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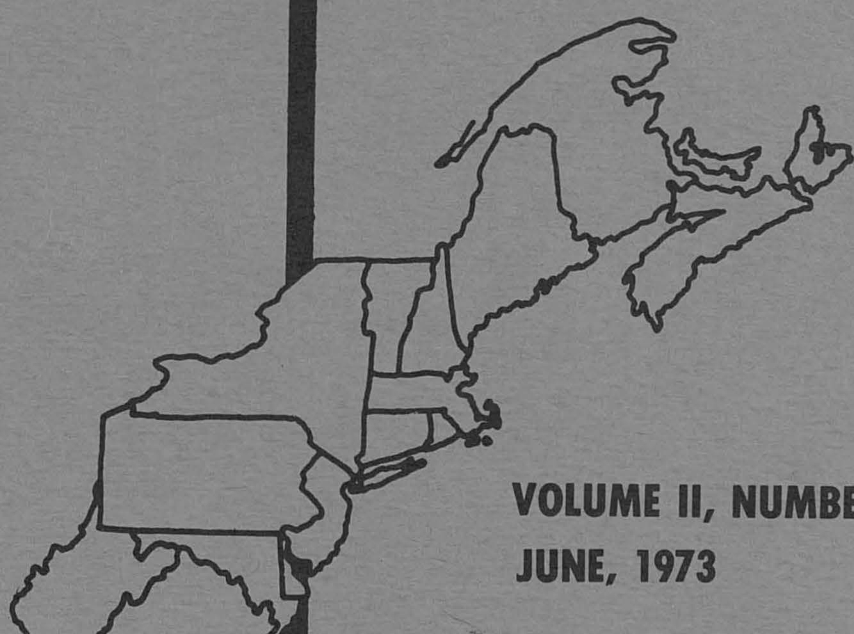

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THE ECONOMICS OF MUNICIPAL STREET TREES[1/]

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This study analyzes the struggle for survival by trees growing along Massachusetts roadsides. Street tree problems have been prevalent for many years. Several organizations have proposals to help solve the street tree dilemma. A majority of the proposed cures have dealt with the application of sound arboricultural principles and latest technological advances. The tree authorities attempted to strengthen their programs by attending short courses and seminars. The utility companies have also sought to solve the problems of keeping their distribution lines clear of obstructions from trees so that both trees and utilities can exist harmoniously.

Present day problems of street trees, varied and complex, were determined by a Street Tree Operations Survey in 1967 and a Utilities Survey in 1968. The existing situation is shown in Table 1.

Adverse Growing Conditions

When the trees were first planted along roadsides in the colonial days, they grew uninhibited in favorable growing conditions. Now, underground conduits and pavement for roads and sidewalks have lessened soil area, water and aeration available for street trees. Not only are the growing conditions detrimental to healthy tree growth, but several species of large trees cause upheaval of sidewalks.

Conflicts for Space between Trees and Utilities

Forest giants, such as mature elms and certain varieties of maples,

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1/ Presented to Northeastern Agricultural Economics Council Annual Meeting, June 19-21, 1972, Nova Scotia Agricultural College, Truro, Nova Scotia. Abstract in Horticultural Science, American Society for Horticultural Science, Vol. 7, page 329, No. 3, June 1972. Presented to 69th Annual Meeting of the American Society for Horticultural Science, August 26-31, 1972, University of Minnesota.

2/ Graduate student and Professor, respectively.

Table 1

SUMMARY OF EXISTING SITUATION FROM 1967 MASSACHUSETTS STREET TREE OPERATIONS SURVEY

Description	# Towns	Low	Average	High	Median	Central Tendency Modes
1. Town Population	27	8900	27,400	88,500	15,700	5 towns 8900-10,100 5 towns 13,600-15,300
2. Miles of Road	27	59	110	262	109	6 towns 95-102
3. Trees per Mile of Road	27	35	186	490	190	6 towns 197-203
4. Tree Population per Town	27	5000	20,604	60,000	16,191	6 towns 15,000-17,124 4 towns 24,000-28,000
5. Total # Trees Removed	27	25	204	446	184	4 towns 188-214
6. Total # Trees Planted	20	15	235	1,200	136	6 towns 125-150
7. $ Spent per Capita	27	$ .48	$2.07	$6.96	$1.62	6 towns $1.49-$1.70 4 towns $2.23-$2.59 5 towns $1.14-$1.33
8. $ Spent per Mile of Road on Trees	27	$100.00	$403.49	$1,031.50	$307.00	6 towns $250-$285 4 towns $481-$551
9. $ Spent per Tree	27	$ .21	$2.40	$7.20	$1.83	4 towns $1.00-$1.23 6 towns $1.60-$1.80 4 towns $2.06-$2.30
10. $ Spent on Supervisory Payroll	23	$1,000	$7,882	$17,395	$7,072	5 towns $6,550-$7,000 4 towns $8,395-$8,830
11. $ Spent on Labor	29	$1,200	$29,102	$99,501	$18,964	5 towns $13,427-$16,803 4 towns $28,964-$31,448
12. $ Spent on Pest Control	27	$ 0	$6,646	$30,000	$3,200	4 towns $1,150-$1,463 4 towns $3,150-$3,951
13. $ Spent on Equipment and Repairs, Average for 5 yrs.	27	$100	$3,713	$15,000	$2,592	6 towns $1,000-$1,500 4 towns $3,000-$3,400 5 towns $5,000-$6,039
14. $ Spent on Wages per Hour Labor	30	$2.00	$2.72	$3.85	$2.65	6 towns $2.50-$2.53 5 towns $2.62-$2.67 6 towns $2.89-$3.00
15. $ Spent on Dutch Elm Disease	27	$1,200	$12,405	$40,000	$7,790	4 towns $3,998-$4,700 5 towns $6,964-$7,709 4 towns $12,000-$13,969
16. $ Spent on Removal	23	$2,235	$17,091	$50,305	$14,047	5 towns $10,130-$12,200 5 towns $19,800-$23,500
17. $ Spent on Planting	22	$50	$3,903	$18,420	$2,144	5 towns $700-$1,275 4 towns $6,000-$7,996
18. $ Spent on Trees	27	$9,000	$47,700	$113,700	$36,725	4 towns $15,000-$17,200 4 towns $26,500-$28,600 4 towns $35,000-$39,600 4 towns $49,000-$54,800

compete for above and below ground space with utilities, [1] creating an economic liability for towns and utility companies. Surveys indicated:

a. Forest Giants are 57.5% of all existing trees.
b. Forest Giants are 43.0% of all new trees planted.
c. Utility companies spent an average of $10,397 per town for distribution line clearance in 1967.

