close to a property owner's sewer line. Ultimately, all this won't help at all when you are confronting an irate property owner with a backed-up sewer.

Of all the cases I have reported to you today and the many more I read, the common factor is lack of adequate inspection by professional people and the supplementing of maintenance programs to prevent accidents from happening. This is, as I see it, the primary function of any shade tree commission or one that can be accomplished with the services of a consultant.

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AN ECONOMIC EVALUATION OF THE PRUNING CYCLE

by Robert W. Miller and William A. Sylvester

City foresters and arborists have been pruning shade trees as long as they have been planting them. The reasons to prune are many, ranging from public safety factors to aesthetic considerations. The need to prune is well established, but the frequency of pruning is not.

Frequency depends on factors such as species, growth rate, tree age, and location. However, the city forester usually does not have the luxury of choosing the proper time to prune a given tree, but rather will depend on an arbitrary pruning cycle determined by budgetary constraints. Discussion with city foresters in the Lake States reveals that many feel an optimum pruning cycle exists; the most favored period being 5 years. Most researchers and managers recommend "frequent" pruning, but they do not define frequent in precise terms. Fenner (2) reported the use of a four year cycle in Lansing, Michigan, while Chapman (1) suggests two to three prunings the first four years followed by infrequent pruning to remove deadwood.

Additional interest in the pruning cycle has resulted during the development of two computer programs by the authors. The first program UW/SP URBAN FOREST (4) was developed as a computer inventory system based on tree value. This program is essentially a data reduction system, providing summary tables and a listing of individual trees by location. The program uses the International Society of Arboriculture tree valuation system (3) to compute the value of city owned trees. The second program UW/SP URBAN FOREST MANAGEMENT is a management simulation model based on the inventory program. This program simulates the growth of an urban forest over time, allowing the user to make management decisions such as planting schedules and pruning cycles, and randomly remove trees based on historic mortality. UW/SP URBAN FOREST MANAGEMENT also calcuates management costs and compares them to the value of the urban forest.

A key problem in development of the management model was determining the long range impact of the pruning cycle on tree value. While it is recognized that a judicious pruning schedule will produce a higher value shade tree by raising its condition class, there has been no attempt to quantitatively determine the effect of pruning.

The objectives of this study are to determine the effect of pruning cycle on the condition class of street trees, and to determine an optimum pruning cycle for a case study.

Relationship Between Pruning and Condition Class

The UW/SP URBAN FOREST inventory program is currently being used by eight communities. Since the inventory program records condition class of street trees for use in computing tree value, this information was available for use in the analysis of the pruning cycle.

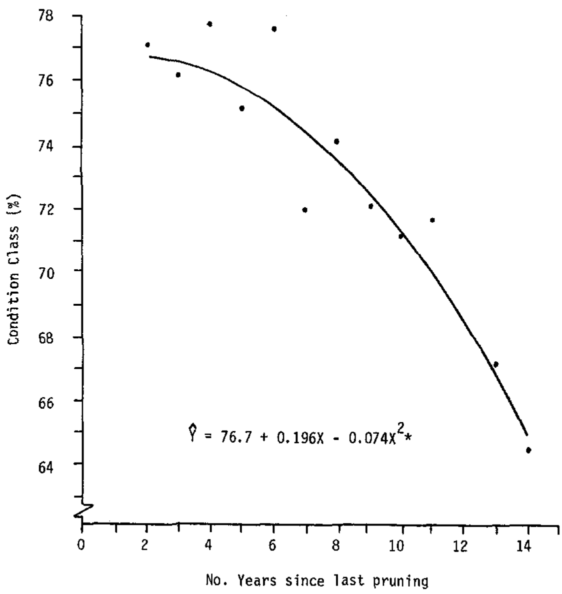
Milwaukee, Wisconsin[1] was selected for the study because of the large population of shade trees and the availability of accurate pruning records. The Milwaukee Forestry Bureau subdivides the city into work units of 160 acres, with pruning and other management activities scheduled by work unit. The inventory system is designed to adapt to work unit subdivisions with output summarized by work unit and by city totals. Each work unit has the average condition class of the trees summarized. Data for Milwaukee are presented in Table 1.

