URBAN FOREST PEST MANAGEMENT

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Abstract. Pest management on street trees in the U.S. aims to protect an asset worth nearly $30 billion plus an investment of over $425 million dollars per year, or $10.62 per managed tree. Tree care accounts for only .49% of city budgets, and spraying, a major pest control method, is only 4% of that. Only 36% of responding cities monitor for pests. The most common method is resident complaints (26%), followed by amount of tree damaged (23%) and number of trees damaged (22%). Results are provided by region, but nationally the most often reported insects in 1986 were aphids, gypsy moth, elm leaf beetle, borers and tent caterpillars, while the diseases were Dutch elm disease, anthracnose, Verticillium, maple decline and oak wilt. The most commonly used insecticides were Sevin^{R}, malathion, diazinon, Orthene^{R} and dormant oil, while fungicides were benomyl, bordeaux, zineb and captan. Only about one-fourth of cities employ either systemic treatments or biological control methods.

Urban forests are increasingly recognized as a vital asset in the ever growing expanses of city concrete and steel. The plants that make up the urban forest contribute engineering, environmental, aesthetic and social functions to the urban situation. The true functional value of urban forests may never be fully calculated. In order to keep these plants healthy, however, municipalities, institutions and homeowners are willing to spend a lot of money. It is estimated that over $425 million is spent every year on street tree care alone (4). The average annual cost per tree for street tree care is about $10.62 (5).

Insect pests and diseases are a major threat to each city's tree assets. The prime example is Dutch elm disease. Many cities first realized the value of their urban forests when thousands of stately American elms began to die. Millions eventually had to be removed at great cost.

The gypsy moth is the insect that has most threatened urban forests. Although less destructive than Dutch elm disease, gypsy moth has stripped bare many urban forests, and created a serious nuisance to homeowners. Gypsy moth became a highly political pest; its control created heated debates and court cases from New England to Oregon.

Even with complications of their use, chemical pest control materials often must be employed in cities. Pesticides are still widely used to control urban pests.

However, the overall status of pest management practices in the U.S., is still unclear, so we compared two separate investigations to find changes and trends. This article brings together data from 1980 to 1986 on tree species composition, pest problems and pest management techniques in the urban forests of the U.S. Analysis of current and past trends in these areas are helpful in bringing an awareness to arborists and city foresters on these issues. The knowledge of past trends in urban pest management is crucial in action planning for the future. With the keen awareness of environmental issues and the importance of urban forests to the public, urban pest management plays a crucial role in the overall management of this important city asset.

Methods and Procedures

Data for 1980 and 1986 were gathered as part of a research project by the Department of Forestry, Michigan State University. Survey questionnaires (84 questions in 1980 and 91 in 1986), sent to 2787 municipalities in 1980 and 2861 in 1986, included 6 questions about pest management. These questions asked about inspection for pest levels, most important pests, use of systemic and biological controls, and methods and materials used in pest control. All cities over 10,000 in population, and a 5-7% sampling of those between 2,500 and 9,999 were sent questionnaires. In 1980, 1534 completed questionnaires (54% of total) were returned; in 1986, 1062 (38% of total). More complete survey results are provided in Giedraitis and Kielbaso (1) and Kielbaso, et al. (4).

Monitoring. Inspection of pest levels on a regular basis is an important way to judge the level

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of pest management in a city. It shows how important the city thinks pest problems are. It also gives crucial information for budgeting and planning. There was little difference between 1980 and 1986 on pest inspection. In 1980, 35% (543 cities) and in 1986, 36% (379 cities) inspected pest levels regularly. The population group of 250,000 to 499,999 had the highest percentages both years: 67% in 1980 and 78% in 1986. The population group of less than 2,500 had the lowest, and had a 5% decrease in monitoring, from 18% in 1980 to 13% in 1986. Two thirds of the population groups showed a decreasing trend; as much as 24% between years. This situation in pest monitoring is disturbing. As pesticide use and finances are more restricted, increased monitoring of pest levels would seem crucial. However, monitoring appears to be easily eliminated or overlooked by many cities.