In modern society it is impractical if not impossible to grow species of trees which will ultimately grow into forest giants in locations restricted by available space above and below ground.

Pest Control Problems - Dutch Elm Disease

The Dutch Elm Disease, as determined in the Survey of towns, is a serious economic liability with costs of prevention and control amounting to 26.1% of all monies spent on trees in the cities and towns surveyed. Some towns have spent up to 87.6% of their total tree budget on elm trees alone. The catastrophe with the elms can in part be attributed to an overplanting of this species several generations ago.

Solutions to the disease problem include costly spraying and removal by town crews, and varying tree species at time of planting to guard against a plant pest from infecting a large percentage of the total street tree population.

Ecological Imbalance

Past and present planting practices have created an ecological imbalance (e.g. too many elms and maples) which is a potential danger of costly losses of street trees. The 1967 Survey indicated:

Of all existing trees, 19.1% were elms;
Of all existing trees, 50.5% were maples;
Of all new trees planted, 73.5% were maples;
Of all trees removed other than elms, 73.1% were maples.

The above findings indicate maples could conceivably represent about three-fourths of all street trees in the future if present planting practices continue. A plant pest as serious as the Dutch Elm Disease could virtually create economic ruin for the local tree programs, to say nothing about the loss in number of street trees. The rate of removal for maples is already beginning to indicate the possibility that the growing life for this species is in jeopardy. Current street tree managers could vary the species being planted; this is a proposed solution. However, the lesson evidently has not been learned, as exemplified by the planting of maples which represent over half of all existing trees today.

Insufficient Appropriations

Lack of funds appeared to be one of the greatest shortcomings of present programs and prevented many towns from providing a sound program to modify current practices leading to an eventual solution to some of the problems cited above.

a. Less than one percent of the average town's total budget was spent on trees. [2]

b. Dollars spent per tree by town ranged from $.21 to $7.20, with an average of $2.40. (Table 1)

c. Dollars spent per capita on trees ranged from $.48 to $6.96, with an average of $2.07.

d. Dollars spent per mile of road on trees ranged from $100.00 to $1,031.50, with an average of $403.49.

e. Planting of low initial cost species of trees was found to be prevalent.

The wide range of expenditures indicates the varied degrees of tree care being provided in Massachusetts cities and towns. In a comparison with the city of Lansing, Michigan, it was found that Lansing [3] spent $7.97 per tree in 1967, which was more than any Massachusetts town expenditure. Lansing is an extreme case, but one reason for their large appropriation was their unique method of reporting the scope of their tree department's activities. A lesson might be learned in Massachusetts from the communicating activities of Lansing to the taxpayers. Such communication is a vital part of a tree warden's job, if he is to get the funds needed to do a better job.

Lack of Understanding and Community Support Towards Street Trees

The problems described above -- adverse growing conditions, space conflicts, pest control and ecological imbalance -- have had solutions suggested by tree authorities for several years. Yet the data reflect that action is not being taken in most Massachusetts towns to solve the problem. Even with the knowledge, there appears to be a lack of positive local street tree programs. This situation is attributed to a lack of understanding and community support towards street trees.

"A Handbook of Selected Trees for New England" by the Electric Council of New England [4] does an excellent job of exploring what action may be taken to solve some of the problems of street trees. The ideas, concepts and suggested types of trees all help to provide the information needed by a town to do a better job. Again, however, the record shows that this is not happening in most communities.

Table 2 summarizes the street problems which have been discussed and the solutions which have been offered.

Table 2
Summary of Street Tree Problems and Solutions

Problems	Solutions
1. Adverse growing conditions	(A) (B)
2. Conflicts for space between trees and utilities	(B) (C)
3. Pest control problems (e.g. Dutch Elm Disease)	(D) (E)
4. Ecological imbalance (e.g. too many maples and elms)	(E)
5. Insufficient appropriations	(F)
6. Need for greater public and private understanding of street tree program	(G)

Solutions

A. Plant further from edge of road up to twenty feet on private property.
B. Select the trees to fit available space.
C. Change clearance distance from utilities.
D. Removal and spraying by town crews.
E. Vary the species at time of planting.
F. Develop more efficient operations.
G. Win increased public support and private endorsement of a longer shade tree program fulfilling human desires.

Statistical Examination of Tree Warden Survey Data[3/]

Some statistical relationships were checked from the data for possible correlations between variables: Figures 1 - 6.

1. Municipal expenditures related to number of street trees.

   The relationship between number of street trees and expenditures on street tree programs (Figure 1) for 27 Massachusetts municipalities has been determined by the following linear regression equation:

   (Municipal Tree Expenses) = \$18,945 + \$1.39 (Number of Trees).

   This indicates a high fixed expenditure for the municipality crew and equipment with a small increase per added tree under maintenance. $R^2 = .328$ indicates the importance of number of street trees but the scatter diagram indicates considerable variation among towns in the responding sample and importance of other variables.

3/ Tabular data from the Tree Warden Survey are available in the Appendix.

