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STUMP SPROUT FORMATION BY RED MAPLE (*ACER RUBRUM* L.) IN NOVA SCOTIA

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During the autumn and winter of 1977, two mixed-wood forest areas near New Ross, Nova Scotia that had been heavily cut or clear cut and one in Kejimukujik National Park were examined for red maple (Acer rubrum L.) regeneration due to stump sprout development. It was established that the number of sprouts produced will be greatest around stumps 30 cm in diameter and 80 yrs old. Maximum elongation of sprouts (76 cm per annum) occurred around stumps with 30 sprouts, whilst above that number the rate of sprout elongation decreased. Sprout numbers decreased with increasing sprout age from a mean of initially 30 to 24 at 10 yrs, to 12 at 30 yrs and 3 at 75 yrs. This was considered to be the result of intraspecific competition (self-thinning).

INTRODUCTION

Information regarding stump-sprout formation in red maple has uses in wildlife management as sprouts are browse for deer and in timber management where fiber production and/or quality may be the primary concern. This study examines red maple sprouting to reveal the relationships between stump characteristics and the number and height of sprouts in Nova Scotia.

METHODS

Three areas, one near Armstrong Lake, Kings County, another near New Ross, Lunenburg County, and a third in Kejimukujik National Park, Queens County, were selected for study. The site located in Lunenburg County had been clearcut 1 yr ago whereas the Armstrong Lake site had been clearcut 5 and 7 yrs ago. The two areas were similar topographically, both consisting of undulating terrain with granite boulders at the surface and areas of swamp. The soils of the area are described by MacDougall and Cannard (1965). The regenerating species included balsam fir (Abies balsamea), white pine (Pinus strobus), and red maple, with red maple being the most abundant species. The area in Kejimukujik National Park was undulating with variable drainage and consisted of maple-oak-birch (Acer rubrum - Quercus rubra - Betula papyrifera) forest which had been cut about 40 yrs previously. The presence of red maple was attributed to stump sprouting rather than the establishment of seedlings. Similar observations have been reported elsewhere, see for example Wilson's (1968) account of red maple in Harvard Forest (Massachusetts).

A total of 84 red maple stumps exhibiting sprout formation were selected. Of these, 12 came from the 1 yr old site, another 12 from data collected at Kejimukujik National Park (mostly 40 and 50 yr old) and the remainder were composed of variously aged (mostly 5,7, and 20 yr old) sprouts from the Armstrong Lake area.

Stumps which were sampled (excluding those from Kejimukujik National Park) were randomly selected and then assessed as to their suitability for enumeration. Suitable stumps were those which occurred singly and not in clusters and those which could be easily aged. It was thought that measurements made on stumps occurring in clusters would introduce a complication in data interpretation because of competitive interactions between sprouts on different stumps. Some stumps, especially those cut 5 and 7 yrs ago, had decomposed to such a degree that aging was difficult. Lower cut stumps were often covered with leaves which appeared to encourage decomposition.

Once a stump had been selected, several parameters were measured. Stump diameter was calculated from circumference measurements; stump vigor (last 10 yr radial increment) and basal area increment were recorded as well as sprout height and sprout diameter 10 cm up from the base of the sprout. Because clear cutting had been practised, the residual basal area of the stands were near zero.

Linear multiple regression and polynomial regression methods as available from the University of Manitoba's Computer Statistical Package were applied to the data in order to establish the relationships between the parameters involved. The equations selected gave the highest coefficients of correlation and the lowest standard deviation of estimate.

RESULTS and DISCUSSION

The number of red maple sprouts was related to the age of the stump (Fig 1) and its diameter (see Fig 2). The equation relating number of sprouts to age is based on 46 5-yr old sprouts and is:

Eq (1) $$y = 2.414 + 0.006x^{3/2} - .0005x^2$$

where y is the natural log of the number of sprouts plus one, and x is the stump age in yrs. This equation is significant at the 1% level and has a coefficient of correlation of 0.855 and a standard deviation of the estimate of 0.229.

Equation 1 is shown in Figure 1 and indicates an age class (65-95 yrs) that produces more sprouts than younger (<65 yrs) or older stumps (>95 yr old). The increase in number of sprouts may be attributed to increasing surface area and increased resources up to 65 yrs of age with a decrease resulting from reduced stump vigor as the stumps become older. Thus, with decreasing vigor fewer sprouts were produced.

