# Stump Sprouting
## *of Four Northern Hardwoods*

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### The Authors . . .

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# Introduction

FRESHLY cut stumps of most northern hardwood species commonly develop sprouts from previously dormant buds at or slightly above the root collar. These sprouts are of interest and concern to both timber and wildlife managers.

Where vigorous sprouts compete with more desirable regeneration, the timber manager often is concerned with retarding sprout development through mechanical, chemical, or other means. However, under some conditions sprout development may be accepted or even encouraged — for example, where a forest is being managed for bulk products. Also, sprouts from small stumps may be acceptable even where sawtimber is the management objective.

The wildlife manager is interested in sprout growth primarily as browse for deer. Generally, for a given site and hardwood timber type, sprout growth will produce more browse than seedling growth. Because the reach of the deer determines browse availability, the wildlife manager is interested in the height development of sprouts as well as in the number of sprouts per stump or per acre.

Information about the relationship of sprouting to stump characteristics and stand conditions would aid both timber and wildlife managers in developing appropriate management programs. Also, such information should aid in the development of multiple-use management plans for areas that are to be devoted to both timber and wildlife production. As a start toward meeting these needs, a study of sprout occurrence and development in recently cutover northern hardwood stands was conducted in the White Mountains of New Hampshire.

# Methods

Four cutover areas on the White Mountain National Forest were chosen for study. These areas, totaling about 500 acres, represented clearcutting and light, medium, and heavy partial cuttings. The clearcutting was of the heavy commercial type. All four areas were cut during the dormant season of 1962-63.

Stumps of four major northern hardwood species were sampled: yellow birch (*Betula alleghaniensis*, Britton), paper birch (*B. papyrifera*, Marsh), sugar maple (*Acer saccharum*, Marsh) and red maple (*A. rubrum*, L.). Beech (*Fagus grandifolia*, Ehrh.) and white ash (*Fraxinus americana*, L.), which also are important northern hardwood species, were not included in the study. Beech, not generally regarded as a very important browse species, produces mostly root suckers or stool sprouts (short-lived adventitious sprouts arising from the cambial area at the top of a stump) rather than true stump sprouts. White ash, although a preferred browse species, was not abundant enough to provide an adequate sample.

A total of 172 stumps, 6 inches in diameter or larger and about equally divided among the four species, were selected for analysis. Within these restrictions, selections were at random. The number of stumps by species was as follows: red maple, 42; sugar maple, 44; paper birch, 42; and yellow birch, 44.

Measurements were taken during the summer of 1964, the second growing season after the stands were cut. The number of sprouts at each stump was recorded; any sprout forking within 2 inches from the point of origin was counted as two (or more) sprouts. For estimating vigor, heights of the three tallest sprouts at each stump were measured to the nearest 0.1 foot. If any of these three sprouts had been browsed recently, height before browsing was estimated by measuring the current year's growth on an adjacent unbrowsed sprout and adding this length to the previous year's growth of the browsed sprout.

Four independent variables were determined or estimated as described below:

1. *Density of the residual stand* was expressed as the basal area per acre in trees 5.0 inches d.b.h. and larger immediately surrounding the sample stump. Basal area was measured in square feet with a 10-factor prism, using the stump center as the point of pivot.

2. *Diameter of the parent stump* was recorded as the average of the widest and the narrowest dimensions measured to the nearest 0.1 inch about 1 foot above ground. Because of the commercial type of cutting, stumps less than about 6 inches in diameter were not available for measurement.

3. *Age of the parent tree* was determined, if possible, from ring counts at stump height. Where annual rings were obliterated, age estimates were developed from the ring counts on nearby stumps.

4. *Vigor of the parent tree* was based on width of the outer 10 annual rings measured to the nearest 0.1 inch. Where radial growth varied considerably, an average width was computed from measurements at several randomly selected places around the stump perimeter. Both the 10-year diameter increment and the 10-year basal-area increment were calculated.

The data covered an adequate range of values for each independent variable. For all species combined, parent stumps ranged from 6 to 25 inches in diameter. Basal area of the residual stands varied from 0 square feet to 120 square feet. Vigor of the parent trees in terms of 10-year basal-area increment ranged from 0.02 to 0.50 square feet, and their ages ranged from 35 to 200 years.