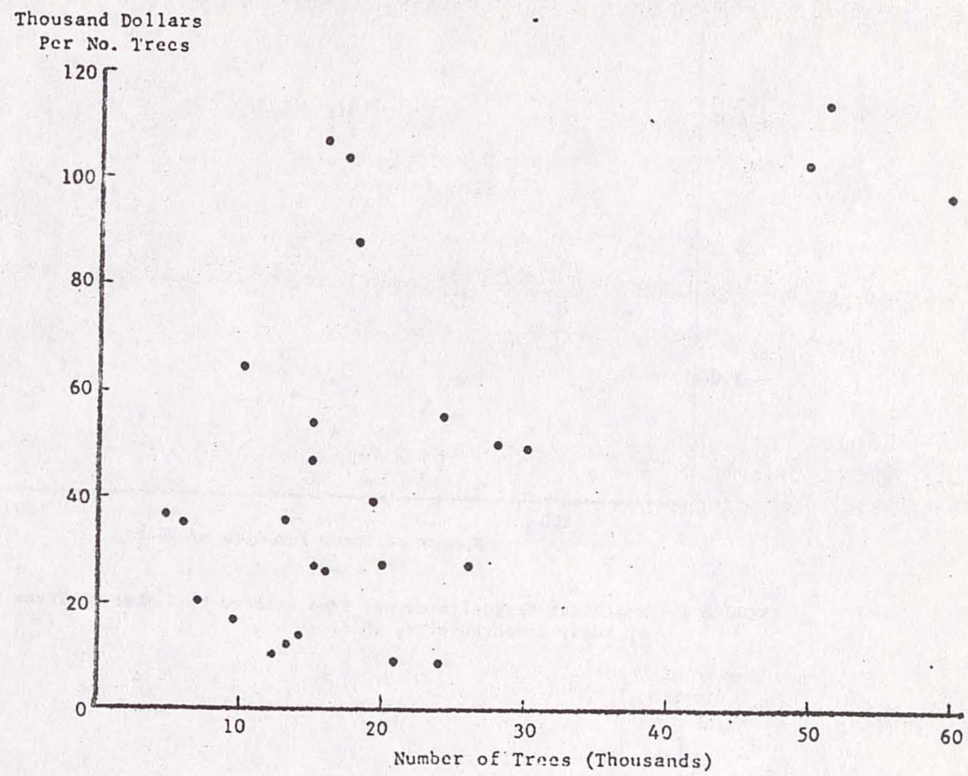

FIGURE 1. Municipal Expenditures Related to Number of Street Trees, Massachusetts Tree Warden Survey, 1967.

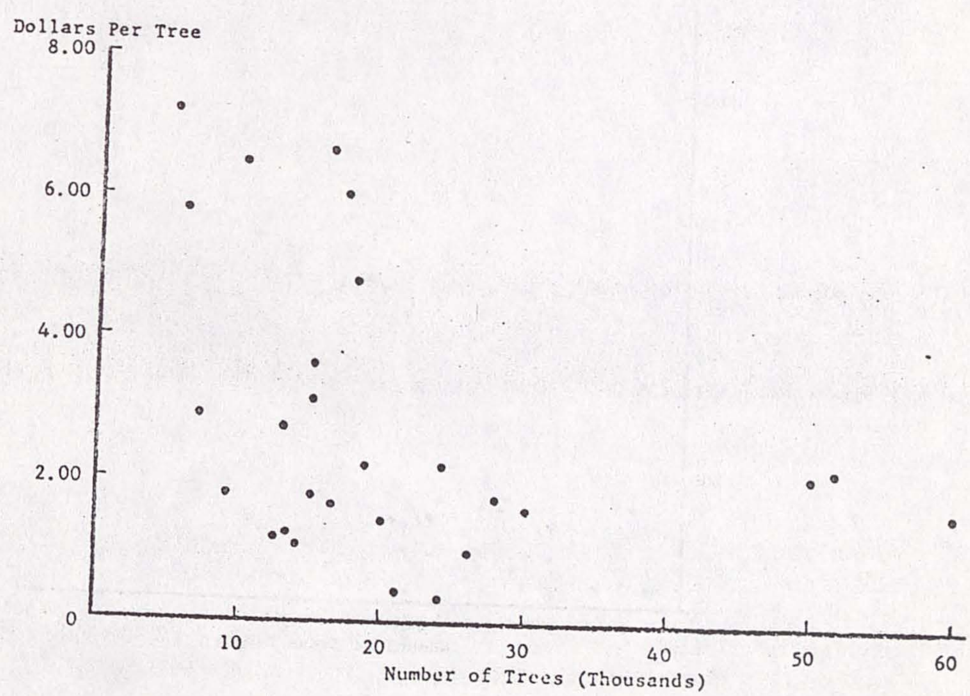

FIGURE 2. Municipal Expenditures per Tree Related to Number of Street Trees, Massachusetts Tree Warden Survey, 1967.

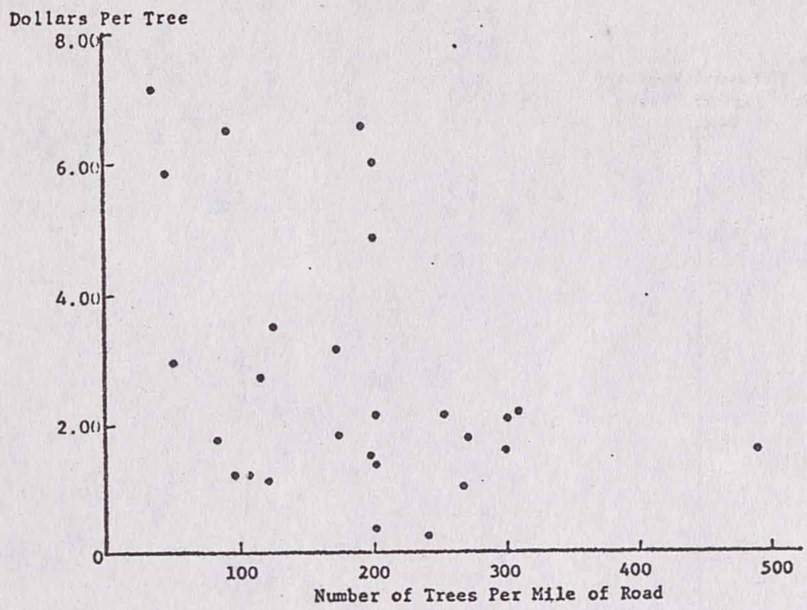

FIGURE 3. Municipal Expenditures per Tree Related to Number of Trees per Mile of Road, Massachusetts, 1967.

