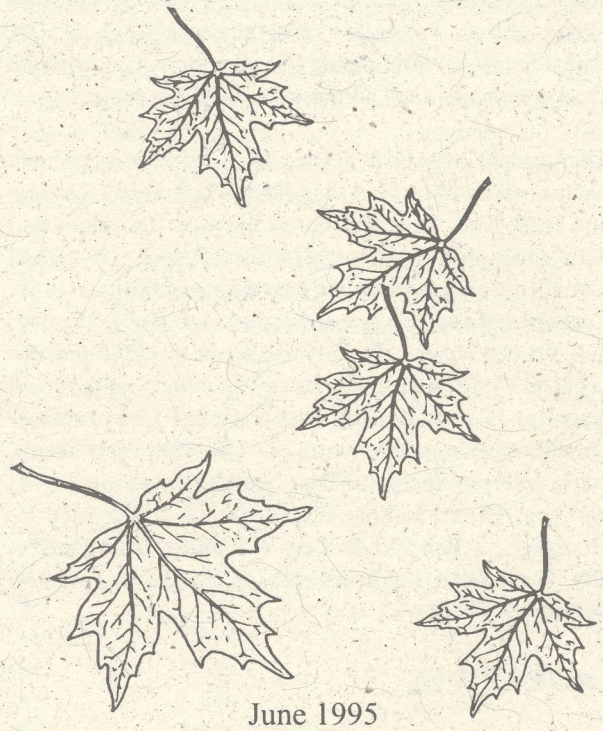
United States
Department of Agriculture

Forest Service

Northeastern Area
State & Private Forestry

Canadian Forest Service
Service Canadian de Forets

Condition of Sugar Maple 1994



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INTRODUCTION

During the late 1970s and throughout the 1980s sugarbush managers, foresters and the general public became concerned about maple decline. In response to these concerns, the North American Maple Project (NAMP) was formed in 1987 between Canada and the United States and authorized by a Memorandum Of Understanding and Special Project Agreement.

The administration and the financial support for the project is provided by the Canadian Forest Service and Forest Health Protection, Northeastern Area, USDA Forest Service. Participating states and provinces provide field crews and local administration of the project.

The current project is guided by a Joint Management Team co-chaired by Gerard D. Hertel, U.S. Forest Service, and Peter Hall, Canadian Forest Service. Ten states and four provinces cooperate in the project. National Coordinators provide day-to-day guidance: Denis Lachance, Canadian Forest Service, and Robert Cooke, U.S. Forest Service. Quality assurance is a high priority because 14 different agencies collect data. Standardized training is provided by the National Coordinators annually. Remeasurements are done between crews, states and provinces for data quality evaluation by the National Coordinators. Data analysis is provided by Douglas C. Allen and Andrew W. Molloy, State University, College of Environmental Science and Forestry, Syracuse, New York.

OBJECTIVES

The objectives of the project are to determine:

1. the rate of change in sugar maple condition ratings.
2. if the rate of change in sugar maple condition ratings is different among:

a. various levels of sulfate and nitrate wet deposition.
b. sugarbush and non-sugarbush forests.
c. various levels of initial stand decline conditions.

3. possible causes of sugar maple decline and the geographical relationships between potential causes and extent of decline.

PLOT ESTABLISHMENT

The total number of plot-clusters (forest stands) monitored and evaluated by NAMP is 233 (Table 1). Geographic coverage now extends from Minnesota and Ontario, south to Ohio and Pennsylvania, and east to Nova Scotia (Fig. 1).

Each plot-cluster consists of five plots (20 by 20 m) located in a sugar maple stand that is 50 to 150 years old. In most states and all the provinces, one-half of the plot clusters are active sugarbushes and one-half are in non-sugarbush stands. Stands were selected to represent a range of initial forest decline conditions, site conditions, and cover most of the prime sugar maple growing areas.

