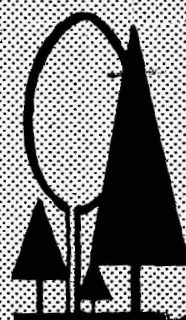
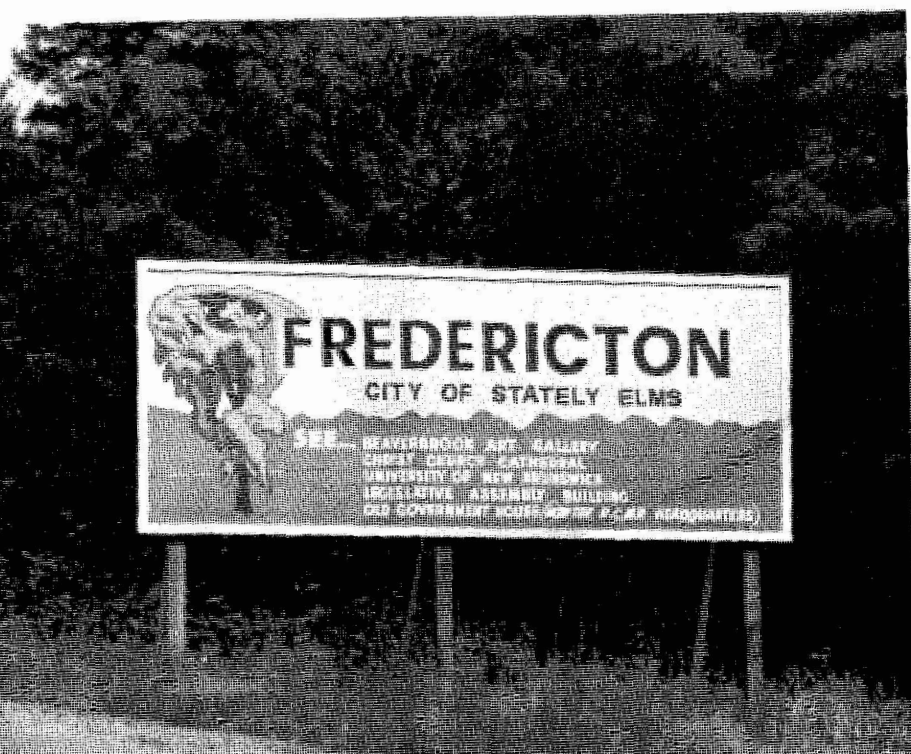




TWENTY YEARS OF DUTCH ELM DISEASE IN FREDERICTON, N. B.

by
L. P. MAGASI
R. E. BALCH
S. E. POND
C. C. SMITH
D. A. URQUHART



MARITIMES

CANADIAN FORESTRY SERVICE

MARITIMES FOREST RESEARCH CENTRE

The Maritimes Forest Research Centre (MFRC) is one of six regional establishments of the Canadian Forestry Service, within Environment Canada. The Centre conducts a program of work directed toward the solution of major forestry problems and the development of more effective forest management techniques for use in the Maritime Provinces.

The program consists of two major elements - research and development, and technical and information services. Most research and development work is undertaken in direct response to the needs of forest management agencies, with the aim of improving the protection, growth, and value of the region's forest resource for a variety of consumptive and non-consumptive uses; studies are often carried out jointly with provincial governments and industry. The Centre's technical and information services are designed to bring research results to the attention of potential users, to demonstrate new and improved forest management techniques, to assist management agencies in solving day-to-day problems, and to keep the public fully informed on the work of the Maritimes Forest Research Centre.

TWENTY YEARS OF DUTCH ELM DISEASE IN FREDERICTON, N.B.

(1961-1980)

by

L.P. Magasi, R.E. Balch, S.E. Pond,
C.C. Smith, and D.A. Urquhart

Maritimes Forest Research Centre
Fredericton, New Brunswick

Information Report M-X-127

Canadian Forestry Service
Environment Canada

1981

TABLE OF CONTENTS

	Page
ABSTRACT	iii
ACKNOWLEDGEMENTS	iv
INTRODUCTION	1
PART I BIOLOGICAL AND HISTORICAL BACKGROUND	2
The Disease and its Carrier	2
Fredericton and its Elms	3
The Fredericton Tree Commission	4
The Parks and Trees Department in Fredericton	4
Dutch Elm Disease in Central New Brunswick	5
Control or Management	7
PART II DUTCH ELM DISEASE MANAGEMENT IN FREDERICTON	7
Dutch Elm Disease in Fredericton	7
Methods for Managing Dutch Elm Disease and their Use in Fredericton.	8
Surveys	8
Sanitation	8
Preventive pruning	8
Preventive tree removal.....	8
Removal of infected trees	8
Burial and burning	10
Stump removal	12
Debarking	13
Insecticides	13
DDT.....	13
Methoxychlor	14
(a) Whole tree spray with methoxychlor.....	14
(b) Basal trunk spray with methoxychlor.....	14
Chlorpyrifos (Dursban 2E®).....	14
(a) Whole tree spray with Dursban.....	14
(b) Basal trunk spray with Dursban.....	15
Trap trees	15
Tree planting	16
Some Other Methods not Used in Fredericton during 1961-1980	17
Tree surgery	17
Tree injection	17
The Integrated Approach to Dutch Elm Disease Management	18

	Page
PART III. AN EVALUATION OF THE DUTCH ELM DISEASE MANAGEMENT PROGRAM ..	18
Beetle Population Differences in Different Treatment Areas	18
The beetle index	18
The boring-dust counts	21
Beetles in whole-tree sprayed elms	21
The Fredericton Dutch Elm Disease Management Area	22
The Cost of Fredericton's Tree Program	25
SUMMARY	26
REFERENCES	27
APPENDIX	29

ABSTRACT

The City of Fredericton, New Brunswick, has saved 80% of its elms since Dutch elm disease was first found here in 1961, while more than 80% of elms in surrounding areas have been destroyed. This report presents the City's efforts during the past 20 years to control the disease. Part I deals with the biological and historical background of the disease and its carrier, and the City's control measures. Part II presents, through text, tables, and figures, all aspects of Fredericton's Dutch elm disease management program - surveys, sanitation, use of insecticides, and tree planting. Part III reports the results of an evaluation - bark beetle population studies, tree losses, and the cost of the program. Of the original elm population, 19.7% was lost to the disease, leaving the City with over 3600 elms within the historical City centre: 1300 of these are high value street trees. Through a vigorous planting program - over 4500 trees planted since 1974 - the old monoculture is being rejuvenated while the character of the City of Stately Elms is retained. The report contains 14 tables, 10 figures and over 20 photographs.

RESUME

La ville de Fredericton au Nouveau-Brunswick a pu sauver 80% de ses ormes depuis que la maladie hollandaise y a été relevée pour la première fois en 1961, tandis que 80% des ormes étaient détruits dans les environs. Ce rapport fait état des efforts de la ville au cours des 20 dernières années pour combattre la maladie. La partie I traite du fond biologique et historique de la maladie et de son agent vecteur ainsi que des mesures de lutte prises par la ville. La partie II présente au moyen de textes, tableaux et figures tous les aspects du programme de gestion de la maladie hollandaise de l'orme mis en oeuvre par Fredericton: relevé, sanitation, usage d'insecticides et plantation d'arbres. La partie III rend compte des résultats d'une évaluation des études sur les populations de scolytes de l'écorce, des pertes en arbres et du coût du programme. La maladie a occasionné la perte de 19.7% de la population initiale d'ormes, laissant à la ville plus de 3600 ormes à l'intérieur des limites historiques de son centre-ville, dont 1300 revêtent une grande valeur comme arbres de rue. Grâce à un vigoureux programme de plantation, soit plus de 4500 arbres plantés depuis 1974, la vieille monoculture se rajeunit en même temps que se maintient le caractère propre de la ville des ormes majestueux. Le rapport comporte 14 tableaux, 10 figures et plus de 20 photographies.

ACKNOWLEDGEMENTS

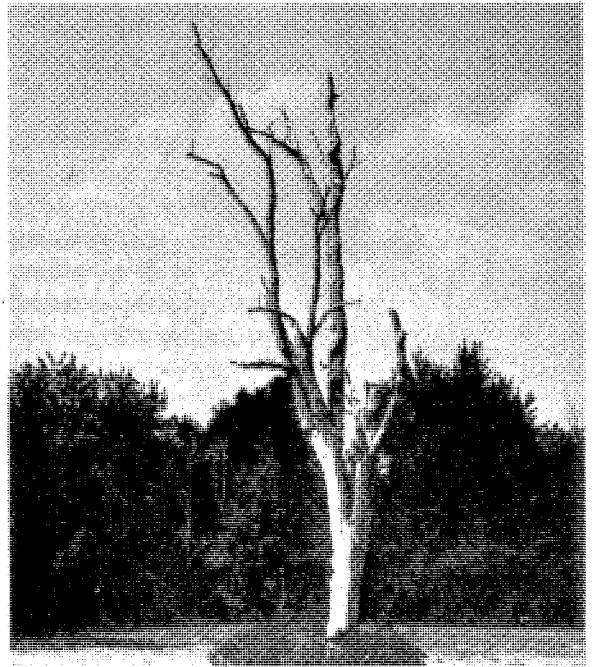
The authors wish to thank all who contributed to this program: without their support this report would not have been possible because there would have been no elm trees to write about.

Special thanks to J.H. Torunski for reading an early draft of the report and making valuable suggestions; to Dr. Ellen MacGillivray for some of the information on the Tree Commission; to Anita Jones for most of the early typing; to A.E. Hale for drafting the figures, to the photographers whose pictures helped tell the story, E.B. Bates, Mr. Ian Brown of the Daily Gleaner, C.L. Burlock, Dr. R.J. Campana, F.G. Cuming, K.J. Harrison, Mr. A.E. King of City Hall, Dr. E.S. Kondo, Dr. G.A. VanSickle and L.E. Williams. And last but not least to Marg Cameron, our Scientific Editor, for her help in all phases of producing this report and for her infinite patience in dealing with the senior author.

INTRODUCTION

Twenty years ago, 1961, elm trees in Fredericton, New Brunswick, were first found infected by Dutch elm disease. The arrival of this dreaded tree killer was not unexpected. Years earlier, City Council, on good advice, had taken some valuable steps when it initiated a program of management designed to prevent such a catastrophe as the sudden destruction of this tree species which is a large part of the beauty of the "City of Stately Elms", the provincial capital.