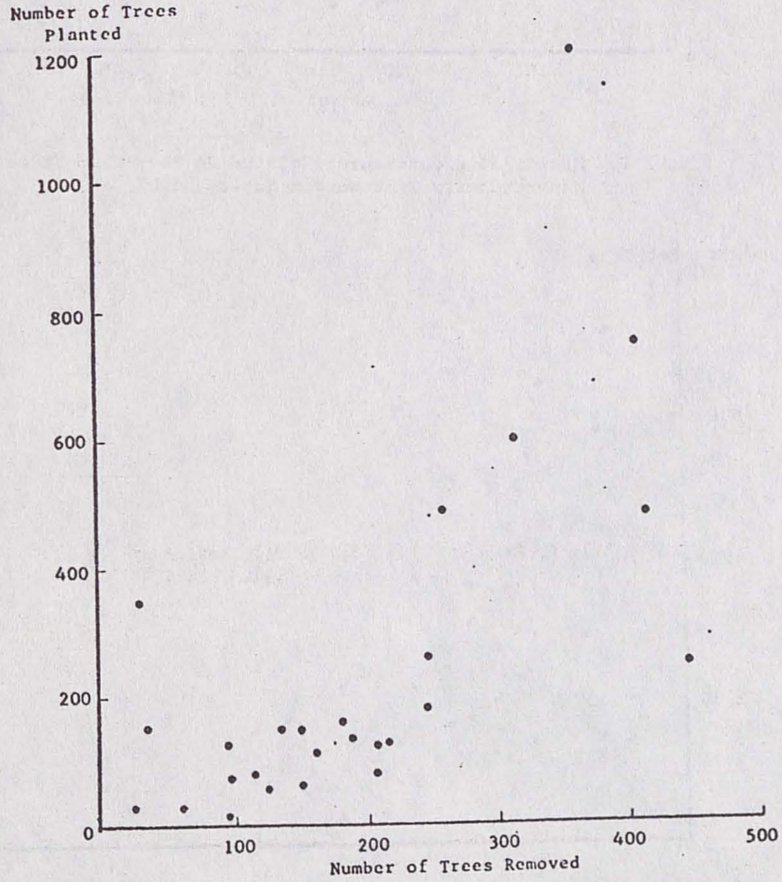

FIGURE 4. Relation between Number of Street Trees Removed and Number of Street Trees Planted in Massachusetts, 1967.

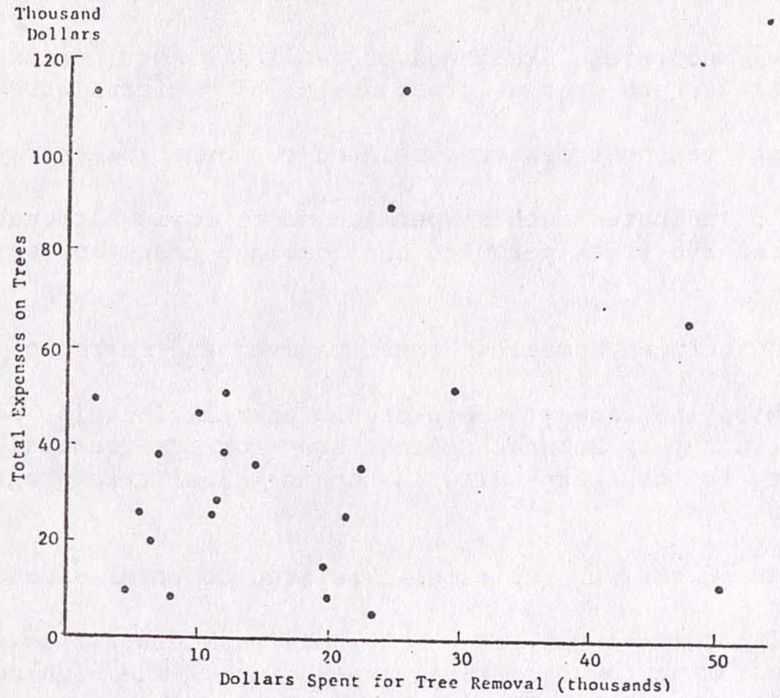

FIGURE 5. Expenditures on Street Tree Removal Related to Total Expenditures on Municipal Street Trees, Massachusetts, 1967.

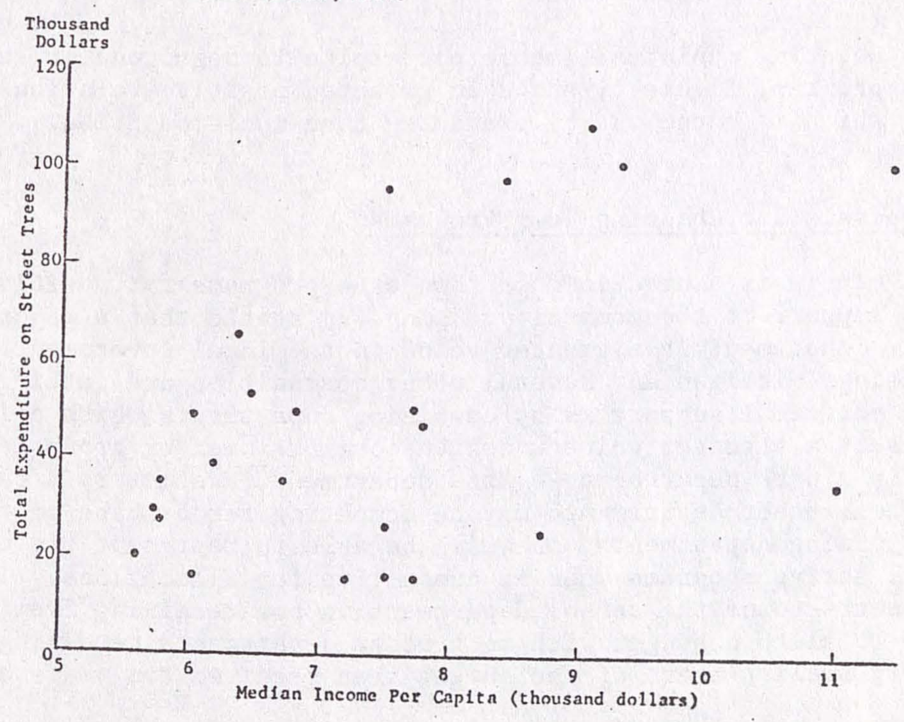

FIGURE 6. Municipal Income per Capita Related to Total Expenditures on Street Trees in Massachusetts, 1967. (Income per capita from Monographs of the Massachusetts Department of Commerce and Development 1968-1972.)