Techniques in monitoring pest levels. How are pest levels monitored? This question was asked with five options: amount of damage to tree, number of trees affected, number of complaints/calls by residents, traps or collectors, and other. Many cities used several of these monitoring methods at the same time. The three major methods were: number of complaints by residents (26%), amount of damage to trees (23%) and number of trees damaged (22%). The other two items, traps or collectors, and "other" accounted for only 5% each. The methods remained constant from 1980 to 1986. Responding to citizen complaints is basically crisis management. Reliance on untrained citizens to alert a city of an insect problem may be cost-effective in the short run, but certainly not over the long run.

City pest management budgets. Since pest control is often unpredictable, it is almost impossible to learn exact amounts of money cities use for pest control. The most widely used method is still chemical spraying, (systemic and biological measures are increasing). So, the cost of spraying trees may be used to estimate the percentage of a tree care budget used for pest control. Kielbaso, *et al.* (4) reported that 4% of the total tree care budget was used for spraying in both 1980 and 1986, which is a small decrease from the 4.9% reported by Kielbaso and Ottman (6). If statistically significant, this small decrease might reflect growing public negative attitudes towards use of chemicals in city environments and/or increasing regulation of such practices.

Tree care is a very small part of total municipal budgets. We found only .81% of 1980 city budgets allocated to tree care, and far less, 49% in 1986, even though actual dollar values increased over those years (Table 1). Pest control is only 4% of this, i.e. .03% in 1980 and .02% in 1986. The downward trend in tree care has a negative

Table 1. Mean tree care budget as a percentage of total municipal budget

	1980			*1986*			
Classification	*# of cities reporting*	*Mean tree care budget $1000*	*% of total city budget*	*# of cities reporting*	*Mean tree care budget $1000*	*% of total city budget*	*change of mean tree care budget %*
Total all cities	946	131	0.81	749	163	0.49	+25
Population group							
over 1,000,000	5	3,128	0.25	2	5,500	0.09	+76
500,000	10	1,050	0.33	8	905	0.02	−14
250,000	24	829	0.42	15	1,088	0.06	+31
100,000	65	300	1.01	50	504	0.06	+68
50,000	132	182	0.94	111	203	0.28	+12
25,000	225	90	1.02	200	124	0.62	+39
10,000	428	32	0.69	320	44	0.70	+37
5,000	27	12	0.43	22	40	0.12	+237
less than 5,000	30	7	0.57	21	5	1.91	+33

impact on pest management practices.

Important Pest Problems in the Urban Forest

City tree managers were asked to indicate the most important tree pests that they dealt with in their municipalities. In 1986, 663 of the 1,062 responding cities answered this question. The managers listed a total of 81 different insects and 40 different diseases that they considered important. In order to compare and rank these pests, *weighted values* were used to determine the ten most important insects and five major diseases, both nationally and regionally, as presented in Tables 2 and 3. Responses were weighted according to rank of listing: the first named assigned a value of 6, and the sixth a value of 1. These were then added over the number of responses to obtain *weighted values.*

Insects nationally. The ten most important insects in U.S. cities, according to city tree managers in 1986 were, in order of importance: aphids, gypsy moth, elm leaf beetle, borers, tent caterpillar, scales, bagworm, webworm, ants and elm bark beetle. These ten account for almost 63% of all insect problems based on their weighted value (Table 2). Aphids, which ranked first nationally, accounted for 15% of total weighted value and 23% of the ten most important insects. Aphids were also ranked highest nationally in 1980 by Kielbaso and Kennedy (3).

Aphids are not equally distributed in all geographic regions. The most signifcant aphid area is the West, accounting for 57% of all aphid listings. The North Central and South have almost equal values of 18% and 16%, respectively. The Northeast accounted for only 9% of all aphid reports. These values are hard to explain by tree varieties. The high ranking of aphids may result from the visibility of honeydew, rather than tree damage (3).

