DUTCH ELM DISEASE CONTROL: PERFORMANCE and COSTS

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ABSTRACT

Municipal programs to suppress Dutch elm disease have had highly variable results. Performance as measured by tree mortality was unrelated to control strategies. Costs for control programs were 37 to 76 percent less than costs without control programs in the 15-year time-span of the study. Only those municipalities that conducted a high-performance program could be expected to retain 75 percent of their elms for more than 20 to 25 years. Communities that experienced the fewest elm losses had a well founded program, applied it conscientiously and sustained their efforts over the years.

"Nature's noblest vegetable" is what the French botanist André Michaux (1746-1802) called the American elm.

SAVING THE ELMS has been a community goal in many of our cities and towns. Some communities are meeting that goal; some are holding their own; some have failed. In many areas highly-valued American elm trees have been virtually eliminated by Dutch elm disease. The methods of disease control have been aimed at blocking the transmission of the fungus to healthy elms by elm bark beetles and through root grafts between diseased and healthy elms.

To find out how well Dutch elm disease control programs are working, we gathered and analyzed public records of control performance and costs for 39 municipalities, many of them in the Midwest, where Dutch elm disease is less likely to be confounded by elm losses due to phloem necrosis. The municipalities studied ranged in population from 3,000 to 1,500,000 and had elm trees ranging in numbers from 2,000 to 50,000.

The records available ranged in time span from 5 years to 18 years. The information reported was: (1) the total number of elm trees in the city or in the control program, (2) the number of elms contracting Dutch elm disease each year, (3) the control measures specified, and (4) the costs of the control program.

Additional data were taken from published sources *(Neely 1967 and 1972, and Neely and others 1960)*.

We combined all these records and other information to find out how well the control measures were keeping the Dutch elm disease within manageable proportions. Community performance in Dutch elm disease control was judged by how successful the community was in saving its elms, and the financial consequences of the control program.

Control Strategies

Control measures can be classified on a technological basis into three major strategies:

Strategy	*Vector control measures*
1. Reduce bark beetle habitat.	Sanitation (prompt removal of infested elms and pruning of infested branches).
2. Reduce bark beetle habitat and control beetle population.	Sanitation and use of insecticide to further reduce beetle population and reduce transmission of the disease.
3. Reduce bark beetle habitat, control beetle population, and prevent tranmission through root grafts.	Sanitation, use of insecticide, and injection of chemicals into soil to prevent transmission through root grafts.

Even though they are technically logical, these strategies cannot be used as a basis for rating performance. We first combined data from different municipalities according to these strategies, expecting to find that those municipalities that had followed strategy 3 got better performance than those that followed strategies 1 or 2. Performance data were measured in number of trees becoming infected each year per 1,000 original elms.

Contrary to our expectations, we found that there was no correlation between performance and strategy. A municipality that sustained a particular level of performance under one strategy (strategy 2) performed similarly when it switched strategies (to strategy 1 or strategy 3). These technological strategies are mere labels, and we question if such labels are relevant to control performance. Good performers (municipalities with a low incidence of Dutch elm disease) did a better job whatever strategy they followed, if the strategy was appropriate to their local situation — that is, tree spacing, disease incidence, factors affecting the beetles, etc.

Control Performance

We grouped municipalities into classes based on sustained control performance. We labeled these:

