TREE GROWTH RESPONSE TO LINE CLEARANCE PRUNING

by John W. Goodfellow, Bing Blumreich[1] and Greg Nowacki[1]

Abstract. The branch and sprout growth response of six species of street trees (Norway maple, box elder, silver maple, sugar maple, Siberian elm and green ash) following electric line clearance pruning was studied in Green Bay, WI. Differences in tree regrowth were observed after three and four growing seasons between species, pruning methods, and crown positions at which the pruning had occurred. Top pruning regrowth rates generally exceeded side regrowth rates. Regrowth associated with roundover pruning was observed to exceed that of natural (lateral/drop crotch) pruned trees, with more variability in regrowth rates associated with trees having been roundover pruned.

Résumé. La croissance des branches et des rameaux de six espèces d'arbres de rues (érable de Norvège, érable à giguère, érable argenté, érable à sucre, orme de Sibérie, frêne rouge) suite au dégagement des réseaux d'électricité fut étudiée à Green Bay, Wisconsin. Les différences de croissance des pousses après trois et quatre saisons de croissance, selon les espèces, les méthodes d'élagage et la localisation des travaux dans la cime, furent observés. Les taux de croissance des repousses suite à un écimage excédaient ceux obtenus suite à un élagage latéral. Les repousses associées à un élagage en boule excédaient celles obtenues suite à un élagage naturel (près du collet de la branche), avec plus de variabilité dans les taux de croissance chez les arbres élagués en boule.

The utility industry's goal of providing customers with reliable electric service establishes the need for management of right-of-way vegetation. Line clearance tree trimming represents a major maintenance expense to most utility companies, exceeding 800 million dollars annually to the utility industry nation-wide. Wisconsin Public Service Corporation (WPS) will spend approximately three and a half million dollars in 1987 in an effort to reduce the frequency and cost of tree related service interruptions to more than 300,000 electric customers. Service to these customers is supported by an electric distribution system of nearly 17,000 miles, spread throughout a 10,000 square mile service territory.

While annual line clearance pruning represents a considerable annual expense little research has been conducted and published regarding tree regrowth rates following pruning. This study was undertaken in an attempt to better understand tree response to pruning with an ultimate goal of reducing tree-caused interruptions and reducing maintenance costs.

The primary objective of the study was to gather information on the maximum rate of tree regrowth following line clearance pruning. Sampling was conducted during the summers of 1985 and 1986 in Green Bay, Wisconsin. Study trees typically had been last pruned between 1981 and 1983 by a contract line clearance crew assigned to routine maintenance work, and were typically street and yard trees located in urban and suburban residential neighborhoods.

The study was designed to identify the maximum rate of branch and sprout elongation following line clearance pruning. The maximum rate of branch and sprout growth was selected as the most operationally significant feature of tree response to line clearance pruning since it would be these stems that would likely contact electric conductors first. Branches exhibiting the most rapid growth rate following pruning are the major limiting factor in pruning cycle lengths. As such, the average observed rate of maximum regrowth is the best indicator of an appropriate pruning cycle period for pre-established, tree-conductor clearance standards, or the amount of clearance necessary to maintain a given pruning cycle.

Methods

Study sites were selected based on predetermined line clearance maintenance schedules rather than by use of a random selection technique. Sampling occurred during the course of routine line clearance pruning. Once selected, species and geographic location were recorded for each tree. Crown position of pruning activity was determined through direct observation of the

1. Forestry Interns, College of Natural Resources, University of Wisconsin, Stevens Point

line clearance crew. Each study tree was categorized as having been top pruned or side pruned based on this observation.

Prior to making any measurements of regrowth it was necessary to determine how old the previous pruning wound was. This was accomplished by severing the branch immediately below the old pruning wound and checking for compartmentalization of discolored or decayed branch tissue associated with the pruning wound. The age of the wound, as described as the number of growing seasons since last pruning, was determined by counting annual growth rings external to the zone of compartmentalization. Where compartmentalization was not readily observable, the age of the previous wound was established through an assessment of callus development.

