THINNING EFFECTS ON BASAL AREA GROWTH OF RED MAPLE (*ACER RUBRUM* L.)

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Abstract—Red maple (*Acer rubrum* L.) is one of the most abundant and wide spread tree species in North America. Due to the characteristic poor form and wood quality of red maple, it is often categorized as a soft maple and most commonly merchandised as pulp. Because of the increasing interest and occurrence of red maple, a study analysis was conducted to test several silvicultural thinning treatments on red maple growth in even-aged stands located in Upper Michigan and northern Wisconsin by examining stand dynamics over a 14 year study period.

The effects of the silvicultural treatments of 40, 60, 80, 100, 120, and 140 ft^2 residual basal area per acre respectively, were examined. Plots were remeasured every 5 years. The increase in stand parameters such as basal area, average percent DBH (diameter at breast height), stand density and stand volume were calculated and analyzed. Diameter and volume growth of the 40 ft^2 were shown to increase the most over time.

INTRODUCTION

Red maple (*Acer rubrum* L.) is one of the most abundant and wide spread tree species in North America, with a contiguous range from Newfoundland to the southern tip of Florida, extending to southeastern Manitoba and East Texas (Burns and Honkala 1990). This species thrives on a wide range of sites and is becoming evermore present as a primary producer in forest communities (Crow 1978). Red maple follows only sugar maple (*Acer saccharum* Marsh.) in terms of growing stock volume on Michigan's timberland, with an annual net increase of over 114 million ft^3 of growing stock in Michigan alone (Leatherberry and Spencer 1996). Red maple has become an important resource on over 1 million acres in Upper Michigan and Northern Wisconsin (Erdmann and others 1981).

Red Maple is often categorized as a soft maple due to its characteristically poor form and wood quality and is most commonly merchandised as pulp for the production of high quality paper products. On good sites, red maple may grow fast with good form and quality, producing a better grade of saw logs. Good quality red maple may be substituted for hard maple in furniture production, thereby raising its value.

Stumpage prices since 1971 for red maple have increased at a higher rate than those of sugar maple (Niese and others 1995). Management efforts for this species, however, are tenuous due to the lack of growth and yield information for even-aged management (Erdmann and others 1981). The objective of this study is to analyze the effectiveness of several levels of residual basal area regimes in red maple stands located in Upper Michigan and northern Wisconsin by examining stand dynamics over a 14 year study.

METHODOLOGY

Permanent study sites were established in fully stocked, even-aged, undisturbed stands growing under uniform conditions with 75 percent or more of the overstory composition in red maple (Erdmann and others 1981). These sites were chosen in even-aged red maple stands on good, medium and poor sites in northern Wisconsin and Michigan. Two or more plots, each consisting of two 1/4 acre (1000 m^2) subplots, were established at each study site. Trees greater than 4.0 in. (10 cm) were numbered, species recorded and dbh measured in 1980. After the growing season of 1981 and before the growing season of 1982, plots at each of the study sites received one of seven thinning treatments: no thinning, or reducing basal area to 40, 60, 80, 100, 120, and 140 ft^2/ac.

Plots were thinned from below to the desired basal area to create a stand of uniformly spaced, defect free, dominant and codominant red maple trees. Smaller suppressed and intermediate red maple trees were removed. Pole size species other than red maple trees were removed to increase the stocking of red maple. Stocking levels were then checked and corrections were made where possible.

Remeasurements of the study sites were conducted in 1985, 1990, and 1996. Observations due to ingrowth, defined as trees reaching 4.0 inches dbh after establishment, were added and remeasured during subsequent measurement periods. To create a post thinning profile of the sites, the 1980 data set was used excluding any ingrowth trees and those recorded as cut in the 1985 measurement data.

Basal area calculations were made using the dbh measurements for each tree and these calculations were summarized by species for each plot. Total stem outside

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bark volume calculations for red maple trees were made using the equation of Crow and Erdman 1984. All calculations were then averaged for plots contained in each basal area category.

