COMMUNITY SHADE TREE PROGRAMS IN MINNESOTA

A Study of Participation and Effectiveness

by

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ABSTRACT

Three major aspects of local Shade Tree Programs in Minnesota were examined: participation in the state Shade Tree Program; variables associated with differences in sanitation effectiveness; and variables associated with differences in replanting success. Measures of the last two were based upon state inspector judgments in 1980 and reports of program activity between 1977 and 1979. Other information was obtained from interviews of program managers in communities both involved and not involved in the state program, interviews with 1,667 citizens in 36 communities with shade tree programs, case studies of eight communities with programs, data from reports and applications filed with the state by communities, and information from a variety of official state and federal sources (e.g. census).

It was found that many communities have distinctive situations, the program managers have few complaints about the state Shade Tree Program, and that community residents prefer a healthy community forest (and are even willing to pay more taxes for same), but only a minority are directly affected by Dutch elm disease (because most have no elms nearby). Communities not participating in the state program appeared to be smaller, not confronted with or are unaware of the threat of Dutch elm disease, and involved in some administrative confusion. Communities with more effective sanitation programs appeared to be located further north in the state, having few infected adjacent wild elms, and citizens that expected local governments to deal with community problems; citizen awareness of the local program, appropriate program operation, and use of elm firewood all seemed to have additional effect. It was more difficult to find factors with a

stable relationship to replanting success, a substantial minority of communities had replanted no trees at all; but citizen awareness of the program, northern location, good condition of neighborhoods, and the level of local taxes seemed to have some effect.

A number of recommendations were developed for consideration by the State Shade Tree Program, including special support for smaller cities, more assistance for administrative procedures, more attention to the uniqueness of the local communities' situations to complement concern for standardizing all aspects of local programs, allowance for sanitation control beyond city limits and promotion of the state replanting program to the nonparticipating communities.

CHAPTER 1

INTRODUCTION

Shade trees are important to Minnesota communities. They serve to moderate temperatures in both winter and summer, thus decreasing energy needs, and have substantial aesthetic value; a healthy, mature community forest provides beauty and privacy, while screening out unpleasant views. All these features add to property values and civic pride. Unfortunately, within the last decade two major shade tree groups have been threatened, oak and, particularly, elms are being lost to species-specific diseases and many communities have established programs to slow or stop the diseases and compensate for the lost trees through replacement. The state Shade Tree Program was established in 1977 to provide expertise and financial assistance to these local programs. Based on the annual reports submitted by the local programs, it has been observed that there is a substantial variation in their effectiveness. This report describes an attempt to identify and understand the factors accounting for variations in local program effectiveness.

Shade Tree Disease

Perhaps because of the aesthetic appeal of a uniform community forest or the particular advantages of elms and oaks, many cities planted or nurtured one of these two species from border to border at their inception (late nineteenth and early twentieth century). Though seemingly justified at the time, years later these monocultures would leave these communities open to devastation when diseases would sweep through the state. Discussion of these events

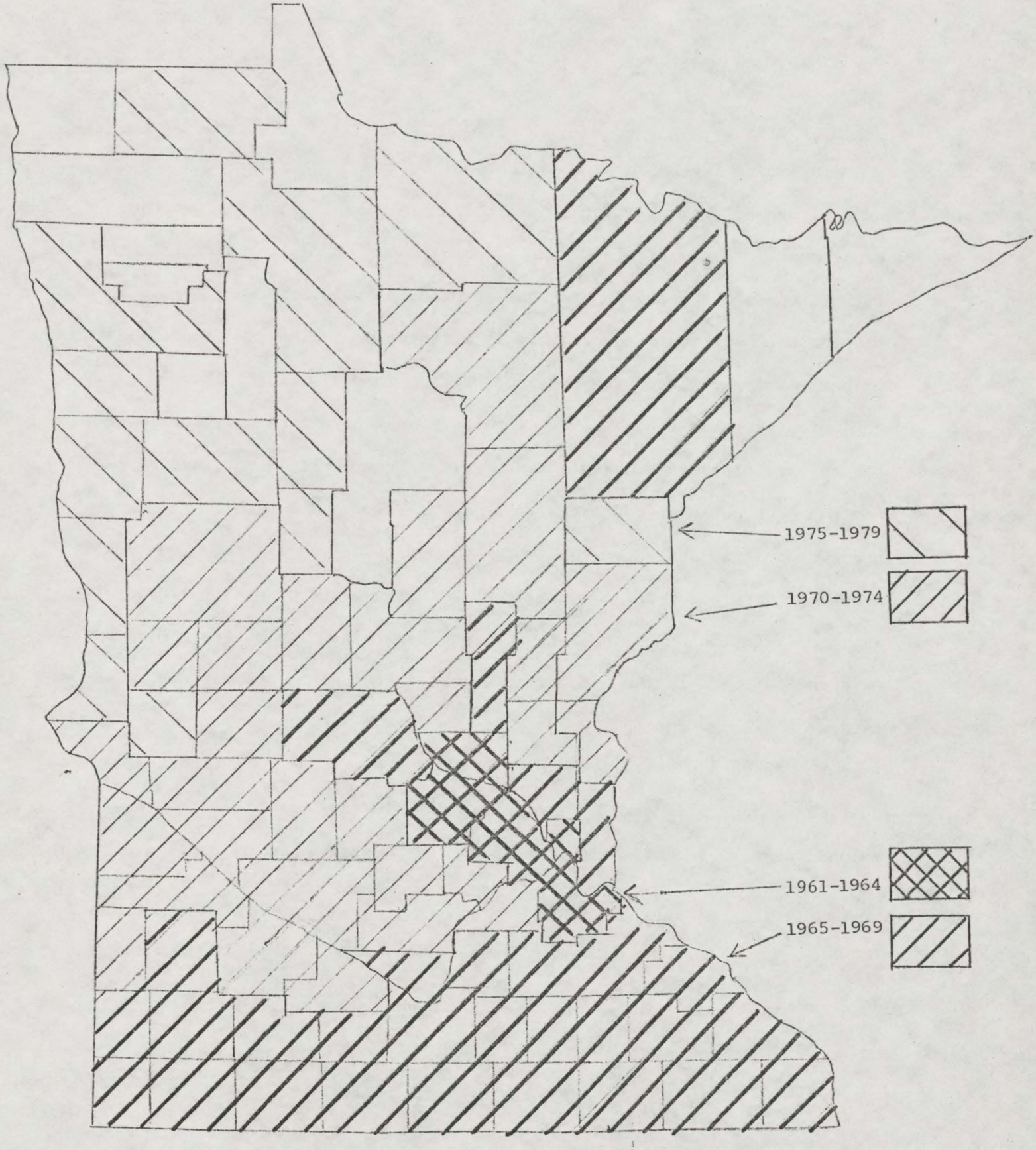
and their implications is clearest when focused on one disease. Since elm losses appear to be ten times as high and the disease is transmitted more quickly, discussion will center on Dutch elm disease. Most programs are similar for both species.

The first reported elms affected by Dutch elm disease were in St. Paul and Monticello in 1961. Counties in and around the metropolitan area were also infected in the early 1960s (see Figure 1-1). By the end of the decade, St. Louis County and three southern tiers of counties had confirmed cases. In the next decade, the 1970s, the disease would spread north and west covering most of the state. Many communities in the south have lost most of their trees while others have been more fortunate. Farther north, the battle goes on.

The only proven method of disease control is quick removal of diseased trees. The elm bark beetle inadvertently infects healthy trees with the fatal fungus when it feeds on the tree's tender new growth. As the tree dies, beetles return to lay eggs beneath the loosened bark. Only if the tree is removed and properly dispose of before the new disease-carrying beetles emerge can other trees be saved. By reducing the annual losses, communities give themselves time to replant their urban forests.

Since the disease is likely to suddenly strike a community, a sanitation program can put a sudden, perhaps severe strain on the community budget. The state can help ease this strain by assisting in the program of each community. State expenditures would be uniform as the ebbs and flows of incidence across the state would even out. Furthermore, the state would be able to provide necessary expertise to help communities quickly prepare to combat the disease when it became a problem. The final argument for state involvement, and perhaps the most important, is that Dutch elm disease is a problem of more than local concern. One uncaring community could negate

Figure 1-1 DISTRIBUTION OF DUTCH ELM DISEASE AND YEAR OF CONFIRMATION FOR STATE THROUGH 1979



source: Shade Tree Division, Minnesota Department of Agriculture

the most intense efforts of other adjacent communities. In response to these needs, the present state Shade Tree Program was established in the Department of Agriculture in 1977.

State Program

The Shade Tree Program was a natural outgrowth of prior Department of Agriculture programs in pest control. Earlier laws had authorized the Department to designate pests and prepare plans for dealing with them. As Dutch elm disease became a Minnesota problem, powers more specific to that disease were written into law. In 1975, funds were allocated to subsidize private landowners removing diseased trees. The 1977 law expanded on this beginning in three areas: funds were substantially increased, subsidies became possible for removing diseased trees from public lands, and replanting expenses could be supported.

Communities in the seven-county metropolitan area are required to have a shade tree program and may participate in the state program thereby gaining access to financial support and state expertise. In outstate Minnesota, existence of any program and participation in the state program are voluntary.

The state has established minimum standards to which it expects communities to adhere if they are to participate in the Shade Tree Program. Beyond these minimums, communities are free to emphasize any portion of their program or expand upon it.

Program Effectiveness

The overall effectiveness of the state program is quite good, though there are substantial variations among communities, some better or worse than average. During the first three years of the program, elm losses fell from 240,000 to 166,000 to 115,000 per year. The losses have been reduced by nearly one-third each year. And 1980 appears to be showing continued reductions. The extent of reforestation has also been gratifying. From 1977 through 1979, the state program has helped plant nearly one-third million trees. Furthermore, replanting is accelerating; more trees have been planted each year than the preceding year.

Many different types of communities participate in the state program. Nearly 500 cities, many counties and a few townships and special jurisdictions are currently participating. The emphasis in this report will be on cities. County programs are too limited to be of general interest, e.g. many cover only county parks. Too few other jurisdictions participate.

Within cities, program effectiveness varies widely. Tree losses from disease across the state have varied from none to complete. Even within a single county, Hennepin, 1977-78 losses range from under 1 percent to over 25 percent. Replanting success has varied as well. As many as 40 percent of the cities have replanted none of their tree losses. At the other extreme, a like number of cities have planted, during the 1977-79 period, more than the number of trees lost during the same period.

Some explanation must exist for these differences. All cities have the same knowledge of technology.* The differences must lie in other areas: environmental, social, organizational, or political. To the extent that some of these factors can be controlled, it is useful to deter-

*Though it may not be available to them.

mine what makes for a successful program. This knowledge can be used to implore local shade tree programs.

Research Objectives

The major focus is to determine what factors are associated with variation in local shade tree program effectiveness in furthering community forests. This was defined in terms of three major issues:

1) What is related to the decisions of local communities to participate in the state shade tree programs?
2) What factors are associated with relative effectiveness in sanitation, or controlling the spread of the Dutch elm disease?
3) What factors are associated with relative effectiveness in replanting, or maintaining community forests through replacement of lost trees?

Conduct of the project involved several major activities; obtaining useful measures of the dependent variables (particuarly sanitation and replanting effectiveness), determining those factors that might be related to variations in these program characteristics, assembling the data required to provide measures of the different variables, and developing a strategy for analysis.

Of the three major issues, the focus of the first--program participation--is relatively easy to measure; the records of the state Shade Tree Program provide clear evidence of community participation. Measures of sanitation and replanting effectiveness of local programs were somewhat more difficult to develop. Two strategies (reviewed in Appendix A) were

utilized; the evaluations (ratings) of state program inspectors and measures of program activity for the years 1977, 1978, and 1979. The latter data were utilized in a variety of measures of impact, such as the annual proportion of total elm inventory removed (as a measure of sanitation effectiveness) or the percentage of removed elms replaced (as a proxy measure of replanting effectiveness). While a careful analysis indicated that the state inspectors tended to make reliable judgments (that is they agreed with each other), there was no systematic relationship between the judgments of state program inspectors and any measure of program activity. This indicated that two different aspects of the local programs were being measured; both were retained for analysis.

Sources of Data

A wide range of sources provided the data used in this project. They will be summarized below; more detail is provided in the appropriate appendices:

State program inspector judgments were obtained for all local programs in terms of overall effectiveness, sanitation effectiveness, replanting effectiveness, and committment to urban forests. (Reviewed in Appendix A).

Telephone interviews with community officials were obtained in July and August of 1980. After controlling for size and location in the state, communities to be studied were selected at random. Over 240 interviews were conducted with those responsible for the day-to-day operations of the local programs, those responsible for programs that had dropped out of the state program, or knowledgeable officials in communities that had not joined the state program. (Reviewed in Appendix C.)

Telephone interviews with citizens in 36 participating communities (selected to represent a range of program effectiveness, size, and location) and two state regions were completed in the summer of 1980. Citizens in these areas were selected at random to be interviewed. A total of 1,667 individuals, a response rate of 70 percent, provided their attitudes toward shade trees, personal actions taken to further the community forests, as well as their perspectives on the local governments and local shade tree programs. (Reviewed in Appendix B.)

Case studies of selected communities were conducted during the summer of 1980 to determine the extent to which atypical features of communities or distinctive historical events may have affected their shade tree programs; a total of eight communities (selected to represent variations in program success, city size, and geographical location) were involved. (Reviewed in Appendix D.)

Local program reports filed with the state Shade Tree Program by the respective communities included the year-end reports for 1977, 1978, and 1979 and the applications for 1980 (which reported plans for the local program). (The forms completed by these local programs are presented in Appendix E.)

Government data from both state and federal sources was obtained and, in some cases, organized specifically for this project. Included were data from the 1970 U.S. census, 1975 and 1977 population updates, information on land areas of communities, area of city parkland, nature of vegetation in the areas adjacent to the communities, nature of local government form, taxes collected in the community as well as many other variables. (Reviewed in more detail in Appendix F.)

This data was selected as representing over 120 possible factors that may be associated with (and perhaps causally related to) variation in local shade tree program effectiveness. The major problem on the project was organizing a systematic, methodological procedure for the integration and analysis of these variables.

Organization of the Report

The report is organized in terms of the five following chapters and a separate appendix (containing the descriptions of data sources reviewed above). An overview of the community programs, the perspectives of the citizens, and the relationship between the community and state shade tree programs is provided in Chapter 2. Chapter 3 is devoted to a discussion of those factors that would seem to be related to the decision of a community to join, participate, or drop out of the state sponsored program. Analysis of those factors responsible for variations in sanitation effectiveness is the emphasis of Chapter 4; Chapter 5 focuses on factors associated with variation in replanting effectiveness. A summary of the major findings and policy recommendations are reviewed in Chapter 6.

CHAPTER 2

ATTITUDES TOWARDS SHADE TREE PROGRAMS

Community forests are part of the physical environment that is the responsibility of both the citizens (as they support the local government and own the land under the private trees) and the local government (as they supervise the shade tree programs and are responsible for the trees on public land). Descriptions of these two major components are available from three sources of data collected for this project. An interpretative description of the situation in eight communities selected for case studies provides a discussion of the interrelation between the local shade tree programs and the citizens: three distinctly different communities are presented here. The telephone interviews completed with community residents in all parts of the state provides background on how the typical citizen (and voter) feels about their community forests and the local programs. Interviews with the managers of slightly less than one half of the local shade tree programs provides information about the initiation of the programs, their operation, and relations with the state Shade Tree Program.

Three Case Studies

St. Cloud, St. Paul and Dayton illustrate the broad range of experience and success which Minnesota cities have had in coping with Dutch elm disease. Those experiences are summarized below. More detailed write-ups of these and the other five case studies are presented in Appendix D.

St. Cloud, one of the state's larger cities, has a program rated very highly by the state inspectors for both its sanitation and replanting effectiveness. St. Cloud is doubly blessed: it has a less severe disease problem than most other cities studied and it also has sufficient financial resources and manpower to remove diseased elms quickly and to replant more trees than

are removed. The operating personnel appear to be enthusiastic about the program and efficient in carrying it out. One factor, mentioned as lacking in St. Cloud, is the interest of the general citizenry or the elected officials; both were described indifferent by local respondents. The program succeeds without their knowledge or support. Perhaps in large cities a general awareness and support are not as crucial to a smoothly operating and efficient program as in small towns. One unique feature of St. Cloud's reforestation program is the steward concept: private citizens plant trees, at their own expense, on the boulevards (which are not considered public property) and have the responsibility for caring for the trees for their first five years. After five years the city accepts responsibility for them. This approach does encourage citizens to take better care of boulevard trees after planting, but St. Cloud officials feel that replanting would be even more successful if the city assumed full responsibility for boulevard reforestation.

A different situation exists in St. Paul, the state's second largest city. Its sanitation program was rated low by the state inspectors but the replanting program received a high evaluation. St. Paul, in contrast to St. Cloud, had an unusually high elm population and, thus, a potential for a severe disease problem. To make matters worse, large tree losses occurred several years before significant state aid was available: 2,000 in 1975, 19,000 in 1976, and 47,000 in 1977. Although major management difficulties were confronted in 1977, the logistical problems of removing and disposing of so many trees have not been faced by any other city in such a magnitude. In the last three years, St. Paul has replaced more trees each year than were lost to disease. In contrast to St. Cloud, this was done with great citizen support and with leadership from the elected officials. St. Paul committed thirty million dollars of its own funds to the program in the past three years (1977-1980). The mayor was instrumental in encouraging such an

allocation. A unique feature of St. Paul's sanitation program is the city's willingness to pay the full cost of removing diseased elms from private property. While there were some problems with the administration, and consequently cost, of this policy, it probably did help to reduce the spread of the disease.