After 20 years of consistent commitment to the management program by successive municipal governments, the City's old core is still hidden beneath a canopy of century old elms, and a young stand comprised of a variety of species is growing to replace them when necessary. The City still has 80% of its original elm population, while surrounding areas are pockmarked with skeletons of trees which are an eyesore to residents and tourists and a hazard to life and property.



This report has several purposes. It is time to take stock of what has been done in the management program during the past 20 years, how it was done, at what cost, and with what results. It is also time to present this information 1) to the citizens of Fredericton so they can judge how their heritage, an unique urban forest, has been managed; 2) to the organizations that supported and participated in the program to tell them how their investment - time, effort, money - has been spent; 3) to other communities facing the extinction of their elms, because they may find some of this information applicable to their circumstances; and 4) to the scientific community as a chapter on how one city handled Dutch elm disease and with what success. It is also time to provide the basis for a critical analysis of the present situation so decisions can be made for the future direction of the program.

The main purpose is not to evaluate success or to justify action but to bring all available information together. Nor is it meant as a textbook on the disease or as a recipe for its control.

This is a report on how Fredericton coped with Dutch elm disease. It is based on studies by the Maritimes Forest Research Centre and on records in the Fredericton City Engineer's Office. The biological and historical background, the management of the disease in Fredericton, and an evaluation of the program are presented.

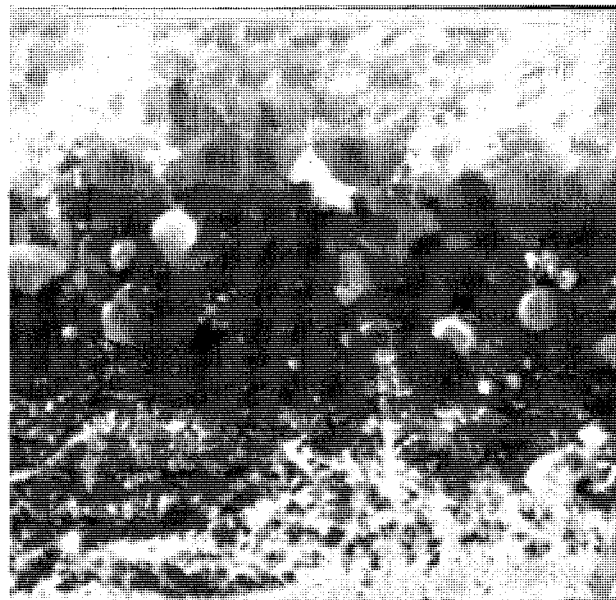
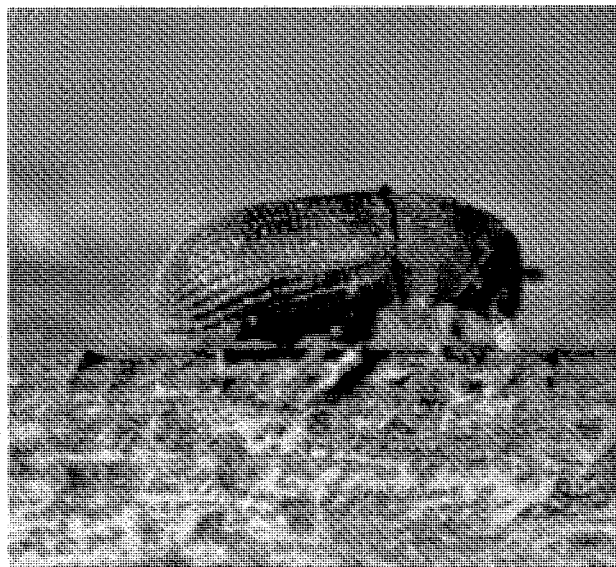
PART I

BIOLOGICAL AND HISTORICAL BACKGROUND

The Disease and its Carrier

Dutch elm disease is caused by a fungus (*Ceratocystis ulmi* (Buism.) C. Moreau) which, when introduced into elms, interferes with the normal physiological processes of the tree. The leaves wilt, turn yellow then brown, and the infected branch dies. The fungus travels fast in the water conducting system and spreads to other parts of the tree within a short time. The tree may die within a year or may "hang-on" for a number of years before it succumbs to the disease.

The fungus, in Fredericton, is introduced into the tree by the native elm bark beetle (*Hylurgopinus rufipes* (Eichh.)). The beetles breed in and under the bark of dying or newly dead trees. When this brood tree is infected, small glutinous structures (spores) of the fungus stick to and are carried by the beetles to healthy trees. Beetles feeding on twigs of healthy trees open a way to the water-conducting vessels, the spores enter the tree, and infect it with the fatal disease.



Some beetles spend the winter by burrowing into the thick bark of the tree trunk and large branches. If these beetles carry the fungus, it multiplies in the beetle's overwintering chamber, covering the beetle when it emerges in the spring. The large number of spores carried by these beetles rapidly spread the infection when the insects start feeding.

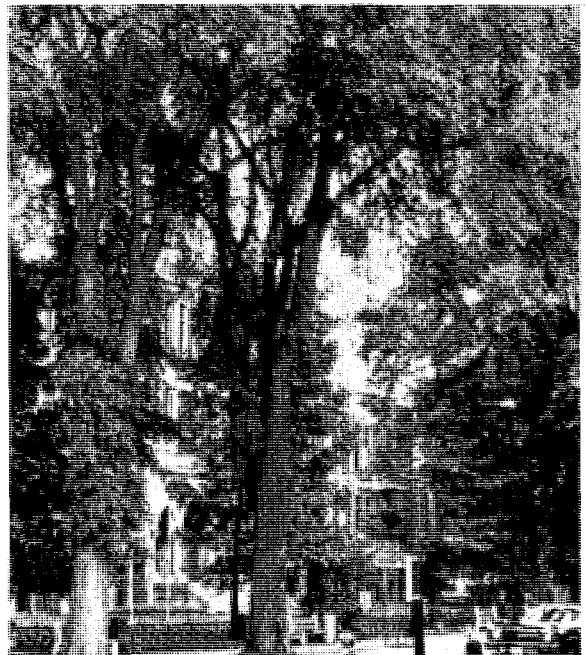
Almost all methods of slowing down the spread of the disease are aimed at this special relationship between the fungus and its carrier. Lowering the number of beetles and preventing them from carrying the fungus has been the basic goal of most Dutch elm disease management programs. Newer methods aim directly at the fungus but to date these have not been used on an operational basis in Fredericton.

Fredericton and its Elms

The city of Fredericton, in the St. John River Valley, was settled by the United Empire Loyalists in 1783 and was declared a city in 1848. It was surrounded by forested areas in which white elm (Ulmus americana) was a predominant species.

The first elm trees in the area were planted by the British garrison around 1810. Another major planting was done by civic authorities between 1883 and 1887 and, in some of the newer parts of the city, shortly after the Second World War. Many of the original elms now 100 to 170 years old are still standing, some of them 32 m (105 ft) tall, and trees with diameters of 100 to 180 cm (3 to 5 feet) are not uncommon.

Our ancestors were aware of the beauty of this magnificent tree and of the benefits of the shade it provides. However, they created an area of single species, an almost even-aged monoculture susceptible to insect and disease attacks, necessitating remedial actions on a large scale if catastrophes were to be avoided.



Forewarned by the Forest Biology Laboratory (predecessor of the Canadian Forestry Services' Maritimes Forest Research Centre) in the 1930's, the City Council became interested in the care of the shade trees. During an outbreak of the fall cankerworm (Alsophila pometaria (Harr.)) severe defoliation of the elms was prevented by a thorough protection program. Cooperation between the City and the Forest Research Centre has continued throughout the years.

In 1973, amalgamation of Fredericton with the villages of Barker's Point, Lincoln, Marysville, Nashwaaksis, and Silverwood more than doubled the area of the City. This created a new situation in tree care which affects some operations to the present day.

The Fredericton Tree Commission

After the Second World War, a tree advisory committee was appointed and in 1952, a City by-law established a permanent Tree Commission. The members are volunteer taxpayers concerned with and interested in trees (Appendix I). Many of them deal with some aspect of tree care and protection in their profession. The City is represented on the Commission by a Councillor, the City Engineer, and the Superintendent of Trees and Parks.

The duties of the Commission are:

- "(a) to formulate plans for and to supervise the planting, setting out, maintenance and care of trees on the streets and lands of the City;
- (b) to protect trees within the City from injury or destruction by insect pests or disease and to provide for the spraying of trees with insecticides and fungicides;
- (c) to encourage proper pruning, protection, and replacing of all trees within the City;

(d) to enter upon any lands within the City for the purpose of inspecting trees to determine whether they are hazardous to persons or property or affected by disease or insect infestation;

(e) to determine whether a tree or limb thereof within the City is hazardous to persons or property or so affected by disease or insect infestation as to endanger the life or health of other trees;

(f) to order the removal of a tree or limb found to be hazardous to persons or property or so affected by disease or insect infestation as to endanger the life or health of other trees."

(By-law 412 of the City of Fredericton)

One of the most important provisions has been the authority to enter private land and cut trees at the expense of the City. This ensures the prompt removal of diseased trees which otherwise might be delayed by the reluctance of the owner. The idea of stand protection has been one of the basic principles from the beginning.

The Parks and Trees Department in Fredericton

All tree work is carried out by employees of the Parks and Trees Department of the City Engineer's office of Fredericton. The department was established in 1967 with the appointment of Mr. D. Urquhart as Supervisor of Parks and Trees, in further recognition of the importance of the tree-care program. Staff members are trained and employed year around, providing a continuity of skilled labor, which in turn increases effectiveness and safety and reduces long-term costs.

Tree climbers are basic to the tree removal program. Fredericton

employs two of these highly specialized craftsmen. They move about in the trees with ease, and skillfully lower branches on ropes from over houses and wires, to the amazement of tourists from areas where bucket trucks (cherry pickers) are the usual sight.

Each climber is supported by a ground crew of two and the two teams are backed up by a support crew of loader, chipper, truck driver, and stump grinder operator. Removal of a tree takes from a few minutes to two or three days depending on its size, shape, location, and condition. The procedures of tree removal and a detailed analysis of time and equipment needed for different types of trees are available in a manual by Van Sickle and Urquhart (1974).