RESULTS AND DISCUSSION

A total of 53 sites were selected and 226 plots established. Each treatment contained from 6 to 66 plots (table 1). Initial basal area measurements varied from 65.4 ft^2/ac to 238.1 ft^2/ac over all the plots with an average of 136.8 ft^2/ac. In 1982, basal area values decreased due to the application of the thinning treatments. Using a F-test of the general linear hypothesis, thinnings were determined to have an affect on the basal area of the stands ($p < 0.05$) over all the subsequent measurement dates. By 1996, basal area measurements for sites thinned to 40 ft^2/ac and the control sites were the only treatments to surpass their initial (1980) basal area measurements. All other sites increased for each of the remeasurements (fig. 1). A Student-Newman-Kuels (SNK) test of the means (Montgomery 1984) indicated that, for each of the measurement cycles, thinning operations produced different basal area values from the control and each other ($p > 0.05$), except for the 140 ft^2/ac thinning treatment which did not differ from the control ($p > 0.05$). The ordering of the means remains constant for all the measurement cycles until 1996, with basal area values being statistically different ($p > 0.05$) and ordered by thinning intensity. There was an interaction between thinning treatments and time, confirming that the treatments resulted in different basal area growth rates over time. Following the 1996 measurement, plots thinned to 40 ft^2/ac had basal area values larger than those thinned to 60 ft^2/ac ($p > 0.05$).

The average percent dbh growth for each stand following treatment over the study period was computed. These values illustrate the response of dbh of each of the treatments (fig. 2). Plots where basal area was reduced to 40 ft^2/ac and 60 ft^2/ac showed the greatest increases in percent dbh growth. All other treatments exhibited an increase in average percent dbh growth ($p > 0.05$) for each of the measurement cycles. One exception occurred in 1996, when areas thinned to 140 ft^2/ac declined slightly from the 1990 average diameter.

While percent diameter growth increased through time for each of the study sites, trees per acre (TPA), in most cases, did not increase ($p > 0.05$) after the thinning applications were applied in 1982 (Figure 3). Where basal area was reduced to 40 ft^2/ac, the number of trees increased over the subsequent measurement cycles. Plots incurring the intermediate thinning applications, 60 ft^2/ac, 80 ft^2/ac and 100 ft^2/ac, exhibited slight increases in trees per acre in the years following thinning. When light thinnings (120 ft^2/ac and 140 ft^2/ac) were applied, trees per acre decreased slightly by the last measurement year, as was the case for the unthinned (control) plots.

Figures 2 and 3 indicate that thinnings applied to red maple stands increase diameter growth for individual trees. With steady or decreasing trees per acre, the increase in basal area growth is distributed among the individual residual trees. This indicates thinning from below operations in red maple stands increased larger stem size, sawtimber yield. Heavier thinnings (residual ≤ 100 ft^2/ac) result in ingrowth, recruitment of smaller stems into the merchantable size classes over time. The effects of the thinning treatments on volume were investigated (fig. 4). These results when compared with the thinning effects on basal area prove to be very similar. Statistical evaluation of thinning effects on volume production also proved to be analogous to the basal area results.

Table 1—Number of study plots and initial conditions by treatment

Treatment	No. of observations	Initial basal area values: Mean	Minimum	Maximum
		Ft²/ac		
Control	22	141.6	111.3	193.2
40 ft^2/ac	6	93.5	72.5	102.4
60 ft^2/ac	42	119.2	65.4	146.2
80 ft^2/ac	66	136.3	87.7	238.1
100 ft^2/ac	56	144.3	105.8	192.6
120 ft^2/ac	28	149.2	117.4	195.6
140 ft^2/ac	6	163.6	130.0	194.4
Total	226	136.8	65.4	238.1

CONCLUSIONS

Rates of increase in basal area growth are greatest in the most heavily thinned stands. These stands also exhibited the highest gain in trees per acre. Actual growth per tree is minimal in stands with intermediate levels of thinning. All treatments except the 40 ft^2/ac treatment, reduced trees per acre to between 215 and 255 individuals. These stocking densities remained constant with little or no ingrowth for the remainder of the study. Target basal area values for these treatments were from 60 ft^2/ac to 140 ft^2/ac. This implies largest trees occur where BA's are the highest. This is a result of the reduction of stand density from below to attain target basal area.