Also distinctive is the situation in Dayton, a medium-sized metro-fringe community. Both sanitation and replanting were rated as very low by state inspectors. The city of Dayton includes within its boundries both residential and farm land, a major source of its problems. Unlike St. Paul, Dayton does not provide city funds for the cost of removal from private property. The reason is that many Dayton residents live on farms (or other areas) larger than five acres; areas of this size are excluded from reimbursement from state funds. City officials treat all citizens equally by not reimbursing anyone for private diseased tree removal. Some property within the city limits may contain as many as 100 private elms, making it quite expensive for the owner to exercise any sanitation efforts. The officials and citizens of Dayton manifest low interest in the program; Dayton would probably not be participating except that all metropolitan communities are required to be involved. There is a very low level of commitment to the existing program; the city does not reimburse the removal of trees from private property and, although it purchases trees for replacement, it relies on volunteers to get them into the ground. State inspectors rated the effectiveness of such a program as very low.

Citizens and Their Trees

Local shade tree programs operate within and through community residents. A total of 1667 typical residents were interviewed as part of the project; all were from communities with more than 200 residents (such citizens represent 73.8 percent of the 1977 Minnesota population), almost all were from communities with local shade tree programs (such citizens represent 68.0 percent of the 1977 Minnesota population). Inferences are therefore justi-

fied only for those 68 percent of the state population that live in communities of 200 or more and have local shade tree programs and not the 32 percent living on farms, in rural residences (included in townships), or in small communities or those without local shade tree programs.* The details of the survey, which was conducted by phone and resulted in a 69 percent cooperation rate, are reported in Appendix A.

CONDITION, CONCERN FOR SHADE TREES

When asked specifically about the importance of shade trees, the majority reflected a substantial concern for shade trees, 43 percent considered them extremely important and 48 percent very important (a total of 91 percent). Most tended to consider their value for summer shade and winter windbreaks as their most useful feature, with contributions to the appearance of the neighborhood and property values as important. Respondents considered the shade trees in their neighborhood as in excellent (24 percent) or satisfactory (51 percent) condition; one in four (24 percent) felt they needed some or lots of work. When compared to satisfaction with the condition of other features of their neighborhood, most placed shade trees in a second category of acceptability, along with the condition of the streets, sidewalks, etc. and the street lighting. The highest levels of satisfaction were associated with the trash collection; conditions of public parks and property; condition of exteriors of homes, buildings; and the condition of yards and shrubs around buildings. Approximately one in ten thought these four latter features required some or lots of work.

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*Most community residents (61percent) live in the Twin Cities metro area and the survey was not designed to provide a random sample of them; respondents were deliberately selected from communities all over the state. As one test of the appropriateness of using the sample as representative of all community residents in the state, the distributions for several questions (attitudes towards trees and property tax increases for the shade tree program) was weighted in proportion to the urban dwellers living in each of the ten regions within the state. For all categories of responses the differences were less than 1 percent between the two frequency distributions (weighted and unweighted). Hence, the following analysis is based upon the unweighted distributions of responses.

Preservation of community forests is clearly threatened by the Dutch elm disease, and most respondents considered it a major (34 percent) or important (28 percent) threat. However, most did not consider it a threat until 1976 (regardless of where they lived in the state), this may reflect the publicity given to the Dutch elm disease by Twin Cities mass media and state government, rather than its history of dispersion. Moderating the direct effects of the Dutch elm disease for typical community residents is the lack of elm trees in their immediate neighborhood, almost two-thirds report there are NO elms either on their own property (63 percent) or on public land (64 percent) adjacent to their property; only 11 percent report that elms constitute all or most of the shade trees in their neighborhood. Hence, while they may consider community forests important, the immediate forest environment of most is not threatened by the Dutch elm disease due to the absence of elms.

PERSONAL ACTIONS RELATED TO TREES

This is, perhaps, why such a small percentage report taking direct action related to the Dutch elm disease: 18 percent have reported an elm suspected of infection (3 percent have reported 4 or more); 5 percent have chemically treated an elm (1 percent have treated 3oor more); 27 percent report that elms have been removed from their property (5 percent report 4 or more removed); and 31 percent have planted trees to replace those lost or expected to be lost (11 percent have planted 4 or more). Further, there has been little government activity on adjacent property (mainly boulevards): 29 percent report that infected trees were removed from adjacent property (9 percent report 5 or more removed) and 23 percent report new shade trees were replanted on adjacent property (9 percent report 5 or more new trees planted by the government). Moreover, there is evidence of willingness to help with newly planted trees: of the 58 percent that considered the question relevant,

one in four reported watering new trees planted by the government sometimes or frequently.

One important activity that is suspected of contributing to the spread of Dutch elm disease is the use of infected elm for firewood, by providing a breeding site for the beetles that carry the disease. When asked about household use of firewood, two-thirds (67.4 percent) reported that they never used firewood or that it did not apply to their situation; 22 percent reported using firewood several times a week, 6 percent once a week, and 5 pe-cent once a month. When the responses were considered in terms of state region of residence, the results (as presented in Figure 2-1, indicated that the heaviest use of firewood was reported in the Twin Cities metro area, closely followed by community residents in the northern regions; community residents in the southern regions reported the least use of firewood. While it is possible that the respondents were not always able to recognize elm firewood, 35 percent of those that used firewood (10% of all respondents) reported that from one-quarter to all of their firewood was elm. Of those reporting that elm firewood was used, one-third said that it was all debarked, one-half said that none was debarked, and one-sixth gave intermediate responses. In other words, five percent of all households apparently use elm firewood and it is not debarked.

While the respondents report a personal concern for their shade trees, few have taken collective action to attempt to cope with the problem: 5 percent report working with others to treat trees; 12 percent report working with others to identify and report infected trees; 15 percent report working with others to remove infected trees; and 15 percent report working with others to replant trees. Most have not taken action directed toward their local governments; 9 percent have made individual presentations such as letters, phone calls or personal visits (representing several hundred thousand individual contacts) and 5 percent have attempted to have an impact as part of a group.

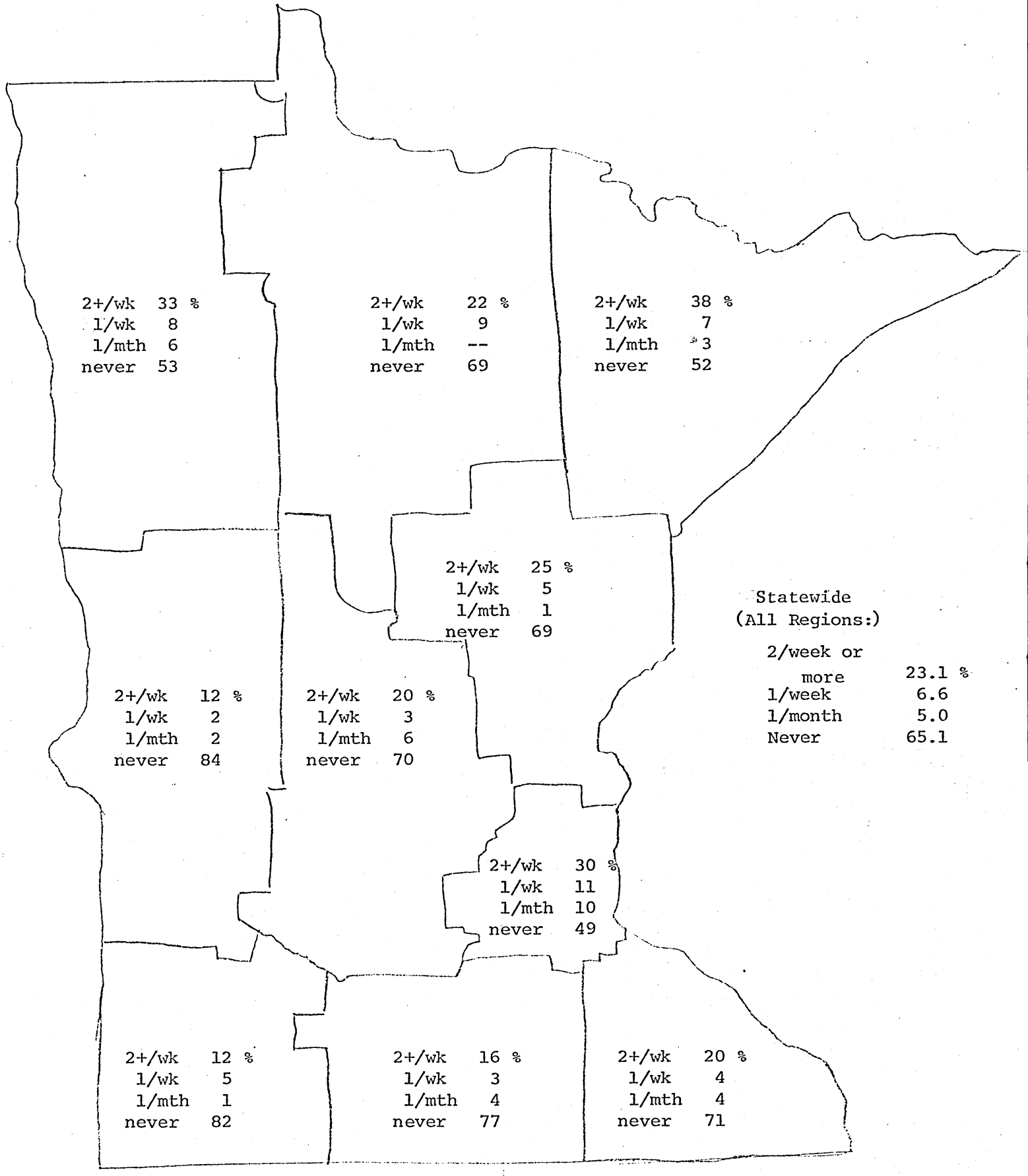

Figure 2-1: REPORTED USE OF FIREWOOD (ALL SPECIES) BY REGION

GOVERNMENT EMPHASIS ON SHADE TREES

This lack of efforts directed toward the local government may reflect the views of what activities local governments should emphasize. Given the choice of a "great deal," "much," "some," or "none," respondents tended to consider that local governments should give a "great deal" or "much" attention to crime, education and fire prevention; give "much" or "some" attention to sanitation and garbage collection, job opportunities, recreational facilities, health care, and housing quality; and "some" attention to racial problems and neighborhood appearance (which would include shade trees). (The low emphasis on racial problems probably reflects the racial homogeneity and absence of racial problems in most communities in Minnesota.) While the respondents valued their shade trees, they did not feel that attention to neighborhood appearance should be a major focus of local government.

Judgements that it was appropriate for the local governments to give some, but not a lot, of attention to shade trees was consistent with a willingness to spend additional taxes to promote shade trees. While slightly more than two-thirds of the respondents (71 percent) were willing to pay from $10 to $200 or more additional property tax dollars per year for an adequate shade tree program, this was affected by household income. Figure 2-2 presents the relationship between household income (listed in three categories) and the cumulative percentage willing to pay each level of increased taxes for shade tree programs: 100 percent were willing to pay at least nothing, from 61 percent to 82 percent $10 per year or more, from 21 percent to 51 percent $25 per year or more, and so on. Only in the very lowest income category, households with less than $5,000 per year income, did the majority (53 percent) indicate a reluctance to pay any additional taxes for a shade tree program. Even if all of the 30 percent of

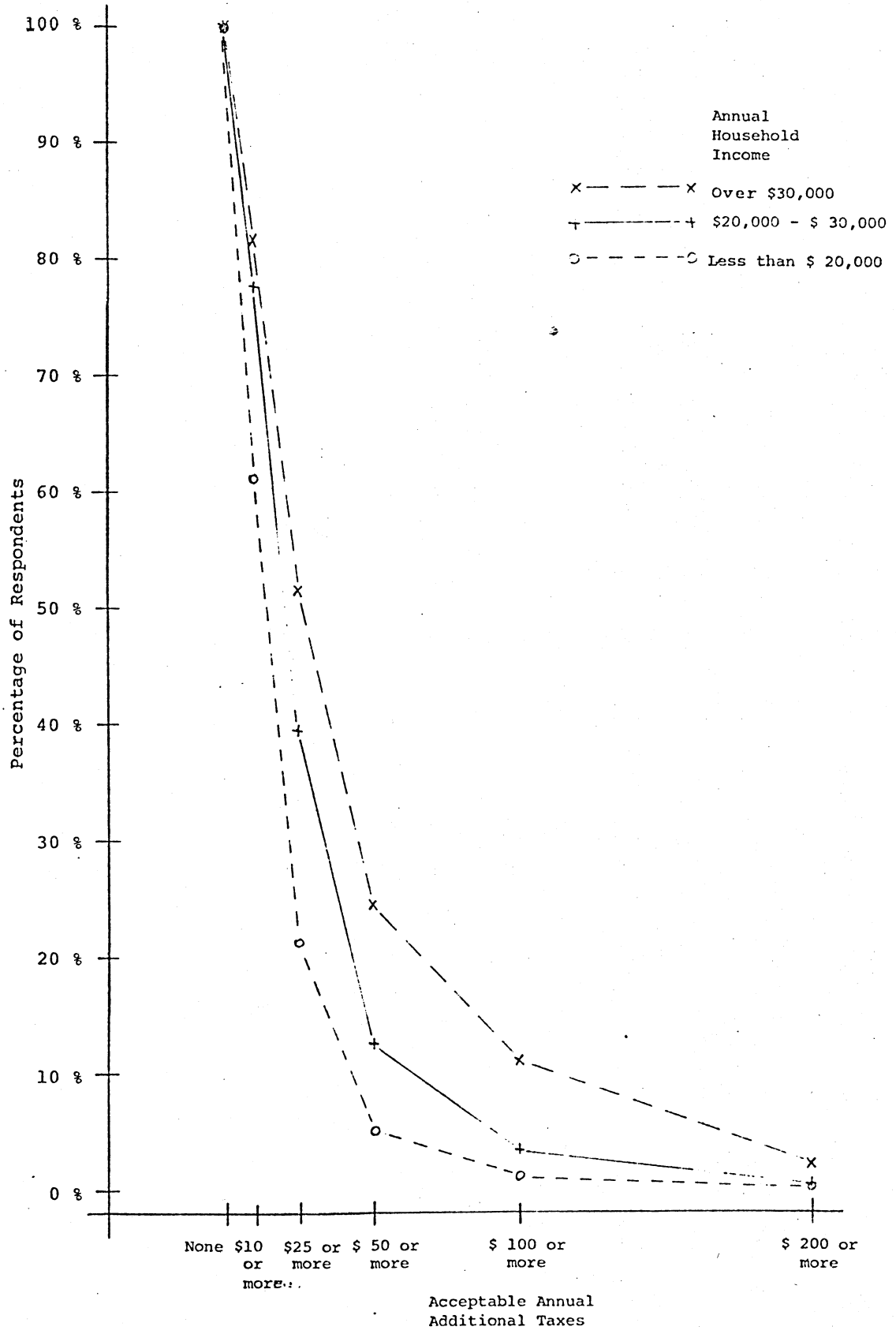

Exhibit II.2 Acceptability of Additional Taxes for Adequate Shade Tree Program

those who chose not to provide the interview were unwilling to pay any additional taxes for shade tree programs, approximately one half of the community residents (49.7 percent) would have indicated a willingness to accept a "shade tree tax increase." Among those interviewed, the weighted average* of an acceptable tax increase was $17.85 per household.

ORIENTATION TOWARD LOCAL PROGRAMS

Most respondents indicated substantial uncertainty about features of local shade tree programs. Less than one half were definite (answering yes or no) about the existence of special phone numbers for reporting suspected trees, financial assistance for removing private but infected trees, existence of a penalty for slow removal of private trees, or financial assistance for replacing trees lost to the disease. The last two characteristics are not mandated parts of all local programs** and the percentage of definite responses (yes or no) declined from 40 percent to 30 percent for these questions. Most community residents are not clear about the emphasis to be given to three major activities in local programs: chemical treatment, removal of infected trees, and replacement of lost trees. These estimates appear to be guesses rather than reasoned judgments.

When asked about the conduct of their local program, most considered it average (54 percent), with a greater number giving good ratings (11 percent excellent and 20 percent above average) than poor (below average 10 percent and terrible 5 percent). Almost identical distributions were provided for a general rating of the effectiveness and efficiency of local government; the ratings were modestly correlated (pearson r of 0.42; highly significant statistically). A major difference was the percentage that did

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*Computed by summing the percentage of responses in each tax increase category multiplied by the dollar value of the tax increase category.

**Special phone number in metro area only.

not evaluate their local shade tree program (25 percent) when compared to the number that failed to evaluate their local government (3 percent).

REVIEW

Overall, this sample of community residents appears to value its shade trees and are willing to have the local government spend some time and tax money on their community forests, but many are not directly affected by Dutch elm disease (the elms are gone or were never present) and would not consider shade trees the first priority of local governments. On the other hand, they would probably support modest efforts (modest in relation to other government responsibilities) and provide their willing cooperation when a program affected them directly. A small, though significant, number have been involved in activities to preserve their community forest or encourage local governments to take action.