Dutch Elm Disease in Central New Brunswick

Dutch elm disease was first discovered in North America in Ohio in 1930, in Canada in Quebec in 1944, (Pomerleau 1964) and in New Brunswick at Woodstock in 1957 (Davidson and Newell 1957). By 1961, the disease was well established in the St. John River Valley from Grand Falls to about 50 km south of Fredericton (Fig. 1). It was first found at Kingsclear in 1958, Durham Bridge and Upper Lincoln, 1959, Marysville, Lower St. Mary's, and preamalgamated Fredericton, 1961, Barker's Point, New Maryland, and Lower Lincoln 1962, and Nashwaaksis, 1965 (Fig. 2).

Many trees were infected and died. Ten years after the disease was found in New Brunswick the incidence of infected trees, expressed as a percentage of total number of living trees, had reached 9% in York County, 13% in Sunbury County, 30% in Victoria County, and 45% in Carleton County (Forbes *et al.* 1967). In four rural check areas, established in 1970 within 45 km of Fredericton (Van Sickle and Sterner, 1976), over 90% of the original elm tree population was lost to the disease within seven years (Table 1, Fig. 3).

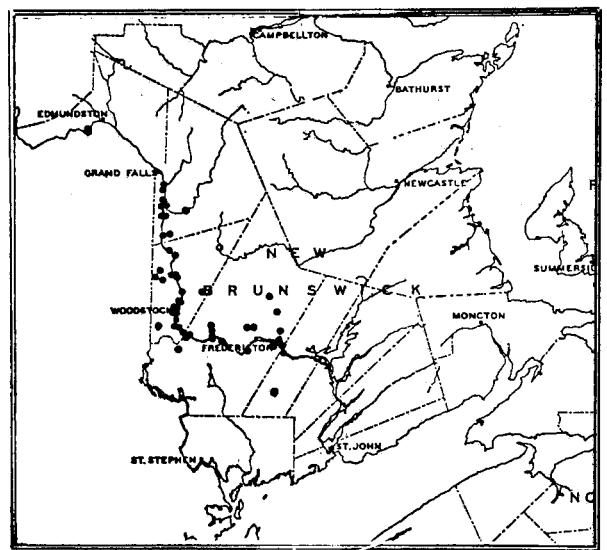


Fig. 1. The distribution of Dutch elm disease in New Brunswick in 1961.

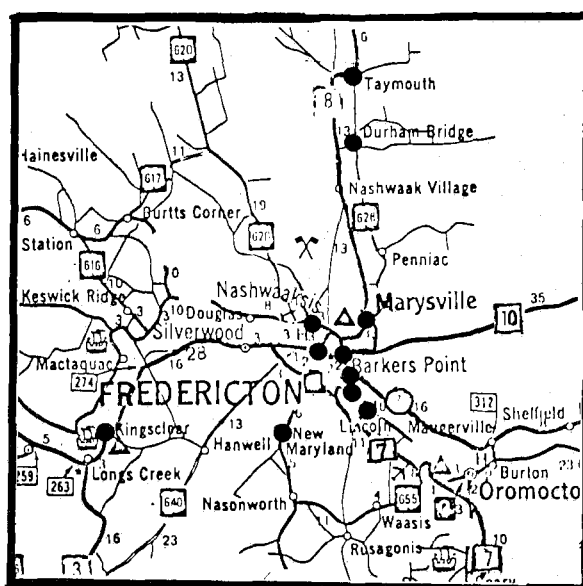


Fig. 2. The distribution of Dutch elm disease in central New Brunswick in 1965.

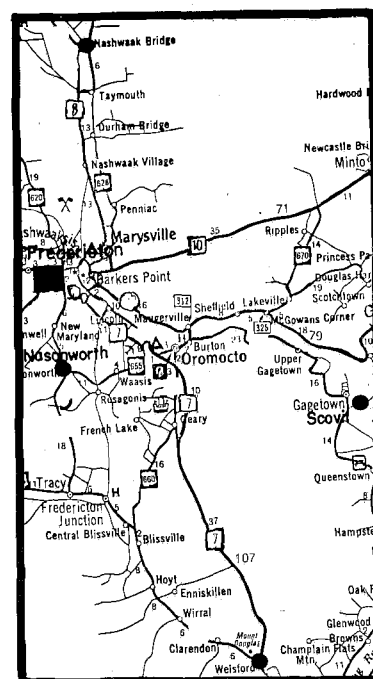


Fig. 3. The study areas in relation to Fredericton.

Table 1. Losses to Dutch elm disease in the intensification study areas

Year	Nasonworth		Nashwaak Bridge		Scovil		Welsford	
Elm population in 1970	84		81		298		115	
Dead in 1970	1		1		0		4	
	Trees lost	Accu- mulated %	Trees lost	Accu- mulated %	Trees lost	Accu- mulated %	Trees lost	Accu- mulated %
1970	3	3.6	2	2.5	13	4.4	3	2.6
1971	0	3.6	4	7.4	12	8.4	1	3.5
1972	0	3.6	11	21.0	67	30.8	6	8.7
1973	11	16.7	9	33.8	78	56.9	12	19.1
1974	14	33.3	20	59.7	55	75.5	21	37.4
1975	24	61.9	20	88.0	plot cut		33	66.1
1976	23	89.3	6	97.3			16	80.0
1977	6	96.4	0	97.3			13	91.3
1978	terminated		terminated				3	93.9
1979							terminated	

Control or Management

The Dutch elm disease "control" program in Fredericton began in 1952 with the appointment of the Tree Commission, nine years before the first diseased elm tree was found in the City.

Confusion exists in terminology regarding the term "control," not only with Dutch elm disease but also with other insects and diseases. The word control to many people implies "getting rid of," eliminating the pest entirely. Control, according to Webster's dictionary, is "to exercise restraining or directing influence over," to "regulate" - not to eradicate, as the popular definition would have it. (Very few diseases have been eradicated, those examples are found mainly in the field of medicine. They were achieved with great effort and horrendous costs and even some of those should be qualified as eradicated for "practical purposes".)

Control, then, means to regulate, to keep the pest in check, to keep losses down. The term "pest management" has been gaining wider acceptance to circumvent misconception regarding the term "control". For the Dutch elm disease problem in Fredericton, the control program means the regulation or management of the disease, holding down the losses, spreading the cost over a long period and, of course, the attempt to keep the elm trees alive as long as possible. Only the naive would surmise that Dutch elm disease can be entirely eliminated from Fredericton (short of eliminating all elm trees) but by managing the disease - in the dictionary sense of 'having a restraining influence over the situation' - the City should be able to keep tree losses down.

PART II

DUTCH ELM DISEASE MANAGEMENT IN FREDERICTON

Dutch Elm Disease in Fredericton

The first two infected trees in the City were found in 1961, one on Odell Avenue, the other on Lincoln Road. They were promptly removed. In the years that followed, the number of trees removed because of Dutch elm disease varied from year to year but the number gradually increased.

Over 2600 elm trees have become infected in preamalgamated Fredericton since the arrival of the disease. This figure includes trees of all sizes and quality, from planted street and backyard giants to small wild ones growing in gullies, along brooks and railroad lines, on farms, etc. It thus represents all infected trees that were physically removed and destroyed by the City. The communities surrounding preamalgamated Fredericton took different approaches towards their Dutch elm disease situation and there are no reliable figures available on losses.

In the early years of Dutch elm disease, the New Brunswick Department of Natural Resources (NBDNR) assisted small communities by removing diseased trees, in an effort to lessen the hazard. Between 1958 and 1967 the number of diseased trees removed by NBDNR was:

Lincoln	17
Silverwood-	
Woodstock Road	1
Nashwaaksis	30
Marysville	98
Barkers Point	6
Lower St. Marys	11
(Smith and Forbes 1968).	

After amalgamation in 1973, an accelerated tree cutting program in these areas "cleaned-up" diseased, dying, decadent, and damaged trees to bring the level of general health of trees closer to the standard of "old" Fredericton.

Methods for Managing Dutch Elm Disease and Their Use in Fredericton

Surveys - Any attempt at "controlling" the disease must be based on continuous, systematic surveillance. In Fredericton, regular surveys by qualified personnel are carried out from mid-June to about mid-September when autumn leaf discoloration interferes with recognition of disease symptoms. All parts of the City are surveyed several times each summer. Infected trees are marked for cutting. The location of the tree, its size, and classification as to ownership are recorded. Until 1977, branch samples were taken from all suspect trees and were analysed at the Maritimes Forest Research Centre. The practice was discontinued because of increased work demands and as a result, infection figures, since 1978, are probably high.

Sanitation - Sanitation, the removal of tree material suitable to the elm bark beetle as breeding sites, reduces the population of the carrier. The removal of infected tree material prevents beetles from breeding in diseased trees hence from picking up spores of the fungus. Although there are other management methods, the City of Fredericton has always believed and is firmly convinced that THE CORNERSTONE OF ANY DUTCH ELM DISEASE MANAGEMENT PROGRAM MUST BE A CONSISTENT SANITATION PROGRAM. There are several aspects of such a program:

Preventive pruning is the consistent and systematic removal of dead branches from healthy trees to eliminate breeding material. In Fredericton, starting in 1952, all elm trees were pruned. Most trees were pruned at least twice and some three or four times between 1952 and 1967 (Smith and Forbes 1968). With the increasing work load of tree removal in the late 1960's and early 1970's, the number of elm trees pruned has decreased and has been confined mostly to City-owned trees and to those that constituted a hazard. In recent years, trees have been pruned "as time permits". All species of City trees are pruned (Table 2), for reasons such as interference with wires, with visibility for traffic, danger, etc., and of course, to help them attain the desired shape. Most, if not all, trees in the tallest class and most in the 6.5-14.5-m class were likely elms.

Preventive tree removal - Decadent, but not diseased, trees with numerous dead branches are also removed to destroy elm bark beetle breeding material. In Fredericton, about 500 decadent elm trees were removed between 1952 and 1967, most of them before 1961. Table 3 lists the numbers of elm trees removed for reasons other than Dutch elm disease in preamalgamated Fredericton (Fig. 4), for which reliable figures are available. Not all of these trees were decadent, some were removed for reasons such as traffic obstruction at stop signs, street widening, danger to property, etc.