The number of years since the units were last pruned and average condition class of the units are plotted in Fig. 1. The condition class of units pruned in 1978 (year 1) did not appear to be drawn from the same population as the condition class of the remaining units. Discussion with members of the inventory crew and officials from the city of Milwaukee Forestry Bureau revealed that units pruned in 1978 contained small trees that were in need of extensive corrective pruning. Removal of structurally unsound branches from these trees produced temporarily misshapen crowns, large pruning wounds, and a lower average condition class for trees pruned that year. Based on this information it was decided not to include 1978 data in further analyses.

Table 1. Date of last pruning by work unit with average tree condition class.

Year	*No. work units**	*No. trees*	*Average condition class*
1978	10	4962	72.5
1977	11	5371	77.0
1976	13	4932	76.0
1975	3	2336	77.6
1974	8	3605	75.1
1973	8	6395	77.5
1972	8	3993	71.8
1971	11	5406	74.0
1970	5	1998	72.0
1969	4	1333	71.0
1968	6	3274	71.6
1967		no data	
1966	3	1683	67.0
1965	1	482	64.3

*160 acre work units.



*Sig. (.005)

Fig. 1. Relationship between average tree condition class and number of years since last pruning.

Curvilinear regression was used to determine the relationship between the number of years since last pruning and condition class using the formula:

$$\hat{Y} = a + bX = cX^2$$

when,

$\hat{Y}$ = condition class

X = years since last pruning

The analysis was significant (.005) with years since pruning accounting for 89.8 percent (R^2) of the variation in condition class. (Fig. 1).

Economic Analysis of Pruning Cycle

The longer pruning is delayed the greater the impact on condition class, and ultimately tree value. While extending the pruning cycle lowers tree value, extending the cycle also saves cost by reducing annual pruning charges. When loss in tree value is compared to savings in pruning costs over time an optimum pruning cycle can be determined.

The curve presented in Fig. 1 represents the condition class of street trees following a given number of years since pruning. To determine the average condition class of an urban forest for a pruning cycle, all condition classes prior to and including the year of pruning must be averaged, i.e., an eight year pruning cycle will yield an average condition class for the street trees of 75.5 percent (Table 2).

Assuming a 100 percent condition class, the 40,808 trees used in this study have a value of $26,539,000 (based on UW/SP URBAN FOREST INVENTORY). Using this value as a base, values were calculated using the average condition class for all trees having pruning cycles of from two to fourteen years (Table 2). The loss in tree value resulting from extending the pruning cycle by one year is the marginal cost attributed to postponing an additional year.

Annual pruning costs are determined by dividing the total number of trees by the number of years in the pruning cycle. This is multiplied by $16.50, the average pruning cost per tree in Milwaukee (Table 2). The savings associated with extending the pruning cycle by an additional year is the marginal return associated with reduced pruning the next year (Table 2).

Comparison of the additional loss in tree value versus the additional savings in pruning costs indicates the optimum pruning cycle to be between four and five years for the city of Milwaukee (Fig. 2).

The relationship between pruning cycle and tree value is further supported by inventories in two other Wisconsin cities. City A has an average condition class of 54.5 percent and City B has an average condition class of 49.8 percent. Neither city has an established pruning cycle, but rather relies on local utility companies to prune trees which interfere with overhead wires. This pruning is infrequent, and often involves topping offending trees.

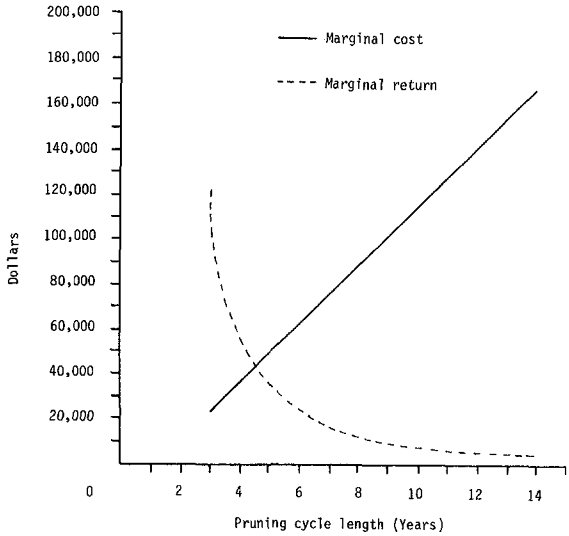


Fig. 2. Comparison of loss in tree value versus savings in pruning costs for various pruning cycles in Milwaukee, Wisconsin.

