, but increased in intensity towards the east. Entire hillsides appeared brown from the air or from high ground east of Saint John as a result of severe leaf browning. Although the discoloration was severe overall, it was less intense than during the previous two years. Browning was also more patchy, with areas of moderate or light discoloration interspersed with severe browning. Other hardwood trees and some herbaceous vegetation exhibited symptoms at some of the more severely affected locations. The first evidence of foliage discoloration on birch was recorded on June 27 and, by August 5, well-developed symptoms were conspicuous throughout the affected area (5).

A marked reduction occurred in the intensity of foliage discoloration in 1986 and symptoms appeared much later in the season than they had in previous years. Although foliage discoloration still occurred throughout the area, it was patchy, much reduced in intensity, and generally only trace or light browning was recorded (11). In 1987, leaf browning occurred again but at such low intensity that it could not be detected during aerial surveys and was observed only from the ground (12). Foliage discoloration in 1988 was general throughout. Browning was severe in much of the area but varied from light to severe. Symptoms appeared very late in the season. Well defined browning, characteristic of the condition throughout the years, coincided with the first signs of fall discoloration but developed rapidly and was unmistakably different from normal autumn color change observable around mid-September.

TREE CONDITION WITHIN THE AFFECTED AREA

As a result of repeated early foliage discoloration and premature leaf fall, white birch is in poor condition in much of the affected area. Tree crowns are thin (i.e., possess less than normal amounts of foliage) even before discoloration appears. Crown dieback, manifested by dead twigs and branches, is evident and some trees have died. The first visible signs of tree deterioration were noted in 1981.

To follow changes in tree condition, permanent plots were established in the area in 1982, with 11 in New Brunswick and two in Nova Scotia (Fig. 2). Each plot consisted of 50 white birch trees in stands where white birch was the major tree species. Trees were assessed annually around mid-August. Each tree was classified according to the "Hardwood Condition Classification" system adopted for the ARNEWS program (4).

A summary of observations on the condition of the 550 white birch trees on the 11 New Brunswick plots from 1982 to 1988 is presented in Table 1. (Observations on the two plots in Nova Scotia indicate trends similar to those found in New Brunswick. However, these results are not presented because of uncertainty regarding the validity of some of the observations in some years due to observer changes.)

The proportion of healthy (no dieback) trees decreased from 92.9% in 1982 to less than half (45.3%) by 1985 and no trees were left without some