Removal of infected trees - Dying and newly dead trees give off an odor which attracts the beetles and provide ideal breeding sites. Beetles contaminated with the fungus, emerge

Table 2. Tree pruning in greater Fredericton

Year	Number of trees pruned by height group			Total trees pruned
	>14.5 m	6.5-14.5 m	<6.5 m	
1974	100	600	2000	2700
1975	127	600	2000	2727
1976	123	592	2000	2715
1977	20	18	2000	2038
1978	45	80	2000	2125
1979	200	150	2000	2350
1980	150	480	3000	3630

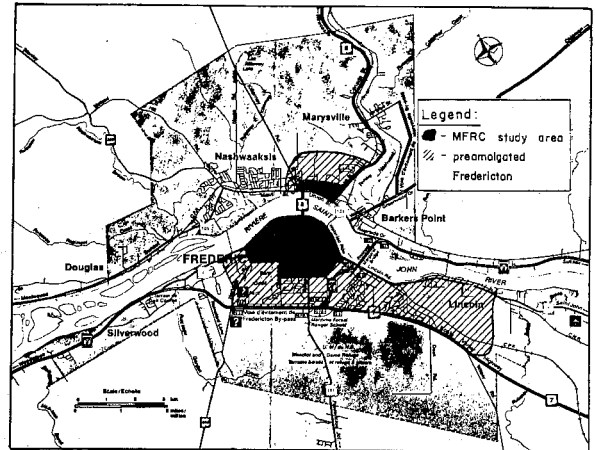


Fig. 4. The Greater Fredericton area.

Table 3. Non-diseased elm trees removed in preamalgamated Fredericton 1967-1980

Year	Trees removed
1967	45
1968	85
1969	43
1970	46
1971	49
1972	69
1973	42
1974	67
1975	69
1976	16
1977	12
1978	22
1979	60
1980	58



from diseased trees, fly to nearby healthy trees to feed, and spread the disease. A single beetle-infested diseased elm tree can become the centre of infection in an area from which the disease quickly spreads. The prompt removal of infected trees is an imperative first step in slowing down the spread of Dutch elm disease. There is no substitute for this aspect of sanitation in any disease management program. In Fredericton, infected elm trees are removed as soon as feasible but definitely before the beginning of May of the year following infection. This date is important because broods must be eliminated before the beetles start flying in the spring. The numbers of infected elm trees removed, annually, from the MFRC study area and from preamalgamated Fredericton are listed in Table 4.

The "catch-up" cutting program in the newly amalgamated area is summarized in Table 5. Although elms other than those infected were cut from 1973 to 1980 most of the trees were dead or dying as a result of Dutch elm disease. Most were wild trees growing as a result of natural regeneration. The Province of New Brunswick, through amalgamation grants, and the federal government, through winter works programs, assisted in these cutting operations.

In the winter of 1978-1979, some areas where most elm trees were dead or dying from Dutch elm disease were clear-cut of all elms (Fig. 5). This was done during the winter, when bark beetles are in the brood trees, to eliminate the high elm bark beetle populations adjacent to healthy areas. Again, most of the work was along brooks and other areas of natural regeneration.

Burial and burning - All elm material suitable for bark beetle breeding, whether infested or not, must be disposed of. In Fredericton,

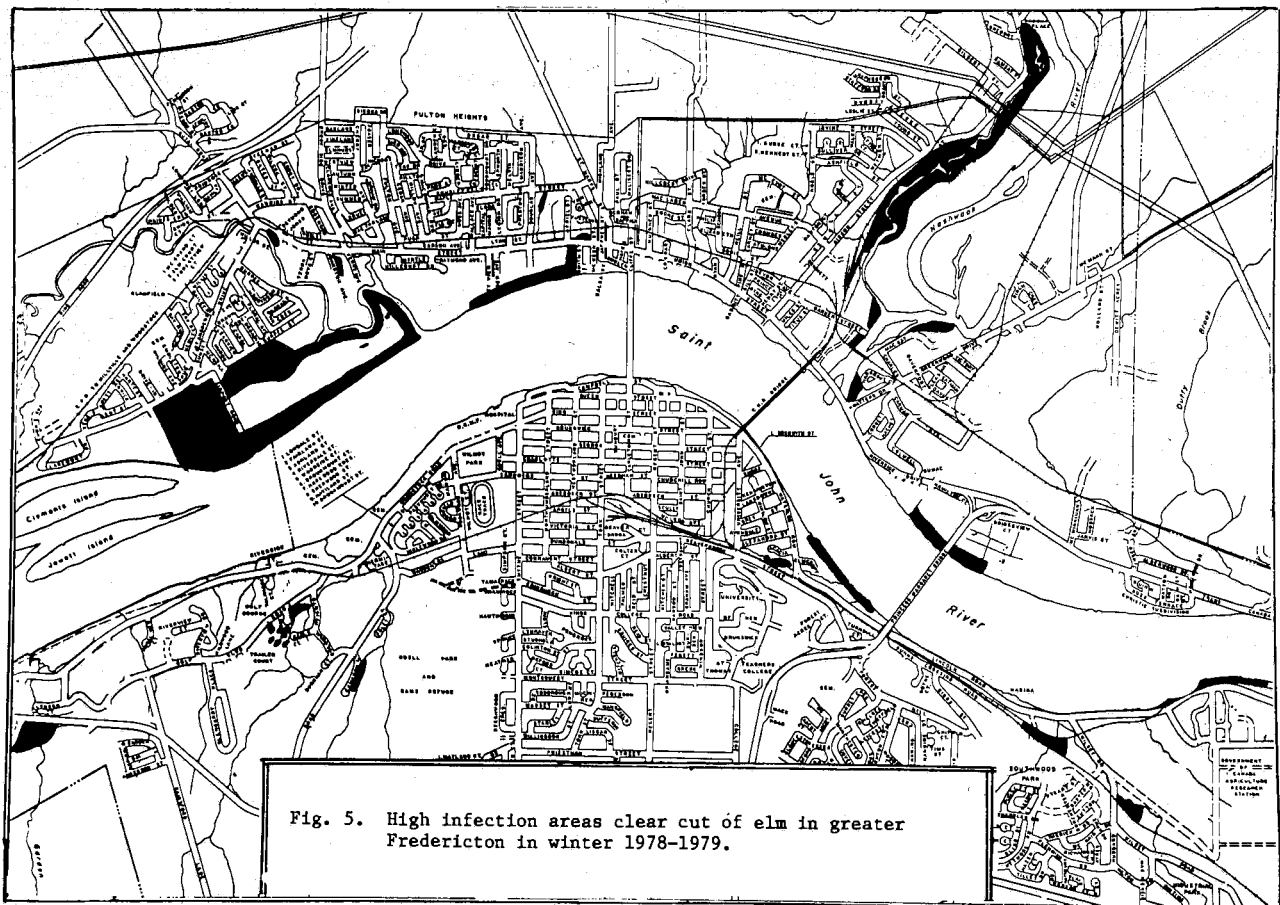
Table 4. Elm trees lost to Dutch elm disease in Fredericton 1961-1980

Year	CFS study area	Preamalgamated Fredericton
1961	1	2
1962	0	2
1963	0	1
1964	5	14
1965	4	11
1966	6	18
1967	1	16
1968	11	33
1969	11	23
1970	35	49
1971	42	57
1972	37	62
1973	64	89
1974	101	131
1975	122	144
1976	253	270
1977	163	408
1978	180	276
1979	355	513
1980	374	514



Table 5. Elm trees cut in greater Fredericton as part of the Dutch elm disease program, 1973-1980

Year	Preamalgamated Fredericton	Lincoln	Silverwood - Woodstock Road	Nashwaaksis	Marysville	Barkers Point - Lower St. Marys	Total
1973	89	69	385	180	91	6	820
1974	398	42	542	126	248	44	1400
1975	271	71	145	494	55	31	1067
1976	418	3	248	3	13	8	693
1977	743	6	9	83	15	20	876
1978	736	7	124	2251	15	47	3180
1979	1026	6	195	371	703	280	2581
1980	514	-	314	88	21	198	1135
Totals	4195	204	1962	3596	1161	634	11752



branches and tree trunks are buried under about 50 cm of soil. Elm material from clear-cutting operations during the winter months is burned at the site. When Dutch elm disease in New Brunswick spread and intensified, the City started selling elm logs to a hardwood mill in 1973 to reduce the cost of the program. In 1980, the City acquired a branch chipper to reduce transportation cost of light but bulky twigs and branches.

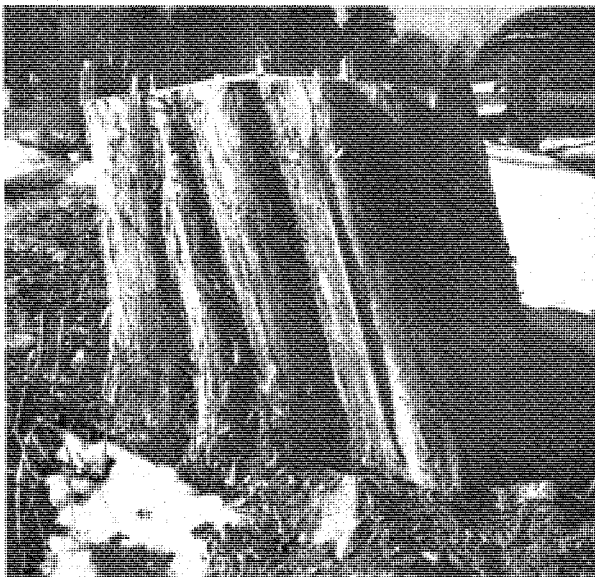


Stump removal The stump of an elm tree with the bark on it is no less attractive as a breeding site for the bark beetles than the rest of the tree. The freshly cut stump may actually attract beetles by giving off the characteristic odor (Euale et al. 1978). Stumps are also unsightly and interfere with snow removal. In Fredericton, all stumps are removed with the aid of the City-owned stump grinder, shortly after the tree is felled. The stump is ground to about 10 cm below the surface, and the hole is filled with soil and seeded. This procedure improves the aesthetic appearance of the area and removes the attraction for the beetles.



Debarking If the stump cannot be ground immediately, it is debarked manually. A debarked elm log cannot be used by bark beetles for breeding and as such poses no threat.

All aspects of the sanitation program have been practiced in Fredericton since long before Dutch elm disease arrived in the City and will continue as the basis of the tree management program. Especially important is the prompt removal of infected trees.