At last measurement, 14 years after treatment, the basal area growth rates were starting to decrease in treatments with higher target basal areas. Sites reduced to 140 ft^2/ac and 100 ft^2/ac increased very little in basal area from 1990 to 1996. The stands where smaller stand densities of 40 ft^2/ac, 60 ft^2/ac and 80 ft^2/ac were retained, basal area is still increasing at a steady and similar rate over time.

Reducing basal area proves to be effective in increasing the growth rates of red maple, however caution should be taken not to open the site too much. Thinning to 40 ft^2/ac produced improved growth rates, but also dramatically increased trees per acre due to regeneration and

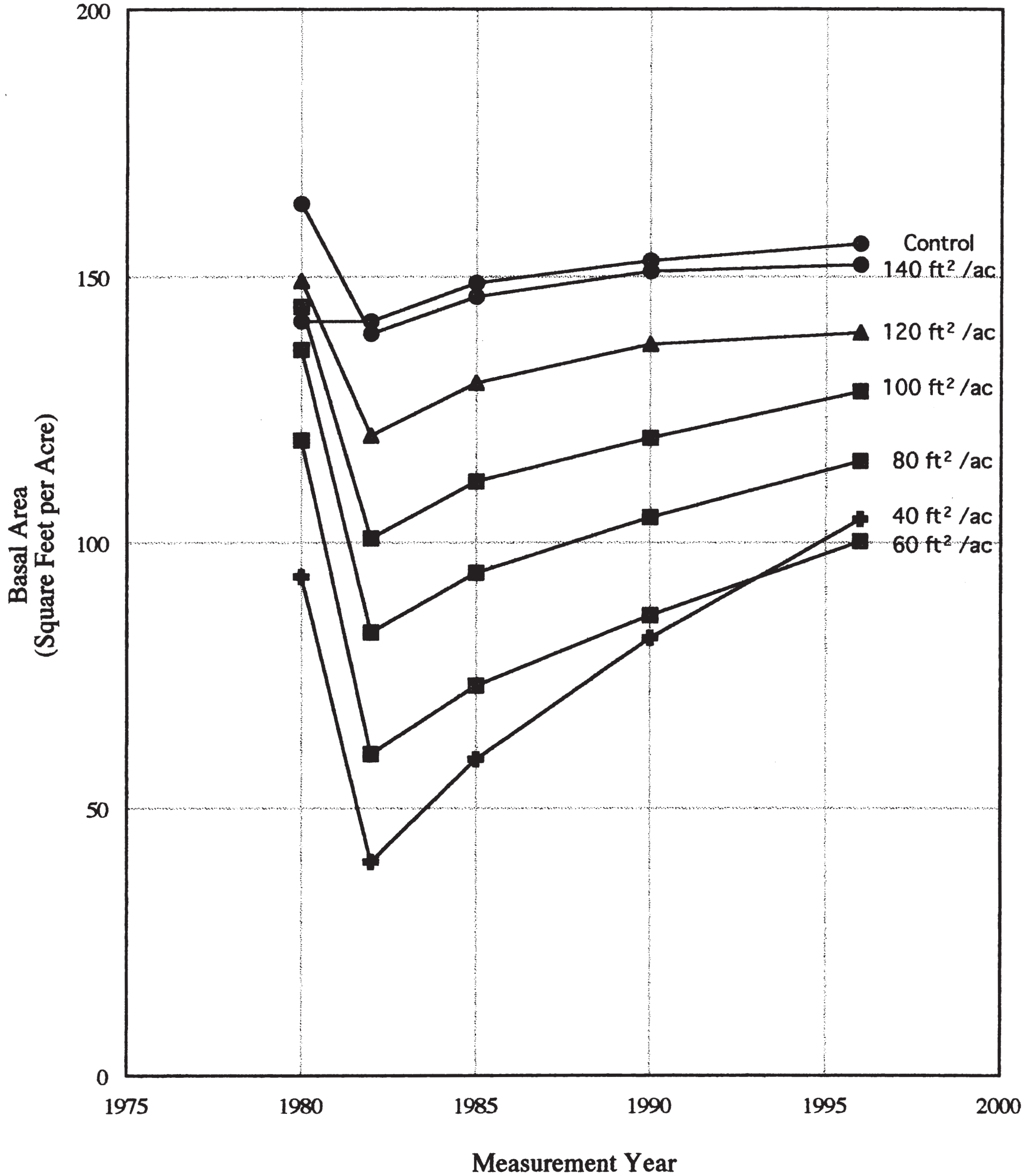

Figure 1—Average basal area (ft^2/ac) given for each thinning treatment and measurement date.

recruitment. Better growth per tree may be attained by reducing trees per acre to between 215 and 235, while keeping basal area between 60 ft^2/ac and 80 ft^2/ac.

These results expand and substantiate the work of Trimble (1974) in which he concluded red maple diameter growth increased after thinning. Consistent with these results, similar work by Voorhis (1990) with yellow poplar (*Liriodendron tulipifera* L.) and paper birch (*Betula papyrifera* Marsh.) showed significant increases in diameter growth after light and heavy thinnings. However, when Voorhis (1990) investigated sugar maple in this same study, diameter growth responses did not increase.

Lamson (1988) investigated cleaning (eliminating trees of similar age but less desirable species or form than that of the target trees) in 7- and 12-year-old stands of basswood (*Tilia americana* L.), red maple, black cherry (*Prunus serotina* Ehrh.) and northern red oak (*Quercus rubra* L.). His research indicated diameter growth increased most