City Program Managers and Their Trees

The local shade tree programs are both the key to maintaining a healthy community forest in the face of the threat from disease and the focus of this research effort. In order to develop descriptions of these community agencies, program managers in 239 operating programs were interviewed by telephone. Their responses provided information related to their own experience and backgrounds in forestry, why their community decided to initiate a shade tree program, the nature of their local situation, the operation of the local program, and comments on their reactions to the state Shade Tree Program. No attempt was made to verify or adjust their responses.

The pages which follow summarize the results of this survey. For the sake of brevity, the median value is often presented as representing the "typical" response. The median value represents a mid-point with half the responses above and half below. Another point will aid the reader in understanding the summary results of open-ended questions. Managers often responded with more than one issue, problem, etc. Data presented indicate the percent mentioning each issue and these can easily sum to more than 100 percent.

PROGRAM MANAGER

The typical person interviewed had worked in the city 6.2 years and in forestry or shade tree programs for four years. The person spends 10 percent of the time administering the shade tree program, 10 percent in the field working directly with trees, and 80 percent of the time in tasks unrelated to trees. Training in forestry or shade trees has been provided in one or more ways: seminars (47 percent), job experience (45 percent), forman training (15 percent), informational literature (14 percent), and agricultural extension courses (13 percent). However, 14 percent indicated they had no training in forestry or shade trees.

Managers were asked their views about the role of local government. Forty percent or more felt local government should give a "great deal of attention" to: housing quality (40 percent), recreation facilities (48 percent), job opportunities (40 percent), education (50 percent), fire protection (69 percent), crime (69 percent), sanitation and garbage collection (54 percent), neighborhood appearance (48 percent), and shade

trees (51 percent). When combined with a feeling that local government should give "much attention" to these issues, the support for action in these areas is amplified. For example, a total of 82 percent felt government should give more than some attention to shade trees. Only health care (35 percent) and racial problems (35 percent) fell below this 40 percent threshold.

REASONS TO START A PROGRAM

Managers were asked a number of questions about the origin of their shade tree program. Nearly half the cities represented (47 percent) had a "shade tree program" in effect by 1976, the year before the current state grant program began. When asked why their city started a program, two-thirds said because Dutch elm disease had become a problem. One quarter (26 percent) mentioned "state influence." No other reason was mentioned by more than 10 percent of the cities.

When asked to rate a number of sources as to their importance in influencing the initiation of the shade tree program, incentives from state or national agencies were rated important by nearly three-quarters (73 percent) or the cities. Concerned energetic individuals were mentioned as important in nearly half the cities (46 percent). Other sources rated important were media (38 percent), organized groups of citizens (26 percent),

neighborhood organizations (21 percent), and local government such as the county (12 percent), and adjacent communities (11 percent). In only the first three sources did the number of managers finding that source important outnumber those finding that source unimportant.

LOCAL SITUATION

Nearly half the cities interviewed first identified the presence of Dutch elm disease by 1974 and had seen the disease take off by 1976. By 1980 the disease had been identified in all of these cities and had become a problem in all cities interviewed.

Of those 150 managers citing an original source of the disease nearly two-thirds (63 percent) mentioned the migration of the beetle. Elm firewood was mentioned as the source by only 9 percent of the managers. Twenty-eight percent mentioned river corridors and 5 percent, other wild elms. When asked whether wild elms were a source of infection this summer, one-third called them a major source and another 48 percent a minor source. Only 54 percent could call half of their wild elms healthy. In four of five cities (79 percent) 10 percent of the wild elms had disease symptoms or were dead less than one year.

Within the city different elm distributions were observed. In a typical (median) city over two-thirds (70 percent) of the elms are evenly distributed while 30 percent are clustered. Were removal necessary, accessibility to the trees would be routine for three-quarters of the elms,

moderately difficult for 15 percent, very difficult or impossible for 6 percent. Specific cities may differ considerably from this typical city.

OPERATION OF LOCAL PROGRAMS

Emphasis of the local program in five areas was estimated by the program managers. One-half the effort in the typical city is spent on inspection and removal. Replanting consumes 20 percent of the effort. Citizen education draws 13 percent of the effort; firewood inspection, 10 percent; and chemical treatment, less than 1 percent. Support for these programs seems high in all quarters - residents, mayor, city council, and city employees. Over 90 percent of each group provide support or enthusiastic support for disease control and replanting programs.

A good shade tree program must contain a large number of features according to the managers interviewed. The most important feature, mentioned by 78 percent, is a good sanitation, removal, and disposal program. A related feature, prevention and maintenance, including an early start with programs and inspection, was mentioned by 44 percent. Cooperation and awareness from the community was mentioned by 24 percent, while additional community resources was mentioned by 16 percent. Other features mentioned by a significant number include adequate financial assistance and reimbursement (14 percent), replanting (13 percent), treatment and control techniques (10 percent), and controlling beyond corporate limits and inter-community cooperation (8 percent).

The managers were then asked to mention the strong points of their program and areas which they felt needed improvement. For the most part, they felt they had emphasized the issues in the same ranking, yet needed to continue to push for improvements. For example, two-thirds felt that good sanitation, removal, and disposal was a strong point of their program and

14 percent saw room for improvement in this area. Other areas mentioned as possible sources of improvement were obtaining additional community resources such as personnel, equipment, and administration (17 percent) and adequate financial assistance and reimbursement (12 percent).

A number of questions were asked about the sanitation programs operating in the cities. Almost all felt the coordination between marking and removal was excellent (37 percent) or acceptable (59 percent). The median delay between marking and removal was about 20 days regardless of whether these were low or high risk trees.* In less than one percent of the cases do citizens make an active attempt to prevent or delay tree removal in the typical city. Citizens need reminding, or other pressure, to remove marked trees from their own property about 5 percent of the time.

Inspection seems complete but some problems are apparent. The typical city inspects all trees by June 15 and again between that date and July 15. One-fourth of the cities miss this mark and inspect 75 percent or fewer of their trees in these periods. In the typical city, only 10 percent of the diseased trees are reported by a citizen before an inspector. Of the trees marked, typically one-quarter are low-risk and three-quarters high-risk.

Questions were asked about the replanting programs. In the typical city, three-quarters of the trees removed from public property were replaced within one year. Half the private trees were also replaced. Citizens were useful in the replanting effort. They provided a great deal (57 percent) or some (32 percent) care for the trees on public property in the great majority of cities. Government coordinates the selection of replanting species with citizens in most cities: a great deal (30 percent) or some (40 percent) of the time. Even in cities not participating in the replanting program, citizens are interested in replanting. Citizens or neighbor-

*Mean delays were 28 and 18 days respectively.

hood groups call and request replantings frequently (23 percent) or occasionally (47 percent) in the full sample of managers.

The use of elm for firewood could devastate an otherwise sound shade tree program. Managers estimated numerous percentage figures about elm firewood in their communities. In the typical participating city, 10 percent of the firewood used is elm. About two-thirds (65 percent) of this has been debarked. When asked what kind of threat the use of elm for firewood posed as a source for new infections of Dutch elm disease only 13 percent answered substantial; 23 percent, major; 41 percent, minor; and 22 percent, trivial. Ninety percent of the firewood in the typical city is inspected. Citizens resent this inspection to some extent: a great deal in many (13 percent) cities, some in most (52 percent) cities, and not at all in one-third (35 percent) of the cities.

In over half of the cities contacted (52 percent) private effort has provided assistance to the shade tree program. In half of these cities (26 percent overall) this assistance was in replanting by a business or civic group. In 8 percent, private citizens were mentioned as participating in replanting efforts and in 5 percent, with disease control treatment, or removal. General assistance of an unspecified nature was provided by the private sector in 17 percent of the cities.

Managers were asked about the adequacy of resources available to them to meet the needs of their program; resources ranged from people and equipment to disposal sites and opportunities for utilization of diseased wood. In only this last area, utilization, were resources deemed less than adequate by a majority (55 percent) of all respondents. However in a large number of other areas, a significant number of managers felt they had inadequate resources. The percentages given below are based only on those cities

rating the adequacy of this resource. The inadequacy of government crews was a major problem in three areas: 62 percent to treat trees, 40 percent to plant, and 39 percent to remove trees. Inadequacy of a private contractor resource to treat trees (25 percent), replant (12 percent), and remove (8 percent) trees was somewhat less of a problem. Equipment was inadequate in 23 percent of the cities, money for supplies or new trees in one-third, and disposal sites in 23 percent. Trained inspectors or foresters were deemed adequate in almost all (92 percent) cities.

REACTION TO THE STATE PROGRAM

More specific questions were asked about the cities' participation in the state program. As might be expected, the most frequently given reason was to receive financial assistance (89 percent). Other reasons were to gain access to information and expertise (16 percent); state suggestion, pressure, or law (10 percent); and miscellaneous reasons (12 percent).

Managers rated the state program quite well suited to their needs. Timing was the biggest problem, starting too late for over one-quarter of the cities (27 percent). Ninety percent of the managers rated financial assistance adequate (85 percent) or more than adequate. Yet 43 percent see the future inability to enact a special levy for the shade tree program as having a substantial (19 percent) or modest (24 percent) effect so satisfaction with reimbursements may decline.

In reviewing the operation of the state program, most managers felt things ran smoothly. At least two-thirds of the managers agreed, and more slightly agreed, with statements that the state technical review program was useful, application forms were clear, forms were not excessive, and payments were timely. Only 12 percent disagreed or slightly disagreed with

these statements, though somewhat more (16 percent) disagreed on the clarity of the application form.

Most managers (55 percent) saw no need to change the structure of the shade tree law. However, a large number (45 percent) did offer some suggestions. Of these, 24 percent desired the ability to expand their program coverage beyond the city limits. Twenty-one percent wanted to change the reimbursement process with either easier guidelines or, for a few, more money. Other recommendations made by a significant number of managers include increased emphasis on utilization (14 percent) and allowance for more flexible inspections (12 percent). Many of these comments were based on unique local circumstances. For example, current guidelines require northern cities to inspect trees before they have leafed out.

REVIEW

Almost all local program managers had some training; most felt that the local government should give more than some attention to shade trees, reflecting more support for local government action than typical community residents. Most managers reported that their community started a program to cope with the threat of the Dutch elm disease but that the state program and the financial incentives were important factors encouraging initiation, as were a number of local influences, particularly the efforts of specific local individuals concerned with community forests. A major factor mentioned with regards to the local situation was the presence of infected wild elms adjacent to the community forests; the typical managers reported that elms were evenly distributed in their community and that inspection and removal were routine for the majority of elms.

One-half the effort in local programs is devoted to sanitation; one-fifth to replanting. Coordination between marking and removal of infected trees was considered acceptable or better by most managers, although follow-up

inspections in the summer were not completed as frequently as the first annual inspections of the spring. Managers claim that most public trees and half the private trees removed are replaced; species coordination is a common activity by local programs. Managers consider their efforts successful in reducing barked elm firewood, but they perceive citizen resentment of this phase of the program. Private assistance to the local programs is reported by half the managers, but the extent of the assistance seems to vary. Almost all program managers consider the inspector/forester staff adequate but think resources to operate the program (treat, remove, replant) are less than adequate, though not dramatically so.

By and large, the local program managers appeared quite satisfied with the state Shade Tree Program; the major reason for participating was to receive financial assistance but the technical expertise is also considered of value. While there were few complaints on the operation of the state program, the most common suggestion was to change the law to allow expansion of the program beyond the city limits to include adjacent wild elms. Others wanted to modify some of the operational procedures or increase the amount of financial reimbursement.

Summary

One of the major impressions from the case studies, reflected in the summaries of the experiences of St. Cloud, St. Paul, and Dayton, is the distinctive and unique nature of the physical and socio-political situation of many shade tree programs. The comments of the local citizens suggest that they are concerned about their community forests and consider it appropriate for additional tax money to be raised to support shade tree programs, but that the majority are not directly affected by a disease that

infects elm trees and have not taken personal action, either physically or politically, to affect the trees or their local government. While not disinterested, most citizens appear quite relaxed about the problem. Local program managers appear to be experienced in forestry; their programs were initiated in response to the threat of the Dutch elm disease and the incentives provided by the state program. Local programs are being operated along the lines suggested by the state Shade Tree Program requirements, and there is widespread satisfaction with the state program among the local program managers.

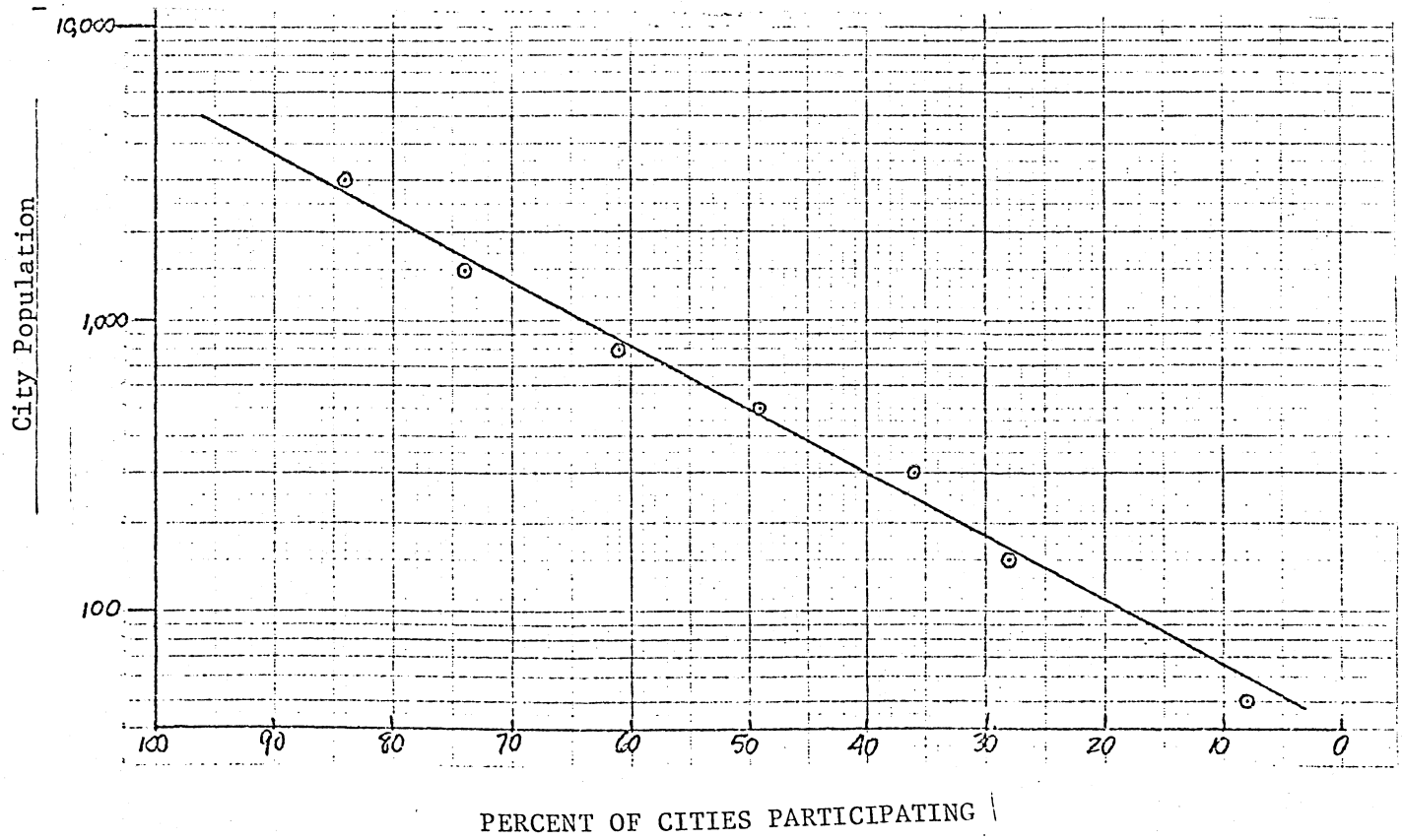
CHAPTER 3

LOCAL PARTICIPATION IN STATE PROGRAM

Not all cities participate in Minnesota's Shade Tree Program. Outside the seven-county metropolitan area, participation is optional.* Many outstate cities, over 360 in 1980, are not in the program. Their absence could indicate either a lack of need for such a program or the presence of obstacles preventing participation. This chapter will investigate the reasons for non-participation.

City size is closely related to participation. Every city over 5,000 people is in the program while less than one-quarter of those with fewer than 200 people participate. Figure 3-1 presents this pattern. Some of these variations can be explained by the increased size and complexity of

FIGURE 3-1: RELATIONSHIP BETWEEN CITY SIZE AND PARTICIPATION RATE OF OUTSTATE MINNESOTA CITIES



*Even within the seven county area, many jurisdictions do not participate in the state program though some may be operating effective independent programs.