Insecticides - Insecticides have a legitimate role in the management of Dutch elm disease to lower elm bark beetle populations. They have been used in Fredericton, from time to time, against a variety of insects, most notably against the fall cankerworm in 1937 and as recently as 1975. Arsenate of lead and pyrethrum were used first, DDT was applied several times before 1972, malathion was used in 1973 and 1974, and methoxychlor in 1975.

The City has kept pace with the growing environmental awareness. Insecticides, when necessary, are used with utmost care. The need is reviewed annually by the Tree Commission, their effectiveness is monitored in cooperation with the Canadian Forestry Service, and their use follows the recommendations of the New Brunswick Pesticide Advisory Board which authorizes application. For Dutch elm disease management, whole-tree spraying is limited to high value trees in uninhabited areas, like parks, and is carried out in early mornings with no wind, and when no people are around. Trunk treatment in residential areas is with low pressure equipment to reduce drift. A further precaution is the use of a mobile screen to contain the insecticide. The schedule for chemical treatments is advertised in advance and is preceded by a door-to-door notification of householders. Private trees are not treated without the owner's permission. The support and cooperation of the public is heartwarming to those responsible for tree care.

DDT - was used to kill elm bark beetles in Fredericton from 1961 to 1963. Healthy elm trees in the vicinity of infected trees (within 330 m radius) were sprayed during dormancy with a 12.5% water emulsion of DDT applied by mistblower. All elms on public property around the Cathedral and University Avenue were sprayed intermittently between 1957 and 1973, to control fall cankerworm. This must have had an effect on the elm bark beetles as well.

Methoxychlor - Because of the increase in infection, Fredericton decided to supplement the sanitation program by using chemicals to reduce elm bark beetle numbers. Methoxychlor was the only insecticide registered against elm bark beetles in Canada during the mid-1970's.

(a) Whole tree spray with methoxychlor. To prevent feeding by elm bark beetles, boles and crowns of 500 elm trees were sprayed along designated streets with 12% methoxychlor in April 1975 (Fig. 6). Evaluation of the program indicated only a minimal reduction in beetle numbers in the sprayed area (Sterner 1975)¹, while the oil base solution caused damage to vehicles and was difficult to remove from any object.

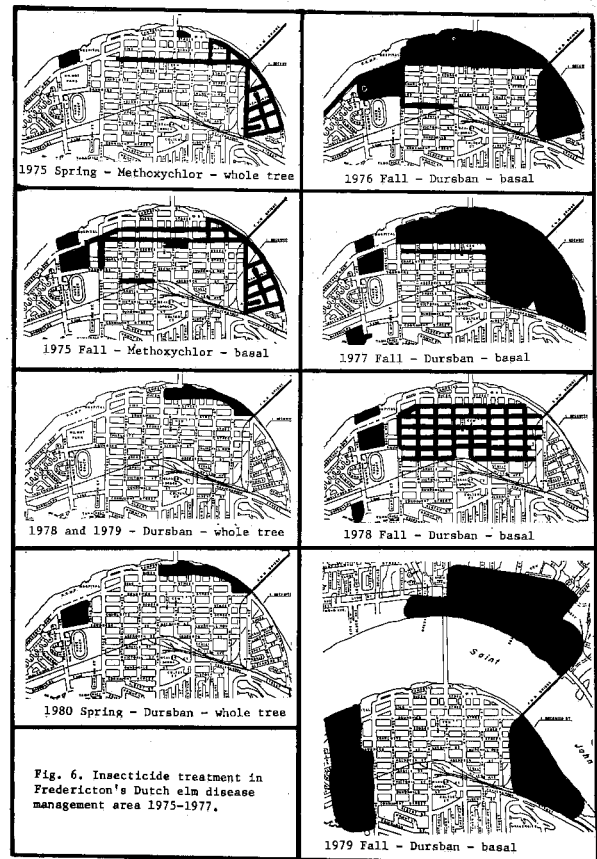
(b) Basal trunk spray with methoxychlor. In August-September 1975, about 3000 trees were sprayed up to 3 m from the ground (Fig. 6) to prevent the beetle from overwintering. This procedure was repeated in late summer of 1976, along George Street between Smythe Street and University Avenue.

Research results (Gardiner 1976) indicated that methoxychlor is rather ineffective against the native elm bark beetle, therefore, the use of this insecticide was discontinued.

Chlorpyrifos (Dursban 2E[®], Dow Chemical) - New research has shown Dursban, an insecticide of wide application in areas of habitation, effective in reducing elm bark beetle populations. In 1976 and 1977, the City and the Maritimes Forest Research Centre participated in a nation-wide research project testing Dursban as part of the process for

registering the insecticide for use in elm bark beetle control. The work in Fredericton was done under an experimental research permit from Agriculture Canada and also under a permit from the New Brunswick Pesticide Advisory Board. (Magasi 1977², Gardiner 1980).

(a) Whole tree spray with Dursban - Entire trees were sprayed with 1% Dursban applied by mistblower before bud break to prevent beetles from feeding. In Fredericton this program was carried out on high-value elm trees between 1977 and 1980 (Table 6). Some doubts were raised by the results of this program regarding its effectiveness (discussed in Part III).



¹ Sterner, T.E. 1975. Notes on the continuing sanitation program and the 1975 test spray for control of Dutch elm disease in Fredericton, N.B. (Internal report to the Fredericton Tree Commission, unpublished).

² Magasi, L.P. 1977. Evaluation of the Dutch elm disease control program in Fredericton, 1977. Internal report, MFRC, to Fredericton Tree Commission and N.B Pesticide Advisory Board.

Table 6. Chlorpyrifos (Dursban 2E) whole-tree spray program in Fredericton

Year	Whole-tree sprayed			Check areas			Difference in percentage
	Number	Lost	%	Number	Lost	%	
1977	54	0	-	-	-	-	-
1978	93	5	5.4	-	-	-	-
1979	86	7	8.1	105	15	14.3	6.2
1980	166	17	10.2	105	15	14.3	4.1

(b) Basal trunk spray with Dursban - To prevent overwintering of beetles in healthy elms, the lower 3 m of the trunks are treated at the end of the summer. Ideally, Dursban is applied (1% solution) to all trees in an area, rather than to individual trees, because the beetles do not confine their feeding to the trees from which they emerge after overwintering. In Fredericton, this "ideal" has not always been possible to achieve. The program, as carried out, is summarized in Table 7 and in Fig. 6.

Table 7. Chlorpyrifos (Dursban 2E) basal trunk treatment in Fredericton

Year	No. of trees treated	Remarks
1976	3000	All trees in area treated
1977	3500	All trees in area treated
1978	3000	Only city trees treated
1979	2500	Only city trees treated
1980	-	

Trap trees Dying and recently dead trees emit an odor which attracts elm bark beetles searching for breeding sites. The beetles seek out these trees, enter through the bark, and

lay eggs. This habit can be exploited in two ways. Trees killed with certain chemicals attract the beetles (Lanier 1979) so, in turn, can be treated with an insecticide that will kill the arriving beetles. In the late fall or winter, the tree is removed and destroyed to eliminate developing bark beetles, the offspring of those that were not killed by the insecticide. Because some beetles attracted by the chemical could feed upon surrounding healthy trees and cause infection, trap trees are used in areas of high beetle populations with the idea of retaining and destroying them in situ, on the site. In Fredericton, the trap tree method has been used only once and the results are not yet available.



Tree planting Dutch elm disease management programs will not prevent all tree losses. Trees will continue to die from Dutch elm disease and other causes. In Fredericton, our legacy is a beautiful but very old stand of elms and the loss of some or even most of these trees is inevitable. However, Dutch elm disease management is likely to lessen losses thus giving the City an opportunity to gradually replace the aging urban forest with a mixed stand of vigorous trees, without the aesthetic and financial upheaval of a major tree cutting program.

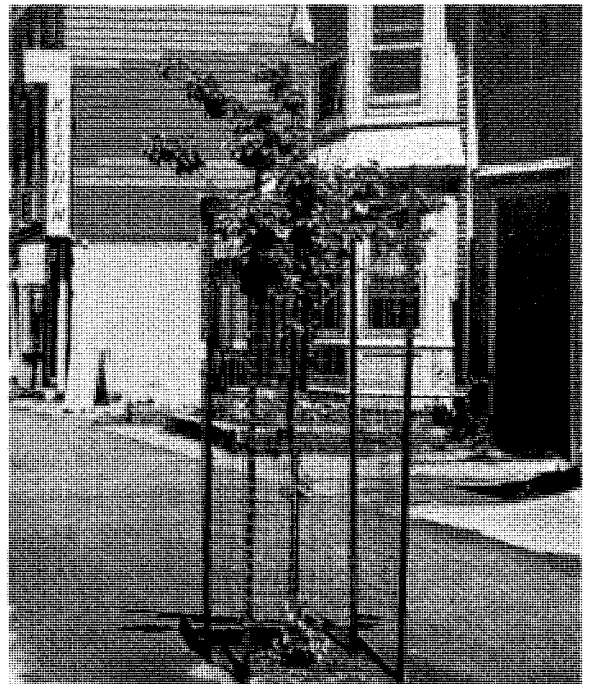
Fredericton also is a growing city with new housing developments. Tree planting in these areas is based on lessons learned, and streets are planted with a mixture of trees suited to the character of the area. Five varieties of maple, linden, oak, mountain ash, and white ash are planted, both as replacements and as new plantings. Some elm is also planted in the historic areas of the City, partly to retain character, and partly to express confidence in the disease management program that "these trees will make it". The Fredericton planting program since 1974 is summarized in Table 8. In

some areas young trees are protected by wire cages. These protectors also increase citizen awareness and appreciation for trees, and provide a certain attractiveness to the area.



Table 8. Tree planting program in Fredericton since amalgamation

Year	No. of trees planted	Replaced	In new areas
1974	420	99	321
1975	495	100	395
1976	656	458	198
1977	743	184	559
1978	764	183	581
1979	702	58	644
1980	750	279	471



Some Other Methods not Used in Fredericton During 1961-1980

All the methods described above are directed against the bark beetles rather than the fungus that causes Dutch elm disease. There are other methods designed to prevent the fungus from infecting the tree and some to stop the fungus from becoming systemic after infection takes place.