STAND DESCRIPTION

In 1994 the average sugarbush in this study had 157 trees per acre (389 trees/ha), 77% of which were sugar maple, and the average tree diameter at breast height (dbh) was 10.4 in (26.4 cm). The non-sugarbush stands averaged 194 trees per acre (479 trees/ha), 69% of which were sugar maples, with a slightly smaller average dbh of 9.6 in (24.4 cm). Average basal areas were 117.6 ft2/ac (27.2 m2 ha) and 119.5 ft2 (27.3 m2/ha) in sugarbush and non-sugarbush stands, respectively.

Observations in 1994 were made on approximately 19,800 live trees, of which 73% are sugar maples. Sixty-six percent of the live sugar maples are in the dominant

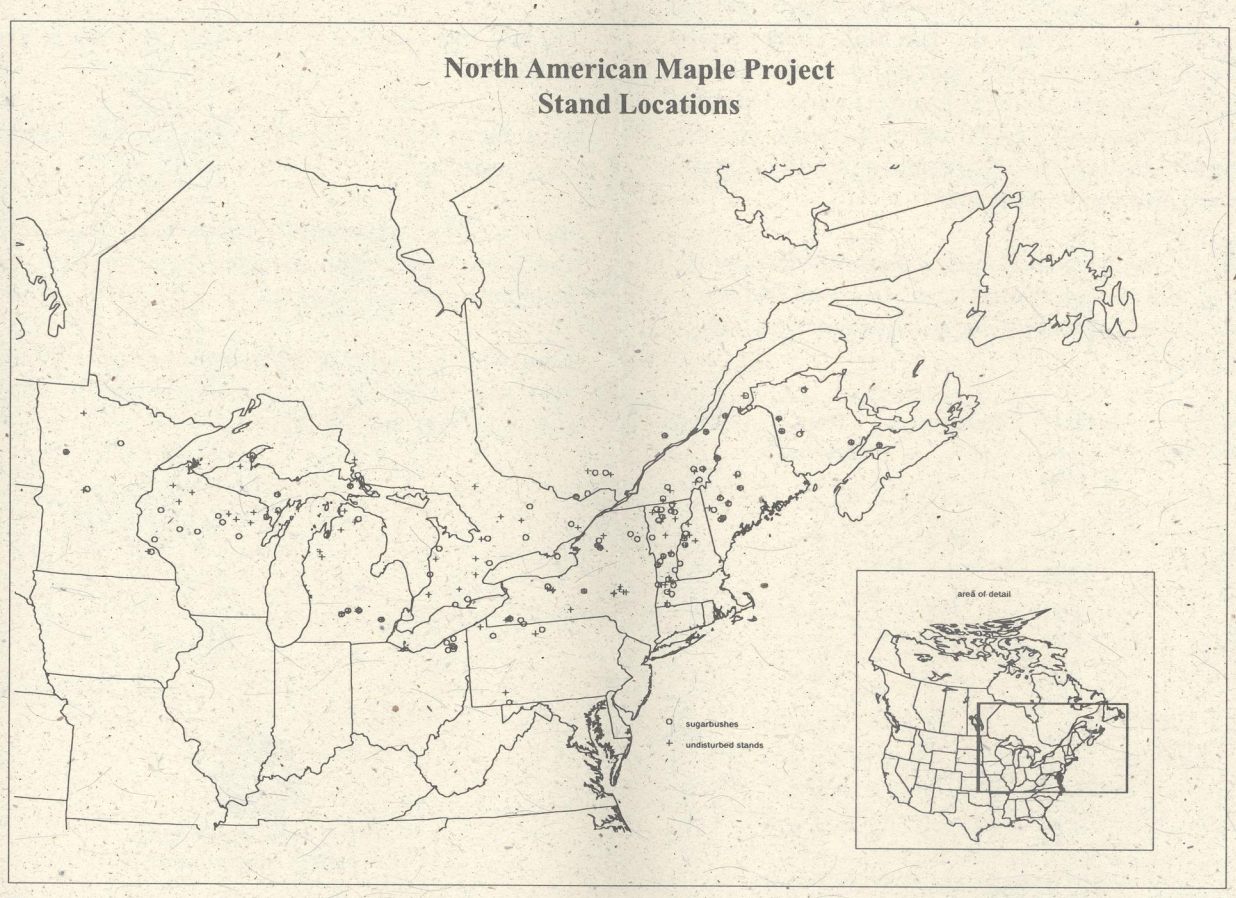

Figure 1. *NAMP plot-cluster locations*

Table 1. *Distribution of plot-clusters in the North American Maple Project by state and province.*