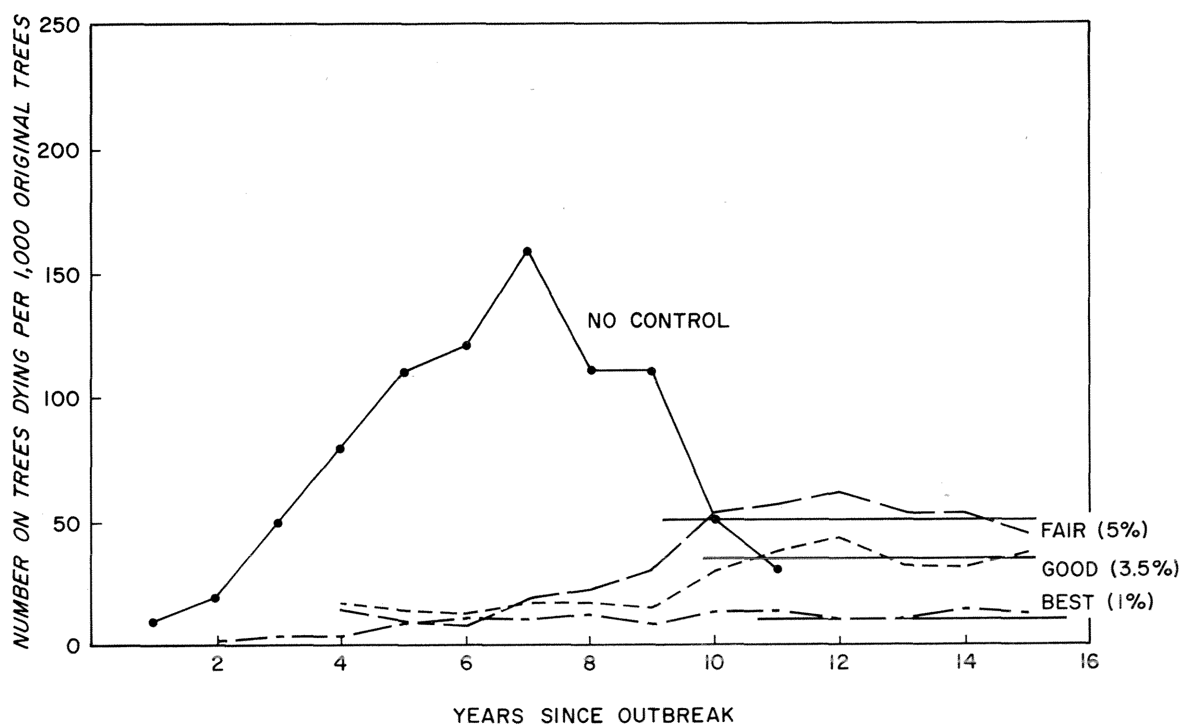
1. Best performance — those municipalities that have an elm mortality of about 1 percent of the original elms per year.
2. Good performance—those municipalities that had a mortality rate of no more than 3.5 percent per year.
3. Fair performance — those municipalities that had a mortality rate of no more than 5 percent per year.
4. No control.

The records of these groups of municipalities were contrasted with those that had no control programs (fig. 1).

To understand the reasons for differences in control performance, we talked to researchers and others in the control business, we read many accounts of how Dutch elm disease progressed in different cities, and we devised a list of reasons for the differences in performance.

Biological reasons.—1. Different spacing of elms call for different control measures. For example, a municipality in which elms are closely clumped together couldn't attain a high performance without root-graft control, whereas a municipality in which elms are widely distributed wouldn't need it. 2. Different physical distributions of elms alter the probability of their contracting the dis-

Figure 1.—Number of trees expected to die each year under each of four control-program performance levels.



ease. For example, elms could be so widely dispersed and such a small part of the total shade-tree population that transmission of the disease by root grafts would be minimal.

Operational reasons.—1. Lack of leadership in the community and failure to understand the gravity of the situation (*Gunderson 1964*). 2. Lack of money. 3. A mixture of authorities, each of which is responsible for a certain group of elms, all operating within different priorities or budget constraints so that their work is inconsistent with a total control program. 4. Group conflicts within the community government or among influential organizations. 5. Lack of effective authority to treat or remove privately owned elms, so that islands of disease elms are left for prolonged periods. 6. Crews in the field who do not conduct their work carefully and conscientiously, and a management that does not allow enough time to do a good job.

Of course, not all of these factors are present in any one municipality, and there could be other ones that are paramount in particular communities. One factor that seems to be of concern in most communities is the privately-owned diseased elm and the community's lack of authority to remove it promptly.

If a community is to have an effective disease-control program, it must plan and study carefully to make sure that it develops a program based on biological conditions. And no matter how good a program is, it will not succeed unless it is carried out vigorously and conscientiously under a unified authority that has the power to compel action.

Control Costs

Different municipalities account for costs differently. We could not relate performance data to cost of control programs. To do so would have required on-site cost studies. The information we brought together was not suitable for a rigorous breakdown of performance against cost. In fact, both good performers and poor performers had a similar range of costs for individual jobs and for the total control program. Some excellent performances seemed very economical while some poor performances seemed very expensive. The costs we did collect are given in table 1.