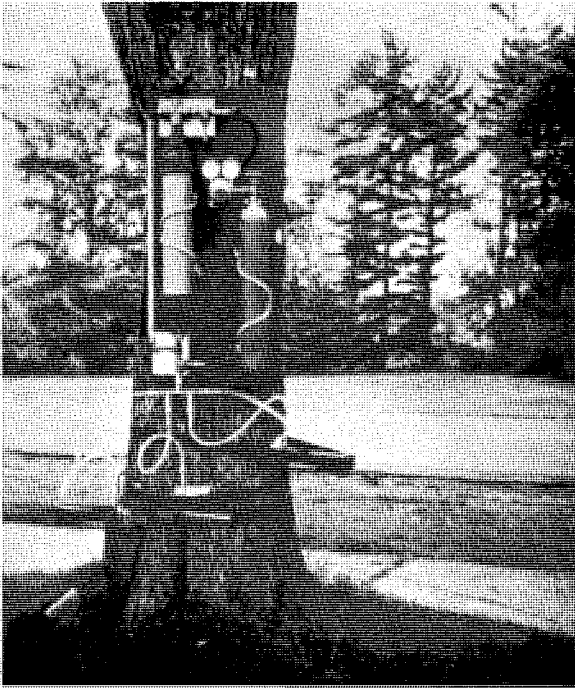
Tree surgery or severe pruning has been used by Dr. R.J. Campana (Univ. of Maine, Orono, Me.) to disrupt the water conducting vessels between the infected branch and the rest of the tree. Since the fungus moves quickly through the tree it is important to ensure that the interruption takes place well in advance of the spread of the fungus. This must be done when the tree first shows symptoms. In some cases a "window" is cut in the tree, when a piece of wood is removed to cause the interruption.



Tree injection A fungicide is injected into the tree through roots, root flare, or the trunk (Kondo 1972). The tree distributes the chemical within its system and when the fungicide comes in contact with the fungus the latter is either killed or inhibited. Basically this is the principle of all chemical injection treatments. Its effectiveness depends on the distribution of the chemical within the tree and annual repetition of the treatment.



The fungicide is used both as a preventive and a curative treatment. Although the cost of application has decreased in recent years, it remains sufficiently high for this method to be used on individual trees only. Injection is not, and never was meant to be, a replacement for sanitation, in spite of the publicity it has received. Injection has been tried in Fredericton only on an experimental basis by scientists of the Canadian Forestry Service. But in 1981, the City plans to acquire some injection equipment and the technical instruction in its proper use.



The Integrated Approach to Dutch Elm Disease Management

There is no known cure for Dutch elm disease. However, there are methods to fight it, but none presently available can do the job by itself. Each helps to a certain extent and for that reason each should be used, and used in an organized, planned manner. Then the results should be cumulative. Fredericton has been using an integrated approach by setting priorities, by monitoring the effect of certain treatments and adjusting the program accordingly, by coordinating treatments and area priorities, etc. Fredericton originally attempted to provide an equal level of service to all areas. However, some areas and some trees are more valuable than others and should be given special treatment. Recognizing this, "high value" trees received the whole-tree spray treatment, a program which could not and

should not include all elm trees in the City. Other aspects of the disease management must also be "fine tuned" to make it a truly planned integrated program.

There is, what appears to be, a successful integrated Dutch elm disease control program carried out by the City of Sault Ste. Marie in cooperation with the Great Lakes Forest Research Centre (Euale *et al.* 1977, 1978, 1980). This system and Fredericton's plan share many elements but differ in some aspects, just as conditions in the two cities differ (e.g. Fredericton's trees are much larger and older than those in Sault Ste. Marie). In the past, Fredericton has accepted new methods and adapted them to the local situation. Sault Ste. Marie's program will also benefit Fredericton if their system can be adapted to conditions here.

PART III

AN EVALUATION OF THE DUTCH ELM DISEASE PROGRAM

The most logical way to evaluate a program designed to save trees is to examine tree losses. However, before presenting this information for the Fredericton Dutch elm disease management area (the district of historical importance), the results of the elm bark beetle monitoring project are given because most of the methods used in Fredericton are directed against this insect. Monitoring is conducted by the Maritimes Forest Research Centre.

Beetle Population Differences in Different Treatment Areas

The beetle index Sticky traps, on selected elm trees placed about 4 m from the ground around the circumfer-

ence of the tree, are designed to capture elm bark beetles in the fall when the beetles migrate downward to overwinter. The beetle index (Sterner 1976) expresses the number of beetles captured per 10 cm^2 of the trap. Since most beetles are captured in the upper 1 cm of the sticky trap, the index is calculated as the number of beetles per 10 cm of the circumference of the trap. The beetle index is not necessarily an expression of the actual beetle population present on the tree but has a comparative value between areas in the same year and between years on the same tree. Beetle monitoring stations are shown in Fig. 7 and the results are presented in Table 9. The figures, evaluated annually in the planning of the Dutch elm disease program, show some interesting trends, such as:

1. The beetle population in the Dutch elm disease management area is much lower than in outside areas;
2. The population is higher within the management area close to trouble spots e.g., the Queens Square trap to the Waterloo Commons; the RCMP Headquarters trap to Nashwaaksis, and RCMP Headquarters trap to Woodstock Road;
3. The 1977-78 and 1978-79 winter clearcutting programs in the Nashwaaksis area reduced beetle populations considerably without "driving the beetles into the City" (see RCMP trap);
4. The beetle population is decreasing in New Maryland, an area with a long-standing Dutch elm disease problem;
5. The beetle population is increasing at Estey Bridge and Cross Creek, both areas where the disease is intensifying.

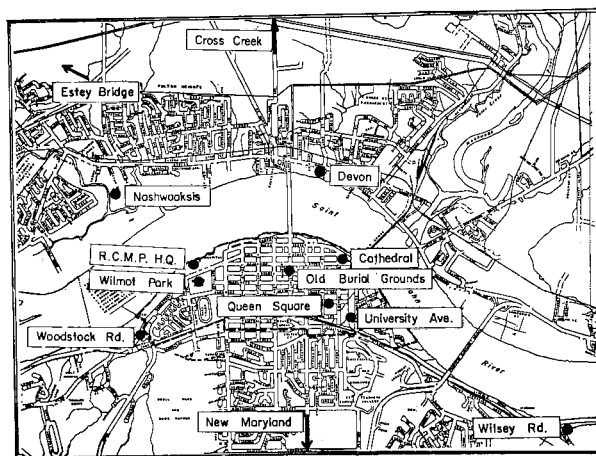


Fig. 7. Native elm bark beetle monitoring stations in the Fredericton area.

Table 9. Beetle index at the native elm bark beetle monitoring stations in the Fredericton area 1976-1980

Location	Beetle index				
	1976	1977	1978	1979	1980
Cathedral	0.3	0.2	0.5	0.2	0.3
Old Burial Grounds	0.1	0.7	0.7	0.5	0.0
Queens Square	3.6	4.6	12.2	5.3	0.5
University Avenue	0.9	0.5	0.5	0.3	0.2
RCMP H.Q.	0.6	1.6	2.2	0.8	1.6
Wilmot Park	-	0.2	0.6	0.5	0.3
Devon	-	-	-	21.7	1.8
Wilsey Road	-	-	-	12.7	1.7
Woodstock Road	-	-	-	276.0*	7.8
Nashwaaksis	-	300.2	120.2	20.0	5.5
New Maryland	-	-	-	125.2	53.3
Estey Bridge	11.5	18.5	63.5	25.1	37.7
Cross Creek	6.7	7.5	12.9	30.5	34.9

* Infected tree

Table 10. The effect of different treatments on overwintering adult populations of the native elm bark beetle in Fredericton and vicinity - Fall 1977

Location and treatment	No. of plots in area	No. of trees examined	No. of beetles/m ²
Fredericton			
Sanitation area			
Trunk spray 1976 & 1977	4	34	0
Trunk spray 1976 only	2	20	1
Trunk spray 1977	2	20	0
No spray	5	45	18
No sanitation			
South side	2	14	86
North side	3	30	623
Outside Fredericton	4	39	419

The boring-dust counts (overwintering population) In 1977, the overwintering bark beetle population was assessed in conjunction with the Dursban registration process. "Boring-dust piles" in the lower 30 cm of tree trunks were counted. These piles are created when beetles burrow into the bark and push out the boring-dust. The results of the survey (Table 10) showed a remarkable reduction in the overwintering bark beetle population within the treatment area. They also showed that the initial population was lower in the sanitation area than elsewhere and that the highest population was on the north side of the City. This information contributed to the decision to clear-cut in the Nashwaaksis area.

In 1979, overwintering adults were again counted. Trees treated with Dursban in 1979 on both sides of the river were examined, as were trees on the south side where treatment was carried out in previous years but not in 1979, and trees on the north side where treatment was never applied. The results are shown in Table 11.

Table 11. Overwintering adult population in different areas of Fredericton -Fall 1979

Treatment	No. of trees	No. of beetles/m ²
Treated in 1979 (North & South sides)	9	6.6
Previously treated (South side)	5	14.8
Never treated (North side)	6	227.2

Beetles in whole-tree sprayed elms
The effect of whole-tree Dursban spray is monitored by comparing losses to a randomly preselected sample of non-sprayed trees. The losses observed among the sprayed trees (Table 7) led to the reexamination of the overwintering habit of the beetles on Fredericton's large trees. Could it be, that in Fredericton, not all bark beetles migrate to the base of the tree to seek the protection of thick bark as they do in other areas of the country on smaller trees with presumably thinner bark in the crown? A preliminary study to determine the numbers and distribution on the tree of overwintering beetles has been inconclusive but beetles were found up to 11 m on some trees. This problem remains unresolved but the Dursban whole-tree program has been suspended until an answer is available.



The Fredericton Dutch Elm Disease Management Area

It has been obvious since amalgamation in 1973 that the City would not be able to maintain the Dutch elm disease program over the entire greater-Fredericton area at the same level of proficiency as previously. There was serious doubt about the future of the program on the north side of the river in Devon, surrounded on three sides by areas of high disease levels. Canadian Forestry Service records showed that by 1975, in Devon 12% of the elms were infected, while on the south side, infection rate was 7%. Although most of the losses were along the river bank and along brooks and the railroads, infection rate was also rising in residential areas.

The City set as a minimum standard the removal of infected elm trees over the entire greater-Fredericton area and then concentrated efforts in a designated Dutch elm disease management area (Fig. 8). This area is comprised largely of the original residential and business districts of 'old' Fredericton. The plan was and still is, to expand this area gradually, as time and finances allow.