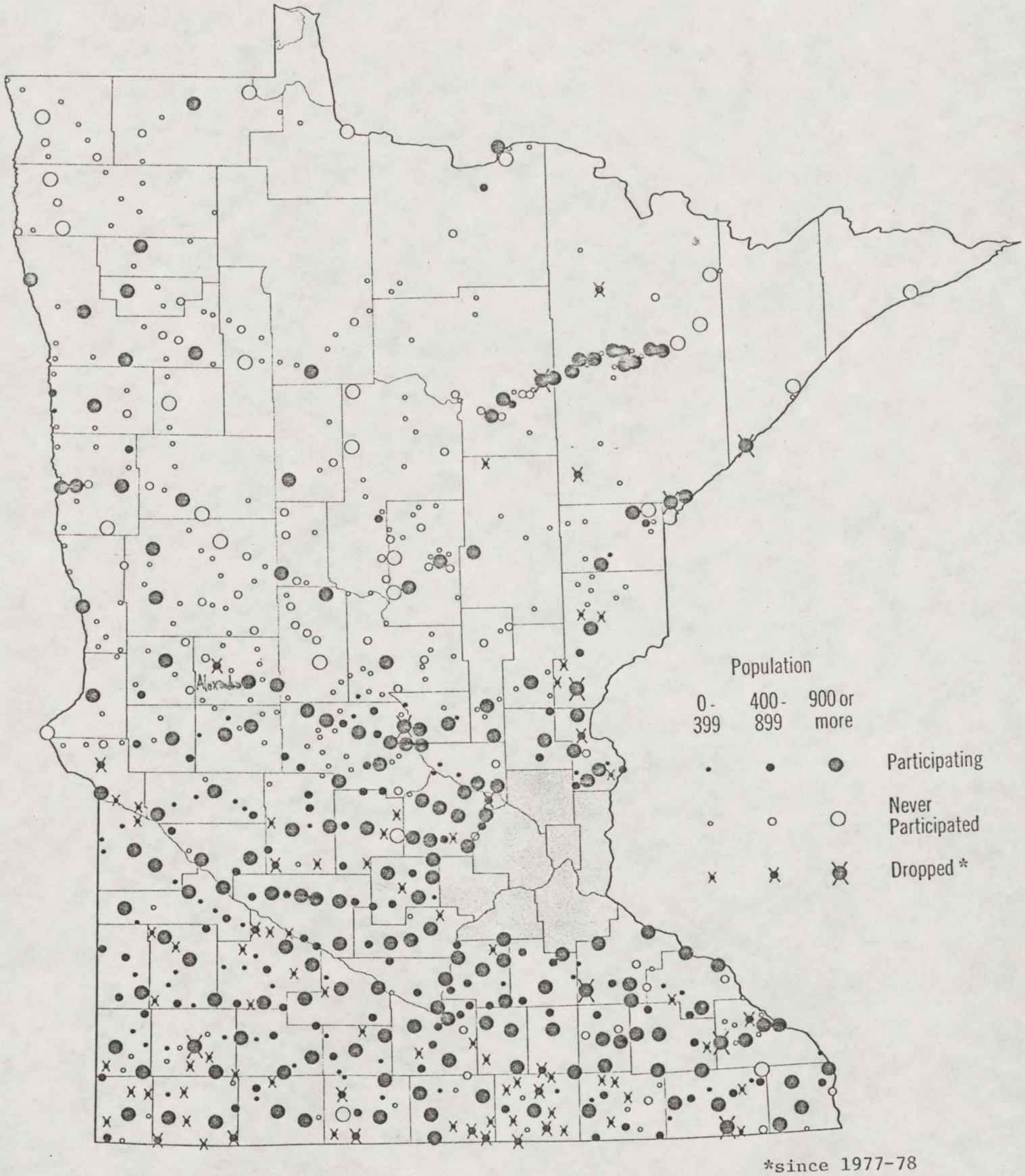
local government available to do the job in larger cities. Also smaller cities often had less ambitious landscaping programs years ago and so have no formidable number of trees to remove now.

Location in the state is another good predictor of participation. While Dutch elm disease is now found across the state, cities in the northern 60 percent are less likely to participate calling their problem minor. Figure 3-2 displays the participation status of cities in outstate Minnesota. Only the largest cities in the north are participating. Smaller northern cities are waiting for the problem to develop.

The non-participating cities are not all of one type. Some cities (about 288) have never participated. Another 76 were in the program earlier, but are not in now. Figure 3-2 differentiates between these groups. Each must be viewed separately.

To further understand the reasons for non-participation, a number of sources were sought out. An interview was held with a public official in a random sample (see Appendix C) of nearly 30 cities in each group. Government structure and tax effort were also investigated. These sources will be used to explain the cities' reasons for non-participation.

FIGURE 2-2: PROGRAM PARTICIPATION OF MINNESOTA CITIES BY POPULATION CLASS; 1980.



*since 1977-78

Never Participating Cities

The largest portion of non-participating cities are those which have never participated. As indicated above, they tend to be small and in the north. Most know something about the program. Their reasons for not participating include no local problem, no local resources, or a philosophy of doing it themselves. Other data sometimes are inconsistent with these statements.

The clerk (17), mayor (11), and/or other city official (3) in 28 cities were interviewed and asked why they had not joined the state program. Their responses are summarized in Table 3-1. Since more than one response was allowed, the percentages total more than 100.

TABLE 3-1: FREQUENCY OF REASONS GIVEN FOR NEVER HAVING PARTICIPATED

Reason	Number	Percent
No threat, no reason, few elms/oaks	15	54
City or citizens doing job; no interest	9	32
Funding, resource difficulties	8	29
General resistance	4	14
Regulations and technicalities prohibitive	4	14
Lack of program information	3	11
City officials not in favor	1	4
Other	1	4

Some of these figures need qualification. The three cities which did not respond could be added to those indicating lack of information as a reason; other cities had incorrect information. Though most cities indicated no threat as a reason, several were seeing the beginnings of a problem and were beginning communication with the Shade Tree Program. Nearly

one-third have some local activity, though it is rarely organized. For two cities in the south, Dutch elm disease had swept through the city before 1977; all trees were removed or the city saw it unfair only to reimburse citizens who had subsequently lost trees. Many cities were unaware of the replanting program or its specifics. Surprisingly, most of the cities indicating funding or resource problems have a low taxing effort as defined by a ratio of property taxes to income.

One northern city had a problem with dying birch trees and was interested in replanting assistance. The cost of neither removal of trees not stricken with Dutch elm disease or oak wilt nor replanting can be reimbursed by the current state program. Rationale could be made for expanding the program to cover tree losses from other causes. This rationale may be similar to those used in creating the current program.

Many small cities have difficulty setting up and operating efficient programs. In Itasca County, the county government provides an option for these cities. It will provide the organization and resources to those communities requesting help. The county acts as broker to the state. In our sample of cities two were in Itasca County: one was experiencing initial problems and preparing to join the county program; another had terminated its own program and already joined the county program.

Compared with participating cities, officials in non-participating cities expressed similar views about most items in our questionnaire. However, only half (23 percent) as many felt local government should give a great deal of attention to shade trees. Nearly twice as many

(30 percent) felt elected officials should concentrate on problems of the present. Less than half commented on the state program, but those who did saw more problems than participants in the following areas: timing too late (40 percent), inadequate financial assistance (50 percent), and unclear application forms (25 percent). More than the participating managers, they wanted the state law changed to give more local control (33 percent) with adaptability to local conditions and simpler accounting.

By a few other measures those cities which have never participated in the Shade Tree Program are different from those which do. Their tax effort, whether made comparable using per capita or per dollar of personal income, is lower. Because most of these cities are smaller, they tend to have a city clerk as their form of government, but a disporportionate number elect their clerk. Of the participating cities studied having populations under 400, only one in five elected their clerk. Similar sized cities which had never participated elected their clerks in nearly half the cases.

A sample of citizens in cities throughout northwestern Minnesota were interviewed. The actions and attitudes of people in non-participating cities could therefore be compared with citizens in participating communities in the same portion of the state. Some bias would result, since only the larger northwestern cities participate. The non-participating cities are smaller and more stable; the residents have lower incomes and less education. Nevertheless, residents of cities which have never participated are much like those of other cities. They have an equally high regard for trees and even more have planted trees on boulevards (19 percent). Though they have a lower opinion of local government and expect it to do less, 55

percent are willing to pay more property taxes to support a local shade tree program. A larger percentage of those using firewood regularly (56 percent) use elm (28 percent) which is not debarked (43 percent).

Dropped Cities

About 76 cities were in the state program in 1977 or 1978, but were not listed as participating in 1980. While most cities dropped because the need no longer existed, a good many dropped for less desirable reasons. Many are continuing some kind of local program.

Plant health specialists in St. Paul were asked to rate the programs that had existed in these cities. Only slightly over half the programs could be rated, but 87 percent of those had below average overall program ratings.

A random sample of 28 cities was drawn and a public official contacted in each to determine their reason for dropping out of the program. From this list 27 contacts were made in 27 cities. Contacted were the clerk (10), mayor (7), or other city official (10). Their responses are summarized in Table 3-2. Again, percentages may sum to more than 100 since multiple reasons could be given.

TABLE 3-2: FREQUENCY OF REASONS GIVEN FOR DROPPING OUT

Reason	Number	Percent (of 25)
Community had inspector, personnel, resource problems	8	32
Accomplished purpose or community handles situation alone	7	28
No disease threat, few diseased present	7	28
Red tape or excessive state regulations	6	24
Few or no elms or oaks in community	5	20
Program application not received, submitted late, not completed	5	20
Inadequate state reimbursements, insufficient local funds	3	12
No community interest	2	8
Public resistance	2	8
Other, general	1	4

The most frequently expressed reason was an inspector-personnel-resource problem. Usually an inspector had left and no replacement came forward or the inspector missed his certification class. The related reason of insufficient funds appears justified with two out of these three cities having above median taxing effort.

Three reasons argue no need for a program in these communities: no trees, no disease, or community sufficiency. Over half the communities gave at least one of these reasons. However, in many such cities large numbers of elm existed on private property as indicated in their last report to the Department of Agriculture. Many cities are continuing with replanting programs on their own. They seem unaware of this state replanting program.

The specific complaints about red tape mentioned excessive numbers of forms, unclear forms, and conflicting rules. Whether these complaints are justifiable is unclear, though one city asserted it never got a check for replanting work done even though a claim was filed. It seems more clear that application processing is a problem. All of the cities dropped for missing the application deadline had been operating average or above

average programs. Of these five cities, one had missed the deadline, one had not applied due to a crisis in the clerk's family, two thought they were still participating, and one had received no application. All are continuing their programs and plan to re-enter next year. Another city had not reapplied and had been listed as dropped and was therefore contacted. However, the study team was told and subsequently it verified that the deadline had been waived and the city was currently participating. It would seem reasonable to have let the other cities participate as well.

In most respects the officials of the dropped cities were like officials in participating cities. However, they saw support from all sources for a shade tree program as "enthusiastic" at about half the level of participating cities. Pressure to start a program by the state was viewed about equal, but local pressure was about half and outside pressure was non-existent. The two groups shared ideas on the emphasis local government should place on various programs including 50 percent feeling a great deal of emphasis should be placed on shade trees.

Local opinions of the state Shade Tree Program often varied however, from those of officials in participating cities. For many (41 percent), the program was available too late. Fewer thought the financial assistance was about right with 11 percent saying it was more than adequate and 16 percent saying less. More felt that the state's technical review had not been useful (21 percent), the application forms not clear (42 percent), and the paperwork excessive (31 percent). Fewer, however, felt that change in the state law should be made (30 percent).

Only a few people residing in dropped cities in south-central Minnesota were interviewed in the study's regional citizen survey. Little can be

said from this small sample. However, all people interviewed felt shade trees to be very or extremely important. Half of them would be willing to pay additional property taxes for a shade tree program. More of them than in participating cities have taken personal or group action dealing with shade trees. Obviously, these people still care for trees.

Conclusions and Recommendations

Most cities that are not in the state Shade Tree Program have no perceived need to be in the program. Usually these cities have no diseased trees. Some however, are replanting and could be participating if they were part of the state program. Three proposals for improving participation came from this study: 1) encourage more and broader county programs, 2) improve the application handling procedure, and 3) expand the program to cover other types of tree losses.

The Itasca County program would seem to solve a major participation problem. Smaller cities do not have the resources to handle the paperwork and field work necessary to run efficient programs. The county can handle this because it has a larger staff and the business of handling many communities is a large enough job to attract the full attention of the staff. Itasca county could serve as a model for other counties. More communities will be able to participate in the state program and they are likely to participate in a better program.

The application process needs improvement. Cities with good programs were dropped because their paperwork was never completed, lost, or sent in late. One solution would be a follow-up phone call or letter when past participants have not reapplied. Another solution would be to eliminate the yearly application requirement except where the city plans a change in its program.

If Minnesota wants to continue to relieve municipal financial burden of large fluctuations in expenditures on trees, it may want to expand removal and replanting programs to cover losses from other sources. To the extent that the program is based on reducing infection centers and that new losses might be caused by infection, the state must certainly be prepared to consider expanding its shade tree program.

CHAPTER 4

SANITATION EFFECTIVENESS

A major strategy for dealing with Dutch elm disease as a threat to community forests is to slow or stop its spread. Removal of infected trees (and those which brood bark beetles) is the only proven method of controlling the disease. A good sanitation program will remove these trees before newly-hatched, disease-carrying beetles can emerge and transmit Dutch elm disease to healthy trees. Determining those factors that are associated with sanitation program effectiveness involves a number of steps: establishing suitable measures of sanitation effectiveness, selection of variables that may be associated with variations in effectiveness, collecting information on these variables, identifying those variables associated with sanitation effectiveness, determining factors that have an independent impact upon sanitation effectiveness, and estimating the relative influence of such variables. The final stage is to review the extent to which those responsible for shade tree programs can affect the outcomes, relative to the influences they cannot control.

Measures of Sanitation Effectiveness

There are several ways to measure the effectiveness of local shade tree programs. One is to ask those familiar with a wide range of local programs to evaluate them in terms of sanitation effectiveness; this was done by six inspectors working for the state Shade Tree Program. Other measures may be based on the actual rate at which elm trees are lost; if a community can keep such losses to 2-3 percent of original mature elms

per year, it will take from 30-50 years before all must be removed: adequate time to replace the lost trees. For communities that are participants in the state Shade Tree Program, estimates of elm inventories and annual losses can be developed from the year-end reports, submitted to the state program. Three measures were developed from such year-end reports: 1) percentage of elm inventory existing at the beginning of 1979 and marked (identified) as diseased during 1979; 2) percentage of elm inventory existing at the beginning of 1979 removed (as diseased) during 1979; and 3) the average percentage of elm inventory (at the beginning of each year) removed as diseased in each year from 1977-79..

These four measures were chosen after a review of a number of possible measures of performance as being both reliable and central to the effectiveness of the sanitation programs. However, despite the relatively high agreement among state shade tree inspectors regarding the quality of the programs (for community programs evaluated by two or more inspectors), these judgments were essentially unrelated to the measures based on local program activity. Since the pattern of relationships between the many candidates for independent variables (causes of success) and these two types of measures of success were quite different, attention was focused upon the measures that reflected diseased trees. Further, as the percentage of elm inventory marked in 1979 correlated highly (0.95) with the percentage of elm inventory removed in 1979, attention was further restricted to the average elm inventory removed over the years 1977-79. (A more complete discussion of the measures of program success and their characteristics is presented in Appendix A.)

The extent to which the communities for which data are available vary with respect to these two measures of sanitation effectiveness presented in Table 4-1. Note that over five hundred community programs are represented. The major difference between the measures is the much larger number of programs that had no elm trees removed in 1979 (28 percent) compared to those that had no elms removed over the three year period (2 percent). While the variation on this variable is asymetric, with a substantial number at the low end, the variation is sufficient for the following analysis, determining the relative impact of various independent variables.

TABLE 4-1: DISTRIBUTION OF MEASURES OF PROGRAM SANITATION EFFECTIVENESS

	Elms removed as a percentage of beginning inventory in 1979	Mean Number of Elms removed as a percentage of beginning inventory for 1977-79
Number of community programs	537	542
Mean (average) value	5.3%	7.2%
Median value (1)	2.4	4.5
Range of values	0-66%	0-50%

FREQUENCY DISTRIBUTION

Percentage of elms removed	Number	Percent	Number	Percent
0	152	28	10	2
0.1 - 1.9	95	17	162	30
2.0 - 3.9	79	15	81	14
4.0 - 6.9	68	13	102	19
7.0 - 9.9	49	9	69	13
10.0 - 19.9	66	13	73	13
20.0 - 39.9	23	4	39	7
40.0 - max	5	1	6	1

NOTE: (1) value midway between the top 50 percent and bottom 50 percent of all communities.

Selection of Independent Variables

In the absence of any clearly formulated model or theory related to the effectiveness of shade tree programs, an attempt was made to develop as many independent variables as possible that could be related to sanitation effectiveness. Such variables were divided into five categories and are presented in Table 4-2. Natural environment was considered to include those features of the physical setting that could not easily be changed. Community characteristics included relatively stable aspects of the community as a social and political system. Residents characteristics included both their general orientation toward their local government, shade trees, and the local shade tree program, but also personal experiences with healthy and infected elms. Local government included characteristics of same; the local shade tree program included both characteristics and operating features of the local programs.

Data were collected from at least nine different and four major sources (official census data, local program reports, interviews with 240 program managers, and interviews with citizens in 36 "representative" communities). For some variables, estimates were available from more than one data source. Unfortuantely, information was not available for all communities from all data sources (the major limitation was the 36 communities chosen for the citizen surveys). The effects of this problem will be discussed as the analysis is described.