The gypsy moth ranked third nationally in 1980, but was second in 1986. Although it accounted for only 8% of total weighted value and 13% of the ten important insects on the national level, its distribution merits attention. Fully 89% of respondents reporting this insect were in the Northeast region. The North Central and South regions accounted for only 11%, and the West for none. In 1980, 98% of this insect problem occurred in the Northeast. Since 1980, a 9% decrease occurred in the Northeast, with a sizable increase in the North Central and South. This is probably because gypsy moth had spread to the North Central and South, and reflects a concern that it will increase in these regions. Scale insects had been listed as the second most important insect in the U.S. They accounted for 17% of the ten important insects in 1980 (3). In those data, cottony maple scale was included in, and accounted for 90% of scales. In the 1986 data, cottony maple scale was separated from other scales. If cottony maple scales (167 weight value), were added to all other scales, they would rank third nationally. There is little change in their importance according to their weighted value. However, cottony maple scales accounted for only 30% of all scales in 1986 and not for 90% as in 1980. Since more than 96% of the cottony maple scale problem was occurring in the North Central region, this probably implies that occurrences of scales, including cottony maple, have in fact been increasing gradually, and that cottony maple scale still remained at peak occurrence in the North Central region.

Elm bark beetle, the vector of Dutch elm disease, was still on the list of the top ten insects. It is no surprise since Dutch elm disease is still listed as the top disease.

Cankerworm was ranked tenth in 1980 (3), and is a pest that reaches outbreak levels as a cyclical problem for the Northeast and North Central. However, cankerworm accounted for only 1% (65 weight values) in 1986 and was not on the list of the top insects. Perhaps cankerworms were at a cyclical low point. Ants occurred on the list, instead of cankerworms, more because of their visibility than their potential for serious damage to urban trees. The remainder of the top ten insect pests are elm leaf beetle, tent caterpillars, borers, bagworm and webworm. Although their rankings in 1986 are different than in 1980, there were no great differences between the two years.

Diseases nationally. Nationally the top five diseases in 1986, ranked in order of reported importance, were: Dutch elm disease, anthracnose, Verticillium wilt, maple decline (not actually a disease), and oak wilt. This is almost the same sequence as the 1980 data expect for maple

decline, which was then not among the top five. Fire blight was fifth in 1980. These diseases accounted for 68% of all disease problems based on their weighted value (Table 3). Dutch elm disease was the highest in both 1980 and 1986. This disease accounted for 35% of the total disease weighted value and 52% of the five top diseases. The North Central is the main region of its occurrence (54%). The other three regions have almost the same proportion of occurrence (17%, 16%, and 13%) (Table 3). The American elm has been reduced to a lower rank on the list of trees occurring along city streets, and apparently is not being widely planted. However, it remains one of the more important species of existing street trees. According to Kielbaso (5), American elm was ranked sixth, behind "maple" (generically), Norway maple, oaks, silver maple, and ash. The fact that Dutch elm disease was ranked as the most important disease and its vector, the elm bark beetle, was also ranked as one of the top ten insects, suggest that both will command attention for at least a few more years.

The top diseases occurred mainly in the North Central region, except that anthracnose had similar weight values in both the North Central and West (Table 3). This relates to the species used for street trees in these regions. Diseases, however, were listed by most tree managers as less important than insect pests; only 25% of all pest problems. Yet diseases more often threaten the lives of urban trees than do insects. Diseases are generally less visible, harder to diagnose, and harder to control.

Regional Pest Problems

Northeast region. The Northeast had the lowest insect problems of the four regions (weighted value was 20% of total pest problems, Table 2). Gypsy moth was reported by municipalities in the Northeast as the most important insect pest. It accounted for 38% of total weighted values and for 47% of the ten important insects in this region (Table 2). Ants, Japanese beetle, aphids, tent caterpillar, scale, webworm, mosquitoes, elm bark beetle, and bagworm followed the gypsy moth. The fact that ants and mosquitoes are on the list, but did not appear in 1980, is unexpected.