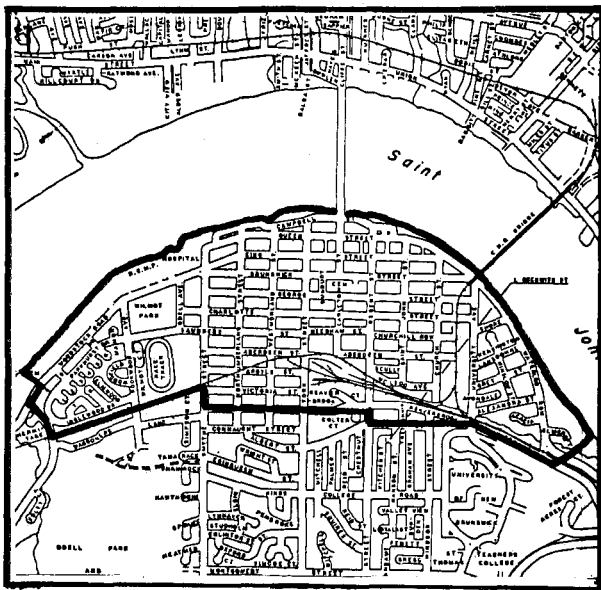


Fig. 8. The Fredericton Dutch elm disease management area.

There were 5692 elm trees in the management area in 1961, and there were 3673 elms at the end of 1980. Of the 1999 trees lost, 1123 fell victim of Dutch elm disease, 19.7% of the original population; 876 were removed for other reasons, 15.4%. Table 12 summarizes the losses on an annual basis. The annual rate of loss to Dutch elm disease is expressed based on both the 'starting tree population each year' and the customary 'based on an estimated original population'. The latter gives better looking results, but does not reflect the actual situation. In 1961, regular City blocks of 1.8 ha (4.5 acres) maintained an average of 60 elm trees per residential block (32.9 elms/ha or 13.3 elms/acre) with a range from 8 to 101 elms. At the end of 1980, the average density was 41 elms per block (22.5 elms/ha or 9.1 elms/acre).

Some blocks have suffered heavier losses than others. Fig. 9 shows the percentage of elms lost to Dutch elm disease to the end of 1980, and in Fig. 10 the deviation from the average loss of 19.7% is indicated.

Most of the problem areas, where losses exceed the average by more than 10%, are on the peripheries of the management area with the notable exception of the Old Burial Grounds and vicinity, and the block along University Avenue between Lansdowne and Grey streets. Of the latter, the source of infection appears to be the area along the river bank or the railroad on Beaverbrook Street, but it is not the case. All but three of the 15 elms lost from the block were along University Avenue and not more than two properties from the Avenue along the side streets (65 m).

An examination of the tree removal pattern during the last three years (Table 13) reveals that more than half of the elms cut in the management area are backyard trees or elms of little value, e.g., small groups of young trees along property lines,

Table 12. Elm tree losses to Dutch elm disease in the Fredericton Dutch elm disease management area*

Year	No. of trees removed		Diseased to date	Accumulated loss to date DED %	Annual rate of loss to DED; based on	
	Dutch elm disease	Other reason			Current population %	Original population %
1961	1	16	1	<0.1	<0.1	<0.1
1962	-	20	1	<0.1	-	-
1963	-	15	1	<0.1	-	-
1964	-	10	1	<0.1	-	-
1965	1	24	2	<0.1	<0.1	<0.1
1966	2	25	4	0.1	<0.1	<0.1
1967	-	50	4	0.1	-	-
1968	5	102	9	0.2	0.1	0.1
1969	6	39	15	0.3	0.1	0.1
1970	25	45	40	0.7	0.5	0.4
1971	28	37	68	1.2	0.5	0.5
1972	22	65	90	1.6	0.4	0.4
1973	47	41	137	2.4	0.9	0.8
1974	40	52	177	3.1	0.8	0.7
1975	63	74	240	4.2	1.3	1.1
1976	120	89	360	6.3	2.5	2.1
1977	79	144	439	7.7	1.7	1.4
1978	150	3	589	10.4	3.4	2.6
1979	219	21	808	14.2	5.2	3.8
1980	315	24	1123	19.7	7.8	5.5

* Original elm population in 1961 - 5692 trees.

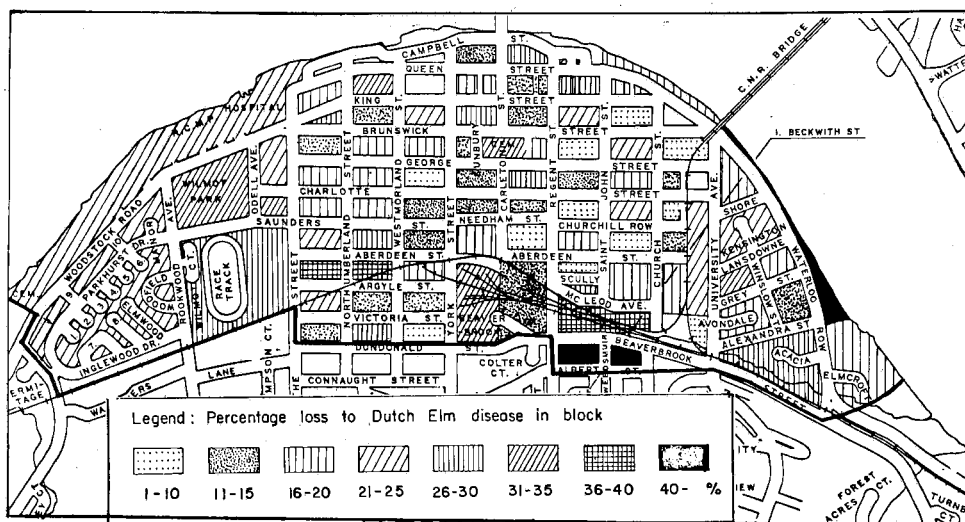


Fig. 9. The level of infection by Dutch elm disease by city blocks within the Fredericton Dutch elm disease management area in 1980.

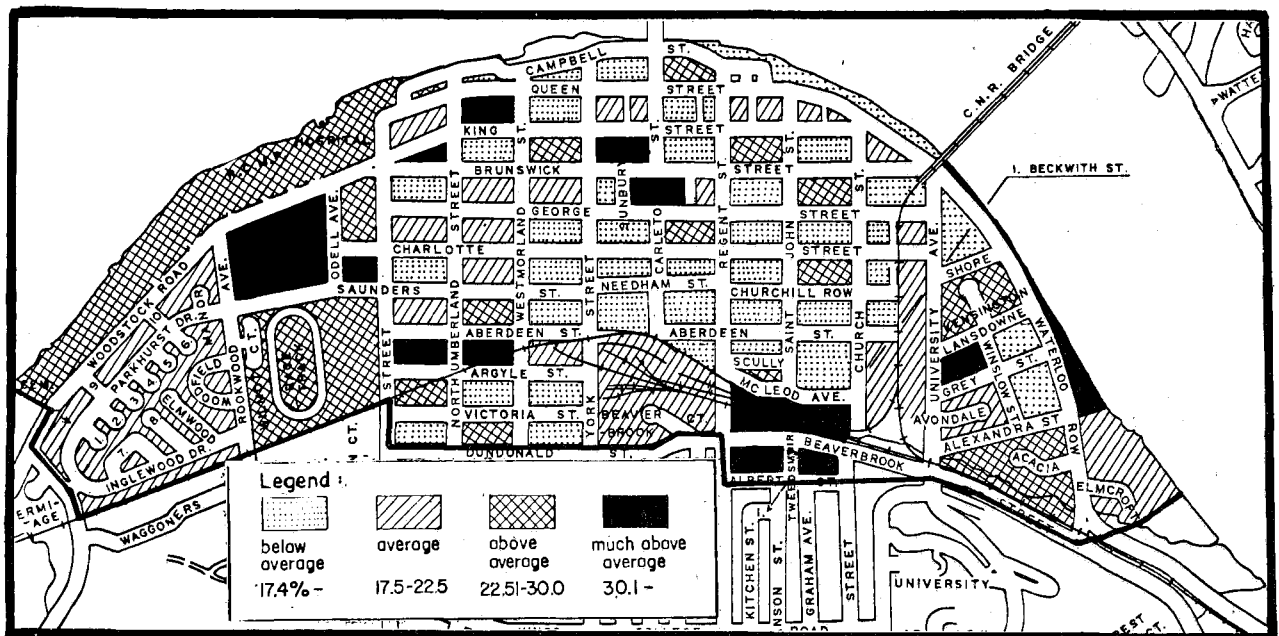


Fig. 10. Deviation from the average infection level of Dutch elm disease by city blocks within the Fredericton Dutch elm disease management area in 1980.

Table 13. The proportion of diseased elm trees removed - by ownership and value - in the Fredericton Dutch elm disease management area

Year	Total DED	Large trees				Trees of little value	
		City trees		Private trees		Number	%
		Number	%	Number	%		
1978	150	65	43.3	75	50.0	10	6.7
1979	219	97	44.3	66	30.1	56	25.6
1980	315	118	37.5	161	51.1	36	11.4

along railroad right-of-ways, thickets, etc., but all these are included in loss calculations.

At the end of 1980 about 1300 of the 3673 elms in the management area are large trees on City property or in front of houses on private

property and comprise part of the "street scape". High value trees of special importance (along with trees of other species) will be selected from these in the process of stratifying the inventory of the urban forest in Fredericton.

The Cost of Fredericton's Tree Program

The citizens of Fredericton, through taxes, supported the program from its inception until 1973. In the outside areas, the New Brunswick Department of Natural Resources bore the cost of removing infected trees in the early years of Dutch elm disease in the Province. From 1973-1977 the Province, through amalgamation grants, assisted in the upgrading of the tree-care standards in the new areas. Since the expiration of this 5-year assistance program, the City has received grants from the New Brunswick Department of Natural Resources. These grants stem from an understanding by the Department and its minister of the special situation regarding Fredericton and Dutch elm disease. The City, a long-standing pilot project in Dutch elm disease management, is encouraged to experiment with new approaches and in turn, to provide consulting services to other communities in the region. Thus, the knowledge and experience gained is of widespread benefit. Also, Fredericton, as the Capital of New Brunswick, represents all citi-

zens and its appearance reflects upon all in the Province.