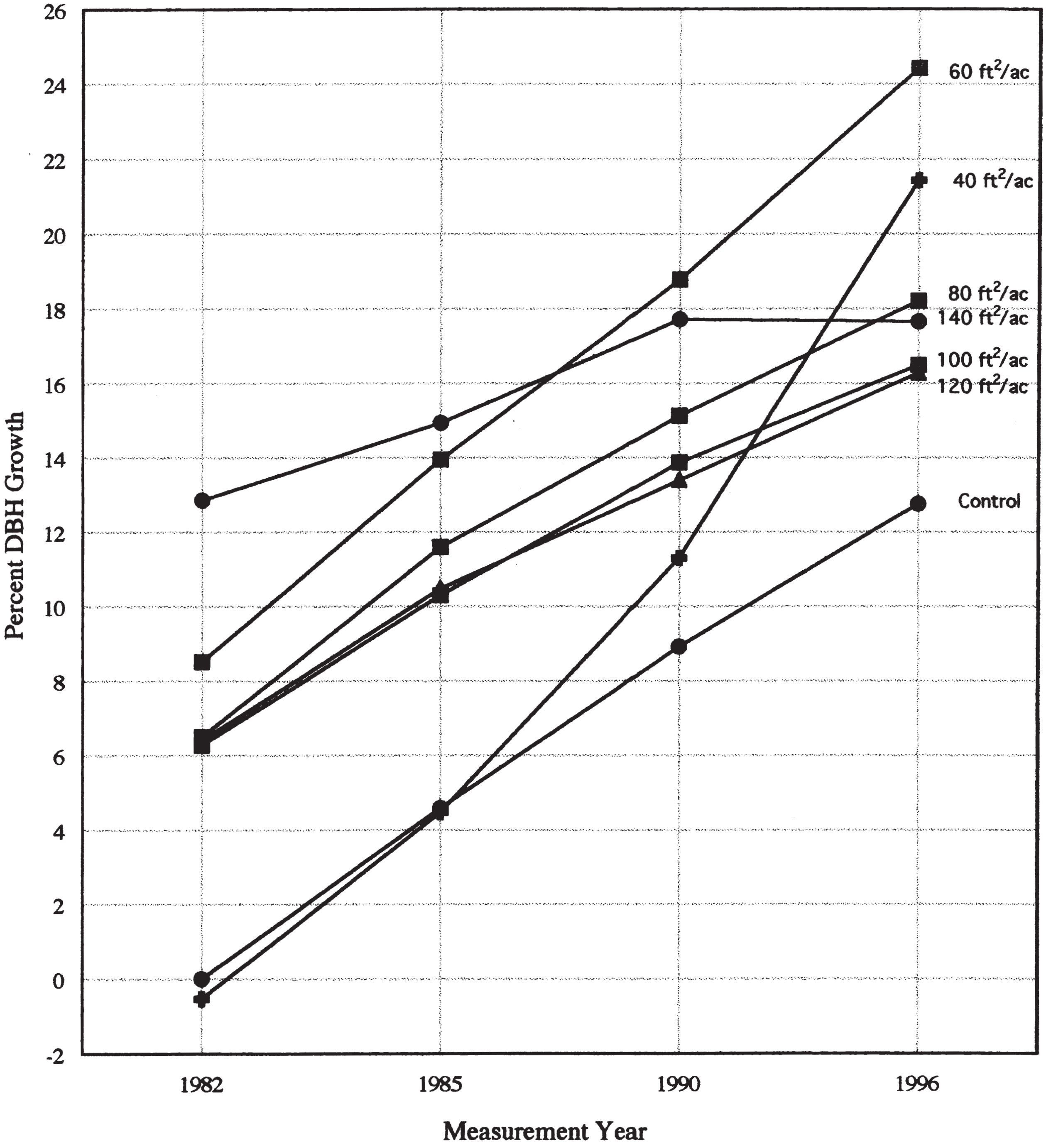

Figure 2—Percent growth of each thinning treatment and measurement cycle.

during the first 5 years after treatment. In this study, this period of increased growth has been extended.

Further research is needed to determine which time is best for these thinnings to occur. The duration of these effects and their influence on the pruning habits, growth patterns and height development of individual trees also needs to be investigated. Finally, research to on the interactions of red maple with the northern hardwood forest species and how relative stand densities influence the volume increment of merchantable wood is another area worthy of research (Nowak 1996).