2. Municipal expenditures per tree related to number of street trees.

   Figure 2 indicates likelihood of declining cost per tree as fixed costs are spread over a larger number of municipal trees.

3. Municipal expenses per tree related to number of trees per mile of road.

   Figure 3 indicates much dispersion among towns although those with more than 230 trees per mile had combined costs approximating $2 or less per tree.

4. Relation between number of trees removed and number of trees planted.

   This chart indicates the expected high relationship, perhaps curvilinear in type. Related expenditures for tree removal and tree planting to total expenditures for municipal tree programs gave an $R^2 = .6457$.

5. Expenses on street tree removal related to total expenditure on trees.

   Examining this single operation shows much dispersion as to its importance among towns on total expenditure. The high cost of tree removal due to Dutch Elm Disease is included in these data but was less important than anticipated.

6. Municipal income per capita related to total expenditures on street trees in Massachusetts, 1967.

   Relating municipal income per capita to magnitude of street tree program, Figure 6, shows an expected positive relationship, $R^2 = .52$ which is borne out by examining case municipalities.

Proposals for Changing Town Programs

There is a need in most town tree programs for positive action with the support of the community. King [5] stated that a major need of a town tree department is a greater voice in the local government. One way that Lansing, Michigan and several other communities are getting more financial and political support is by combining departments which collectively will present a stronger voice under one commissioner or group leader. Presently a park department, a tree department, a cemetery department, and several other departments may be competing for a share of town tax dollars. By joining departments, one will be able to represent the needs of several active programs when it comes time for allocations. In most Massachusetts towns the school department is now receiving from 60% to 80% of the total town budget with most other departments receiving a proportionately smaller share of the budget than received ten years ago.

A recent Act in Massachusetts [6] (1970) has made it possible for a town to establish an Office of Lands and Natural Resources. This allows a town to combine the tree department with the other departments involved with natural resources and open space under one director qualified in the field of arboriculture and licensed by the pesticide board in the Massachusetts Department of Public Health. The director would be able to set up an advisory commission to help him formulate policy and to assist in obtaining political support. The commission would be made up of key people in the community such as a newspaper editor, a bank executive, the garden club president and other people concerned with their community. When the new Office cf Natural Resources is established by the town, it will be in a position to pursue a comprehensive street tree program. With greater public and private understanding towns will be better able to carry out the suggested solutions to the most prevalent street tree problems.

Strengthening Functions of Existing Municipal Tree Program

The functions as carried out by Massachusetts municipalities are to:

1. Remove any trees along public roadways which represent a hazard to public safety or by harboring plant pests or diseases pose a threat to other healthy trees.

2. Provide satisfactory care and maintenance to existing trees and to prevent and/or control any plant pests attacking street trees.

3. Plant new trees in newly developed areas or to replace trees removed from established areas.

4. Accomplish the above three operations within a budget which is reasonable and economical.

The Survey information, Table 1, was used to indicate the Existing Situation and with the application of basic municipal street tree management principles, a more Ideal Program has been developed.

Ideal Model Program

The Ideal Model Tree Program modifies the Existing Situation as to tree population by type. (Table 3) Costs were calculated for each type tree and then a total cost for the full Model Program was computed.

Variables Used to Develop Ideal Program

1. Classification of all trees into three general groups by approximate mature size in height and life expectancy:

   a. Dwarf Type - Height, 20 to 25 feet; 25 to 35 years life
   b. Medium Size - Height, 26 to 50 feet; 40 to 65 years life
   c. Forest Giant - Height, 51 to 120 feet; 70 to 90 years life.

TABLE 3

QUANTITIES AND VARIETIES OF TREES [4] FOR MODEL TOWN BY TYPE

Forest Giant	Quantity	%	Medium Size	Quantity	%	Dwarf Size	Quantity	%
Sugar Maple Acer saccharum	500	2.5	Alleghany Serviceberry Amelanchier laevis	625	3.125	Amur Maple Acer ginnala	750	3.75
Sycamore Maple Acer pseudo platanus	500	2.5	Norway Maple Acer plantanoides	625	3.125	Chinese Dogwood Cornus kousa	750	3.75
London Plane Tree Platanus acerifolia	500	2.5	European Hornbeam Carpinus betulus	625	3.125	Lavalle Hawthorn Crataegus lavallei	750	3.75
Thornless Honeylocust Gleditsia triacanthos inermis	500	2.5	Eastern Redbud Cercis canadensis	625	3.125	Washington Hawthorn Crataegus phaenopyrum	750	3.75
Red Oak Quercus borealis	500	2.5	Dolgo Crabapple Malus dolgo	625	3.125	Carolina Silverbell Halesia carolina	750	3.75
Pin Oak Quercus palustris	500	2.5	Japanese Flowering Crabapple Malus floribunda	625	3.125	Hopa Crabapple Malus hopa	750	3.75
Black Gum Nyssa sylvatica	500	2.5	Korean Mountain-Ash Sorbus alnifolia	625	3.125	American Hophornbeam Ostrya virginiana	750	3.75
Red Pine Pinus resinosa	500	2.5	European Mountain-Ash Sorbus aucuparia	625	3.125	Kwanzan Cherry Prunus serrulata "Kwanzan"	750	3.75
Little Leaf Linden Tilia cordata	500	2.5	Yellow-Wood Cladrastis lutea	625	3.125	Pyramid European Hornbeam Carpinus betulus fastigiata	750	3.75
Zelkova Zelkova serrata	500	2.5	Amur Cork Tree Phellodendron amurense	625	3.125	Oriental Upright Cherry Prunus serrulata "Amanogawa"	750	3.75
	5000	25%	Japanese Pagoda Tree Sophora japonica	625	3.125		7500	37.5%
			Crimean Linden Tilia euchlora	625	3.125			
				7500	37.5%			

2. A plan where trees should be planted on existing or new streets (planting strip, edge of road or away from edge of road) and what size trees should be used (forest giant, medium size, or dwarf type).

3. Adoption of planting program similar to that suggested in the Transitional Model instead of in the street tree operations Survey.