Table 2. Tree value and pruning costs for various pruning cycles, based on 40,808 street trees in Milwaukee, Wisconsin.

Pruning cycle	*Average condition class for specified pruning cycle*	*Tree Value for specified pruning cycle*	*Marginal cost*	*Anual pruning cost for specified pruning cycle**	*Marginal return*
2 yrs.	76.8%	$20,381,000	—	$337,000	—
3	76.7	20,358,000	$23,000	224,000	$113,000
4	76.6	20,321,000	37,000	168,000	56,000
5	76.4	20,272,000	49,000	135,000	33,000
6	76.2	20,210,000	62,000	112,000	23,000
7	75.9	20,134,000	76,000	96,000	16,000
8	75.5	20,046,000	88,000	84,000	12,000
9	75.2	19,944,000	102,000	75,000	9,000
10	74.7	19,829,000	115,000	67,000	8,000
11	74.2	19,702,000	127,00	61,000	6,000
12	73.7	19,561,000	141,000	56,000	5,000
13	73.1	19,407,000	154,000	52,000	4,000
14	72.5	19,239,000	168,000	48,000	4,000

*Assume average pruning cost of $16.50 per tree.

Summary & Conclusions

The length of the pruning cycle has a significant effect on tree value. Longer pruning cycles result in reduced tree value, with the decline in value accelerating over time. Savings to the city may be realized by longer pruning cycles, but only at a loss in tree value. This loss in value exceeds savings once the pruning cycle is extended to and beyond five years.

This provides a strong argument in favor of frequent pruning, with a pruning cycle of between four and five years being optimum for the city of Milwaukee. While this may be a convincing argument to city foresters, it remains the task of the city forester to convince city government officials.

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Literature Cited

1. Chapman, Douglas. 1978. *Pruning young trees increases efficiency.* Weeds, Trees & Turf 17(4).
2. Fenner, Carl. 1953. *A modern city forestry program.* Arborists News 18(2).
3. International Society of Arboriculture. 1979. Guide for Establishing Values of Trees and Other Plants. P.O. Box 71, Urbana, IL. Revision IV, 42 pp.
4. Miller, Robert W., William A. Sylvester, and Michael S. Marano. 1979. UW/SP URBAN FOREST: A computerized urban forest inventory based on tree value. Forest Resource Inventories, Workshop Proceedings, July 22-26, 1979. Colorado State University, Fort Collins, CO., p. 450-470.

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[1] Milwaukee is currently being inventoried using UW/SP URBAN FOREST. At the time of writing approximately one fourth of the city had been inventoried.

ABSTRACT

Hamilton, D.F. & S.J. Kreutzer. 1980. **How to control pests in the nursery.** Am. Nurseryman 151(11): 8-9, 34, 36, 38.

Pest control is a very important part of the nursery business. The best method of control is integrated pest management, the major components of which are sanitation, environmental control, mechanical control, and chemical control. This method allows flexibility, enabling growers to use the appropriate control for each pest problem. Controlling weeds in the past was usually done manually, either by hand or with a hoe. Salt was used by some early nurserymen as a soil sterilant, but most forms of chemical control were developed only recently. Much of the insect and disease control in the past was also done manually. Some of the methods used were: swatting insects, picking worms off the leaves, cutting out cankers and other diseased wood, and placing foul-smelling mixtures throughout the nursery to keep deer and rodents away from the plants. After Bordeaux mixtures were found to be helpful in controlling insects and diseases, chemical pest control methods began to develop. Sulfur was used as a fumigant and an insecticide, arsenates were used as stomach poisons and mercury was used as a soil sterilant and a seed disinfectant. Many of these chemicals are no longer used because of their toxicity to man and the environment; newer, safer and better chemicals are now being used. Many of today's forms of pest control are similar to those used in the past. Manual weed removal is still necessary, but mechanical cultivators, plows, and mowers have increased weed control efficiency. Chemical herbicides are highly selective. Insecticides, fungicides, and fumigants are safer to man and the environment and also control pest problems better. Animal traps, electric fences, baits, and scents protect trees from animal damage.