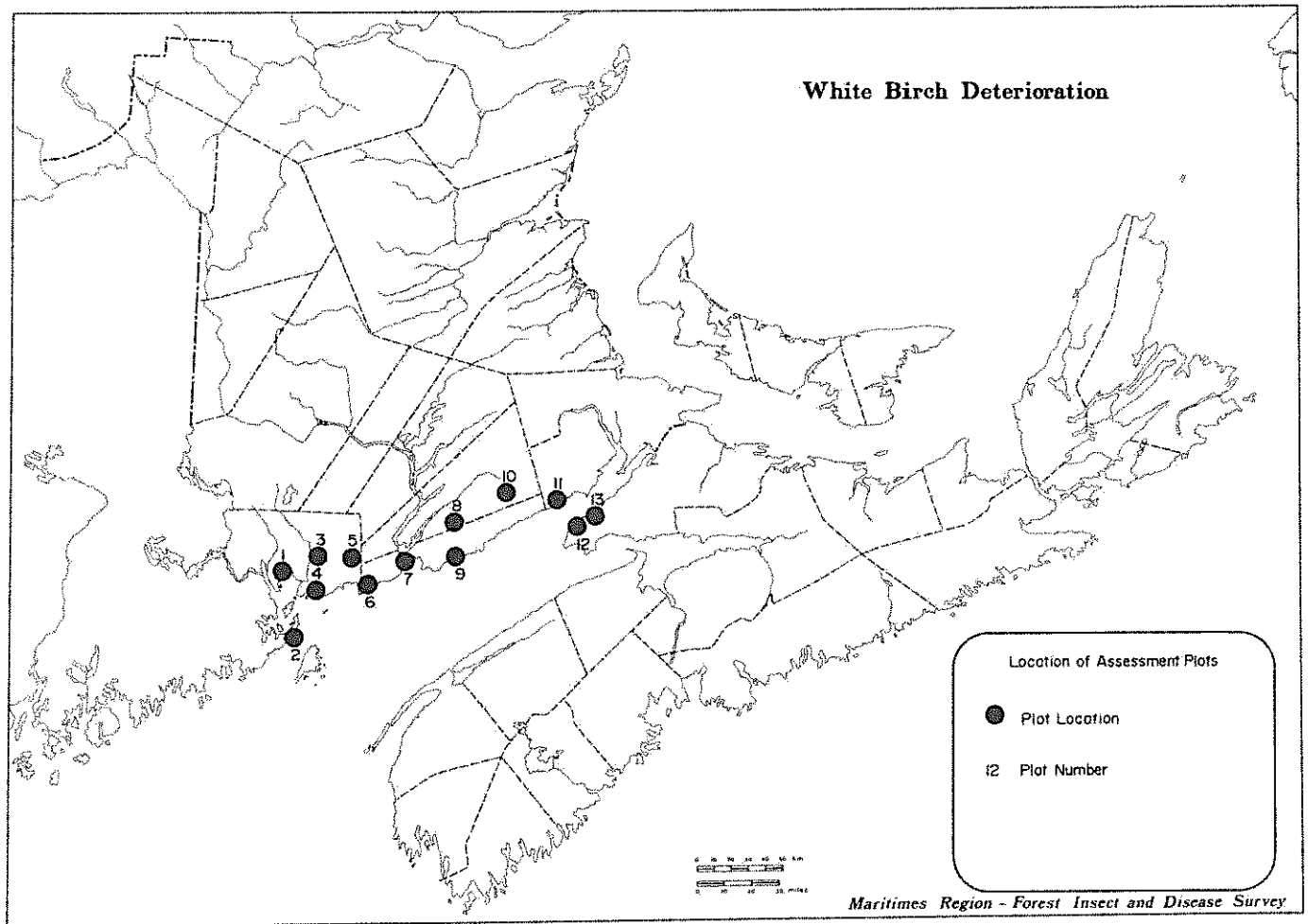


Figure 2

Table 1. Condition of white birch along the Bay of Fundy in New Brunswick. (Based on assessment of 550 trees on 11 permanent plots). 1982-1988

Tree condition class	Percentage of trees in class						
	1982	1983	1984	1985	1986	1987	1988
No dieback	92.9	83.7	64.0	45.3	14.5	0.0	0.0
Twig dieback only	1.5	8.6	24.9	34.9	47.3	42.6	38.0
Twig and branch dieback	4.7	6.0	7.8	14.4	31.3	49.8	54.0
Dead	0.9	1.7	3.3	5.4	6.9	7.6	8.0

sign of deterioration by 1987. Correspondingly, there was an increase in the percentage of affected trees and, while tree mortality to date has been gradual and slow (averaging 1.2% per year), both twig- and branch-dieback increased dramatically until 1986, when almost half of the trees (47.3%) exhibited twig dieback and nearly a third (31.3%) also suffered branch dieback. Trees have continued to deteriorate since 1986 and the proportion of those with "twig dieback only" has decreased as the percentage of trees with branch-dieback increased. The amount of branch-dieback on individual trees has also been increasing (unpublished data) and it is expected that, unless there is a dramatic reversal in the condition causing the deterioration, some of these trees will soon die.

To obtain a preliminary indication regarding the effect of deterioration on growth, single increment cores were collected from 10 randomly selected trees on each of the 11 New Brunswick plots in 1986. These were taken from the north-facing side of trees at breast height. Similarly, for comparison, 10 increment cores were collected on each of three white birch plots, located at least 80 km from the coast, well away from the affected area and established for other purposes.