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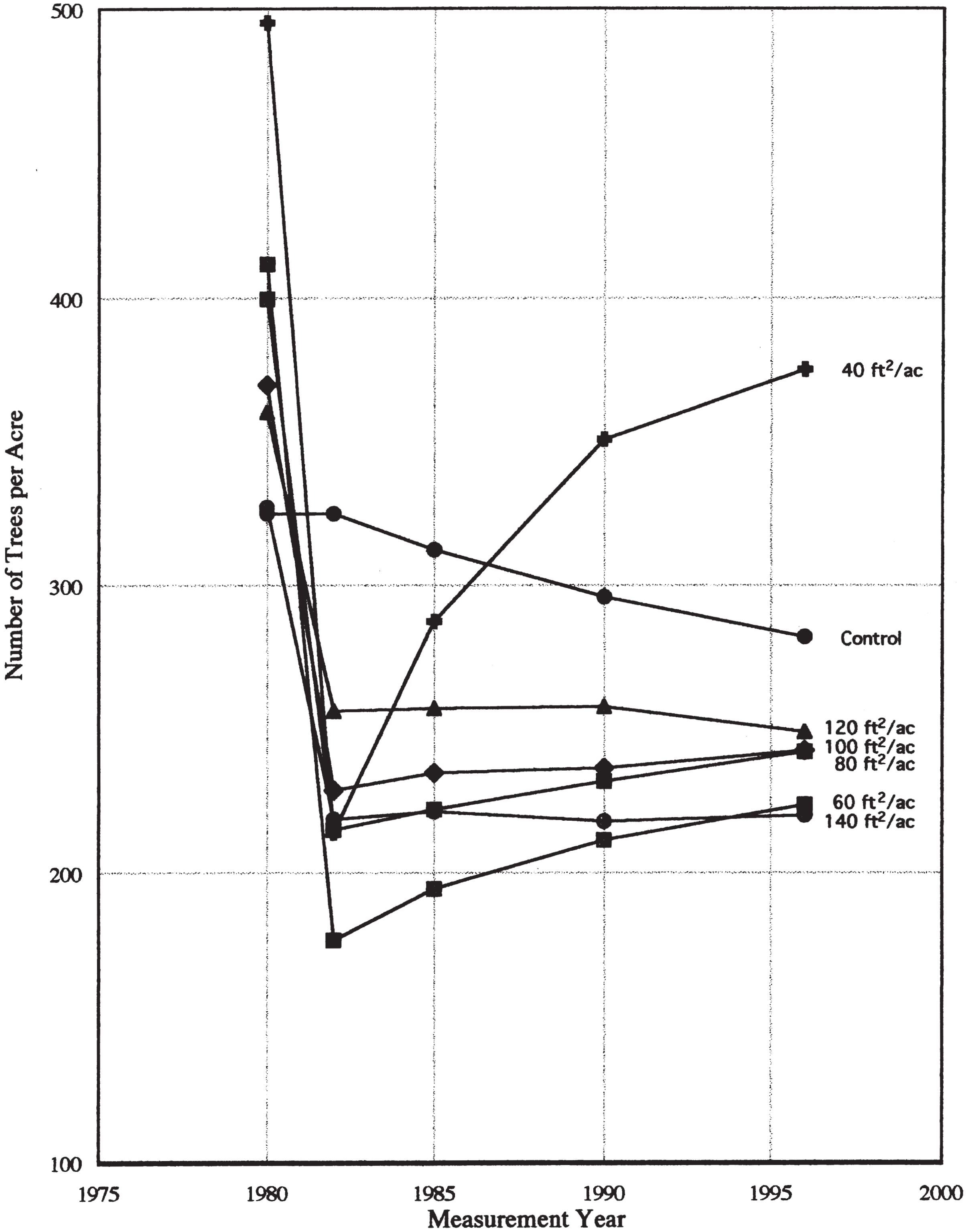

Figure 3—Trees per acre (TPA) of each thinning treatment and measurement cycle.

REFERENCES

Burns, R.M.; Honkala, B.H. 1990. Silvics of North America. Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture, Forest Service. 871 p. Vol. 2.

Crow, T.R. 1978. Biomass and production in three contiguous forests in northern Wisconsin. Ecological Society of America. 59(2): 265-273.

Erdmann, G.; Crow, T.; Rauscher, H.R. 1981. Managed even-aged red maple growth and yield study. In: Study proposal from North Central Forest Experiment Station FS-NC-1102-NH-80-02.

Lamson, N.I. 1988. Precommercial thinning and pruning of Appalachian stump sprouts - 10-year results. Southern Journal of Applied Forestry. 12: 23-27.