Multiple regression screening techniques were used to relate both the number of 2-year-old sprouts and the average height of the three tallest sprouts to selected combinations of the independent variables. Stumps that had no sprouts were eliminated from the analysis of sprout height. Several transformations were applied to the dependent variables to determine the best fit. The transformation that produced the highest correlation for both dependent variables was the logarithm to the base 10 plus 1. The final regression equations were selected on the basis of high multiple correlation, low standard error of estimate, and practicality for application in the field.

# Results

## Red Maple

As expected, red maple was the most prolific sprouter among the four species in the study. The number of sprouts per stump was related to both the past 10-year basal-area increment of the parent tree and to the interaction of stump diameter and basal-area increment, as shown in equation I below:

$$[I] \quad Y = 0.995 + 11.600\ (X_2) - 0.704\ (X_1)\ (X_2)$$

where Y is the $\log_{10}$ (number of sprouts + 1), $X_1$ is the average stump diameter in inches, and $X_2$ is the past 10-year basal-area increment in square feet. This equation has both regression coefficients significant at the 1-percent level, a multiple correlation coefficient of 0.49, and a standard error of estimate of 0.074.

The number of sprouts increased with increasing basal-area increment for stumps up to about 16 inches in diameter. Above 16 inches, the number of sprouts decreased with increasing basal-area increment (fig. 1).

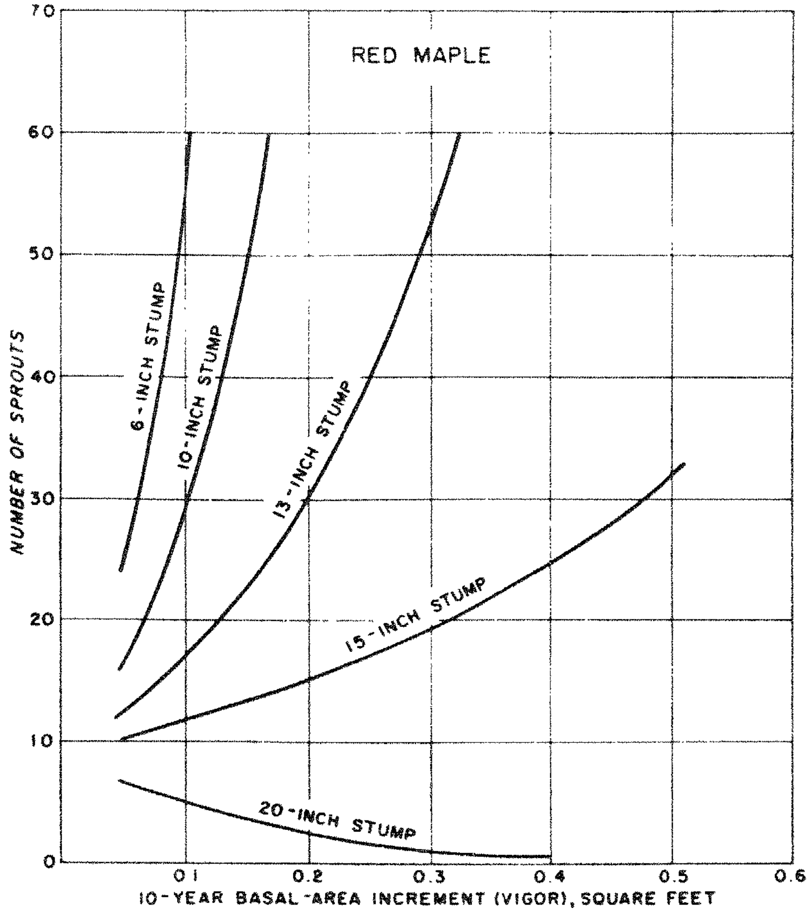
Because the past 10-year basal-area increment is difficult to measure on standing trees, equation I is not convenient to use for prediction purposes. For practicality, equation II is better:

$$[II] \quad Y = 0.779 + 0.134\ (X_1) - 0.007\ (X_1)^2$$

where Y is $\log_{10}$ (number of sprouts + 1) and $X_1$ is the average stump diameter in inches. The regression coefficients are almost significant at the 5-percent level in equation II. The multiple correlation coefficient is 0.42, and the standard error of estimate is 0.077.