United States		Canada	
Maine	18	New Brunswick	12
Massachusetts	10	Nova Scotia	2
Michigan	24	Ontario	24
Minnesota	8	Quebec	24
New Hampshire	10		
New York	27		
Ohio	6		
Pennsylvania	10		
Vermont	40		
Wisconsin	18		

or codominant crown positions. The other most common species are American beech, basswood, ash, red maple, and yellow birch.

METHODS

Sugar maple crowns are evaluated annually for dieback and foliage transparency and visited twice annually to assess insect defoliation. Annual visits are required because the incidence of dieback and transparency are expected to fluctuate from year to year as a result of individual tree response to changes in weather and site conditions. Insect defoliation may occur in both spring and mid-summer, therefore two annual visits are required.

Quality and consistency of data are assured through annual training and certification of field crews. At least 5% of crown ratings are remeasured to assess data quality. Approximately 90% of remeasurements in 1988 fell within the prescribed standards. This repeatability of measurements improved to approximately 95% in 1989 and has remained at this level through 1994.

The results presented here are based on analyses of the crown condition of 7,054 upper canopy sugar maples. Branch dieback in the upper crown is a disease condition caused by various stresses. For this project, 5% dieback is considered normal; 6% to 15% percent indicates moderate damage; and more than 15% dieback indicates a high level of damage. Foliage transparency, or abundance, is estimated by the amount of light penetrating the crown. A transparency of 25% or less is considered normal, 26% to 55% transparency indicates a moderately thin crown, and greater than 55%

transparency is considered high. The latter suggests that a tree is severely stressed.

SUGAR MAPLE CONDITIONS IN 1994

Dieback

Crown dieback reflects the general, long-term health of individual trees. The average dieback of upper canopy sugar maples in 1994 for all 233 plot-clusters was approximately 7% in sugarbushes (SB) and 6% in non-sugarbushes (NSB) (Table 2). Over 7 years this average changed by less than 2% for both categories. The highest crown dieback for 1994 was located in Quebec where sugarbushes averaged 10.6% and non-sugarbushes, 7.9%. Average dieback was greater in sugarbushes in 11 of 12 regions. The range of differences was 0.1-2.7%, and none were statistically significant.

Table 2. *Average dieback and transparency of upper canopy sugar maples, 1994.*

	Average dieback		Average transparency	
Region	**SB**	**NSB**	**SB**	**NSB**
ME	6.4	5.8	11.8	10.8
MA	7.6	7.2	14.8	13.1
MI	4.7	4.2	11.0	8.7
MN	3.9	4.2	7.4	8.4
NB/NS	7.6	7.1	11.0	10.8
NH	6.9	6.3	13.4	12.5
NY	5.4	4.2	19.9	10.7
OH	7.3	-	10.4	-
ON	6.3	6.1	17.3	16.8
PA	4.5	4.4	12.8	8.9
QU	10.6	7.9	12.7	10.8
VT	7.8	7.6	13.7	13.3
WI	5.9	5.8	11.8	12.9
ALL	6.8	6.0	13.5	11.7

Figure 2 compares the incidence of high dieback (>15%) between regions using all upper canopy sugar maples in 1994. Quebec had the greatest percentage (14.5) of trees with high dieback in sugarbushes and Vermont had the greatest percentage (7.7) in non-sugarbushes. Minor changes occurred in many regions