Planting Practices

Street Tree	Survey	Transitional Model
Forest Giants	43%	14.0%
Medium Size	43%	30.5%
Dwarf Type	14%	55.5%

4. Vary species planted so that no one species exceeds 15% of the total street trees.

5. Develop a reporting procedure for budget requests and reports which describes the tree program activities and budget expenditures.

Budget Reporting ($)

By Expenditure	By Activity
Supervisory Payroll	Planting
Labor	Pruning & General Tree Care
Equipment & Repairs	Pest Control
Supplies & Miscellaneous	Removal
Total	Total

6. Promote public and private support for the town tree program through a public relations program designed to communicate the value and needs of trees.

Many benefits would accrue by adoption of the transitional program. The trees would have better growing conditions, thus reducing the chance for plant pests attacking weakened trees causing premature death and costly removal. Utility costs for line clearance could be nearly eliminated. An ecological balance would be achieved, helping to prevent a plant pest from ever being as destructive as the Dutch Elm Disease. Mature street trees would be an asset to the community, increasing real estate values and helping to create greater community pride among the town residents.

2. Assignment of tree population by type, age and size to fit an Ideal Model Town Program based on:

    a. Road Miles - linear feet planted in trees
    b. Planting interval between types of trees
    c. Estimated total population of typical Massachusetts town from Survey.

3. Life cycle of planting and removal by type, population, and life expectancy:

$$\frac{\text{Total Number of Trees by Type}}{\text{Life Expectancy in Years}} = \text{Number of trees removed and planted each year.}$$

4. Life cycle costs per tree in total, by year, and for one complete 80-year cycle for all types:

    a. Planting including initial cost of tree
    b. Pruning and pest control
    c. Removal of trees.

5. Total annual budget for Ideal Tree Program:

    a. By Operation
    b. By Tree Type
    c. By Expenditure.

The Ideal Street Tree Program (Table 4) estimates an 80-year-cycle cost of $210.96 for a dwarf type tree as compared to $330.00 for a forest giant -- a savings of $119.04 by using the dwarf type. An even greater savings is realized when the maintenance costs to utilities are reduced or eliminated. In 1967, utility companies spent $.52 per tree for line clearance, or $10,397 per town. The cost of line clearance to the utilities and to consumers of their services could be almost eliminated by proper selection of street trees at the time of planting.

This study does not advocate the complete elimination of forest giant type trees. Where space is adequate to allow a large type tree to grow to maturity, then a forest giant may be selected for planting. Massachusetts allows a town to plant trees on private property; such a practice is advocated for the forest giants if there is a lack of adequate space along the edge of the road on public property.

The summary of a more Ideal Tree Program represents a hypothetically balanced situation by type, size and age in each of the three classifications. As a model, it was assumed that the growing conditions were ideal, the space above and below ground was adequate for uninhibited growth and that all trees would have opportunity to reach maturity.

Planting costs per tree were estimated, based on current nursery prices. It is assumed all trees are bought bare root, and grown for at

Table 4

SUMMARY OF A MORE IDEAL PROGRAM BY CLASSIFICATION

	Dwarf Type		Medium Size		Forest Giant	
Mature size (ht.)	20 to 25 feet		26 to 50 feet		51 to 120 feet	
Life expectancy (approx. yrs.)	25 to 35 years		40 to 65 years		70 to 90 years	
Total population (20,000 trees)	7500 - 37.5%		7500 - 37.5%		5000 - 25%	
Age groups in years	1 to 7, 7 to 15, 15 to 35		1 to 10, 10 to 30, 30 to 55		1 to 15, 15 to 40, 40 to 80	
Size by age group in feet (ht.)	5 to 7', 7 to 12', 12 to 25'		10 to 20', 20 to 40', above 40'		10 to 25', 25 to 50', 50 to 120'	
Population by size and age	1,700 2,200 3,600		1,300 2,600 3,600		800 1,600 2,600	
Per cent of total population	(8.5%) (11%) (18%)		(6.5%) (13%) (18%)		(4%) (8%) (13%)	
Planting interval	30 feet		50 feet		90 feet	
Linear feet planted (100 miles road, planted both sides)	7,500 trees @ 30'=225,000'		7,500 trees @ 50'=375,000'		5,000 trees @ 90'=450,000'	
Life cycle of planting and removal (Total Number of Trees / Life Expectancy = Number Removed and Planted per Year)	7500 trees / 30 years = 250 trees per year		7500 trees / 55 years = 137 trees per year		5000 trees / 80 years = 63 trees per year	
Life Cycle Costs per Tree	Per Year	Total (30 yrs.)	Per Year	Total (55 yrs.)	Per Year	Total (80 Yrs.)
Planting	$1.17	$35.00	$ .545	$ 30.00	$ .375	$ 30.00
Tree pruning and pest control	.80	24.00	1.30	71.50	2.25	180.00
Removal	.667	20.00	1.20	66.00	1.50	120.00
Total	$2.637	$79.00	$3.045	$167.50	$4.125	$330.00
80 Year Cycle Cost per Tree	$210.96		$243.60		$330.00	
Total Annual Cost for Complete Program by Operation (20,000 trees)						
Planting	250 trees @ $35.00 = $8,750		137 trees @ $30.00 = $4,110		63 trees @ $30.00 = $1,890	
Pruning and pest control	7500 trees @ $.80 = $6,000		7500 trees @ $1.30 = $8,350		5000 trees @ $2.25 = $11,250	
Removal	250 trees @ $20.00 = $5,000		137 trees @ $66.00 = $9,020		63 trees @ $120.00 = $7,560	
Sub Total	$19,750		$21,480		$20,700	

Total, All Types of Trees	Operation Costs
Planting	$14,750
Pruning and pest control	25,600
Removal	21,580
Sub Total	$61,930
Supervision (Tree Warden)	10,500
Total Cost	$72,430

Total Cost for Complete Program by Expenditures	
Supervision	$10,500
Labor and fringe benefits	40,000
Equipment and repairs	6,491
Supplies and Miscellaneous	15,439
Total Expenditure	$72,430

least one year in a municipal nursery.