TABLE 4-2: VARIABLES EXPLORED AS HAVING A SIGNIFICANT RELATIONSHIP TO SANITATION PROGRAM EFFECTIVENESS

I. Natural Environment

1. Ease of access to elm trees in the community
2. Percentage of adjacent area containing wild elms
3. Estimated condition of wild elms in adjacent areas
4. Estimated problems attributed to wild elms
5. Homogeneity of elms within the community
6. Years between onset and takeoff of the Dutch
7. Years between onset of Dutch elm disease and program start
8. Years between takeoff of DED and program start
9. Latitude (northness) as a proxy for severity of winters or history of the spread of the Dutch elm disease

II. Community Characteristics

10. Population
11. Area
12. Population density
13. Density of elms
14. Per capita number of elms
15. Proportion of community devoted to park land
16. Median age of population
17. Dwelling density
18. Percentage of dwellings owned (versus rented)
19. Density of rented dwellings
20. Percentage of single-family dwellings
21. Percapita income
22. Dwelling age (percentage built since 1950)

III. Resident Characteristics (Knowledge, Behavior, Orientations)

23. Support for sanitation program
24. Support for replanting program
25. Importance assigned to shade trees
26. Willingness to pay additional taxes for shade tree program
27. Importance of neighborhood appearance
28. Perceived threat of Dutch elm disease to shade trees
29. Estimated effectiveness of local government
30. Estimated effectiveness of local shade tree program
31. Existing elms on private property
32. Percentage of elms in the neighborhood
33. Number of suspected diseased elms reported
34. Number of infected elms removed from private property
35. Number of infected elms removed from adjacent public land
36. Number of private elms personally treated with chemicals
37. Trees planted on private property to replace lost elms
38. Trees planted on adjacent public land by local government
39. Estimates of citizen's reports of suspected elms prior to local program inspector reports
40. Local program citizen coordination on species of replacement trees
41. Local citizen requests for species replanting
42. Firewood utilization
43. Elm firewood utilization
44. Debarking of elm firewood

TABLE 4-2 (1 of 4)

45. Citizen perception of availability of financial assistance for diseased elm removal
46. Citizen perception of penalty for slow removal of infected private trees
47. Awareness of special phone number for reporting elms suspected of infection
48. Participation of neighborhood organizations to promote shade trees
49. Tendency to see local government as a source of assistance for problems in the community
50. Preferred emphasis of local shade tree program on chemical treatment
51. Preferred emphasis of local shade tree program on removal of infected trees
52. Preferred emphasis of local shade tree program on replanting
53. Private replanting of trees as a proportion of privately removed elms
54. Help provided to local shade tree program from business or other local sources

IV. Local Government

55. Per capita tax levy
56. Per capita special assessments
57. Per capita total local government revenues
58. Per capita total local government debt
59. Total local government revenue per elm tree
60. Form of local government
61. Concern of local government officials for shade trees
62. Concern of local government officials for neighborhood appearance
63. Mayor's concern for sanitation program
64. City council concern for sanitation program
65. City employees concern for sanitation program
66. Mayor's concern for replanting program
67. City council concern for replanting program
68. City employees concern for replanting program
69. Per capita local tax effort
70. Per capita local tax effort as proportion of median income

V. Local Shade Tree Program

71. Assistance planned for private tree removal in 1980 (city funds)
72. Assistance planned for private tree removal in 1980 (state funds)
73. Assistance planned for private tree removal in 1980 (any form)
74. Sanitation program staff man-hours per elm inventory in 1979
75. Replanting program staff man-hours per elm inventory in 1979
76. Total program staff man-hours per elm inventory in 1979

TABLE 4-2 (2 of 4)

77. Sanitation costs for 1979 per capita
78. Replanting costs for 1979 per capita
79. Total program costs for 1979 per capita
80. Total shade tree program budget as a percentage of total city budget
81. Sanitation costs for 1979 per elm tree
82. Total program costs for 1979 per elm tree
83. Assistance provided for private elm tree removal in 1979 (city funds)
84. Assistance provided for private elm tree removal in 1979 (state funds)
85. Estimated adequacy of resources available to the program
86. Years program in operation
87. Relative program emphasis upon identification of infected elms
88. Percentage of existing elm inventory inspected before June 15th
89. Percentage of existing elm inventory inspected between June 15th and July 15th
90. Percentage of marked trees that are low risk
91. Percentage of marked trees that are high risk
92. Coordination between marking and removal of trees
93. Delay in removal of low risk trees in 1980
94. Delay in removal of high risk trees in 1980
95. Policy for low risk tree removal for 1980
96. Policy for high risk tree removal for 1980 from public property
97. Policy for high risk tree removal for 1980 from private property
98. Emphasis given in the program to informing the public in 1980
99. Improvements possible in the local program
100. Emphasis in the program to sanitation in 1980
101. Emphasis in the program to firewood inspection in 1980
102. Emphasis in the program to replanting in 1980
103. Replanting costs per public tree inventory in 1977
104. Replanting costs per public tree inventory in 1978
105. Replanting costs per public tree inventory in 1979
106. Absolute size of forestry staff for 1979
107. Average replanting costs
108. Years program manager worked in forestry
109. Estimated adequacy of size of local program crews
110. Estimated adequacy of outside contractor availability
111. Estimated adequacy of availablity of equipment
112. Estimated adequacy of money available for supplied and new trees
113. Elms marked for removal as percentage of elm inventory in 1978
114. Replanting expected in 1980 as percentage of removed trees
115. Voluntary replanting by citizens expected in 1980
116. Payment for reforestation from general funds in 1980
117. Payment for reforestation from ad valorem tax in 1980.
118. Payment for reforestation from special assessments in 1980
119. Payment for reforestation from federal grants in 1980
120. Payment for reforestation from "other sources" in 1980

TABLE 4-2 (3 of 4)

NOTES: 1) Some variables were estimated from more than one source of data.

2) The same list was used for analysis of both the measures of sanitation success and replanting success.

TABLE 4-2 (4 of 4)

Identification of Significant Independent Variables

The next stage of the analysis involved identification of those variables that were significantly related to the measures of sanitation success; keeping in mind that a low removal rate (reflecting a low infection rate) is the measure of success--lengthening the time elms would remain part of the community forest. In general, the criteria for considering a variable of significance was a correlation coefficient greater than +0.10 (or -0.10) with a minimum statistical significance (probability that the relationship would have occurred at random less than once in ten occasions). But as the sample size varied for different independent variables, a substantial measure of association was retained even if the statistical significance was less than satisfactory; this was particularly important for the data developed from the citizen surveys conducted in only 36 communities.

The effect of this policy was to substantially reduce the number of variables that would be given serious attention, from almost 120 (including the alternative measures of many) to a total of 59. These fifty-nine were then considered in terms of the extent to which they were interrelated, that is, two or more measuring the same events in slightly different ways. When the correlation matrix for the entire sample was examined, eight variables were found to be redundant and the number of independent variables associated with program success was reduced to 51. These, organized in relation to their major category, are presented in Table 4-3; within category, they are rank ordered in terms of their impact upon the three year average of percentage of elms removed. The measure of association is placed in one of two columns depending upon whether or not a higher value is associated with an increase or decrease in the rate at which elms were removed.

TABLE 4-3: VARIABLES ASSOCIATED WITH MEASURES OF PROGRAM SANITATION EFFECTIVENESS

		FEWER TREES LOST		MORE TREES LOST	
		% Removed / Elm Inventory (1979)	% Removed / Elm Inv. (1977-1979)	% Removed / Elm Inventory (1979)	% Removed / Elm Inv. (1977-1979)
NATURAL ENVIRONMENT					
1)	Percentage of 1977 elms remaining in 1979	-.33[a]	-.74[a]		
2)[d]	Latitude North (winters more severe; disease started in in the south)	-.16[a]	-.37[a]		
3)[d]	Infection of wild elms adjacent to community			+.16[b]	+.24[a]
4)[d]	Delay in DED takeoff after initial onset			-.07	+.23[a]
5)[d]	Delay in shade tree program initiation after DED onset	-.13[b]	-.21[a]		
6)[d]	Percentage of wild elms within 0.5 miles of community	-.15[b]	-.09		
COMMUNITY CHARACTERISTICS					
7)[d]	Elm density (trees/sq. mile)	-.12[a]	-.18[a]		
8)[d]	Percentage owned dwellings			+.02	+.16[a]
9)[d]	Percentage single family dwellings	-.17	-.13		
10)[d]	Area	-.05	-.10[b]		
11)[d]	Dwelling age (% built 1950-1970 in 1970)			+.22[a]	+.09
12)	Median Age of Population			+.11[a]	+.07[c]
RESIDENTS'S PERSPECTIVES, KNOWLEDGE, AND BEHAVIOR					
13)[e]	Perception that financial aid is available for removal of infected trees	-.42[a]	-.38[b]		
14)[e]	Prefer local program emphasize chemical treatment	-.40[a]	-.38[b]		
15)[d]	Number of private infected elms removed			+.31[b]	+.30[a]
16)[e]	Firewood utilization (any species)	-.38[b]	-.34[b]		
17)	Number of infected elms removed from public land adjacent to private property			+.28[b]	+.34[b]
18)	Trees planted by private citizens to replace those lost to disease			+.31[b]	+.34[b]

	FEWER TREES LOST		MORE TREES LOST	
	Removed / Elm Inventory (1979) %	Removed / Elm Inv. (1977-1979) %	Removed / Elm Inventory (1979) %	Removed / Elm Inv. (1977-1979) %
RESIDENTS'S PERSPECTIVES, KNOWLEDGE, AND BEHAVIOR (Con't)				
19)[d] Seek assistance for community problems (of all types) from the local government	-.16	-.27[c]		
20)[d] Exist nce of elms on private property	-.24[c]	-.26[c]		
21) Private trees replanted as a proportion of private elms removed	-.24[c]	-.25[c]		
22)[e] Use of elm firewood	-.20	-.24[c]		
23) Perceived effectiveness of local shade tree program			+.24[c]	+.23[c]
24) Public trees planted on land adjacent to private property			+.13	+.23[c]
25)[d] High value placed on shade trees (represented by a low number)			+.20	+.19
26)[e] Tendency to provide private trees with chemical treatments	-.19	-.17		
27) Perceived effectiveness of local government			+.12	+.15
28)[e] Stated awareness of local shade tree program phone number			+.33[b]	+.13
29)[d] Willingness to pay additional property taxes for shade tree programs	-.23[c]	-.13		
30)[e] Program managers' estimate of volume of citizen reports of elms suspected of infection			+.03	+.11[b]
31)[e] Program managers' estimates of citizens reporting infected trees prior to inspectors reports	-.09[c]	-.11[b]		
32) Citizens prefer local program emphasize tree removal			+.29[b]	+.07
LOCAL GOVERNMENT				
33) Total local government revenues per existing elm			+.11[a]	+.36[a]
34) City employee concern for sanitation effectiveness			+.02	+.12[b]
35) Special assessments (any purpose) per capita	-.08[b]	-.10[a]		

TABLE 4-3 (2 of 3)

		FEWER TREES LOST		MORE TREES LOST	
		Removed / Elm Inventory (1979) %	Removed / Elm Inv. (1977-1979) %	Removed / Elm Inventory (1979) %	Removed / Elm Inv. (1977-1979) %
LOCAL SHADE TREE PROGRAM					
36)	Total program costs per inventory tree in 1979			+.67[a]	+.46[a]
37)	Trees marked for removal in 1978 as proportion of 1978 inventory			+.78[a]	+.42[a]
38)	Program staff man-hours per tree in 1979			+.33[a]	+.36[a]
39)	Replanting costs per tree in inventory in 1978			+.05	+.31[a]
40)	Emphasis planned on replanting in 1980 program			+.07	+.18[a]
41)[e]	Percentage of inventory inspected in 1979 between June 15 and July 15			+.17[a]	+.16[a]
42)[e]	Policy on removal high risk trees (days delay)			+.11[b]	+.16[a]
43)	Replanting costs (1979) per tree in inventory in 1977			-.02	+.14[a]
44)	Replanting costs (1979) per tree in inventory in 1979			+.19[a]	+.14[a]
45)[e]	Program managers estimate of adequacy of available equipment	-.08	-.12[b]		
46)	Assistance planned for private tree removal in 1980			+.05	+.10[c]
47)	Shade tree program costs as a percentage of total city budget			+.33[a]	+.09[b]
48)	Program manager's estimate of adequacy of shade tree program resources	-.10[c]	-.07		
49)	Days delay before low risk trees removed (policy)			+.13[c]	+.06
50)	Replanting costs per capita (1979 program)			+.19[a]	+.04
51)	Average replacement costs per tree in 1979			+.18[a]	+.00

NOTE: a indicates probability of occurrance less than 0.01
b indicates probability of occurrance between 0.01 and 0.05
c indicates probability of occurrance between 0.05 and 0.10
d indicates variables considered casually important but outside the control of local shade tree programs
e indicates variables considered casually important and under some influence by local shade tree programs

TABLE 4-3 (3 of 3)

Estimates of the Relative Impact of Different Variables

Attempting to determine the relative impact of various factors on sanitation effectiveness is substantially more complicated than determining those variables that may or may not be associated with variations in effectiveness. While there are several methodological procedures that may be used to provide estimates of relative impact, they all require a large number of cases (in this case community shade tree programs) to provide reliable estimates when a large number of potential independent variables have been identified, as has occurred with sanitation effectiveness. As a number of measures are based on citizen surveys completed in only 36 communities, this is a maximum number of programs that can be included in the analysis of multiple influences upon sanitation effectiveness. (Additional complexities, related to the absence of specific data on specific communities, further reduce the value of the result.) However, this is an important issue and any analysis, even a rough estimate, is more helpful than none at all.

Further, it was clear that the fifty-one factors identified as having significant associations with variation in tree removal were quite different in terms of their causal relationship to the control of the Dutch elm disease by a local shade tree program. Three categories were developed: 1) factors uncontrollable by a local program (e.g. median age of the human population) 2) factors associated with the spread of the disease (e.g. funds spent on public elm removal), and 3) factors that seemed to be under the partial or complete control of the local program (e.g. percentage of elms examined by local shade tree inspectors). This was necessary in order to reduce the number of variables explored in a

multiple regression analysis with the small sample of 36 communities on whom the full range of data were available.

From the fifty-one variables, fifteen (identified by a "d" superscript in Table 4-3) were chosen as having an unambiguous and possibly significant causal effect on the spread of the Dutch elm disease and success of the local program but out of the control of the local program managers. Three were found to be statistically and substantively significant. One (variable 3 in Table 4-3) was based on two estimates of the program managers: percentage of community forests bordered by wild elms multiplied by the percentage of wild elms estimated as infected or dead less than one year. It was found that the second factor, estimates of infected adjacent wild elms, was predominant; creating the significant association. The other two factors were latitude of the community (related to the severity of the winters and the historical spread of Dutch elm disease in Minnesota) and the tendency of community residents to favor local government involvement in a wide range of community problems (from garbage collection and health care to police and fire protection). Residents desire for local government involvement appeared to be unrelated to the evaluation of either the local shade tree program or the local government and clearly reflects a community norm regarding appropriate solutions for local problems.

The statistical and substantive significance of these variables with removals in 1979 or average removals 1977-79 was about the same. For the sake of simplicity, only the average removal analysis is presented below.

The relationship between these three variables for the 36 communities on which data is available from the survey of citizens is presented in Table 4-4. The simple correlations indicate where a change in the variable can be expected to produce an increase or decrease in elms removed. The percentage of variation, explaining the cumulative impact upon the measures of trees removed, is 64 percent. As data is available for two of these three variables from those communities where the managers were interviewed, a comparable analysis is completed with them. While the variables continue to be significant (more so than any other that are available), the percentage of explained variance drops from 64 percent to 18 percent, in part because the amount of variation in program success is greater among the 36 communities than the 226 where manager surveys were completed. This makes clear that some caution is required before generalizing conclusions based on the 36 communities to the entire population of 500+ with a local shade tree program, a problem related, in part, to the decision to use judgement to select these communities rather than a strict random sampling procedure. The comparable analysis using the inspector's ratings as the dependent variable indicates that very little of the variation is explained, only 1 percent, and the results are not statistically significant, consistent with the earlier finding that measures of program activity are unrelated to the inspector ratings.

Several conclusions seemed justified by this analysis (and the problems associated with determining these relationships). First, it is clear that there are two or three factors influencing the rate at which elm trees are being removed and may have an impact that is somewhere between important to substantial. Of the three major factors (adjacent, infected wild elms, latitude, and citizen support for local government solutions

TABLE 4-4: ESTIMATED VARIATION IN SANITATION EFFECTIVENESS EXPLAINED WITH STEP-WISE MULTIPLE REPREGESSION INVOLVING FACTORS OUTSIDE LOCAL PROGRAM CONTROL.