Save-the-elms Evaluation

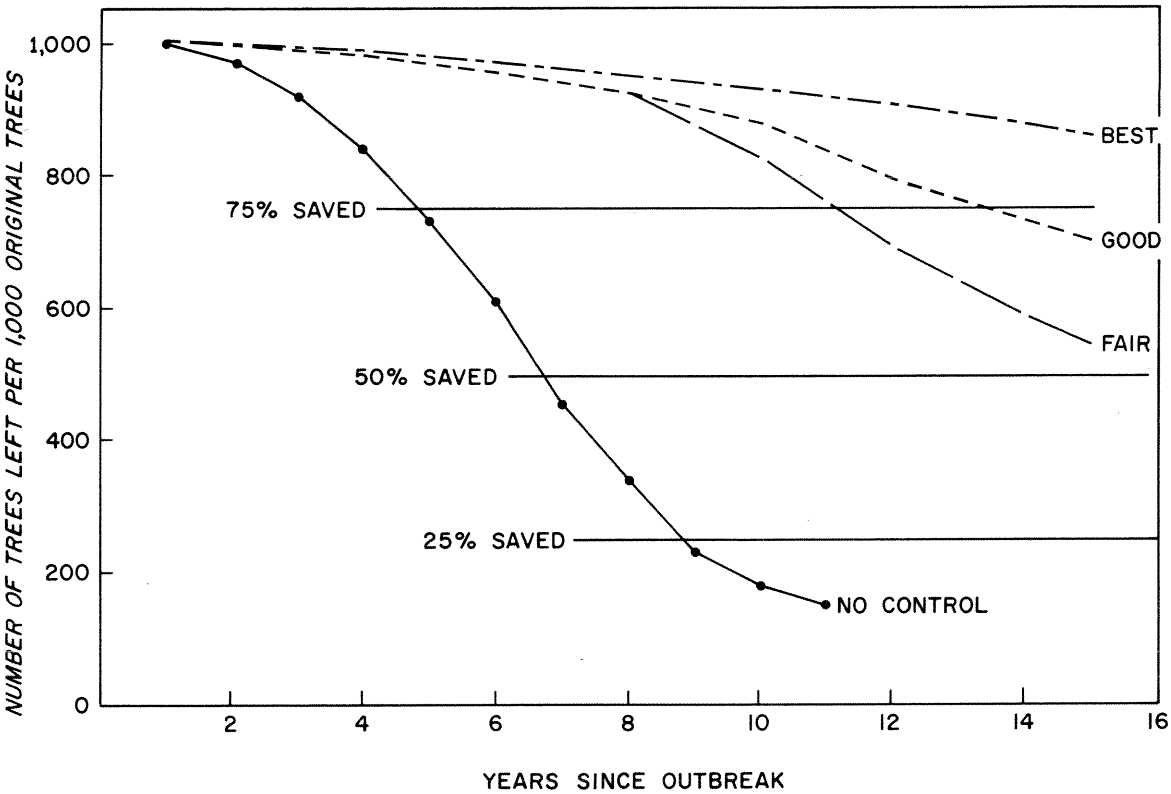
Most communities engaging in a Dutch elm disease control program would like to save as many elms as possible for as long as possible. What do these control performances mean in terms of *save-the-elms*?

For example, we might select *75 percent saved* as a goal. All but the best performance level will allow the elm population to fall below this goal in the 15-year time frame of the study (fig. 2). Without any control, the population of elm trees would drop to the 75-percent level in about 5 years. With the fair and good levels, it would take 11 and 13 years respectively. But with the best

Table 1.—1972 costs of individual jobs comprising the municipal Dutch elm disease control program

Job	Units	Cost	
		Range	Average
Tree removal	Per tree removed	$60.00-250.00	$125.00
Sanitation	Per tree in population	1.00- 2.00	1.50
	Per tree sanitized	15.00- 40.00	25.00
Spraying	Per tree in population	0.50- 0.70	0.60
	Per tree sprayed	1.50- 2.75	2.00
Root-graft control	Per tree treated		5.00
Survey for symptoms	Per tree in population	0.15- 0.30	0.20

Figure 2.—Length of time in which save-the-elms goals can be achieved with different control-program performance levels.



control, it would take 25 to 27 years to drop the population to the 75 percent level.

Of course, if we were willing to use a goal of 50 percent saved, our time frames would be greatly expanded (table 2).

Table 2.—Years before the elm population is reduced to various percentages of the original number of elms by following any one of four municipal performances

Performance class	Years to reduce elm populations to designated levels of the original elms[a]	
	75% Level	50% Level
No control	5	7
Fair control	11	(16-18)
Good control	13	(20-22)
Best control	(25-27)	(44-48)

[a]Estimates in parentheses are extrapolated, assuming continuation of the recorded trends.

Financial Consequences

Most municipalities operate on a budget basis rather than on an investment basis. In our financial evaluation, we did not use a discount rate to conform to budgets. We used our cost data (table 1) and our performances data (fig. 1) to develop a 15-year budget for three alternative courses of action.

1. Tree removal with no control, an estimate of the cost of doing nothing.
2. Tree removal with fair control, using the higher costs from the cost range (table 1). This gives us an estimate of the highest average costs to be expected from an active control program.
3. Tree removal with the best control performance, using the lowest costs from the cost range. This gives us an estimate of the lowest average costs to be expected from an active control program.