This equation indicates that, for red maple, the number of sprouts increased with increasing stump diameter up to about 9 inches; beyond 9 inches, the number of sprouts decreased (fig. 2). Sprouting was most prolific on stumps in the range of about 6 to 12 inches in diameter. These results are in accord with findings by Keetch (3) that sprouting of hardwoods increases with tree size up to 5 inches d.b.h. (approximately 7 inches in stump diameter)

Figure 1. — Relationship of number of 2-year-old red maple sprouts per stump to the last 10-year basal-area increment for five stump diameter classes.




and then decreases. Other studies conducted in oaks and sugar maple support the results expressed by these equations: that, as the tree diameter increases, the number of sprouts per stump decreases (*1, 2, 5, 6, 7*).

Average height of the three tallest red maple sprouts per stump was inversely related to the 10-year basal-area increment of the parent tree and to tree age. The most accurate expression of this relationship was:

[III] $Y = 0.961 - 1.484\ (X_1) - 0.003\ (X_2)$

where Y is the $\log_{10}$ (average height in feet of the three tallest sprouts + 1), $X_1$ is 10-year basal-area increment in square feet, and $X_2$ is tree age (fig. 3). The regression coefficients are significant at the 5-percent level. The multiple correlation coefficient is 0.478, and the standard error of estimate is 0.030.

Because basal-area increment is not easily measured in the field, we tested other equations that did not involve this variable in the hope of finding a more convenient one to use. However, these other equations all had considerably higher standard errors of estimate for predicting sprout height.

The inverse relationship between sprout height and stump age was to be expected because older plant material generally exhibits less vigor in vegetative reproduction than younger material. However, the inverse relationship between sprout height and 10-year basal-area increment in red maple is not so easily explained. Possibly, the greater number of sprouts produced on stumps of the

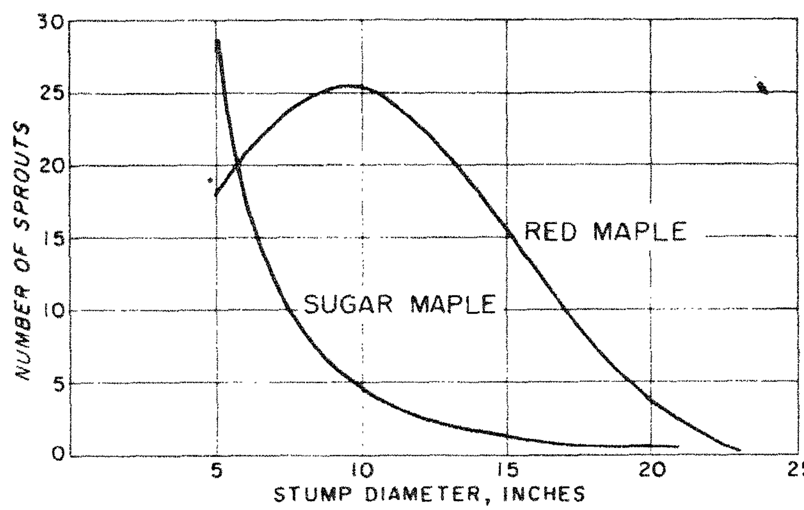



Figure 2. — Relationship of number of sprouts per stump to average stump diameter for red maple and sugar maple.