The equation relating the number of sprouts to stump diameter is based on 46 5-yr old sprouts and is expressed:

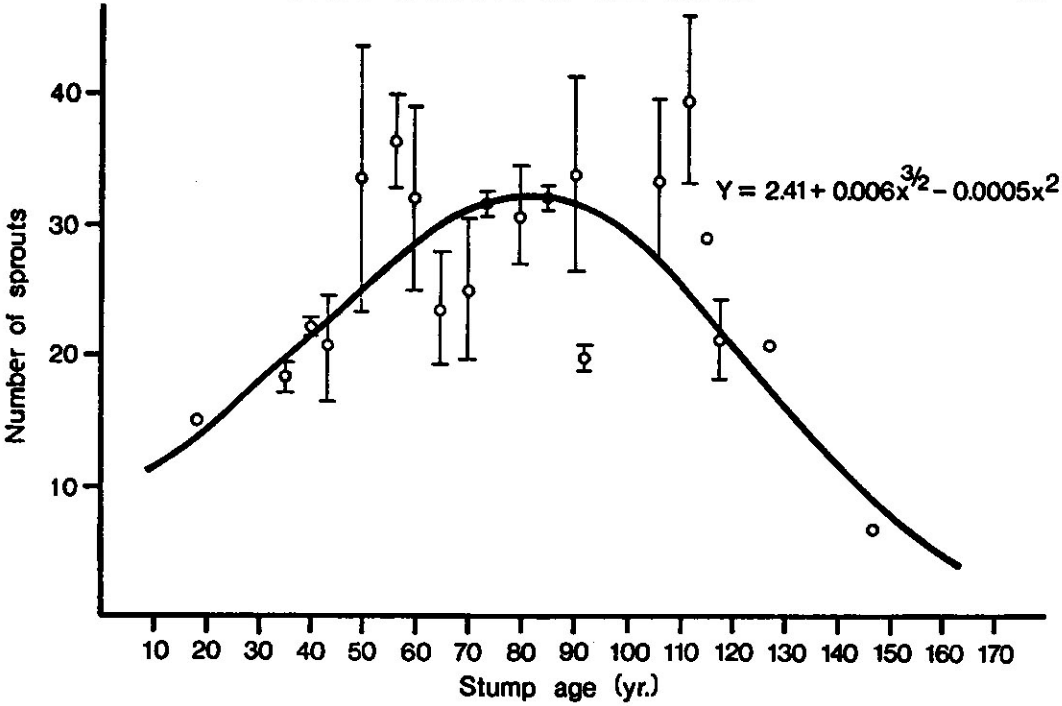

Fig 1. Relationship between number of sprouts and stump age; vertical line indicates one standard deviation and Y = log (no. of sprouts + 1).

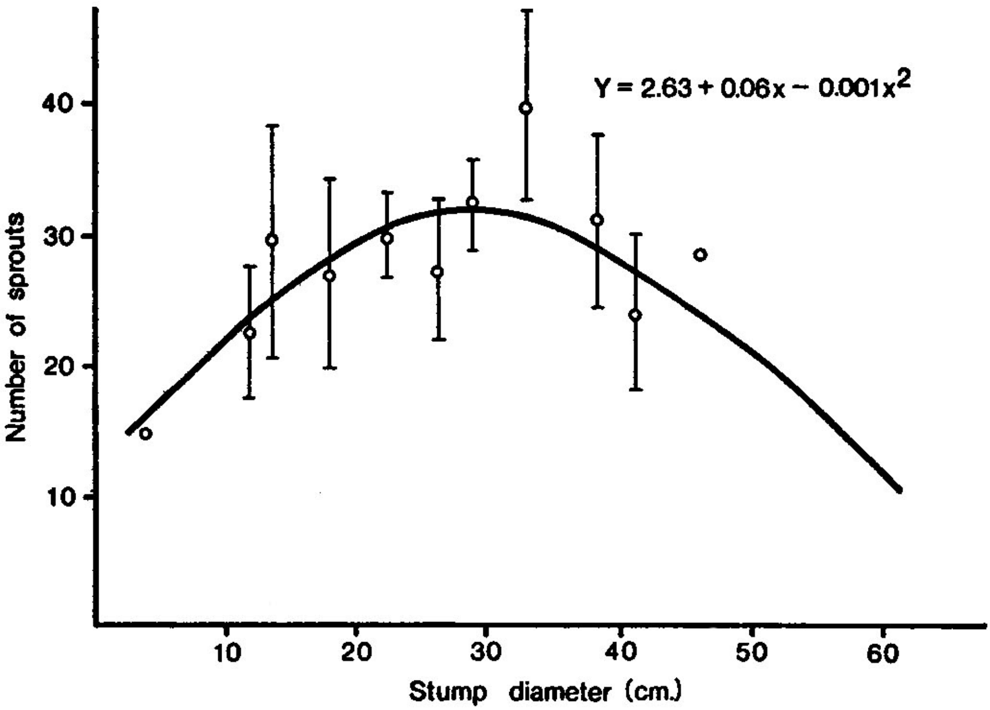

Fig 2. Relationship between number of sprouts and stump diameter for red maple; vertical line indicates one standard deviation and Y = log (no. of sprouts + 1).