Once pruning wound age had been established the type of pruning which had been previously employed was determined. Previous pruning method was determined by observing where the cut had been made relative to a lateral branch. Natural (lateral/drop crotch) pruning was characterized by cutting main stems back to a lateral at least one-third the diameter of the portion being removed, or by properly placed cuts of laterals back to a main stem position adjacent to the branch bark collar. Roundover pruning was characterized by indiscriminately placed pruning cuts, which typically resulted in a branch being stubbed off. In addition to natural and roundover regrowth an additional category was added in 1986. This category, called "natural sprout growth" included epicormic sprouts originating from adventitious buds on branches and tree boles as a result of excessive crown reduction. Water sprouts associated with natural pruning techniques employed on sucker-prone species (e.g. box elder) were also included in this group. The study was further modified in 1986 to include determination of the diameter of the branch and any lateral present at the time of last pruning, and the present branch and sprout diameter. Roundover pruning was often observed to have been accomplished by repeated cutting back to a previous wound, making diameter measurements difficult.

Measurements of maximum regrowth rates were taken directly from branches excised by trimming crews working on regularly scheduled line clearance operations. These branches were of obvious operational concern, and typically were those closest to the conductors. Only branches with evidence of previous pruning wounds were included in the study. Branches exhibiting obvious symptoms of pathological problems or damage from contact with energized electric conductors were excluded from further study.

Once a sample had been described in terms of the previously defined parameters, maximum sprout/branch elongation measurements were taken. Measurements of maximum annual stem elongation were made by identifying annual bud scars and recording the distances between each corresponding years' scars. Annual bud scars on regrowth tissue were readily observable. Measurements of stem elongation within the growing season in which the sampling was being conducted were not included until a well developed terminal bud was easily observable and stem elongation had ceased. There was no limit to the number of observations made from any single tree, however, only the longest leader or sprout above the previous wound was included in the sample.

Results and Discussion

Once field investigations were completed an analysis of data was conducted. Among the parameters investigated were mean annual and mean total stem elongation by pruning method and crown position. The median, maximum, minimum, standard deviation and standard error of the mean were also computed for each category of regrowth. In addition, linear regression analysis techniques were employed in an investigation of possible relationships between regrowth rate and the ratio of diameter of cut to diameter of the lateral branch.

The study was initially intended to include investigation of many of the tree species commonly encountered by line clearance tree crews in the area. The scope of the study was subsequently revised to concentrate efforts on six of the most common species. The six species included Norway maple *(Acer platanoides)*, sugar maple *(Acer saccharum)*, box elder *(Acer negundo)*, silver

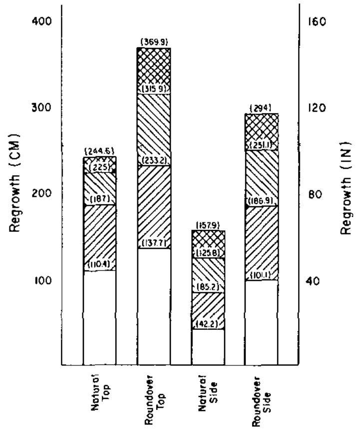

Figure 1a. Cumulative average maximum regrowth of box elder (*Acer negundo*)

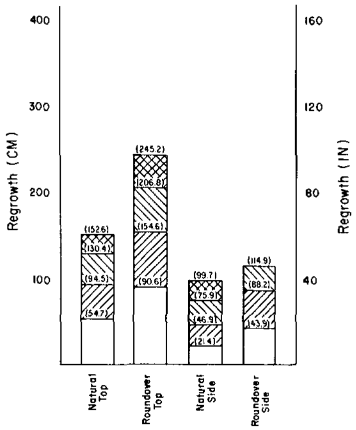

Figure 1b. Cumulative average maximum regrowth of Norway maple (*Acer platanoides*)

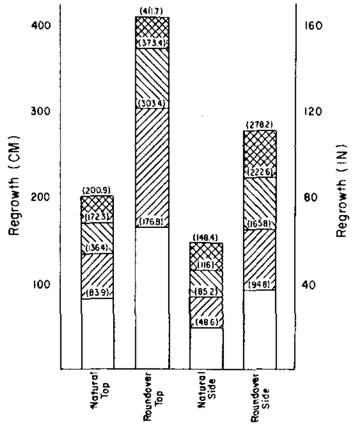

Figure 1c. Cumulative average maximum regrowth of Silver Maple (*Acer saccharinum*)