Japanese beetle, not among the top ten on the national list, occupied the third spot in this region. It accounted for 9% of the ten top insects, and increased 5% since 1980. Elm bark beetle, not on the earlier list, ranked 9th on the 1986 list. Although it accounted for only 2% of total weighted value, its association with Dutch elm disease warrants concern. Most of the urban forest insect problems in the Northeast are defoliators. Disease in this region account for 13% of all disease problems. Dutch elm disease ranked the highest, (but only 17% of all DED nationally). Maple decline, anthracnose, ash dieback and oak wilt ranked below Dutch elm disease. These five diseases accounted for 82% of disease problems in the Northeast.

North central region. Insect pest problems in this region account for 25% of the national; the same as the South, and a little higher than the Northeast. Cottony maple scales were ranked second in this region, with 96% of this insect problem in the whole country. If "scales" were added to the cottony maple scales, the combination would rank highest. It was also highest in the survey of 1980, being included as part of "scale". This was predictable since cottony maple scales were in an outbreak phase in many areas of the Midwest in 1980 just prior to that survey (3). Did it maintain a high level up until 1986 or did another cyclical peak occur? It's hard to be certain from these surveys, but entomologists in the region suggest that it was probably two peaks.

Aphids ranked number one in importance in this region, primarily due to their attack on maples and elms, tree species that are most abundant in this region. The most serious defoliators, elm leaf beetle, bagworm, and cankerworms, among the top insects in 1980, were still on the list of 1986, except for cankerworm. Bagworm, which is mainly a problem in the southern parts of the region, rose from seventh in 1980 to fourth in 1986. Cankerworms and leaf-hoppers did not occur among the top ten listed pests in 1986, although in 1980 they were fifth and eight, respectively. The most serious defoliators in this region in 1986 were bagworm and elm leaf beetle.

Various borers are still a serious pest problem in this region. The two-lined chestnut borer, *(Agrilus bilineatus)*, bronze birch borer *(A. anxius)*, and

Table 2. The ten most important insect pests in 1986 by region, with rank comparison to 1980.

	Weighted Value[a]
Northeast	
1 (1)[b] Gypsy moth	487
2 (-) Ants	112
3 (8) Japanese beetle	89
4 (3) Aphids	83
5 (2) Tent Caterpillar	82
6 (7) Scales	56
7 (4) Webworm	35
8 (-) Mosquitoe	31
9 (5) Elm bark beetle	30
10 (10) Bagworm	25
Total weighted value, top ten	1030
Weighted value of all insects in region	1271
Percent of all insects	19.5%
Percent of all pests	14.6%
NorthCentral	
1 (2) Aphids	174
2 (-) Cottony maple scale[c]	160
3 (4) Borers	123
4 (7) Bagworm	121
5 (9) Tent Caterpillar	120
6 (3) Elm bark beetle	115
7 (6) Elm leaf beetle	105
8 (-) Web worm	70
9 (-) Birch borers	60
10 (1) Scales[b]	58
Total weighted value, top ten	1106
Weighted value of all insects in region	1641
Percent of all insects	25.2%
Percent of all pests	18.8%
South	
1 (2) Borers	197
2 (1) Bagworm	170
3 (4) Aphids	151
4 (5) Web worm	145
5 (3) Scales	132
6 (7) Elm leaf beetle	94
7 (6) Tent caterpillar	79
8 (9) Pine bark beetle	66
9 (-) Mosquitoe	62
10 (8) Japanese beetle	29
Total weighted value, top ten	1125
Weighted value of all insects in region	1620
Percent of all insects	24.9%
Percent of all pests	18.6%
West	
1 (1)Aphids	539
2 (3) Elm leaf beetle	233
3 (8) Borers	120
4 (5) Thrips	112
5 (2) Scales	89
6 (6) Tent caterpillar	70
7 (10) Mites[d]	57
8 (4) Caterpillar	49
9 (-) Spider mite[d]	49
10 (-) Oak moth	48
Total weighted value, top ten	1366
Weighted value of all insects *in region*	1970
Percent of all insects	30.3%
Percent of all pests	22.7%
National	
1 (1) Aphids	947
2 (3) Gypsy moth	546
3 (5) Elm leaf beetle	445
4 (6) Borers	451
5 (4) Tent Caterpillar	351
6 (2) Scales	335
7 (7) Bagworm	322
8 (9) Webworm	265
9 (-) Ants	218
10 (8) Elm bark beetle	196
Total weighted value, top ten	4076
Weighted value of all insects nationally	6502
Percent of all pests	74.8%