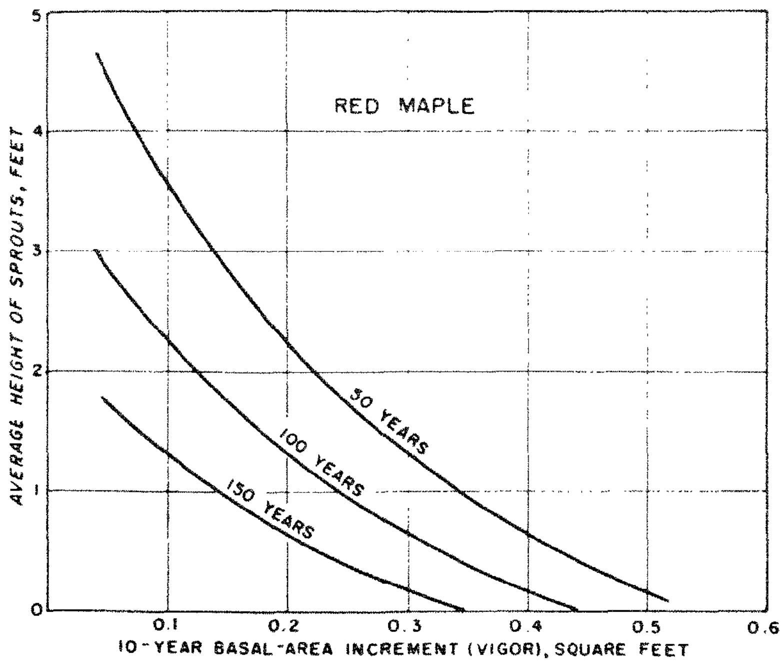



**Figure 3. — Relationship of the average height of the three tallest sprouts per red maple stump to 10-year basal-area increment of the parent tree for three tree age classes.**

more vigorous trees (see fig. 1) resulted in enough competition to reduce average height of all sprouts.

## Sugar Maple

Sugar maple is a considerably less prolific sprouter than red maple. And unlike red maple, sprout numbers did not increase with stump diameter in the lower range of stump sizes. In sugar maple, the number of sprouts decreased rapidly with increasing stump diameter over the entire size range in the sample (fig. 2). This inverse relationship is expressed in the following prediction equation:

[IV] $Y = 2.582 - 0.257\ (X_1) + 0.007\ (X_1)^2$

where Y is the $\log_{10}$ (number of sprouts + 1) and $X_1$ is the stump diameter. Both coefficients are significant at the 1-percent level. The multiple correlation coefficient is 0.49, and the standard error is 0.093.

The average height of the three tallest sugar maple sprouts was for the most part inversely related to stump diameter. The most accurate equation for predicting sprout height was:

$$[V] \qquad Y = 0.974 - 0.064 \ (X_1) + 0.002 \ (X_1)^2$$

where Y is the $\log_{10}$ (average height of three tallest sprouts + 1) and $X_1$ is the diameter of the parent stump. Equation V has both regression coefficients significant at the 1-percent level, a multiple correlation coefficient of 0.590, and a standard error of 0.025.

The general inverse relationship between sprout height and stump size for sugar maple illustrates the same principle revealed by the red maple data: that the older the parent tree, the less vigorous the sprout reproduction. Although stump size proved to have greater predictive value than stump age in sugar maple, this did not negate the age relationship. Possibly the greater tolerance of the sugar maple — its greater capacity to grow in an understory position — accounted for the emergence of stump size as the more important variable in computing the regression for this species.

The stump-diameter/sprout-height relationship for sugar maple is shown graphically in figure 4. The increase in height for stump diameters greater than about 16 inches could be due to sampling variation; we can suggest no other explanation for it.

## Paper Birch

The number of sprouts and the average sprout height for paper birch appeared to be influenced by both parent stump diameter and residual basal area. However, the multiple-regression equations did not depict relationships that could be explained biologically. Because no conclusion could be reached, these equations are not presented.

Sprout height did appear to be inversely related to residual basal area. Paper birch is the only species in the study that exhibited this relationship. Because of their intolerance, paper birch sprouts