Perusal of preliminary data (unpublished) indicates that, as expected, the older interior trees (average age 84 years) grew at a slower rate than the younger coastal trees (average age 51 years). Relatively little change occurred in the annual increment of interior trees during a 40-year period between 1946 and 1986, apart from annual fluctuation, but the growth of the coastal trees, which slowly accelerated from 1946 to 1970, slowed down considerably after 1970. By 1986, radial growth of the coastal birch trees was only about one half that in 1970.

A number of the white birch plots in New Brunswick also serve as plots for several other tree condition monitoring projects. Those projects are scheduled for major reassessment in 1990. The collection of new increment cores for analysis from all white birch plots is planned to coincide with those assessments to maximize data collecting efficiency.

POSSIBLE CAUSES FOR THE CONDITION

Elucidating possible causes of changes in forest conditions is one of the mandates of FIDS, in order to facilitate management decisions regarding either

the control of causal agents or the assignment of resources towards research. Efforts to describe the condition and to follow tree deterioration have helped in this elucidation and in the elimination of possible but unlikely causes.

Insects and diseases - There were 68 species of insects and 12 species of fungi collected from birch in the affected area during the 10-year period. More than half of these species were found in only one year and could not have caused the chronic foliage discoloration. Most of the insects found were foliage feeders and symptom expression is inconsistent with their habits. None of the species, insects or diseases, with the possible exception of *Septoria* leaf spot (*Septoria betulina* (Lib.) West.), were found at high populations or were distributed widely enough to have been able to cause the type of damage observed.

Of all the organisms collected in the affected area, only the leaf spot fungus, *S. betulina* has been consistently associated with the phenomenon. It has been prevalent on the discolored portion of white birch leaves each year, regardless of the severity of leaf browning. However, the fungus was also present and prevalent on white birch in other areas of the Maritimes in 1981 and in 1985 (6, 9) but without the scorched-like browning. The fungus was much less frequent in the area in 1979 and 1980, at the onset of the condition, when foliage browning was severe (found in only 2 and 9 collections, respectively), than in 1985 when it was collected 30 times. It was not present on other tree species or on ground vegetation which also exhibited typical symptoms. The association of *S. betulina* with birch deterioration requires further investigation.

Abiotic conditions - Drought, global climatic changes and other similar factors affecting forests have been considered and discarded as causal agents because this area was not exclusively affected by these factors. A winter storm in 1976 deposited large amounts of ocean salt over extensive areas, as far as 80 km from the coast, and caused severe foliage browning of conifers in the spring of 1976 in essentially the same area affected by birch deterioration (1). Ocean salt damage, as a delayed effect, however, is not consistent with the seasonal appearance of symptoms.

Air pollutants - Long range transportation of air pollutants was first suspected as a possible cause in 1981, when it was shown that air masses associated

with weather fronts were transporting male gypsy moths into the area in great numbers from outbreak areas in the industrial United States (7). The assumption was made that if these storms are capable of bringing insects of relatively large size into the southern parts of the Maritimes then atmospheric impurities are also likely to be transported in those air masses.

Younger, later-developed birch leaves, at times, remained unaffected while older leaves were severely discolored. This suggested an episodic or cumulative environmental factor rather than a pathological condition.

The affected area roughly coincides with areas which experience a high incidence of summer fog events along the Bay of Fundy coast. A study of weather records in 1984 indicated a possible association of light browning and fewer than average number of fog events in 1982.

None of these pieces of circumstantial evidence alone explains the situation or implicates air pollutants. However, taken together, they raised enough questions and provided sufficient indication by the mid-1980s to warrant detailed examination of air pollutants as possible causal agents.

Consequently, research was initiated in 1986 to investigate the role of acid rain, acid fog, and ozone in the chronic browning and early leaf-fall of white birch and the relationship between these abnormalities and tree health in the affected area along the coast of the Bay of Fundy. Results of these studies will be published elsewhere.

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