The costs of active control measures were used to produce a band of costs rather than cost lines (fig. 3). We would expect that the costs to a community for undertaking a control program would fall inside this band of costs.

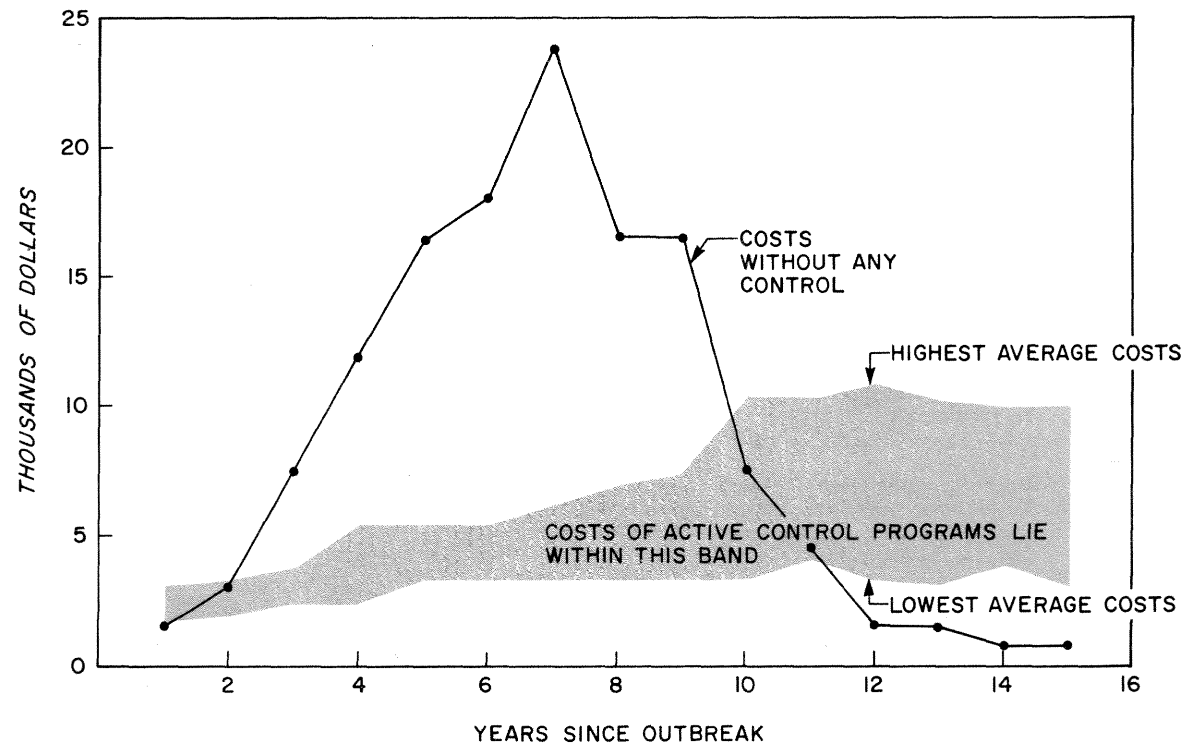
The costs of the no-control alternative rise spectacularly, peaking at about 7 years, then declining to well below the cost band for active control measures at about 12 years. At that time only 10 to 15 percent of the elms remain alive. Early active control efforts slow the increase in costs; and finally, in 5 to 10 years—depending on the efficiency of control—the costs will settle into fairly steady patterns. In 15 years we will still have 55 to 85 percent of the elms left alive, depending on control performance. The benefits of a control program are:

1. More time to enjoy our elms.
2. Fewer budget fluctuations.
3. Time for scientists to find better control measures.

By far the largest loss to the community where control is not undertaken is the reduction of property value associated with loss of shade trees. The minimum value of an elm tree is the cost of removing it, but most people would assign a higher value to it for such esthetic reasons as shade and beauty. Hart (*1965*), in a report on the economic impact of Dutch elm disease in Michigan, stated that the loss in esthetic value greatly overshadowed all other losses. In addition, there are losses of urban wildlife and changes in microclimates. In view of the difficulty in assigning a dollar value to these losses, we chose to use property-value losses since Payne and others (*1973*) suggested that shade, microclimatic, and esthetic benefits can be considered as they relate to residential property values. They indicated that a loss of $250 per tree was appropriate.

Summary costs and average annual costs for the 15-year period are given in table 3. Tree mortality was multiplied by $250 per

Figure 3.—Tree removal and control costs, based on a unit of 1,000 trees.



tree to estimate property loss. For the no-control alternatives, annual budget requirements for the peak year are 2.7 times the average budget requirements. Where positive control measures are taken, the peak budget requirements amount to 1.2 to 1.6 times the average.