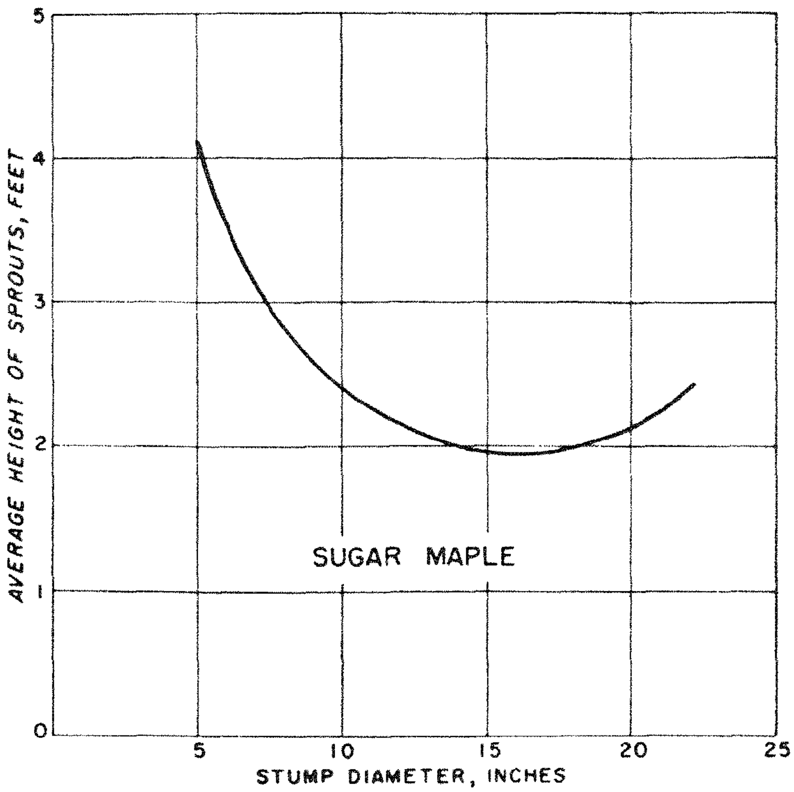



**Figure 4. — Relationship of the average height of the three tallest sprouts per sugar maple stump to stump diameter.**

may be more sensitive to the shade or other effects of residual trees than are those of red and sugar maples (fig. 5).

## Yellow Birch

Yellow birch may be considered as non-sprouting in the White Mountain area. For the areas sampled, only 3 of 44 stumps had sprouts, and only 1 of the 3 stumps had any appreciable number of sprouts.