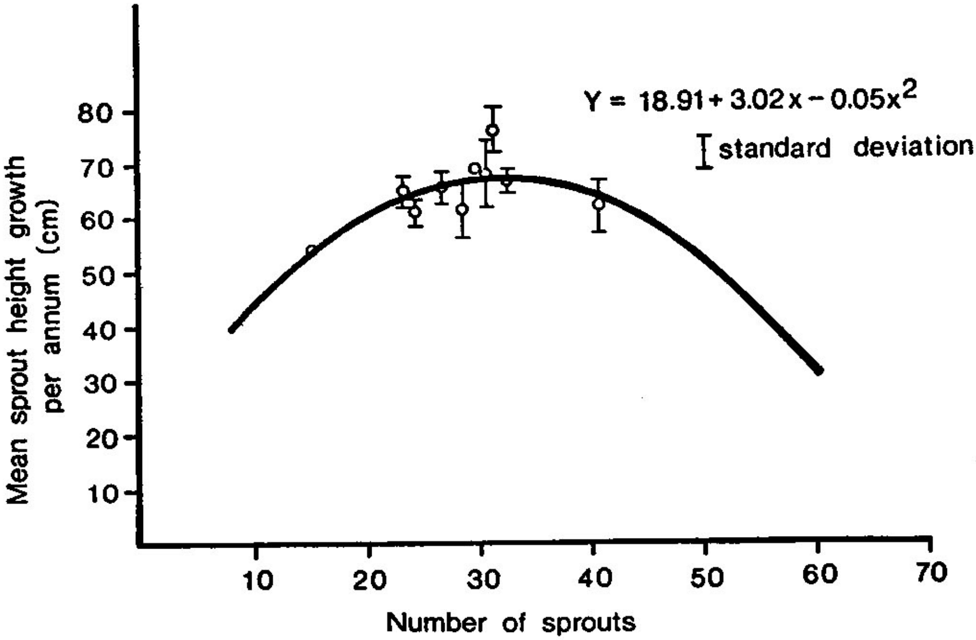

Fig 3. Relationship between sprout height elongation and sprout numbers; the points represent diameter classes at 5 cm intervals.

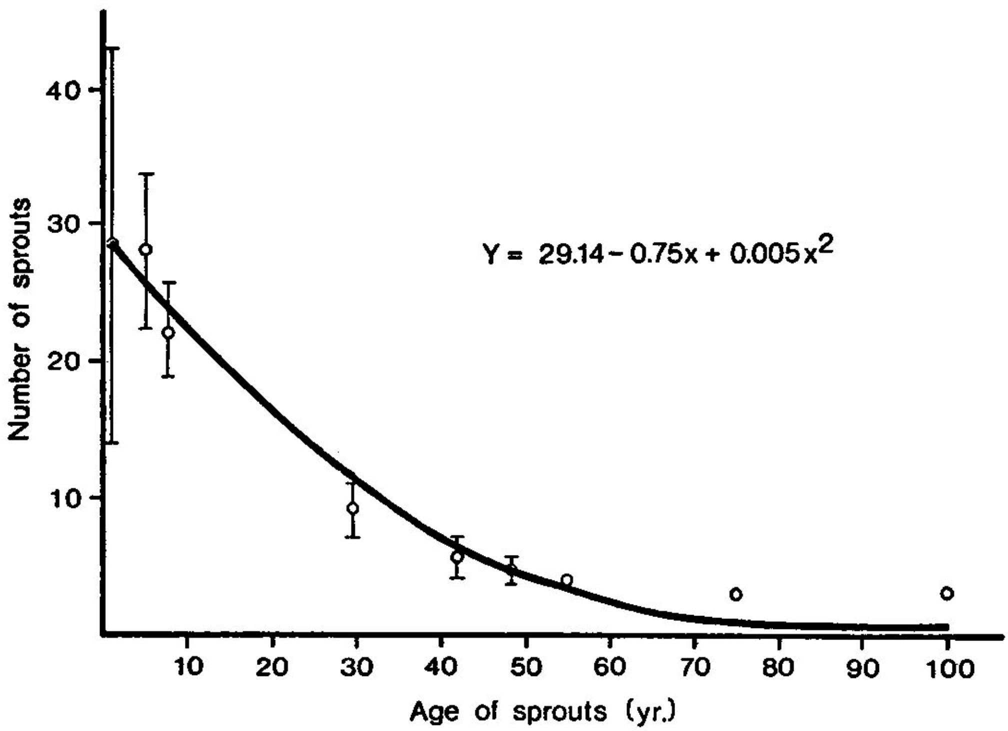

Fig 4. Self-thinning curve for red maple stump sprouts; vertical line indicates one standard deviation.