Total loss during the 15-year period (table 3) includes the cost of control (table 1), disposal of dead and dying trees, and property value loss. If effort is made to remove elms before they become physical hazards, the budget requirements of a do-nothing program can exceed those of a control program, especially during the 12-year period after introduction of the disease. Larger losses of elms each year require greater personnel and equipment to deal with the situation. A recent development to reduce the costs of tree removal and disposal, and also reduce the volume of material going into sanitary landfills, is to sell the wood for lumber, pulpwood, and other useful products.

While we didn't consider replanting values in our costs, a tree-replanting program could lessen the impact of elm losses on property values in future years. One can hardly equate the esthetic and shade value of newly planted trees 2 to 3 inches in diameter with that of elms 20 to 30 inches or more in diameter, but replacement would eventually assure a stable tree population that would benefit the community.

We judged the effectiveness of the control program in terms of the budget figures and in terms of community values, which include property-value loss. The highest and lowest costs were subtracted from the no-control totals and expressed as savings in dollars and as a percentage of the no-control costs (table 3). The budget savings in control and disposal costs alone amounted to between \$20,000 and \$80,000 for our 1,000-tree unit or between 16 and 63 percent of the no-control option.

These savings were calculated at a zero discount rate as being relevant to a budget situation rather than an investment situa-

Table 3.—Economic impact of control measures for a 15-year period

Items of concern	Cost and performance for three alternatives, based on a 1,000-tree unit[a]		
	No control	Low performance: high cost control	High performance: low cost control
Status of elm population after 15 years:			
Dead (number)	880	438	133
Remaining (number)	120	562	867
Annual budget cost:			
Average (dollars)	8,800	7,400	3,300
Maximum (dollars)	24,000	11,900	4,050
Maximum increase above average: (dollars)	15,200	4,500	650
(percent)	173	60	20
Total loss + cost during the 15-year period:			
Cost of control and disposal (dollars)	132,000	111,290	49,030
Property value loss[b] (dollars)	220,000	109,500	34,250
Total cost + loss (dollars)	352,000	220,790	83,280
Effectiveness of control operation over the 15-year period:			
Savings in control disposal costs: (dollars)		20,710	82,970
(percent)		16	63
Total savings: (dollars)		131,210	268,720
(percent)		37	76

[a]Based on 1972 dollars.
[b]Payne and others (1973).

tion. Had we calculated them with a positive discount rate, say 5 percent, the percentage savings would have been larger. The peak costs of the no-control option against which the active controls were compared would have been disproportionately greater. Our percentage savings on a budget basis are conservative.

Both Marsden (*1953*) and Sinclair and others (*1968*) proposed that the annual expenses of a control program might be substantially less than the expense of elm removals in the absence of a program. The experiences of the municipalities in our study bear this out (fig. 3). Of course, the annual cost of elm removals in a no-control program will decline as fewer and fewer elms remain to be infected with the disease. The additional cost of an active control program will, at that time, be protecting a substantial elm population (table 3).

The implication for managers in terms of budget requirements is that even the costliest control program would create less of an impact on the annual budget than the tree-removal costs of no control (fig. 3). If the disease were allowed to proceed unchecked, the annual budget requirements would rise sharply. This would probably disrupt the budget planning of most communities.

Summary and Discussion

The efforts made by municipalities to suppress Dutch elm disease have had highly variable results. Differences in performance could be traced to both biological and operational reasons. In many instances the operational difficulties outweighed the biological factors. We found that performance was not related to particular control strategies.

The budget costs of control programs were less than the costs of removing the large numbers of elms associated with the no-control alternative. Fluctuations in the annual budget were minimized, enabling managers to plan for the long pull and to maintain control performance. Total savings attributed to control programs ranged from 37 to 76 percent.

A community attempt to save the elms is greatly enhanced by an active control program. If we assume that a reasonable goal is to save 75 percent of the elms, the lack of an active control program will allow the elm population to sink below the goal in 5 years. An active program can extend this time by a factor of 3 to 5, depending on the level of control performance.

The quality and quantity of effort to apply control programs to limit Dutch elm disease inevitably reflects the interests and resources of local communities and their governing bodies. Some communities temporarily suspended control programs during a period of temporary financial stress only to find that they could not regain control of the disease situation later. Faced with increasing elm losses, and lacking the resources to substantially increase their control efforts, they found themselves with an ever worsening situation until few elms remained. The communities that experienced the fewest elm losses not only had well-founded control programs and applied them conscientiously, but sustained their efforts over the years.

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