	Citizen Survey Com'tys (n=36)		Manager Survey Com'tys (n=226)	
	Simple Correlation	Cumulative variation Explained	Simple Correlation	Cumulative variation Explained
Relationship to the Average Percentage of Elm Inventory Removed: 1977-1979				
WILDELM - Estimated percentage of adjacent wild elms infected or dead less than one year	+0.62	38[a] %		
LATITUDE - Northness of community	-0.51	51[a]		
LOCGOVT - Residents tendency to see local government as a solution to any local problem	-0.27	64[a]		
LATITUDE			-0.41	16 %
WILDELM			+0.18	18
Total Variation Explained		64%		18%
Relationship to State Inspector Ratings of Local Program Sanitation Effectiveness				
LOCGOVT	+0.26	7 %		
WILDELM	+0.05	8		
LATITUDE	-0.14	8		
LATITUDE			-0.10	1 %
WILDELM			-0.06	1
Total Variation Explained		8%		1%

[a - indicates probability of occurrence less than 0.01]

for local problems), only the first may be substantially affected by the local shade tree program. It may be possible for a buffer zone to be developed between the community forest and adjacent wild elms. While the exact width and treatment of such a buffer cannot be determined from this research, it may be one way to improve the performance of sanitation programs and reduce the spread of the Dutch elm disease.

Second, not all local shade tree programs are confronting the same types of problems or constraints. Those programs with a number of external factors that operate to increase the spread of the disease -- adjacent infected wild elms, southern location, and citizens indifference to local government activities -- may have a difficult task in attempting to maintain existing elms. Conversely, a local shade tree program in a context with favorable external conditions -- no adjacent infected wild elms, northern location, and citizen support for local government action -- may be able to have a substantial impact upon the spread of the Dutch elm disease, as the external factors are innocuous. The next section will attempt to explore the relationship between potential for impact and the actual impact of local shade tree programs.

Finally, the importance of the external, uncontrollable factors may suggest a basis for the low relationship between the measures of program effect and the ratings of the state shade tree inspectors. If the inspectors are evaluating the programs on their plans and activities, they may not be taking the external conditions into account and, hence, the judgements will be unrelated to the measures based upon the impact of the shade tree program. In the next section, an attempt will be made to determine the conditions under which the measures of sanitation program effectiveness (trees removed and inspector ratings) agree.

Estimated Effect of Factors Influenced by Local Programs

Estimates of the impact of the local program was completed by exploring the relationship between the variables considered to be under the control of the local program and the measures of sanitation effectiveness. Eleven such variables were chosen (identified by the superscript "e" in Table 3-3); they fell into three major categories: measures reflecting the enthusiasm and cooperation of the local citizens for the elm shade trees (4 measures), operational features of the local shade tree program (5 measures), and use of firewood (2 measures). Regardless of which measures used in attempts to predict sanitation effectiveness, at least one variable from each of these three categories are involved. Examples of the relative impact are presented in Table 4-5. Both the three year average of elms removed and inspector ratings are included as measures of effectiveness.

Combining the causal factors, 35 percent of the variance in average removals were explained by the 6 variables indicated in Table 4-5. Twenty-nine percent of the variation in inspectors' ratings could be explained using the 5 variables indicated in the lower half of that table.

While similar factors are found in both regression equations, they do not have similar effects in all cases. Chemical treatments of private elms reported by citizens is associated with a low average loss of elms and a better rating from the state inspectors; reported use of elm firewood tends to be associated with a decrease in the average loss of elms but a lower effectiveness rating from the state shade tree inspectors. Despite the relative high percentage of variation explained in these two measures of sanitation success, it is clear that there are two different aspects of the sanitation program involved.

TABLE 4-5: ESTIMATED CAUSAL IMPACT UPON MEASURES OF PROGRAM SANITATION BY FACTORS UNDER LOCAL CONTROL (n - 36)

	Simple Correlation	Percentage of Variance Explained
Relationship to the Average Proportion of Elm Inventory Removed: 1977-1979		
Percentage of citizens that think financial aid is available for removing infected private elms	-0.38	15 %
Citizens preference for the local shade tree program to emphasize chemical treatments	-0.38	23
Percentage of citizens that chemically treated private elms one or more times	-0.17	29
Percentage of private citizens reporting they use elm firewood	-0.24	31
Program managers estimates of the percentage of infected elms reported by citizens before inspectors noticed them	-0.26	33
Program managers estimates regarding the adequacy of available equipment	-0.04	35
Total Variation Explained		35%
Inspectors Ratings of Shade Tree Programs		
Percentage of citizens that think a special phone number exists for the local shade tree program	+0.32	10 %
Percentage of citizens that chemically treated private elms one or more times	+0.24	15
Program manager's estimate of the percentage of elms inspected between June 15th and July 15th in 1980	-0.11	24
Program managers estimate of the percentage of infected elms reported by citizens before inspectors noticed them	-0.20	27
Percentgge of citizens reporting they use elm firewood	+0.14	29
Total Variation Explained		29%

NOTES: Regression equation is statistically significant at 0.10 level or better with all variables entered into equation.

Because it seemed reasonable to assume that the inspectors were evaluating programs on the basis of plans and operating procedures, an attempt was made to determine if it would be possible to explain a larger amount of the variation in the inspectors ratings when there was little potential for uncontrolled influences upon the local programs (e.g. no adjacent infected trees, northern location). When 11 communities with the highest potential for local program control were compared with the 14 communities with the lowest potential for local program control, the variation in inspector's ratings was approximately the same and a larger percentage (53% versus 40%) could be explained by the variables reflecting local program activities (at the bottom of Table 4-5) although neither predictive equation was statistically significant. (Other analyses were confounded by differences in the amount of variation in measures of percentage of elms removed). The hypothesis that state inspectors attend to program operation rather than actual rates of trees removed is partially supported by the analysis.

Conclusions and Recommendations

The analysis was based on a major feature of the local shade tree programs, the substantial variation among the local community programs in the rates at which elm trees are being lost to the Dutch elm disease. It was found that 51 factors, from the approximately 120 that were explored, were systematically associated with variation in the loss of elms and appeared to be unrelated to each other (they were independent). Despite the large number of factors associated with variation in elm losses, few could be considered as casually related to elm losses. Major factors outside the control of the local programs and casually related to elm losses were the presence of adjacent infected wild elms, northness of the community

(related to harsh winters, for the beetles that transmit the disease, or dispersion of the disease across the state), and general support among community residents for local government approaches to local problems.

Major factors that are both under the influence of local shade tree programs and affecting the loss of elm trees include citizen awareness and support for the preservation of the elms, effective operation of the local program (adequacy of equipment and systematic inspection of existing elms), and the use of firewood by the local citizens.* Confidence in the importance of these factors is somewhat less than in the influence of the external factors reviewed above. There is some evidence to suggest that the state shade tree inspectors may evaluate programs on the basis of whether or not they follow the rules developed for program operation; substantial evidence suggests that the rate of elm tree loss is not reflected in their evaluations.

At least two recommendations can be derived from this analysis. First, serious consideration should be given to the development of a buffer zone between the community forest and adjacent wild elms; such a zone should be wide enough to minimize the contagion of the Dutch elm disease and its maintenance should be supported by state funds, as a necessary feature of an effective program.** However, many communities will not require a substantialbuffer, as 32 percent of the program managers reported that there were no adjacent wild elms and an additional 16 percent reported that 10 percent or less of the community border was adjacent to wild elms. This was one suggested change in the state program made by many local program managers, discussed in Chapter 2.

*Note that no other factors were found to be systematically related to the rate of loss.

**Details of width and payment formulas are beyond the scope of this study.

It would also seem worthwhile to modify the review and consultation procedure between the state shade tree inspectors and the local program managers. This could be diversified to include two emphases; the extent to which program operations are meeting the minimal criteria developed by the state and the percentage of elms lost. Emphasis upon minimizing the rate of loss and treating it as a problem to be approached with multiple solutions may have more payoff, in terms of extending the life of existing elms, than exclusive attention to program requirements.

CHAPTER 5

REFORESTATION EFFECTIVENESS

A second component of the Shade Tree Assistance Program is the replanting of trees once the original elms have been lost to disease. The Act provides for state funding of 50 percent of the cost of new trees but not more than $50 per tree. In municipalities of less than 4,000 people, up to 90 percent of the cost (but not more than $60 per tree) of the first 50 trees is paid for by the state. In either case, the Act provides only for replanting on public property (including boulevards or street terraces), but not replanting on private property. This is a major difference between the sanitation and reforestation components of the program: disease control is funded on both private and public property since success requires total control of the disease, while replanting can be disaggregated into public and private components, i.e., publicly funded planting on public land and privately funded planting on private property. Since 1977, 332,164 trees have been planted by this program.

In this chapter the factors which may determine the effectiveness of reforestation are investigated. First, to be discussed is how effectiveness can be measured and how Minnesota cities rank on these measures. Next is considered a wide variety of factors which might conceivably affect variation in effectiveness. Using a number of different data sources, evidence is offered for the importance of each of these factors in explaining reforestation effectiveness. The most important factors are selected and their impact on the rate of replanting is discussed, paying particular attention to those factors or conditions which can be controlled by the program manager. Finally, recommendations for improving replanting are made; our recommendations are based upon these statistical results as well as our visits to eight cities.

Measures of Reforestation Effectiveness

When thinking of a successful planting program, one immediately thinks of the actual number of new trees planted. However, a measure based only on the raw number requires the smallest town to plant as many as St. Paul, for example, and requires northern cities with little disease to plant as many as southern cities whose forests are long destroyed by the disease. Therefore, a measure is needed which is sensitive to the number of elms in the city and the rate of loss of trees. With this need in mind, two measures were chosen: 1) the number of trees planted from 1977 to 1979 as a percentage of the original public elm inventory in 1977; 2) the number of trees planted from 1977 to 1979 as a percentage of the number of trees removed 1977-79. The first measure gives an idea of planting relative to the original elm population. An even better measure would use the elm population at an earlier date but the 1977 annual report is the earliest source of data available. Cities scoring over 100 percent on this measure have more than replaced their elm inventory at the start of the program. Cities scoring 0 percent on this dimension have obviously planted no trees at all. The second measure gives a notion of planting relative to the losses suffered during the first three years of the program. Cities scoring over 100 percent have been replanting faster than they have been cutting; they have made progress under the program. It is possible that in certain cases, the variable may not measure reforestation success but rather forestation itself, such as in new subdivisions. For this reason, the outlying cases were dropped before analysis was done.

Though these two measures seem to measure two aspects of the effectiveness of any reforestation program, it is possible that these objective measures overlook local conditions which mitigate against a successful program: severe climate, lack of personnel to plant new trees, preoccupa-

tion with controlling the disease first, etc. Only an expert familiar with the city's unique situation and with similar programs across the state could estimate how successful each city is given its unique situation. For this reason the city programs were rated by the state tree inspectors. The inspector rating measure, then, expresses an overall evaluation by six inspectors on many unspecified dimensions of effectiveness. Together, these three measures form the empirical indicators of the actual success of programs in reforesting the state.

Tables 5-1 and 5-2 show the variation across the state in the three measures of the dependent variable replanting effectiveness. Taking the inventory-based measure first, 29 percent of the communities have done no replanting at all, and 17 percent have done a negligible amount (less than 10 percent). At the other end of the scale, 13 percent of the communities have planted more than their 1977 inventory. There is a great discrepancy between the mean and median values, making it difficult to describe the typical community's experience. This is due to the great range of the replanting rate, from doing nothing to planting 3700 percent of inventory. Turning to the removal-based measure, the same table shows that 40 percent of the communities, an even larger group (probably due to differing amounts of missing data) planted no trees during the last three years. However, at the other end of the spectrum, 42 percent of the cities planted more trees than they lost in the same period. Again, the mean and the median are discrepant because of the large range from 0 to 31,800 percent.

Finally, the inspector-based measure of reforestation effectiveness is presented in Table 5-2. The modal category is the 2.5-3.5 range labelled typical: 62 percent of the cities were placed here by the inspectors. Only

TABLE 5-1: FREQUENCY DISTRIBUTION AND DESCRIPTIVE STATISTICS FOR TWO MEASURES OF REFORESTATION EFFECTIVENESS

	Public Trees Planted as Percentage of 1977 Public Elm Inventory	Public Trees Planted as Percentage of Public Trees Removed, 1977-79
Number of programs	528	615
Mean value	76.3%	359.4%
Median value	12.9	60.9
Range of values	0-3700%	0-31,800%

FREQUENCY DISTRIBUTION

Percentage of Trees Planted	# of cities	% of cities	Number	Percent
0%	154	29	244	40
0.1 - 9.9	85	17	5	0
10.0 - 39.9	119	23	45	6
40.0 - 99.9	99	18	67	12
100.0 - 399.9	50	10	156	26
Over 400.0	21	3	103	16

TABLE 5-2: FREQUENCY DISTRIBUTION FOR INSPECTOR'S RATING OF REPLANTING EFFECTIVENESS

Average Program Ratings		Number of Cities	Percent of Cities
4.5 - 5.0	Excellent	1	0
3.5 - 4.49		57	14
2.5 - 3.49	Typical	253	62
1.5 - 2.49		90	22
1.0 - 1.49	Very Poor	8	2
Total programs rated		409	100

one city was rated as truly excellent and 14 percent as near excellent. But only 2 percent of the programs were placed in the very poor category and 22 percent as below average. Thus, it seems that inspectors think most cities, even those who have planted no trees, are doing a good job.

The cities that have planted no trees on either measure are especially intriguing. Why is it that they have done nothing in the last three years? Of course, the law in effect in 1977 and 1978 may be one contributing explanation. The original Act restricted replanting to the number of trees lost the previous year except during the first year of the program. At most, the effect of the restriction would be to limit planting for one year. Hence, this provision would not explain no planting at all.

Another hypothesis is that these cities might be in areas of the state such as the north where the disease has not taken many trees and thus there is not yet need to replace trees. However, when these cities were plotted on a map, they were located predominantly in the southern part of the state as were the cities which had replaced more than 100 percent of inventory. For example, in the nine counties across Minnesota's southernmost boundary, 12 cities reported planting 0 percent of initial inventory and 10 cities reported planting more than 100 percent of inventory. The Dutch elm disease reached 7 of these counties in 1967 and the others in 1968 and 1969. One would expect that these communities need to replant more than any other group yet, about half are replanting and half are not. Thus, it can be concluded that there is no apparent geographic pattern or relationship underlying the variation in the rate of replanting. The source of variation, then, must lie in social or political factors, rather than biological factors.

While all the possible social or political factors cannot be examined, there are two factors which might most immediately affect their ability to mount a replanting program: size of city and form of government. Smaller cities might have trouble planting any trees at all due to lack of finances and city staff. Of course, the almost "free" tree provision for communities under 4,000 (formerly 1,000) was designed to operate as an incentive program for these cities. In Table 5-3, on either measure of replanting, the small communities (under 2,000) have the largest percentages of communities doing no planting. Medium and large sized cities, in contrast, are more likely to plant more trees than they removed during this period. This finding would suggest that the almost "free" trees are still too expensive an option for the smallest communities.

TABLE 5-3: RELATIONSHIP OF REPLANTING INDICES AND POPULATION SIZE

Replanting	Population		
	Small (under 2000)	Medium (2000-10,000)	Large (over 10,000)
REMOVED INDEX			
0	48.6	23.8	7.1
.1 - 99.9	15.0	23.8	32.1
Over 100.0	36.3	52.4	60.7
	100.0	100.0	100.0
INVENTORY INDEX			
0	47.7	23.8	7.1
.1 - 99.9	39.6	68.2	82.1
Over 100.0	12.7	7.9	10.7
	100.0	100.0	100.0
	N = 432	N = 126	N = 56

Another possibility is that the form of government, though highly related to actual size of the population, may have an impact upon the replanting rate. After all, city governments were reformed, in part, so that public services could be provided more efficiently. Those cities, either small or large, which have professional managers are more likely to participate effectively. In Table 5-4 we find that on the removal-based measure, city manager governments among the home rule cities have the most cities doing no replanting at all and the fewest cities planting more than they lost. City manager governments do look better on the inventory-based measure however. Still, mayor-council cities seem to be doing a better job. Among statutory cities, however, the council manager communities are doing the best job of replanting: they have no communities doing no replanting and 57.2 percent have replanted more than they lost. Thus, the manager, perhaps because he/she tends to be in the larger small towns, seems to maximize replanting success among statutory cities. Also, cities with appointed clerks do considerably better on replanting than do cities with elected clerks. This finding is consistent with the finding in Chapter 3 that elected clerk cities tend not to participate in the program at all.

TABLE 5-4: RELATIONSHIP OF REPLANTING INDICES AND FORM OF GOVERNMENT

	Home Rule Cities		Statutory Cities		
Replanting	City Manager	Mayor-Council	Appointed Clerk	Council Manager	Elected Clerk
REMOVED INDEX					
0	11.5	6.7	39.3	0	48.1
.1 - 99.9	42.3	17.8	15.2	42.9	22.2
Over 100.0	46.2	75.6	45.5	57.2	29.6
	100.0	100.0	100.0	100.0	100.0
INVENTORY INDEX					
0	11.5	6.7	37.7	0	48.1
.1 - 99.9	80.8	82.2	46.6	92.9	33.3
Over 100.0	7.7	11.1	15.7	7.1	18.5
	100.0	100.0	100.0	100.0	100.0
	N = 26	N = 45	N = 191	N = 14	N = 27

The next step is to examine the interrelationships among the three measures of reforestation success. If they capture three aspects of the same dimension, a high intercorrelation is expected. In other words, the three ratings would "hang together": one city would be rated highly on all three measures and a poor city would be rated low on all three. However, the intercorrelations are low: the inspector rating correlates .04 with the inventory-based measure and -.04 with the removal-based measure. The two objective measures correlate modestly with each other at .28. Thus, the two percentage measures tend to measure the same underlying dimension of replanting, though imperfectly, while the inspector rating captures

quite different aspects of replanting. Since the three measures are not highly related, they cannot be combined into one indicator but instead must be analyzed separately. Furthermore, different independent variables would be expected to explain the different measures of the dependent variable since they are essentially unrelated. Thus, the analysis will take somewhat longer to explain and each analysis may point to different recommendations about program improvement.