The operational costs of Fredericton's tree program since amalgamation are summarized in Table 14. Included are costs of tree-and-stump removal and disposal, of chemicals and spray programs, of new trees and planting programs, of equipment, etc. In spite of the introductory statement, that the "purpose of the report was not ... to justify action", a brief explanation regarding costs seems desirable.

No dollar value can be put on quality of life, on heritage, on civic pride or on beauty. But figures could be calculated for factors such as extra energy needed for cooling buildings, because of 16-19°C warmer temperatures in the City without trees, or for a drop in tourist trade. Any Dutch elm disease program must be continuous if it is to succeed. Diseased trees left in place have a multiplying effect, and it would take but a few years without action to have most of the City's high density elm stand destroyed (see Table 1). Furthermore, most of the trees would soon become hazardous to life and property and would have to

Table 14. The cost of the Fredericton tree program since amalgamation in 1973*

Year	Total expenditure	City	Province	Canada Works program
			dollars	
1973	85,972	55,939	30,033	-
1974	100,111	50,111	50,000	-
1975	88,704	48,704	40,000	-
1976	89,401	49,401	40,000	-
1977	135,330	88,629	40,000	6,799
1978	214,943	103,488	61,184	50,278
1979	220,798	151,982	68,816	-
1980	212,057	147,057	65,000	-

* Costs include tree- and stump- removal and disposal, chemicals and spray programs, new trees and planting programs, equipment, etc.

be removed within a short time. By managing the situation, Fredericton has spread the cost of tree removal, which amounts for most of total tree-program expenditures, over many years, kept losses to 20% in 20 years, and retained the character of the City.

In addition to the above cost, the Maritimes Forest Research Centre, involved with the program from its inception, has borne the costs of evaluation and monitoring, culture identification, assistance in tree marking, advice, and research associated with the project. Other establishments of the Canadian Forestry Service, notably the Great Lakes Forest Research Centre, also participated at times at their own expense.

There is another factor to which no monetary value can be attached but without which the program simply would not work, the dedication of the Tree Commission members who unselfishly donated their time and effort throughout the years.

SUMMARY

Dutch elm disease is caused by a fungus which is carried by the elm bark beetle, an insect which breeds in dead and dying elms and spreads the disease to healthy trees. With the spread of the disease in North America and its advancement towards New Brunswick, Fredericton found itself in a vulnerable position. Having inherited a beautiful but almost even-aged monoculture of elms from its forefathers, the City faced the catastrophic prospect of losing most of the trees. Thanks to the cooperation between researchers and foresighted civic authorities, the City of Stately Elms embarked on a course of action which has enabled it to save 80% of the city's elms for 20 years while more than 80% of the elms in surrounding areas died.

Some of the most important factors of Fredericton's Dutch elm disease management program have been:

1. The City's preparedness for the arrival of the disease, having started the management program almost a decade BEFORE it reached the area;
2. The establishment of the Tree Commission, which provided City Council with a well-informed advisory committee which, through its permanency, ensures the continuity necessary for any consistent, sustained program;
3. The By-law which authorizes the City to enter private property to remove - at public expense - infected trees ensures that the protection of the City's trees does not depend on the reluctance of an uninformed or of a financially unable property owner;
4. The Parks and Trees Department of the City has a well-qualified, skilled, efficient work force to carry out Council's wishes, based on advice from the Tree Commission. The City Engineer and the Superintendent of the Parks and Tree Department are active participants;
5. The cooperation between the City and two of its corporate citizens, the federal and the provincial governments; and, most important,
6. Strict adherence - for nearly three decades - to the basic principle that "THE CORNERSTONE OF ANY DUTCH ELM DISEASE MANAGEMENT PROGRAM MUST BE A CONSISTENT SANITATION PROGRAM".

There have been two distinct phases to Fredericton's Dutch elm disease program. During the first phase, from 1952 to 1973, "preamalgamated" Fredericton protected a well-maintained, old, largely-planted population of elms. In the second phase, since 1973, greater-Fredericton has embarked on a program to

upgrade the new areas, to create a mixed-species, rejuvenated urban forest, while maintaining the historical character of "old Fredericton" within the Dutch elm disease management area.

Fredericton's Dutch elm disease program has mostly used methods directed at the carrier, the elm bark beetle. These include sanitation (pruning, tree removal, and disposal), insecticides (DDT, methoxychlor, and chlorpyrifos) and trap trees. Surveys, monitoring, and evaluation provide the basis for the work and tree planting takes care of the scars - and of the future.

In the Dutch elm disease management area 1123 elm trees were lost to the disease in 20 years - 19.7% of the original population. At the end of 1980, there were 3673 elm trees left, 1300 of these large, planted trees along city streets.

The cost of the Dutch elm disease program, over one million dollars in 20 years, may appear prohibitive. However, without a management program, removal of hazardous dead trees would have cost almost as much; Fredericton, without saving money, would have lost its trees, like hundreds of cities and towns in North America that did not care. It would no longer be the City of Stately Elms.

REFERENCES

- Davidson, A.G., W.R. Newell, 1957. Atlantic Provinces Forest Disease Survey. In Annual Report of the Forest Insect and Disease Survey 1957. Can. Dep. Agric. For. Biol. Div., Sci. Serv., Ottawa.
- Euale, L.R., L.M. Gardiner, G.D. Huntley, E.S. Kondo, L.G. Jago. 1977. An integrated Dutch elm disease control program for Sault Ste. Marie. Can. For. Serv., Great Lakes For. Res. Cent. Inf. Rep. O-X-268.
- Euale, L.R., L.M. Gardiner, G.D. Huntley, L.G. Jago, E.S. Kondo. 1978. An integrated Dutch elm disease control program for Sault Ste. Marie. Part II. Can. For. Serv., Great Lakes For. Res. Cent. Inf. Rep. O-X-283.
- Euale, L.R., L.M. Gardiner, G.D. Huntley, L.G. Jago, E.S. Kondo. 1980. An integrated Dutch elm disease control program for Sault Ste. Marie: Part III. Can. For. Serv., Great Lakes For. Res. Cent. Inf. Rep. O-X-307.
- Forbes, R.S., G.R. Underwood and G.A. Van Sickle. 1967. Maritimes Region. In Ann. Rep. For. Insect and Disease Survey 1967, Ottawa.
- Gardiner, L.M. 1976. Control of Dutch elm disease sectors, present and future. p.20 Workshop on Dutch elm disease. Winnipeg, March 3, 1976. Dep. Environ., Can. For. Serv., Edmonton, Alberta.
- Gardiner, L.M. and D.P. Webb. 1980. Tests of chlorpyrifos for control of the North American elm bark beetle (*Hylurgopinus rufipes* Eichh.). Can. For. Serv., Inf. Rep. Great Lakes For. Res. Cent. Inf. Rep. O-X-311.
- Kondo, E.S. 1972. A method for introducing water-soluble chemicals into mature elms. Can. For. Serv. Great Lakes For. Res. Cent. Inf. Rep. O-X-171.
- Lanier, G.N. 1979. New developments in Dutch elm disease control. In Proc. 12th Annual Northeastern Forest Insect Work Conference. SUNY College of Environmental Sciences, Syracuse, N.Y.
- Pomerleau, R. 1964. History and distribution. In A review of the Dutch elm disease. Can. Dep. For.,

For. Ent. Path. Br., Bi-mon. Prog.
Rep. 20 (4):1.

Smith C.C., and R.S. Forbes. 1968.
Dutch elm disease in New Brunswick,
1957-1967. Can. For. Serv.,
Marit. For. Res. Cent. Inf. Rep.
M-X-14.

Sterner, T.E. 1976. Dutch elm disease
sector populations are low within
Fredericton, N.B. Can. For. Serv.
Bi-mon. Res. Notes 32: 20.

Van Sickle, G.A., D.A. Urquhart.
1974. A guide to elm tree removal
in urban areas. Can. For. Serv.,
Marit. For. Res. Cent. Inf. Rep.
M-X-44.

Van Sickle, G.A. and T.E. Sterner.
1976. Sanitation: A practical
protection against Dutch elm
disease in Fredericton, New
Brunswick. Plant Dis. Rep. 60:
336-338.

APPENDIX

The Fredericton Tree Commission

Jean Adams	- member - 1957 - ?
Nelson Adams	- member - 1952 - ? - founding member
Mrs. Hazen Argue	- member - ?
David Baird	- member - 1977 - 1978
R.E. Balch	- member 1952- 19-; founding member
W.L. Barrett	- City Engineer - until 1979
H.W. Blenis	- member - 1973 - 1977
E.J. Bliss	- City Engineer - 1979 - 19-
L. Brewer	- Councillor
K.B. Brown	- Councillor - 1952 - ? - founding member first chairman
John Clark	- member - 1957 - 1971
A.G. Davidson	- member - 1957 - 1962; chairman - 1957
Alex Dickson	- member 1978 - 19-; chairman elect 1981
A.M. (Sandy) DiGiacinto	- Councillor - 1974
J.M. Gibson	- member - 1952 - ? founding member
H. Goldman	- member - 1957
H. Hughson	- second chairman
R.L. Kilburn	- Councillor
H.D. Long	- member - 1952 - ? - founding member
J.D. MacKay	- City Engineer - 1952 - ? - founding member
H.G. MacGillivray	- member - 1975 - 19-
M.E. MacGillivray	- member - 1957 - 19-; secretary since 1974
Mrs. Vera MacKenzie	- Councillor - 1973 - 1974
L.P. Magasi	- member - 1973 - 19-
R. Ogilvie	- Councillor - 1957 - ?
R.A. Redmond	- member - 1973 - 19-
L.R. Seheult	- member 1973 - 1974
C.C. Smith	- member - 1957 - 19-; chairman 1957 - 1978
J.H. Torunski	- member - 1975 - 19-; chairman 1978 - 19-
D.A. Urquhart	- Superintendent, Parks and Trees - 1967 - 19-
C. Weyman	- Councillor - third chairman
W. Whittingham	- Councillor
R.L. Yeomans	- Councillor - 1974 - 19-

Dr. J.J.F. Winslow, Q.C. - honorary member of the Fredericton Tree Commission, whose ancestors were responsible for planting many of City's first trees.

Note: This list is complete only as far as sketchy early records and fading memory allowed. We sincerely apologize to anyone we may have inadvertently missed.