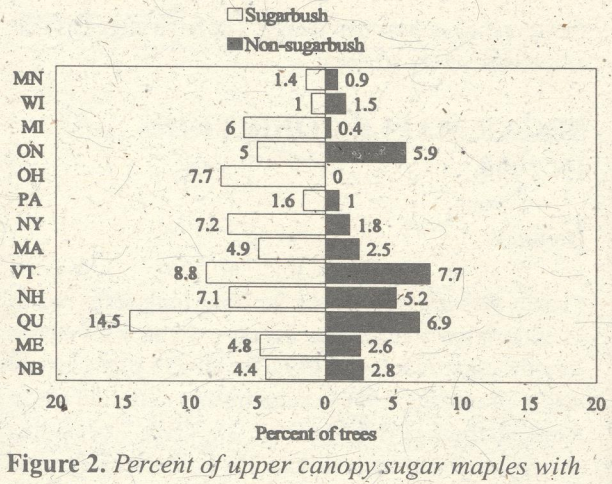

Figure 2. *Percent of upper canopy sugar maples with high dieback*

relative to the proportion of upper canopy sugar maples with >15% crown dieback. These changes may reflect normal fluctuations in crown condition. In Quebec's sugarbushes, however, the percent increased from 6.8 in 1993 to 14.5 in 1994. The percentage also doubled in Quebec in non-sugarbushes. At this point we are uncertain of the cause or causes of this change, but it may be related to extreme cold temperatures recorded throughout the province in winter 1994, which may have killed numerous twigs on exposed trees.

Transparency

Crown transparency reflects annual flucuations in tree condition due to disturbances such as defoliation, drought and other stresses. The average plot-cluster transparency of upper canopy sugar maples in 1994 was 14% in sugarbushes and 12% in non-sugarbushes (Table 2). These averages have been consistent since 1990 and are lower than the 1988 and 1989 averages. The average plot-cluster transparency decreased by approximately 4.5 % in sugarbushes and non-sugarbushes since 1988. The highest average transparency occurred in NY sugarbushes (19.9%; largely a reflection of pear thrips and forest tent caterpillar defoliation) and Ontario sugarbushes (17.3%; cause(s) not determined at this time). For non-sugarbushes, the highest average transparency in 1994 appeared in Ontario (16.8%; causes(s) not determined). Average transparency was greater in sugarbushes compared to non-sugarbushes in 10 of 12 regions, although only the NY difference was statistically significant.

In 1988, 22.0% of the upper canopy sugar maples in sugarbushes were rated with more than 25% transparency;

by 1994 this declined to 5.5%. In non-sugarbushes the percentage decreased from 19.2% to 3.4% during the same period.. The trend of low transparency numbers continued in 1994 (Fig. 3). The relatively high percentage of trees with high transparency in New York sugarbushes is due to pear thrips and forest tent caterpillar defoliation. The 1994 percentages for NH and QU sugarbushes increased slightly over the previous year; NH went from 1.4% in 1993 to 5.1% in 1994 and QU went from 1.9% in 1993 to 5.3% in 1994. Light pear thrips activity observed in some plot-clusters may account for this change in NH. As mentioned above for dieback, QU experienced extremely cold temperatures in winter 1994, and this may have increased transparency as well as levels of dieback.

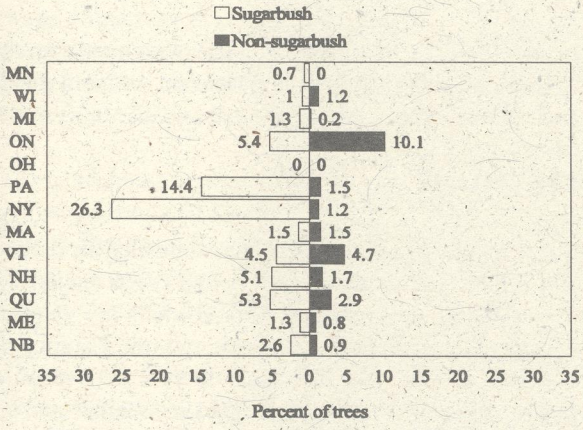

Figure 3. *Percent of upper canopy sugar maples with high transparency*

Mortality

The long-term NAMP dataset enables the determination of the natural mortality rate at which sugar maples died in the original NAMP plot-clusters. This natural mortality rate does not include trees that were healthy when cut as part of a stand management activity or that were killed as a result of management-related practices.