The pruning and pest control costs were estimated for the life of the tree assuming such work would be applied when necessary. Some varieties of trees may be pruned or sprayed every year whereas others may be treated once every ten or fifteen years.

The largest difference in the Ideal Model Program as compared to the Existing Situation was in the quantity and type of trees being planted. Some principles applied in the planting practices of the Ideal Model were:

1. Select the size tree which will fit the available space so that trees planted can reach maturity. By application of this space principle, almost all conflicts for above ground space, such as with utility lines, would be eliminated. Planting back of sidewalk is suggested wherever feasible.

2. Vary the species. To provide an ecological balance and to prevent specific plant pests from destroying a large portion of one species along the roadside, no more than 11.25% of the total street trees were allocated to the same species.

3. Create an aesthetically pleasing environment with trees along the roadside: with new shapes and different forms of trees, colorful spring blooms on flowering trees, and a brilliant array of fall foliage.

Transitional Model Tree Program

The Ideal Tree Program varied drastically from the Existing Situation as reported in the Survey. Since there was little likeness between the two programs, a Transitional Model was developed to show that modifications of present program practices and expenditures would be necessary in order to achieve ultimately a more ideal program. The Transitional Model was derived from the Survey average and median for tree population and existing types of trees. (Table 1)

The Survey requested existing quantities by type for maple, elm, dwarf trees, and all others. Since the Survey results were incomplete in defining the existing trees by type as stated above, some assumptions had to be made to complete the existing situation.

Assumptions on Existing Trees by Type and Removal Practices

a. Since all varieties of maple are not Forest Giants, it was assumed that 50% of the total maple trees reported were Forest Giant Type and the remaining 50% were Medium Size Type.

b. It was assumed that 50% of the trees reported in the Survey as "All Others" were Forest Giants and the remaining 50% were Medium Size Type.

c. It was assumed that 67% of all trees classified as Forest Giants by species and variety were able to reach maturity, the other 33% only Medium Size by type at the time of removal.

d. It was assumed that 90% of all trees classified as Medium Size by species and variety were able to reach maturity. The remaining 10% were unable to reach maturity and were at time of removal only using space suited for dwarf trees. (Tables 5A and 5B)

The reason for the assumptions c. and d. under removals was based on an overpopulation of forest giants in a typical town, causing relatively poor growing conditions, causing the larger type trees to die at an immature age.

The Transitional Model approaches the Ideal Model in its percent of trees planted by type. The total number (325) of trees planted in the Transitional Model was determined by the amount of linear footage made available from removals. Linear footage planted in the Transitional Model was proposed as:

	Removed		Planted	
Forest Giants	129 trees x 90' =	11,610'	46 trees x 90' =	4,140'
Medium Size	126 trees x 50' =	6,300'	99 trees x 50' =	4,950'
Dwarf Type	24 trees x 30' =	720'	180 trees x 30' =	5,400'
	279	18,630'	325	14,490'

The reason 14,490 feet would be planted initially while 18,630 feet were cleared by removals was because of the prior overpopulation of trees. In an actual town situation, the number of plantings per year would be determined directly by the amount of linear road footage made available for new trees. Of the quantity planted, the percentage by type would remain the same as listed under the Transitional and Ideal Model Programs.

Budget Expenditures. Budget expenditures are shown by type of expenditure and by operation for the Survey median and average, the Transitional Model and the Ideal Model. The expenditures for the two proposed models are adjusted for inflation from 1967 to 1972 and because of a more extensive planting program. (Tables 5C and 5D)

The "Transitional Model Street Tree Program" or some modification of it could be one of the first programs to be adopted by the new Office of Lands and Natural Resources. It is a balanced program which emphasizes sound arboriculture principles, meets street tree needs and has a long range design to reduce or eliminate major street tree problems. To put the transitional program into operation, the steps to follow include:

1. Taking a physical inventory of all existing trees and classifying them by species, present size, ultimate size and estimated remaining life expectancy.

Table 5

SUMMARY OF TRANSITIONAL MODEL PROGRAM SHOWING SURVEY MEDIAN, SURVEY AVERAGE, AND IDEAL MODEL

A. Existing Trees by Type

Number of Trees by Type	Survey Median	Survey Average	Transitional Existing Model	Ideal Model Program	Survey and Transitional Aggregate %	Ideal Model %
Forest Giants						
Maple	4048	5151	4500	1000	24.4	5.0
Elm	3076	3915	3420	0	19.0	.0
All others	2186	2782	2430	4000	14.1	20.0
Total Forest Giants	9310	11838	10350	5000	57.5	25.0
Medium Size						
Maple	4048	5151	4500	625	24.4	3.13
All others	2186	2782	2430	6875	14.1	34.37
Total Medium Size	6234	7933	6930	7500	38.5	37.50
Dwarf Type						
Maple	a)	a)	a)	750	a)	3.75
All others	a)	a)	a)	6750	a)	33.75
Total Dwarf Type				7500		37.50
Total All Existing Trees	16192	20605	18000	20000	100.0	100.0

a) Not available.

B. Removal Practices for Transitional Model

By Classification of Species and Variety

Total Number of Forest Giants Removed (mature and immature Giants) — 129
$\frac{10,350 \text{ trees}}{80 \text{ years}}$ = 129 trees removed

Total Number of Medium Size Removed (mature and immature Medium Size) — 126
$\frac{6,930 \text{ trees}}{55 \text{ years}}$ = 126 trees removed

Total Number of Dwarf Type Removed (mature and immature Dwarf Type) — 24
$\frac{720 \text{ trees}}{30 \text{ years}}$ = 24 trees removed

Total Trees Removed — 279

By Size at Time of Removal

Total Number of Forest Giants Removed (mature Giants only) — 86
67% of 129 trees = 86 mature trees

Total Number of Medium Size Removed — 156
Mature Medium Size
90% of 126 trees = 113
Immature Forest Giants
33% of 129 trees = 43

Total Number of Dwarf Type Removed — 37
Mature and immature Dwarf Type = 24
Immature Medium Size
10% of 126 trees = 13

Total Trees Removed — 279

C. Planting Practices by Types of Trees

	Median	Average	Transitional	Ideal	Survey	Ideal Transitional %
Forest Giants						
Maple	50	82	9	12		
All Others	8	19	37	51		
Total Forest Giants	58	101	46	63	43.0%	14.0%
Medium Size						
Maple	50	81	8	11		
All Others	9	20	91	126		
Total Medium Size	59	101	99	137	43.0%	30.5%
Dwarf Type						
Maple	a)	a)	18	25		
All Others	a)	a)	162	225		
Total Dwarf Type	19	33	180	250	14.0%	55.5%
Total All Trees Planted	136	235	325	450	100.0%	100.0%

a) Not available.