a. Weighted according to rank of listing: first = 6, second = 5, etc.
b. (#) The sequence of the most important insects in 1980 (see Kielbaso and Kennedy 1983)
c. Cottony maple and "scales" combined as #1 in 1980—separated in 1986
d. Mites and spider mites were combined as #10 in 1980.

Table 3. The five most important disease pests by region in 1986, with rank.

	Weight Value[a]
Northeast	
1 (1)[b] DED	135
2 (4) Maple decline	45
3 (3) Anthracnose	21
4 (-) Ash dieback	18
5 (-) Oak wilt	16
Total of above	235
Weighted value of all diseases in region	286
Percent of all diseases	13.1%
Percent of all pests	3.3%
North Central	
1 (1) DED	416
2 (3) Anthracnose	134
3 (2) Oak wilt	98
4 (4) Maple decline	90
5 (5) Verticillium	82

Total of above	820
Weighted value of all diseases in region	1031
Percent of all diseases	47.2%
Percent of all pests	11.9%
South	
1 (1) DED	102
2 (-) Lethal yellowing	30
3 (-) Powdery Mildew	22
4 (-) Ganoderma	21
5 (-) Oak decline	20
Total of above	195
Weighted value of all diseases in region	330
Percent of all diseases	15.1%
Percent of all pests	3.8%
West	
1 (1) Anthracnose	137
2 (2) DED	120
3 (-) Drought	42
4 (-) Verticillium	41
5 (3) Fire blight	37
Total of above	377
Weighted value of all diseases in region	539
Percent of all diseases	24.7%
Percent of all pests	6.2%
National	
1 (1) DED	773
2 (2) Anthracnose	299
3 (3) Verticillium	140
4 (6) Maple decline	135
5 (4) Oak wilt	133
Total of above	1480
Weighted value of all diseases nationally	2186
Percent of all pests	25.2%

a. Weighted according to rank of listing: first = 5, fifth = 1.
b. 1980 ranking from Jamieson 1985 (unpublished).

flatheaded apple tree borer, *(Chrysobothris femorata),* probably are the three major borer species reported (no data shown).

Elm bark beetle ranked sixth among the top insect pests, and Dutch elm disease in this region accounted for 54% of its incidence nationally. This disease accounted for 40% of the weighted value for diseases in this region. Its top position is followed by anthracnose, oak wilt, maple decline, Verticillium wilt and canker. Diseases account for 47% of the national weighted value of disease, making the North Central the most heavily weighted region for diseases.

South region. Responses from the Southern region indicate that borers were the most important insect pests according to tree managers. A group of defoliators, bagworm (2nd), webworm (4th), elm leaf beetle (6th), tent caterpillar (7th) and Japanese beetle (10th) were on the list of the top ten insects. Pine bark beetle was listed as important, which makes sense with pine trees being the 3rd most important street tree species in the South. Two sucking insects, aphids and scales, ranked 3rd and 5th (Table 2).

Dutch elm disease was the most important disease listed in the South, although its incidence in this region accounted for only 13% of the whole country. It accounted for 31% of this region's diseases.

The remaining important diseases in this region are lethal yellowing of palms, powdery mildew, Ganoderma root rot, and oak decline. Disease pests in the South account for 15% of all disease problems, slightly more important than in the Northeast.