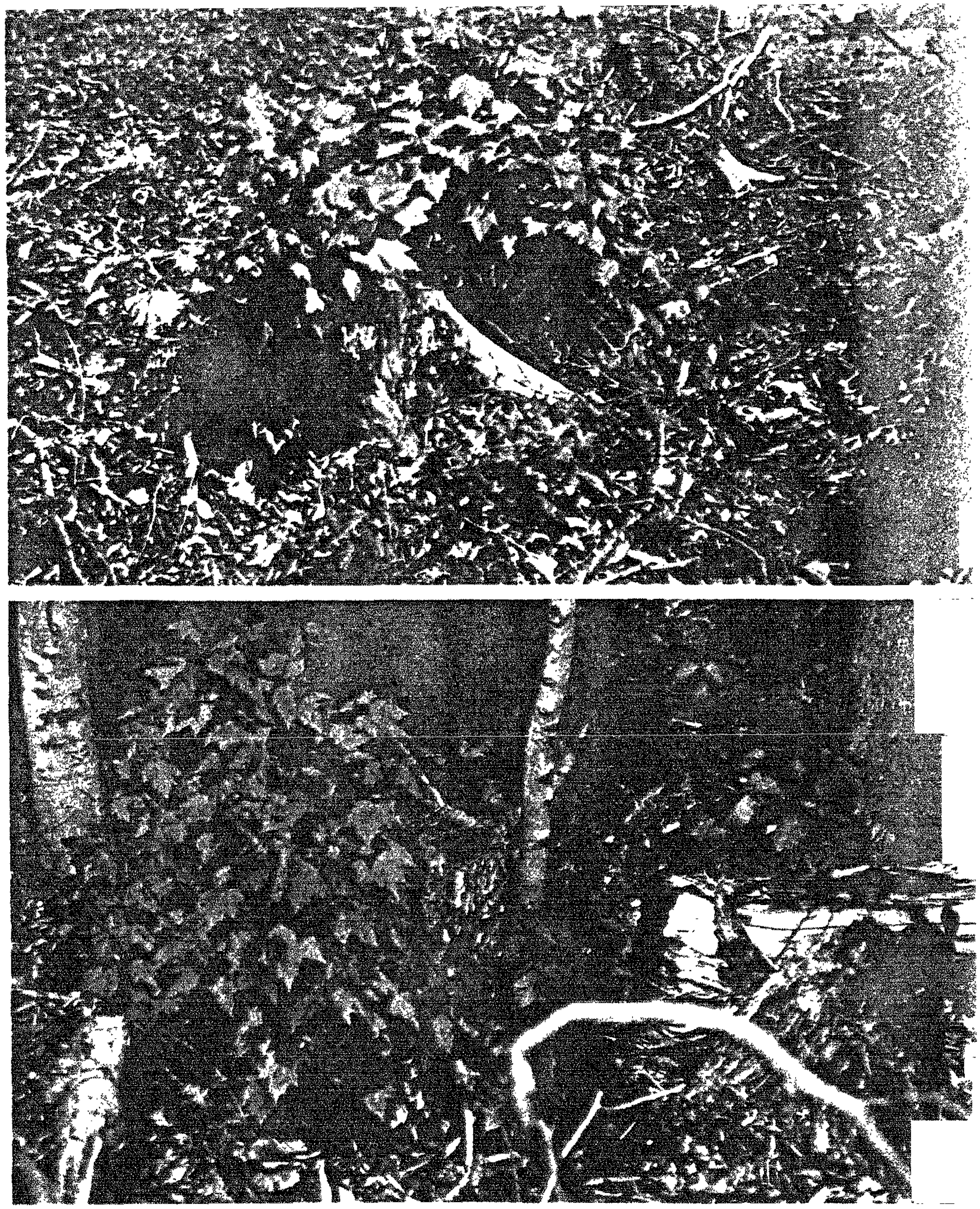


Figure 5. — Residual basal area had no appreciable effect on number or height of 2-year-old red and sugar maple stump sprouts: A, a sprouting red maple stump in a clearcut area; B, a comparable sprouting stump in a partially cut area.

# Discussion and Recommendations

Although the correlations were not exceptionally high, the regression equations presented in this paper appear to be sufficiently accurate to provide useful generalizations about the sprouting of red and sugar maples. Further, the observations on sprouting — or the lack of it — in paper and yellow birches should be similarly useful to forest and wildlife managers.

Small stumps generally produce more sprouts than large stumps. For red maple, the number of sprouts increased as stump diameter approached 9 inches and then decreased at greater stump diameters. In sugar maple, the number of sprouts declined rapidly as stump diameter increased above 6 inches (the minimum size measured). Furthermore, the smaller (sugar maple) or younger (red maple) stumps produced the taller sprouts. Relationships for paper birch were inconclusive, and yellow birch proved to be essentially a non-sprouting species.

Increased vigor of red maple trees, as reflected by 10-year basal-area increment, was associated with heavier sprouting in stumps up to about 16 inches in diameter. However, the average height of red maple sprouts decreased with increasing tree vigor, possibly because of competition among sprouts. Tree vigor did not appear to be an important factor for any species other than red maple.

In paper birch, sprout height tended to decline with increasing residual basal area, but this factor had no discernible effect upon either number or height of the 2-year-old sprouts of red maple and sugar maple. In general, this observation on the maples is in accord with the findings of Little (*4*), who, in a thinning study of coppice oaks 2 inches d.b.h. and smaller, reported sprouting to be only slightly influenced by the surrounding residual stand.

However, moderate to high residual basal areas could be expected to gradually suppress the height growth of sprouts as their age increases beyond 2 years. This expectation is supported by the work of Clark and Liming (*2*), who found that competition from untreated trees did not affect the percentage of girdled trees that sprouted but did reduce sprout height growth over a 6-year period of observation.

Wildlife managers who wish to induce sprout growth of red and sugar maples can do so by cutting vigorous, small trees. However, after a heavy cutting, stumps of such trees tend to produce fast-growing sprouts that may soon grow beyond the reach of browsing deer. Hence, a more appropriate technique might be crown thinning (or weeding) in immature hardwood stands. This treatment should produce large numbers of sprouts, and the residual stand should gradually suppress their height growth.

Another argument in favor of crown thinning in immature hardwoods is that this technique can be used to accomplish timber management, as well as wildlife management, objectives. In this connection also, Shafer (8) has suggested the use of intermediate cuts for integrated timber-browse management of hardwoods in the Northeast.

Where northern hardwood stands in New England are to be managed strictly or primarily for timber, managers are often concerned with suppressing sprout competition — red maple in particular — to favor more desirable regeneration. In these situations, sprouting can be minimized by restricting harvest operations insofar as possible to mature trees or stands, and by chemically treating the smaller stumps and unwanted smaller trees.

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