Eq (2) $y = 2.629 + 0.059x - 0.001x^2$

where y is the natural log of the number of sprouts plus 1, and x is the stump diameter in cm. This equation is significant at the 1% level, the coefficient of correlation is 0.855, and the standard deviation of the estimate is 0.142.

Equation 2 is shown in Figure 2 and demonstrates an initial increase (up to 30 cm) and subsequent decrease in sprout numbers with increasing stump diameter. The trend is consistent with, but higher than the observations of Solomon and Blum (1967) who noted that stump sprouting was most prolific in the 15 to 30 cm range.

With increasing stump diameter there is an increase in the resources available for sprout development. Because of this 'reservoir' it is probable that it encourages an increase in sprout numbers. In Figure 2 we can attribute the decline in the number of sprouts, after the diameter exceeds 30 cm, to the lower vigor of older stumps (see Fig 1) since stump diameter generally increased with age.

The relationship between sprout elongation and numbers is based on 46 5-yr old sprouts and can be written:

Eq (3) $y = 18.915 + 3.016x - 0.047x^2$

where y is sprout elongation and x is the number of sprouts. The equation is significant at the 5% level, with a coefficent of correlation of 0.81 and a standard deviation of estimate of 3.672. Some polynomial equations having a higher coefficient of correlation were rejected because, when plotted, graphs were produced that depicted relationships that were intuitively incorrect (ie, with multiple kinks or repeatedly falling below the x axis). The plotted equation (Fig 3) exhibits an interesting relationship between sprout elongation and increasing sprout numbers. The graph that might have been expected would have been one that had a "y" intercept at some value above 70 (see Fig 3) and a line that gradually decreased with increasing sprout numbers. This would have resulted from increased sprout numbers causing an increase in the degree of competition (the amount of nutrients and space/light become less). Such a relationship, however, we would expect with any stump diameter. In Figure 3 the stump diameters vary as well as stump ages and both are influencing the result. From Figure 2 it is evident that initially an increase in the number of sprouts is associated with an increase in stump diameter. Thus in Figure 3 an increase in sprout numbers, up to about 30 sprouts, is also reflecting an increase in stump diameter (which may be thought of as an increase in the resources available). Therefore, with increasing resources there is an increase in sprout elongation. Since competition is playing a part, we might say that the small elongation for the small number of sprouts results from two components: (1) competition between sprouts and (2) the small initial supply of resources. In Figure 3 initially the latter component is the more important. However, the number of sprouts decreases as age increases (corresponding to an increase in stump diameter). At the same time the component for competition between sprouts is increasing and continues to increase as more sprouts are added. In other words, as the resources available for sprout formation and growth increase and reach their maximum, the competitive interactions between sprouts become increasingly more important as the major influence on sprout elongation.

The equation relating sprout age and number of sprouts is:

Eq (4) $$y = 29.14 - 0.75x + 0.005x^2$$

where y is the number of sprouts and x is the sprout age in yrs. The equation is significant at the 1% level and has a coefficient of correlation of 0.988 and and a standard deviation of estimate of 1.997. Figure 4 shows quite distinctly the effect of competition on the number of sprouts. As sprouts become older and larger, the number of sprouts decreases.

Initially, because of the great variability within all measurements, the relationship between the parameters was unclear. In order to reduce the amount of variability, values that were being plotted on the x-axis were grouped into classes from which means and standard deviations were calculated. The mean values were then used to determine the equations which were then plotted as were the calculated mean values. With each mean value the standard deviation about that point was plotted and this should be taken into consideration when interpreting the graphs (eg, one standard deviation implies a probability of approximately 0.68 that any point in that class is to fall on the indicated margin.)

The relationships which were obtained were the only ones that could be shown significant at the 5% level (or less). Relationships which could not be established were those between numbers of sprouts or sprout height and 10 yr basal increment (in cm^2) or mean 10 yr radial increment.

CONCLUSIONS

This preliminary study indicates trends and features of sprout formation from red maple stumps. Equations 1 to 4 have potential for manipulating the regeneration of red maple. If an area is to be managed for timber production, then in order to produce suitable maple trees the large number of sprouts may have to be reduced. Equation 3 suggests that in order to maintain the maximum growth in height, elimination of all sprouts but one (to reduce competition) may not be the answer. Thus, the optimum method of maximizing sprout height would be to harvest some sprouts each year. The numbers of sprouts removed would be a function of the number present, stump diameter and age and the number of years since the stump had been cut. If harvesting is to be carried out with the intention of increasing future yields of red maple, then trees that are in the diameter class 20 to 24 cm and the age class 65 to 95 yrs would produce more fiber (as new sprouts) than other stump diameter and age classes.

If the primary management objective is concerned with providing food for deer, then the trees that should be cut would be those that did not produce fast growing sprouts since such sprouts would soon be beyond the reach of the deer. Thus, sprouting features to be maximized are (1) large numbers of sprouts with (2) smaller height increase per year.

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