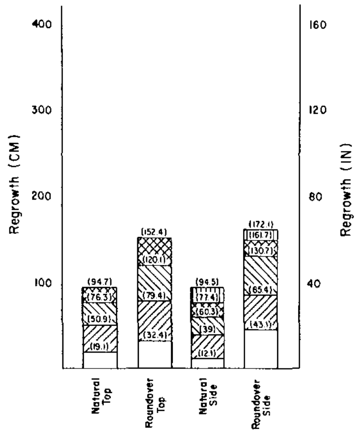

Figure 1d. Cumulative average maximum regrowth of sugar maple (*Acer saccharum*)

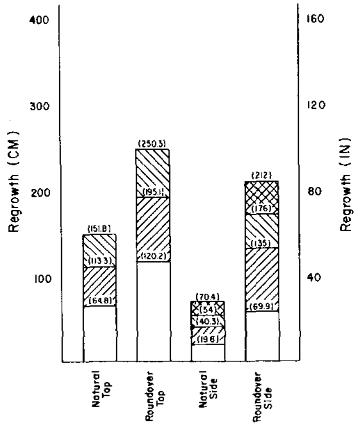

Figure 1e. Cumulative average maximum regrowth of green ash (*Fraxinus pennsylvanica*)

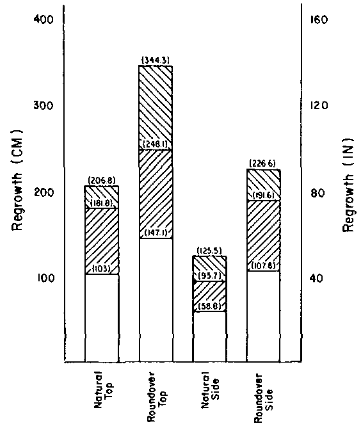

Figure 1f. Cumulative average maximum regrowth of Siberian elm (*Ulmus pumila*)

Cut Method and Position

Legend: Year 1, Year 2, Year 3, Year 4

maple *(Acer saccharinum)*, green ash *(Fraxinus pennsylvanica)* and Siberian elm *(Ulmus pumila)*. Some expected trends between these six species were confirmed. Siberian elm, silver maple and box elder consistently outgrew the others regardless of pruning method and crown position. Average maximum rates of stem elongation in sugar maple were lowest after two growing seasons.

Trends in tree response to line clearance pruning by species were identified. A summary of results is presented in Figure 1. Top roundover pruning consistently produced the greatest average maximum regrowth in all species except sugar maple, where side roundovers outgrew top roundovers by a narrow margin. Without exception natural side-trimmed trees exhibited less regrowth than did roundover side trims.

Natural-pruned trees as grouped by species demonstrated less regrowth than did trees pruned by the roundover technique. The study supports the premise that natural pruning is an effective technique for use where sprout regrowth is a concern. In addition to exhibiting greater stem elongation than natural-pruned trees, the roundover technique resulted in far greater variability in regrowth response. It should be noted however, that natural-pruned regrowth rates were also identified as quite variable as well.

A model of tree response to pruning over time can be developed from data derived from this study. The growth response of silver maple over time is presented in graphic format in Figure 2. Among the findings is that the regrowth response is greatly exaggerated in the growing season following pruning. The rate of seasonal stem elongation decreases with each increasing season post pruning, attaining normal stem elongation rates at some future point. A lack of data on "normal" stem elongation rates precludes identification of the period over which pruning stimulates exaggerated regrowth. It can be said that normal stem elongation does not resume until at least four growing seasons after pruning. Based on these findings, it is clear that much of the tree-conductor clearance achieved through pruning is lost over a relatively short period of time early in the pruning cycle. This fact must be considered in evaluating the use of tree growth regulators. A delay in control of stem elongation for one growing season is commonly observed with the materials presently being evaluated and used. The maximum annual rate of regrowth will have already occurred in this case. Another implication of the diminishing rate of tree growth response over time is that the clearance necessary to extend a pruning cycle an additional year is less than one might initially suspect. As the rate of stem elongation approaches a background level, a corresponding reduction in the amount of tree-conductor clearance necessary to maintain reliable operating conditions throughout each year is appropriate.