West region. Aphids were the number one insect pest listed, with 27% of the weighted value. The presence of these insects in the West accounted for 57% of their occurrence in the whole country (Table 2). Scales dropped from second (16% of the top ten insects) in 1980 to fifth (8% of the top ten insects) in 1986. Thrips ranked fourth. Defoliators are as important as the sucking pest complex in this region. Compared to 1980, there's little difference, but scales and caterpillars did drop in importance and borers increased. Mites and spider mites, combined and tenth in 1980, are both among the top 10; if combined, they would now be fifth. The West region is the only region in which Dutch elm disease was not ranked highest. Anthracnose ranked first followed by Dutch elm disease, "drought", Verticillium wilt, and fire blight. These five "diseases" accounted for 70% of the diseases in this region. While disease problems in this region account for 25% of all disease problems, second to the North Central region, they account for 6.2% of all problems

nationally.

Which insects and diseases occur on urban forest trees reflects which tree species they prefer. The urban forest manager thus can understand what pests will be most important. Managers may select new trees for a particular community to avoid or reduce serious pest problems, but they must consider what diseases and pests *those* trees are most likely to get.

Pest Control

Three specific pest control questions were asked: were systemic and biological treatments used? what important chemicals were used? and what was the schedule of spray pesticides for pest control?

Systemic treatment has been considered a good alternative to spraying, but in our data only 22% of cities used systemic treatments for pest control (Table 4). The West had the highest use (35%) in both 1980 and 1986, mostly for aphid control, but also for elm leaf beetles, leaf miners, borers and Dutch elm disease (data not shown). The South ranked second, the North Central third, and the Northeast ranked the lowest. Although the percentage of cities using systemic treatment in 1986 remained about the same as 1980, in reality most of the population size groups had some small decrease (Table 4). Small cities, with small totals, skewed the percentage figures. The decrease in systemic use may be because some managers think that systemic treatment may injure trees and even increase the possibility of being invaded by disease, or because systemics are slower or less effective than foliar application. With increased public pressure against spraying, however, systemic treatments may become more important in pest control in future years.

Biological control. Only 25% of the responding cities indicated that they use biological control. The West was the leader with 36% of cities in 1980, and 29% in 1986, reporting use of biological controls. In 1986 the North Central also reported a 29% response, an increase of 5%. These were followed by the South (22%) and Northeast (16%) (Table 5).

Selective pruning was the major method of biological control used by cities (no table shown). Some others, such as trapping, milky spore disease for Japanese beetle control, and planting of resistant varieties, were also listed by some managers. Even though biological control is not yet commonplace, highly sophisticated, or integrated in most cases, its advantages have been considered by many city tree managers. They have begun to realize the availability of different control measures and have integrated a few into urban pest management control practices.

Pesticides used. Thirty-six different chemical pesticides were reported as being used in the

Table 4. Use of systemic treatments in US cities, 1980 and 1986.

	1980		*1986*	
Classification	*Number reporting*	*Response % yes*	*Number reporting*	*Response % yes*
Total all cities	1114	22	804	22
Population group				
Over 1,000,000	5	60	2	50
500,000	11	45	9	33
250,000	26	31	18	22
100,000	67	34	56	34
50,000	143	31	117	29
25,000	257	24	210	24
10,000	527	17	353	18
5,000	33	9	18	33
less than 5,000	45	13	21	-
Geographic Region				
Northeast	266	17	161	14
North Central	354	14	263	16
South	237	26	187	25
West	257	35	193	35

Table 5. Extent of biological control in US cities, 1980 and 1986.

	1980		*1986*	
Classification	*Number reporting*	*Response % yes*	*Number reporting*	*Response % yes*
Total all cities	1012	25	747	25
Population group				
Over 1,000,000	5	40	2	50
500,000	12	25	8	50
250,000	25	36	17	29
100,000	60	37	56	30
50,000	131	32	112	29
25,000	228	28	196	29
10,000	179	21	310	20
5,000	36	19	23	17
less than 5,000	13	19	23	23
Geographic Region				
Northeast	229	16	150	16
North Central	338	24	241	29
South	208	24	168	22
West	237	36	188	29

U.S., among them 25 insecticides and 11 fungicides. On a weighted basis, insecticides accounted for almost 95% of all pesticides used in city pest control.