Having investigated the characteristics of the non-planting communities, we will turn our attention to explaining the variation in success of the cities which are doing some replanting. Basically, there is nothing more to explain about the non-planters. They have been described as small cities and cities with elected clerks. Hence, further analyses will be conducted only on those cities scoring above zero on both replanting measures, i.e., the active replanting programs. The active programs occur in 371 communities.

The Selection of Independent Variables for Active Replanting Programs

The variables considered here were already presented in the last chapter in Table 4-2. They include features of the physical environment, characteristics of the community, orientations of citizens, local government conditions, and operating emphases of the shade tree program. Among the 120 variables listed, the variables directly related to reforestation would be expected to be more important than the variables directly connected to sanitation. The latter would usually have indirect impact by setting the need for replanting dur to loss of elms. Nevertheless, the results for all variables are reported. The data sources are the same as cited previously.

Also, the limitation of having only 36 citizen surveys precludes many generalizations based only on resident characteristics. This limitation has more serious effects upon the analysis in this chapter than it did upon the last chapter's analysis. For our measures of the dependent variable, the sample of 36 cities tends to cluster toward the middle of the distribution and not to represent the extremes of the distribution. For example, considering replanting as a percentage of original inventory, 13 percent of the 528 cities are over 100 percent, whereas in the sample of 36 cities, only 5.6 percent report such planting. Similarly, considering replanting as a percentage of elms removed, in the population of 615 cities, 26 percent report planting between 100-400 percent but in the sample of 36, 50.4 percent of the cities fall into the category. But the sample of 36 communities was selected on the basis of the inspector ratings and thus tend to cluster in the middle of the distribution. Hence, the sample overrepresents the middle and underrepresents the extremes. If citizen factors are found to be important for these 36 cities, one must generalize to the universe with caution.

Identification of Significant Independent Variables for the Active Replanting Programs

The first step in analyzing the factors which facilitate replanting is to identify those which individually are closely related to replanting success. The criteria for selection is the same as in the last chapter: generally a correlation of +.10 (which is significant at the .10 level except for the citizen variables where it would take a correlation of .20 to be significant). Table 5-5 presents the bivariate association for each significant variable, organized in the same way as in the last chapter.

In comparison with the list of sanitation correlations, the replanting correlations are generally lower. The inferences from the numerous significant resident variables will pose more of a problem in this chapter than in the last. The area in which there is the biggest difference in the number of significant variables is in the local government category. Local government may be more important in explaining replanting success than it was for sanitation. Perhaps this is due to the smaller number of state regulations governing replanting than govern sanitation. Overall, there are many variables whose causal connection to replanting is unclear: the signs are in the direction contrary to our hypotheses or the relationship seems spurious. Given this plus the low level of association, it is anticipated that many of these relationships will "wash out" or change or disappear altogether when the association among sets of variables is examined, rather than variables taken singly. Hence, the findings will not be discussed until considerable data reduction has taken place.

TABLE 5-5: SIGNIFICANT CORRELATION OF INDEPENDENT VARIABLES WITH REPLANTING MEASURES FOR ACTIVE PROGRAMS

	Inspector Rating	Percent of Public Elm Inventory	Percent of Public Elms Removed
NATURAL ENVIRONMENT			
1) Ease of access to trees	-.05	.13[b]	-.08
2) Percentage of 1977 elms remaining	.04	-.08[b]	.11[b]
3) Percentage of wild elms within .25 mile	-.01	-.09	-.15[c]
4) Percentage of wild elms within .5 mile	-.04	-.04	-.12[c]
5) Wild elm problem	.04	.03	.14[c]
6) Homogeneity of wild elms	-.19[a]	.02	-.15[b]
7) Years between onset and takeoff	-.36[a]	.08	.01
8) Years between takeoff and program	.19[a]	-.06	.01
9) Latitude north	.11[b]	-.03	.20[a]
COMMUNITY CHARACTERISTICS			
10) Population in 1975	.27[a]	-.04	-.03
11) Area in square miles	.29[a]	-.07	-.04
12) Median age in 1970 of population	-.12[b]	-.02	.03
13) Population density	-.10[b]	-.01	.05
14) Percentage owned dwellings	-.27[a]	.16[a]	.04
15) Per capita income	.10[b]	-.09[b]	-.06
RESIDENT"S PERSPECTIVES, KNOWLEDGE, AND BEHAVIOR			
16) Citizen support for program, disease control aspect	-.15[b]	-.07	.00
17) Citizen support for program, replanting aspect	-.17[b]	.11[c]	.09
18) Willingness to pay more than $10 in additional taxes	.40[a]	.03	-.13
19) Willingness to pay any additional taxes	.11	-.38[b]	-.09
20) Low perceived effectiveness of local govt.	-.31[b]	-.04	-.10
21) Low effectiveness of local program perceived	-.24[c]	-.23[c]	-.24[c]

TABLE 5-5 (1 of 4)

	Inspector Rating	Percent of Public Elm Inventory	Percent of Public Elms Removed
22) Low percentage of elms in neighborhood	-.23[c]	.09	-.19
23) Number of private elms chemically treated	.23[c]	-.09	.28[c]
24) Number of trees planted on adjacent public land by govt.	.03	.27[c]	-.01
25) Program manager's estimate of citizens reporting diseased elms	-.17[b]	-.03	-.00
26) Firewood utilization (any species)	.02	-.31[b]	.09
27) Use of elm firewood	-.12	-.23[c]	.29[b]
28) Program manager's estimate of elm firewood debarked	-.11[c]	.11[c]	.12[c]
29) Elm firewood debarked	.24[c]	-.26[c]	.16
30) Awareness of special DED phone #	-.38[a]	.11	.09
31) Low value placed on shade trees	.15	.23[c]	-.02
32) Low tendency to seek assistance for problems from local govt.	-.42[a]	-.28[c]	.11
33) Prefer emphasis on tree removal	.08	.22[c]	.02
LOCAL GOVERNMENT			
34) Special assessments per capita	.11[b]	-.00	.01
35) Total revenue per capita	.12[b]	-.02	.03
36) Total expenses per capita	.13[a]	-.01	.06
37) Total debt per capita	.10[a]	-.02	.01
38) Total revenue per elm tree	.02	.19[a]	.01
39) Program manager's estimate of mayor's concern for replanting	-.14[b]	.11[c]	.10[c]
40) Program manager's estimate of city council's concern for replanting	-.12[c]	.13[b]	.10[c]
41) Program manager's estimate of city employees' concern for replanting	-.10[c]	.12[c]	.06
42) Mayor-council form of government, town	-.41[a]	.16[b]	-.05
43) Mayor-council form, city	.25[a]	-.10[c]	.13[b]
44) Manager form	.23[a]	-.09[c]	-.07
45) Commission form	.11[c]	-.01	-.02
LOCAL SHADE TREE PROGRAM			
46) Assistance planned for private tree removal in 1980 from city funds	.20[a]	-.11[c]	-.08

	Inspector Rating	Percent of Public Elm Inventory	Percent of Public Elms Removed
47) Assistance planned for private tree removal in 1980, state funds	.16[a]	.00	.08[c]
48) Assistance planned for private tree removal in 1980, from any source	.37[a]	-.12[c]	.03
49) Man-hours of program staff per elm tree	.13[b]	.13[b]	-.03
50) Man-hours of reforestation staff per elm tree	.14[a]	.11[b]	-.04
51) Replanting costs per capita	.10[b]	.05	.02
52) Total size of staff per elm tree	.09[c]	.06	-.00
53) Sanitation costs per elm tree	.12[b]	.06	-.08[c]
54) Program costs per elm tree	.12[b]	.16[a]	-.05
55) Assistance provided for private tree removal from city funds	.30[a]	-.06	-.05
56) Assistance provided for private tree removal from state funds	.14[a]	-.06	.05
57) Program manager's evaluation of program resource inadequacy	.02	-.17[b]	-.14[b]
58) Low risk trees as percent of marked trees	.15[b]	.01	.13[c]
59) # of days delay before low risk tree removal	-.12[c]	-.04	-.07
60) # of days delay before high risk tree removal	-.17[b]	.06	.06
61) Policy for low risk removal	.03	-.02	.13[b]
62) High risk trees as percent of marked trees	-.15[b]	.00	-.13[c]
63) Policy for high risk removal from public property	-.15[b]	.01	-.03
64) Policy for high risk removal from private property	-.16[a]	.04	-.00
65) Emphasis on replanting	-.09	-.06	-.11[c]
66) Emphasis on informing the public	.07	.03	.16[b]
67) Replanting cost per 1977 inventory	-.06	.18[a]	-.01
68) Replanting cost per 1978 inventory	.00	.09[b]	-.01
69) Replanting cost per 1979 inventory	.00	.30[a]	.02
70) Absolute size of forestry staff	.02	.08[b]	.05
71) Average replacement costs in 1979	.12[b]	-.06	-.10[b]
72) Years program manager worked in forestry	.21[a]	-.01	.05
73) Program manager's estimate of inadequacy of govt. crews	-.06	-.07	.10[c]
74) Replanting done by city crews	-.10[c]	.21[a]	.08

TABLE 5-5 (3 of 4)

	Inspector Rating	Percent of Public Elm Inventory	Percent of Public Elms Removed
75) Program manager's estimate of inadequacy of supplies & new trees	-.01	-.00	.10[c]
76) Total trees expected to be replanted in 1980	.26[a]	.02	.05
77) Replanting paid from general fund	-.21[a]	.24[a]	.11[c]
78) Replanting paid from ad valorem tax	-.18[a]	.22[a]	.10[c]
79) Replanting paid from special assessments	-.20[a]	.23[a]	.11[c]
80) Replanting paid from federal grants	-.19[a]	.23[a]	.11[c]
81) Replanting paid from other sources	-.18[a]	.22[a]	.11[c]

Notes: a indicates probability of occurrence by chance less than .01
b indicates probability of occurrence by chance between .01 and .05
c indicates probability of occurrence by chance between .05 and .10

TABLE 5-5 (4 of 4)

However, there are some interesting "null" findings from the first correlation exercise. It is interesting to note that various tree and population density measures are not correlated with any measure of the dependent variable. Similarly, given the emphasis placed on citizen income in the case studies, it is remarkable that tax levy is not related to any measure of replanting success. Several variables specific to replanting were unimportant: the amount or percentage of private replanting, the program manager's estimate of citizen watering of new trees, his estimate of coordination on species selection, the citizen requests for replanting he receives, his emphasis on replanting, and who plants the trees (city crews, nurseries, or volunteers). Thus, not all the expected relationships are confirmed.

Estimation of Independent Variables' Impact on Replanting Among Active Programs

A variety of techniques was used to reduce the number of variables from 81 to a manageable number where "manageable" is constrained by the 36 cases available for the citizen variables. Obviously, one must work with less than 36 variables. First, multiple measures of any variable were eliminated; then redundant variables were eliminated (as judged by

their intercorrelation). Next, a stepwise multiple regression procedure was used separately for the citizen variables in the 36 cities and the other variables for all available cities. This procedure selects the most important explanatory variable from the entire set specified, then the next most important, and so on, until it exhausts the variables which are significant in their explanatory power. When the relative contribution of each variable was examined, the equation was further reduced to the best few significant variables. Then the best citizen and non-citizen sets of variables were merged so their joint impact among the 36 cities could be estimated. Since the measures of the dependent variables are so unrelated, one can expect that the best-fitting equation for each measure will contain different independent variables from the other measures.

Tables 5-6 through 5-8 report results of the best-fitting equation for each measure when only citizen variables are used, when non-citizen variables are used, and when both are used. First, to be examined are those non-citizen factors which help to explain variation in replanting success as a percentage of trees removed. Little of the variance is explained but both factors are significant: the percentage replanted increases as one goes north and as the program emphasizes informing the public. Second to be examined are those citizen factors which help to explain the same variation among the set of 36 cities. The best set of variables explains a modest 18 percent of the variance but only one of the factors (using lots of elm firewood) is significant. Its impact upon replanting is indirect at best. With the use of elm firewood, the perception of the tree program as excellent, and lack of bad neighborhood conditions are merged with the citizen variables, a more respectable 24 percent of the variance is explained.

TABLE 5-6: RELATIONSHIP OF REPLANTING AS PERCENTAGE OF REMOVED AND SELECTED INDEPENDENT VARIABLES AMONG ACTIVE PROGRAMS

	Variance Explained
Non-Citizen Set (n=176)	
emphasis on informing the public latitude north	8%
Citizen Set (n=36)	
lack of bad neighborhood conditions perception of the tree program as excellent use of elm firewood	18%
Merged Set (n=36)	
lack of bad neighborhood conditions emphasis on informing the public latitude north perception of the tree program as excellent use of elm firewood	24%

However, only one of the variables is significant and thus it is difficult to say what is the direction of the other relationships. It is probably safe to say that, for whatever reason, the use of lots of elm firewood is associated with replanting success. However, none of these factors (latitude, emphasis, firewood) is considered to be causally related with replanting success.

Turning now to the inventory-based replanting measure, the non-citizen list in Table 5-7 shows that 18 percent of the variance is explained by three variables, all significant: replanting cost per 1979 tree inventory, cities whose replanting funds come from the general fund, and the percentage of residents who own their houses. The ability to plant many trees relative to the 1977 inventory seems to be associated with a high cost per 1979 inventory, the use of general funds, and owning your own house. The first variable is not considered causal but possibly there is a causal relationship with the other two variables. The use of general funds, rather than ad valorem tax, special assessment, federal grants or other funds, increases replanting success. Replanting takes place more frequently in cities with a high owner-occupancy rate, probably because these citizens are more interested in improving their property values and pressure their city governments to make the adjacent public property more attractive.

The citizen list shows that two variables explain 22 percent of the variance: the unwillingness to pay any more taxes at all for trees and attributing a high responsibility to local government to solve problems. The first factor is significant but the sign would appear to be in the "wrong" direction. Upon further reflection, it may be that the

TABLE 5-7: RELATIONSHIP OF REPLANTING AS PERCENTAGE OF INVENTORY AND SELECTED INDEPENDENT VARIABLES AMONG ACTIVE PROGRAMS

	Variance explained
Non-Citizen Set (n=177)	
percentage of residents who own their houses replanting funds come from the general fund cost per 1979 tree inventory	18%
Citizen Set (n=36)	
high responsibility to local government to solve problems unwillingness to pay any more taxes at all for trees	22
Merged Set (n=36)	
unwillingness to pay any more taxes at all for trees cost per 1979 tree inventory	53

citizens unwilling to pay any more taxes are just part of the tax-revolt, rather than people who don't like trees. In fact, the correlation between the city's tax effort and unwillingness to pay more taxes is positive. When these variables are merged into one set for the 36 cities, the best two variables (tax unwillingness and replanting cost) explain 53 percent of the variance with both variables significant. Again, one variable is clearly non-causal and the other's impact is indirect through the existing tax rate.

Finally, to be explained is variation in inspector ratings among the communities which have done any planting at all. For this measure, presented in Table 5-8, 27 percent of the variance is explained by four non-citizen variables: home rule cities and those statutory cities with a manager, area, the number of years the program manager has worked in forestry, and non-reliance upon "other" funds. All four variables are significant. Thus, state inspectors think the best programs are in certain types of cities with particular forms of government, with experienced managers and who don't rely on other funds. Basically, these would be the larger cities of Minnesota.

Focusing upon the citizen variables now, three variables can explain 20 percent of the variance among the 36 cities: debarking all firewood, a perception that local government is effective, high home ownership. Only the debarking variable is significant however. Inspectors think the best replanting programs also have effective debarking programs but this would not be a causal factor. When the two sets of variables are merged, 24 percent of the variance can be explained but none of the variables are now significant.

TABLE 5-8: RELATIONSHIP OF INSPECTOR RATINGS AND SELECTED INDEPENDENT VARIABLES AMONG ACTIVE PROGRAMS

Non-Citizen Set (n=177)	Variance Explained
non-reliance upon "other" funds number of years program manager has worked in forestry area home rule cities plus statutory cities with managers	27%
Citizen Set (n=36)	
percentage of home ownership perception that local government is effective debarking of firewood	20
Merged Set (n=36)	
non-reliance upon "other" funds area debarking of firewood home rule cities plus statutory cities with managers	24

Conclusions and Recommendations

From the statistical analyses and from the case studies, one can learn several things about the replanting component of the Shade Tree Assistance Program. First, there is a considerable number of communities participating in the program which are doing no replanting at all; based on the state data, between 30 and 40 percent are not replanting. This phenomenon does not seem to be related to the spread of the disease but rather to the size of the city and perhaps the form of its government. Smaller communities are less likely to plant trees unless the government has a council manager or an appointed clerk. Perhaps the manager can function as a grantsman for the community more so that can the elected city clerk. It would appear that more is needed to stimulate the participation of small cities than currently appears in the statute in the form of the 90 percent subsidy. The state program might work with the Minnesota League of Cities to develop informational programs for the smaller communities so that they learn about the benefits of the Shade Tree Assistance Program and its relatively low cost.