While the results identify some strong trends, they are of limited statistical strength, largely due to variability in the data and limited sample size. The results do identify actual maximum regrowth rates commonly expected for the six species studied. The authors believe that the identified rates of regrowth are of operational significance and can serve as a basis for establishing

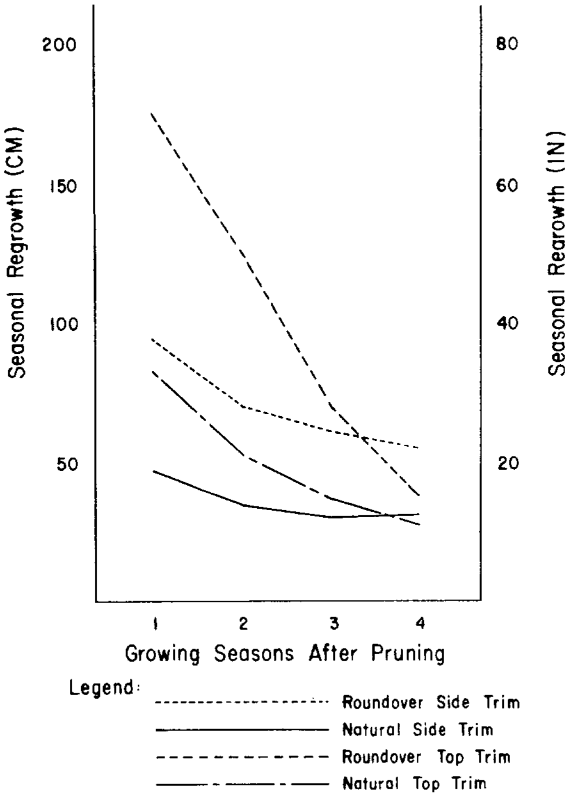

Figure 2. Growth response over time of silver maple *(Acer saccharinum)*

clearance requirements and appropriate trim cycle periods.

Variability in regrowth rates within a species and trim type is likely attributable to a number of factors. The age and overall vigor of study trees was undoubtedly quite variable. No attempt was made to select study trees based on relative vigor. As previously noted, tree diameter measurements were included in 1986 field investigations. Subsequent statistical analysis yielded no correlation between tree diameter and average maximum regrowth rates.

Site specific factors having direct influence on stem elongation were not recorded. Edaphic factors are often thought to limit tree growth in urban areas. The effects of weather within any given growing season was not considered in this study.

A further limitation of these findings is that no attempt was made at documenting the number of actively growing terminal buds (branches or sprouts) present above the pruning wound. Unusually short regrowth measurements were often associated with comments such as "very bushy" or "one of several sprouts" on the field data form.

Variability in regrowth rates within a species may also be due to differences in the intensity of the pruning each tree received. The percent reduction in live crown is likely to have an effect on both stem elongation and numbers of sprouts. The pruning type category "natural sprout" was added to the study in 1986 in an attempt to better understand this relationship. No conclusive results can be reported. It appears that natural pruning can control sprout growth to some level of crown reduction, above which adventitious buds break dormancy and stem elongation is accelerated. This trend was also observed within specific regions of the pruned tree's crown. While not specifically documented, it appeared that natural pruning was less successful in controlling regrowth in lower crown positions where side trimming left a "shelf" or "mantel" of crown beneath conductors. These areas tended to exhibit "natural sprout" growth rates similar to that of natural top sprouts.

Conclusion

Both pruning method and the position of pruning within a tree influence subsequent tree response described in terms of stem elongation. This study reaffirms the belief that natural pruning techniques are more appropriate than are roundover pruning practices for utility line clearance work. Natural line clearance pruning resulted in slower, less variable regrowth rates than did roundover pruning. These findings also support the position that replacement of species such as box elder and Siberian elm in favor of smaller scale street trees is a desirable management technique particularly when trees require top pruning rather than side pruning.

Wisconsin Public Service Corp
P O Box 19001
Green Bay, WI 54307-9001