In both the lower canopy and upper canopy there was no consistent difference in mortality between sugarbushes and non-sugarbushes. For five of six years however, average annual natural mortality of upper canopy sugar maples in sugarbushes was slightly higher than in non-sugarbushes (Fig. 4). There are differences between mortality levels in the upper and lower canopy, where annual natural mortality ranged from 0.3% to 0.8% and from 0.9% to 2.3%, respectively. Sugar

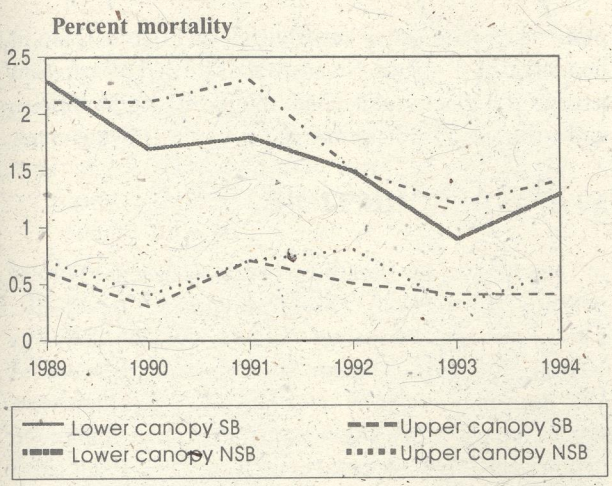

Figure 4. *Percent (trees) mortality for sugar maple (1988-1994)*

maples in lower canopy crown positions are expected to have higher mortality due to competition.

Within states/provinces there is no consistent pattern in upper canopy natural mortality between sugarbushes and non-sugarbushes (Table 3). The high upper canopy average annual natural mortality in New York sugarbushes is partially explained by a severe ice storm that decimated one plot-cluster. Otherwise, no clear pattern in average annual natural mortality appears between states and provinces.

Table 3. *Average annual natural mortality of upper canopy sugar maples in the North American Maple Project by state/province and management type from 1988 to 1994*

State/ Province	Live Trees in 1994	Sugarbush %	Non-Sugarbush %	All Trees %
ME	1,107	0.8	0.5	1.0
MA	581	0.1	0.5	0.8
MI	261	0.9	0.3	0.7
NB/NS	971	0.3	0.3	0.4
NH	347	0.5	0.4	1.3
NY	978	1.6	0.4	1.2
ONT	1,276	0.2	0.5	0.6
QU	1,758	0.9	0.5	1.1
VT	1,470	0.6	0.9	1.2
WI	993	0.4	0.2	0.5
TOTAL	9,742	0.6	0.5	0.9

DISCUSSION

More than 90% of the sugar maples on all of the plot-clusters are considered healthy based on an evaluation of crown conditions.

The overall condition of sugar maple crowns in stands managed for syrup production is similar to the condition observed in non-sugarbushes. There are more sugar maples with high levels of dieback in sugarbushes.

Most improvements in crown condition between 1988 and 1994 are associated with recovery from damage by pear thrips in Vermont and Massachusetts, forest tent caterpillar and maple webworm in New York, forest tent caterpillar in northern Ontario, and recovery from severe drought in 1987 through 1989 (1988 was the worst year) in Michigan and Wisconsin. Although crown conditions improved overall, various localized factors have been responsible for annual changes within some regions.

CONCLUSIONS

Overall, sugar maples at the NAMP sites are in good condition.

Sugar maple health is similar between sugarbush and non-sugarbush stands.

Insect defoliation, unusually low winter temperatures and drought adversely affected sugar maple crown condition in some local areas.

Natural tree mortality of sugar maple averaged 0.9% per year, which is within the normal variation expected as stands develop and age.

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