Secondly, it was difficult to find causal factors which might explain the variation in replanting rates among those cities which are doing some replanting. Among the significant factors which are possibly causal are the use of general funds and the owner-occupancy rate. However, the data only indicate whether a city uses general funds at all, not how much it relies on them or how many other sources of funds are used. Thus, one cannot make a conclusive inference from this finding. Probably those cities which have the flexibility to draw from several sources of funds, or to move around among sources as financial conditions change, are the most successful cities. The fact that a high owner-occupancy rate is

important reinforces a similar finding from the case studies but this is not a factor within the control of the state program.

The lack of success in explaining systematically the variation in rates should not be inferred to mean that efforts to improve any of the factors studied are doomed. Rather, two other conclusions can be drawn. One is that the conditions are unique from one community to another so that what is successful in one community does not lead to success in another. In the case studies, factors which seemed crucial to success in a small community were unimportant in a larger city. For example, the conditions faced by northern cities are completely different from those in southern cities where the forests were destroyed 10 years ago. In this type of situation where the causal factors vary across communities, it is important that the state program recognize the local variation and context, rather than attempt to place programs within a rigid procedural mold. In this regard, the absence of complaint from any program manager about working relationships (e.g. amount of red tape, delays in processing, etc.) with the state is noteworthy. Managers working in different localities do seem to feel that the state program is flexible enough to accommodate their different needs and conditions. This perception is very important to the continued success of the program. The flexible partnership between state and local governments should be stressed in any changes in the law.

Another possible reason for our lack of success in explaining replanting rates, especially when compared to our success in explaining sanitation rates, is that replanting very likely is an activity which can be deferred. A city must fight the Dutch elm disease when it first hits,

otherwise, the forest is lost. In contrast, the disease control expenditures cannot be put off until next year. Money can more easily be taken away from other programs to fight disease because the loss of trees is a crisis. When the crisis is past, then the community can turn to replacing the lost trees and to other priorities. For example, St. Paul tied up nearly all of its public works budget for three years in order to fight disease and to replace trees. Now street repairs are beginning to make a bigger claim upon that budget and tree expenditures are declining. More trees can be replaced later when there are less pressing competing claims. Since planting is lower priority, then it follows that the decision to replant is more complicated (and hence harder to explain across cities) than the decision to fight the disease. Planting depends on many aspects of the tree program and upon the number of other problems competing for expensive solutions. Data of a statistical nature will be less able to contribute an explanation for replanting.

Thus far, conclusions have been offered from the analysis of non-participants and from the statistical data. A third kind of analysis was the visits to eight case study communities. In those visits it was learned that the reliance on volunteers to do the planting is not always conducive to much planting. Cities using this method might be encouraged, as soon as finances permit, to contract with nurseries or to provide city employees to do the planting. Further, the inclusion of boulevards into city-financed programs appeared to lead to a more successful program as rated by state inspectors. This inclusion is provided for in the Act but not everyone chooses to spend money on boulevards or has boulevards. The other important condition seen in the case studies was the value of citizen enthusiasm in small towns. In

larger cities, there are some very successful replanting programs where citizens don't seem to care about or have knowledge about the program. If that attitude is present in small towns, however, the program tended to be unsuccessful. In the more successful small programs, citizens helped by reporting trees as diseased and by watering newly planted trees, thereby stretching the already thin financial resources of the small community. Perhaps a small portion of state funds could be earmarked for public relations campaigns in the smaller communities only, where an increment in public concern will make a difference.

The fourth type of analysis was of inspector ratings of the replanting component of the program. The lack of correlation of inspector ratings and measures of performance was puzzling at first. The rating is correlated (.24) with the total number of trees replanted, as distinct from the relative number of trees planted. Inspectors also tend to rate more highly those cities which are large and whose program managers are more experienced. Certainly, these are the communities one would expect to have particularly good programs. Nevertheless, the ability to plant more than one lost (or started with) is not concentrated in those particular cities. Perhaps the state program might pay more attention to the unique circumstances each community is up against, rather than some of the procedural requirements. One might begin to judge the program outcome, in terms of sanitation and replanting, rather than the process by which it is achieved.

TECHNICAL APPENDIX

Relationship of replanting as percentage of removed and selected independent variables among active programs:

Non-citizen set (n = 176)

$$R = -276.16 + .397\ EMP^{b} + 6.169\ LAT^{a} \qquad R^2 = .08$$

Citizen set (n = 36)

$$R = 18.71 - .403\ NEIGH - .181\ PROG + .307\ FIRE^{c} \qquad R^2 = .18$$

Merged set (n = 36)

$$R = -42.32 - .689\ NEIGH + .083\ EMPH + 1.357\ LAT - .148\ PROG + .315\ FIRE^{c} \qquad R^2 = .24$$

NOTES: EMP = emphasis on informing the public
LAT = latitude north
NEIGH = lack of bad neighborhood conditions
PROG = perception of the tree program as excellent
FIRE = use of elm firewood

Relationship of replanting as percentage of inventory and selected independent variables among active programs:

Non-citizen set (n = 177)

$$R = -3.586 + .050\ OWN^{b} + .466\ GEN^{a} + .035\ COST^{a} \qquad R^2 = .18$$

Citizen set (n = 36)

$$R = 2.24 - .066\ LGOVT - .017\ TAX^{b} \qquad R^2 = .22$$

Merged set (n = 36)

$$R = .600 - .012\ TAX^{b} + .024\ COST^{a} \qquad R^2 = .53$$

NOTES: OWN = percentage of residents who own their houses
GEN = replanting funds come from the general fund
COST = cost per 1979 tree inventory
LGOVT = high responsibility to local government to solve problems
TAX = unwillingness to pay any more taxes at all for trees

Relationship of inspector ratings and selected independent variables among active programs:

Non-citizen set (n = 177)

$$R = 2.81 - .066\ OTHER^{a} + .013\ EXP^{a} + .012\ AREA^{a} - .368\ CITY^{a} \qquad R^2 = .27$$

Citizen set (n = 36)

$$R = 2.620 + .019\ OWN - .014\ LGOVT + .045\ FIRE^{b} \qquad R^2 = .20$$

Merged set (n = 36)

$$R = 3.02 + .217\ OTHER + .008\ AREA + .027\ FIRE - .464\ CITY \qquad R^2 = .24$$

NOTES:
- OTHER = non-reliance upon "other" funds
- EXP = the number of years the program manager has worked in forestry
- AREA = area
- CITY = home rule cities plus statutory cities with council-manager plan
- OWN = percentage of home ownership
- LGOVT = perception that local government is effective
- FIRE = debarking of firewood

a indicates probability of occurrency by chance less than .01

b indicates probability of occurrency by chance between .01 and .05

c indicates probability of occurrency by chance between .05 and .10

CHAPTER 6

SUMMARY AND RECOMMENDATIONS

Shade trees are an important part of the quality of life in Minnesota. The onslaught of Dutch elm disease and oak wilt are threatening the state both by eliminating much of this resource and by placing surging financial burdens on cities forced to remove diseased trees and replanting within a few brief years. Because of this burden, and because diseased trees in one location provide an incubator for disease-carrying beetles in another, the legislature created the state Shade Tree Program in 1977. Expertise and financial assistance are thereby made available to communities across the state. Since its inception, annual tree losses have been cut each year while replantings have grown; obviously the program has been successful. Yet the success has varied from city to city. It was to explain this variation that this study was undertaken. The previous chapters will be summarized below and followed by a general set of recommendations relevant to the three major topics of inquiry: participation status, sanitation success, and replanting success.

Data Collected

This is a social science study. It was undertaken with the assumption that all cities have knowledge of the same technology so that it is not a determining factor in explaining variation in success. Rather, it is how the people, citizens and officials, view the problem and attack it which is important. These attitudes and resulting actions, together with environmental conditions, are the factors which determine the success of the program.

Against this background, the study collected a great deal of data relevant to measuring success and factors which might be significant in determining this success.

The records of the Shade Tree Program provided most of the information used to measure success. Cities participating in the program, those which had dropped, and those which have not participated were identified. The number of trees in their inventory, the number removed, and the number planted 1977-79 for the participating cities were used to create sanitation and replanting success indices. Finally, these quantitative measures were supplemented with subjective ratings of the state inspectors.

The program managers in 239 cities were interviewed by telephone to determine the characteristics of their programs. The typical program was initiated in response to the Dutch elm disease threat and is operating in compliance with state procedures. It would be the deviations from this typical program that explain the relative success of each city's program.

Residents of 36 communities were also interviewed. These cities were chosen to represent a range of success, size, and location across the state. Most have a strong appreciation of shade trees and are willing to support governmental efforts to protect and develop this resource. Few have actively participated in these efforts. Again the deviations from this typical picture would explain program success in each city.

In-depth investigations were undertaken in eight cities. These cities were also chosen to provide variation in size, location, and success. Cities were visited and a large number of people interviewed in a relatively unstructured way. These case studies would provide the basis for understanding the more quantitative data collected above.

Information on the demographic, environmental, and economic status of each city was gathered from a variety of public records. This secondary information complemented the attitudinal and perceptual data collected directly by the study.

Participation in State Program

While the majority of cities do participate in the state Shade Tree Program, over 360 cities in outstate Minnesota do not. About 288 cities have never participated and another 76 were in the program in its early years, but had dropped by 1980. Most of these cities had been operating ineffective programs according to the state inspectors. Governmental records and interviews with city officials and citizens in these cities were used to explain their reasons for not participating.

The most dramatic explanation for not participating is city size. The smaller the city the lower the probability that it will participate. Less than 10 percent of the cities under 100 people were in the state program, while every city over 5,000 participates. Small cities in the south are more likely to have experienced a disease problem and therefore participated. Most small cities run their government with a clerk. Those who appoint, rather than elect, this clerk are more likely to participate.

The cities not participating seem to have a minimum disease threat. Northern cities are likely to have not yet experienced the disease. Southern cities may have already lost all their trees and dropped out. If most trees were lost before 1977, they may have never joined. Citizens in all parts of the state care for trees and are willing to pay additional taxes to support them.

Some of these cities do have a disease threat, but are not participating for one reason or another. The most disconcerting reason was misplaced application forms. Five cities, most of which have been running good programs, were not in the 1980 state program. Other cities complained state regulations and paperwork were excessive, but this type of complaint is common for any state program. Likewise, many of the cities claiming lack of financial resources were found to be in the lowest categories of local taxing effort.

Three recommendations for improving the state program come from this investigation. First, small cities need administrative support which could be provided by the county. Such support programs should be encouraged. Second, follow-up should be provided for applications not returned. Finally, consideration should be given to funding removals and replantings caused in the future by blights other than Dutch elm and oak wilt.

Sanitation Effectiveness

A good sanitation program will reduce tree losses by removing sources of infection. Several measures of the effectiveness of sanitation programs were tried including state inspector ratings and percentage losses. These measures, though having substantial variation and obviously important, were not statistically related. The most satisfactory measure was the mean of the losses in each year, 1977-79, as a percentage of the tree inventory in 1977. Having selected this mean loss measure of success, the next steps were to determine variables which related to relative degrees of success and how these variables could be combined to "predict" success.

Variables possibly related to sanitation success could be grouped into five categories: natural environment, community characteristics, resident characteristics, local government characteristics, and local shade tree characteristics. Within each category variables were found which were statistically related to mean tree losses. Fifty-one such variables were so identified.

Combining a subset of these variables, three have a significant effect on sanitation effectiveness. The cities further north had lost fewer trees. Similarly, those cities with a lower percentage of adjacent wild elms infected or recently killed, had significantly lower domestic elm losses. Finally, where citizens expect their local governments to handle community problems, tree losses were low. In all, 64 percent of the variation in losses could be explained with these three measures. Unfortunately, these significant variables are beyond the control of local programs to influence.

Restricting the analysis to those which could be affected by local programs yielded more useful results, but at the loss of statistical purity. Six variables were combined which explained 35 percent of the variation in losses. The variables involved included citizen awareness of local shade tree programs and concern for community forests, effective operation of the local program, and the use of elm firewood. The same types of variables explained 29 percent of the variation in inspector ratings.

The ability to predict sanitation effectiveness was not high; fewer than a dozen of 120 variables were found to have any causal relationship--usually modest. The final explanatory ability of these variables was relatively low. There may be two reasons for this low predictability.* First,

*A third reason is also possible. It is possible that data were inadvertently muddled during collection or analysis. Many steps were taken to prevent this from happening.

it may be that a number of unmeasured or unexplored features of the host communities or the local programs were not given consideration in the analysis. The key factor was not included in the analysis. Second, it may be that the attempts to standardize local programs may have been so successful that there is little variation in the way they are conducted and all variation is due to unexplored random factors (such as those mentioned above). If so, the only sources of variation in effectiveness that remain will be subtle distinctive features of each program and its community context. A combination of these two interpretations probably accounts for the low level of predictability.

Replanting Effectiveness

A similar approach was used to explain variation in replanting effectiveness. Again, several measures of effectiveness were used including two quantitative measures and the more qualitative state inspector ratings of municipal replanting programs. Both quantitative measures were ratios involving the number of trees replanted from 1977 through 1979. One used the 1977 public elm inventory as a base and the other used public elm removals as a base. Some problem existed with each measure. State inspectors tended to rate most programs near average with few being rated poor or excellent. The major problem with the quantitative measure was that a large number of cities had planted few or no trees.

Possible explanation for these low participation rates were investigated. One explanation was found by looking at city size. Only half the cities in the general state program, but with under 2,000 people, had replanted any trees compared to much higher rates for larger cities. Those smaller cities with

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appointed clerks were more likely to have a replanting program than those with elected clerks.

Explaining different replanting success was restricted to those cities with a replanting program. The same potentially explanatory variables were tested against the measures of success. Though a larger number, 81, were found statistically related, the magnitudes of the relationships were lower than found in the analysis of sanitation effectiveness.

A combination of a subset of these variables proved useful in explaining the variation in each of the success measures, but a different subset was required for each. The success measure relating replanting to removals was best explained (24 percent) by good conditions in the neighborhood, emphasis on informing the public, northern location, citizen perception of the program excellence, and the use of elm firewood. The success measure relating replanting to initial inventory was best explained (53 percent) by citizen unwillingness to pay more taxes for trees and replanting cost per 1979 tree inventory. Inspector ratings were best explained (27 percent) by non-reliance on other funds, forestry experience of program manager, land area of city, and form of government.

The limited success in explaining replanting success possibly can be attributed to two reasons. First, to repeat from above, the situations and programs in and across the state are too unique to allow generalization. Second, as opposed to sanitation efforts, where timing is critical to success, replanting efforts can be attenuated or delayed without substantial ill effects. These options are attractive to cities since they minimize financial shocks and are esoecially appealing during the late seventies when sanitation costs escalated. To the extent these options were taken, attempts to predict replanting success for a short 3 year period would be confused.

Recommendations

The state Shade Tree Program has been successful by any measure. It has cut tree losses and encouraged accelerated replantings. Furthermore, local officials rate highly all aspects of the state program.

The purpose of this study was to make recommendations for improving the operating effectiveness of the program. Those recommendations are made below. While they may evoke some degree of improvement, dramatic improvements do not seem possible--especially in sanitation success. Increased replanting success could be most dramatic by converting that 40 percent of cities participating in the overall state program, but without active replanting programs.

Cities: For the cities themselves, three recommendations appear worthy of comment.

- Conduct the local program under existing state rules to the extent possible. Control of the use of elm firewood and complete regular inspections should yield improved results. Where adequate equipment is available to support the program, results are also improved.
- Promote citizen awareness and support for the program. Cities where citizens are involved have greater success.
- Participate in the state's replanting program.

State Shade Tree Program: Five factors, under the control of the Department of Agriculture, might be manipulated to maintain or improve program success.

- Respect the uniqueness of each situation. Each aspect of this study found unique characteristics in various cities which helped explain their success. This uniqueness requires a flexible response. Appreciation of these circumstances requires the continued understanding

of state inspectors fostered by the relationship with local program managers. The flexible response will follow when laws and rules permit them. Wisdom will be required where discretion is allowed, but the staff and advisory committee can consult each other in these matters.

- Foster special support mechanisms for smaller cities. Smaller cities are not dealing effectively with the loss of shade trees. They are less likely to participate in the state program and when they do participate, their success is lower. One possibility is to follow the Itasca County example and have the county provide the administrative vehicle.
- Provide more support for administering procedures within the state program. In particular, the application process needs improvement so the state can easily verify who is in the program at any one time. Good programs should not be dropped. Either continuous enrollment should be allowed for good programs (where no alterations are planned) or a rigorous follow-up procedure established to remind cities that their application is tardy.
- Promote the replanting program. Too few cities are aware of its existence. Even some cities participating in the state program seem unaware of this possibility. Direct mailings, League of Cities announcements, presentations at state meetings, and use of regional development staff and newsletters are all possible means. All cities losing trees should be encouraged to join the replanting program.

Legislature: Four factors affecting success are under control of the state legislature. They are in the statute that establishes and directs the state Shade Tree Program.

- o Allow for a control zone beyond city limits. This factor was frequently mentioned by city personnel and found significantly related to tree losses. Yet by law, funds will not support removal outside city limits. Consideration of a buffer area should be made.
- o Unique situations require unique solutions. Again the state law restricting payment to 50 percent of expenses is a barrier. Under certain conditions, higher levels of compensation may be required.
- o The educational research and service should be made permanent and improved.
- o Consider expanding the program to cover other threats to trees as they occur.