D. Budget by Expenditures

Expenditure	Survey Median	Survey Average	Transitional Model	Ideal Program
Supervisory Payroll (Tree Warden)	$7,072.00	$7,882.00	$8,500.00	$10,500.00
Labor	$18,964.00	$29,102.00	$42,500.00	$40,000.00
Equipment and Repairs	$2,542.00	$3,713.00	$6,000.00	$6,491.00
Supplies and Miscellaneous	$8,097.00	$7,003.00	$13,053.00	$15,439.00
Total Budget	$36,725.00	$47,700.00	$69,553.00	$72,430.00
Total Number of Trees	16,192	20,604	18,000	20,000
$ Spent per Tree	$2.04	$2.40	$3.86	$3.62

E. Budget Expenditure by Operation

Operation	Survey Median	Survey Average	Transitional Model	Ideal Program
Planting	$2,144.00	$3,903.00	$8,887.00	$14,750.00
Pruning and General Tree Care	$9,544.00	$7,655.00	$31,484.00	$25,600.00
Dutch Elm Disease	$7,790.00	$12,405.00		
Pest Control and Spraying	$3,200.00	$6,646.00		
Removal	$14,047.00	$17,091.00	$20,682.00	$21,580.00
Supervision	(included above)	(included above)	$8,500.00	$10,500.00
Total Budget	$36,725.00	$47,700.00	$69,553.00	$72,430.00

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6. Massachusetts. General Laws. "Shade Trees." Chapter 87, Art. 7.

Appendix

Data Compiled From Tree Wardens Survey, 27 Massachusetts Towns, 1967

Name of Town	# Trees	$ Spent on Trees	$ Spent on Dutch Elm Control	# Trees Removed	# Trees Planted	$ Spent on Removal	$ Spent per Tree
Wilmington	5,000	$ 36,470	$ 13,969	95	125	$ 6,175	$ 7.20
Holyoke	6,000	35,000	7,000	300	150	22,500	5.83
Taunton	7,000	20,000	12,500	150	60	14,500	2.86
Holden	9,600	17,150	4,700	95	15	4,766	1.79
Northampton	10,000	65,000	40,000	415	100	50,305	6.50
Wilbraham	12,500	15,000	4,500	180	160	7,000	1.20
E. Longmeadow	13,000	16,000	3,000	98	76	8,230	1.23
Longmeadow	13,000	35,800	3,998	32	350	N.A.	2.75
Amherst	14,122	15,615	7,709	136	150	5,456	1.11
Pittsfield	15,000	53,730	38,250	446	252	47,670	3.58
Reading	15,000	47,278	5,892	161	114	11,596	3.15
Westwood	15,000	27,000	13,500	125	80	N.A.	1.80
Brookline	16,000	106,444	7,651	325	600	23,500	6.63
Easton	16,620	16,849	6,964	124	59	10,130	1.61
Wellesley	17,124	103,728	29,899	207	79	29,760	6.06
Arlington	18,000	27,000	12,000	258	492	N.A.	4.83
Hudson	18,848	39,578	6,456	188	136	10,900	2.10
Greenfield	20,000	28,550	25,000	25	30	N.A.	1.43
Holliston	21,000	9,025	2,987	63	30	2,570	.43
South Hadley	24,000	9,000	4,500	35	158	2,235	.38
Andover	24,000	50,791	14,898	245	180	19,800	2.11
Gardner	26,000	26,473	10,682	245	260	12,200	1.02
North Andover	28,000	49,838	8,791	214	132	12,140	1.78
Attleboro	30,000	48,959	26,849	208	125	19,975	1.60
Needham	50,000	103,214	1,200	407	750	24,700	2.06
Newton	51,500	113,746	15,000	364	1200	21,500	2.20
Framingham	60,000	96,370	7,043	415	483	25,600	1.61

Appendix (continued)

Name of Town	Population	Median Income	Miles of Road	# Trees per Mile of Road	$ Spent per Mile of Road	$ Spent per Capita
Wilmington	15,300	$ 6,708	100	50	$ 364.70	$ 2.38
Holyoke	41,700	5,755	130	46	269.23	.84
Taunton	42,000	5,597	200	35	100.00	.48
Holden	11,500	7,546	90	107	190.56	1.49
Northampton	31,200	5,856	135	76	481.11	2.08
Wilbraham	9,700	7,766	110	114	136.30	1.55
E. Longmeadow	12,000	7,271	64	203	250.00	1.33
Longmeadow	13,800	11,116	65	200	550.77	2.59
Amherst	10,100	6,198	82	172	190.43	1.55
Pittsfield	56,500	6,455	167	90	321.73	.97
Reading	21,200	7,801	74	203	638.89	2.23
Westwood	12,100	8,690	59	254	457.60	2.23
Brookline	87,200	8,380	168	95	633.57	1.22
Easton	10,100	6,216	97	171	276.90	2.68
Wellesley	14,900	11,478	135	127	768.35	6.96
Arlington	52,500	7,538	95	189	915.79	1.66
Hudson	13,600	6,187	70	269	505.40	2.97
Greenfield	18,300	5,692	100	200	285.50	1.52
Holliston	8,900	N.A.	68	309	132.72	1.14
South Hadley	14,200	N.A.	80	300	112.50	.63
Andover	10,000	7,694	200	120	273.95	5.48
Gardner	20,500	5,738	95	273	278.66	1.29
North Andover	12,500	6,793	140	200	356.00	3.98
Attleboro	28,700	6,171	125	240	391.60	1.70
Needham	29,300	9,282	102	490	1,031.50	1.84
Newton	88,500	9,008	262	197	584.64	1.28
Framingham	52,400	7,495	200	300	431.80	1.82