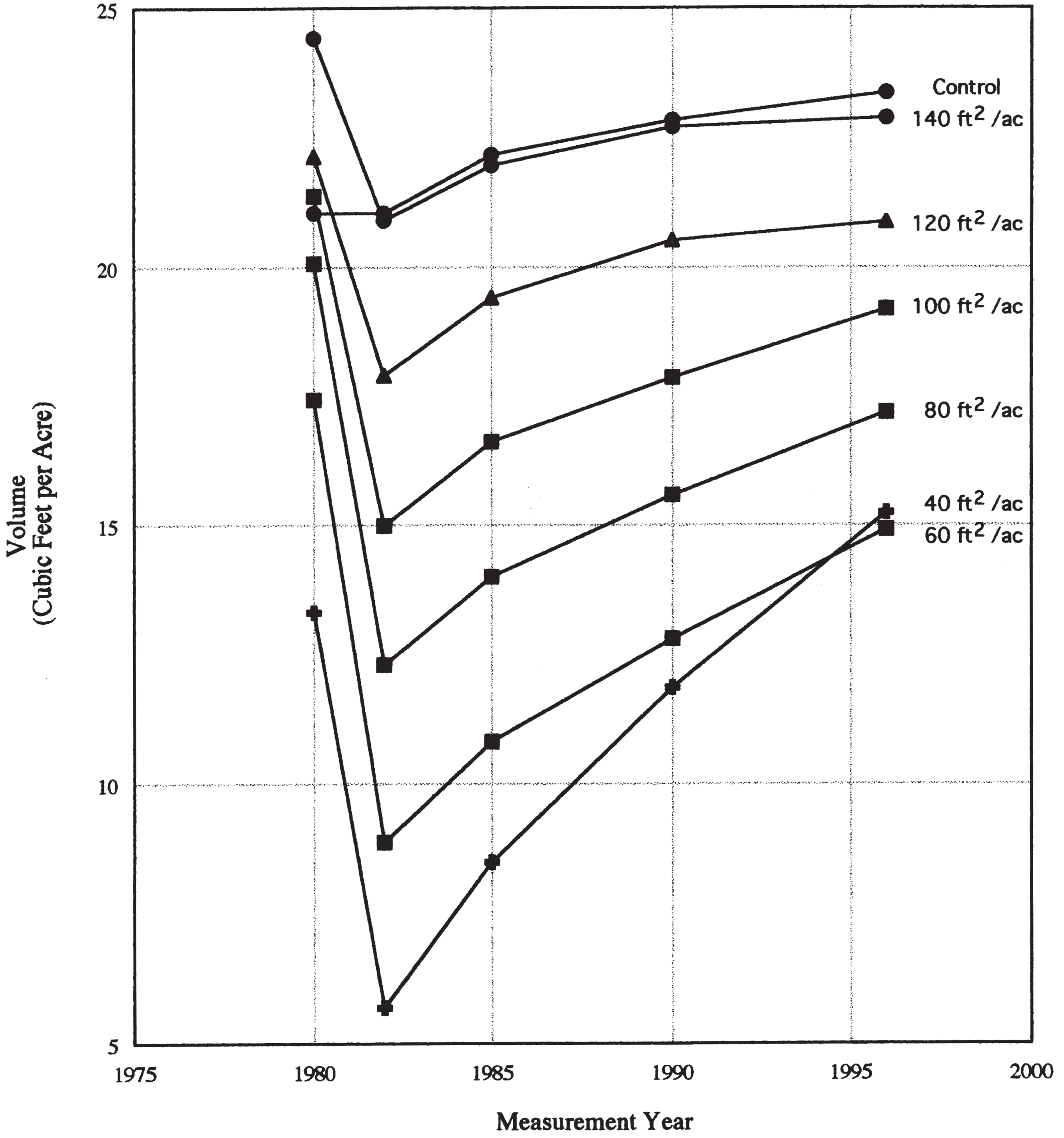

Figure 4—Volume per hectare (ft^2) for each thinning treatment and measurement cycle.

Leatherberry, E.C.; Spence, J.S., Jr. 1996. Michigan forest statistics, 1993. Res. Bull. NC-170. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station.

Montgomery, D.C. 1984. Design and analysis of experiments. New York: John Wiley. 504 p.

Neise, J.M.; Strong, T.F.; Erdmann, G.G. 1995. Forty years of alternative management practices in second-growth, pole-size northern hardwoods. II. Economic evaluation. Canadian Journal of Forest Research. 25: 1180-1188.

Nowak, C.A. 1996. Wood volume increment in thinned 50- to 55-year-old, mixed species Allegheny hardwoods. Canadian Journal of Forest Research. 26: 819-835.

Trimble, G.R. 1974. Response to crop tree release by 7-year-old stems of red maple stump sprouts and northern red oak advance reproduction. Res. Pap. NE-303. U.S. Department of Agriculture, Forest Service.

Voorhis, N.G. 1990. Precommercial crop-tree thinning in a mixed northern hardwood stand. Res. Pap. NE-640. U.S. Department of Agriculture, Forest Service.