The ten most important insecticides are ranked in order of importance nationally (Table 6). Sevin® , a broad-spectrum insecticide with relatively low toxicity, ranked number one, being used most commonly for the control of gypsy moth, elm leaf beetle, bagworm, tent caterpillar, and aphids. This corresponds closely to the listing of top insect problems. Sevin® accounted for 19% of all weighted values and 24% of the top ten important insecticides.

Malathion followed closely behind Sevin® as the second most commonly used insecticide. Aphids were the most frequent target of malathion. Other insects listed as being sprayed with malathion included: tent caterpillars, mosquitoes, bagworms, and elm leaf beetles. As with Sevin® , the popularity of malathion may be traced to its low toxicity.

Diazinon was the third most commonly used, although considerably less than Sevin® or malathion. Aphids were mentioned most often as a target of diazinon. It was most commonly used in the West region (49%). Other insecticides, such as Orthene® , dormant oil, lindane, Kelthane® and B.t. had almost the same rankings in 1986 as in 1980. B.t. is a biological product but is usually reported as a spray chemical, and is therefore included in the pesticides. Dursban® (7) replaced Meta-systox® on the list in 1986.

Methoxychlor, which ranked fourth as a chemical control in 1980, dropped to tenth in 1986, only 1/6 as common as Sevin® . Methoxychlor has a low toxicity and a long residual, making it attractive for the control of bark beetles in urban areas. It's drop in importance may be traced to many cities' decrease in spraying to control Dutch elm disease by controlling elm bark beetle.

Fungicides accounted for only a small part (5%) of the weighted values of pesticides. Four major chemicals are listed in Table 6: Benlate® , bordeaux, zineb, captan. These four fungicides account for 60% of the weighted value of all fungicides used in this country for urban tree protection.

Spraying schedules. About 30% of the reporting cities do not spray for pest control, and a great majority 66% (1986) spray only when a need is apparent (Table 7). Only 7% of the cities sprayed on calendar dates. Pesticides were applied at some regular (monthly, weekly, etc.) interval by 5% of the municipalities. The percentage of cities with an "as needed" spray schedule increased from 62% (1980) to 66% (1986). The differences in city population size did not seem to affect the type of spray scheduling (data not

Table 6. Most commonly used insecticides and fungicides in US cities; 1980 and 1986.

Rank	*Pesticides*	*Weighted value*
1.	(1)[a] Sevin® (Carbaryl)	834
2.	(2) Malathion	824
3.	(3) Diazinon	549
4.	(5) Orthene®	311
5.	(7) Dormant Oil	205
6.	(8) Lindane	167
7.	(*) Dursban®	157
8.	(6) Bt *(Bacillus thuringiensis)*	142
9.	(9) Kelthane®	139
10.	(4) Methoxychlor	121
		3449
Weighted value of all insecticides		4375
Fungicides		
1.	Benomyl/Benlate®	68
2.	Bordeaux	28
3.	Zineb	19
4.	Captan	15
		130
Weighted value of all fungicides		217

a. The sequence of the most important insecticides in 1980 from unpublished data (Jamieson 1985). No similar data for fungicides.
* not on top 10 list in 1980

Table 7. How sprays are scheduled in US cities, 1980 and 1986.

Spraying schedules	*1980*[a]		*1986*[b]	
	# Cities	*%*	*# Cities*	*%*
Regular intervals	74	6	45	5
Calendar dates	92	8	60	7
Apparent need	711	62	548	66
Not at all	347	30	234	28

a. 1,137 responded to question
b. 830 responded to question

shown).

Conclusions and Discussion

The value the urban forest has been estimated by many people and the results consistently point to the fact that the urban forest is an asset worthy of protection from insect and disease pests. This protection is just one of the needs of the urban forest. The results of the 1980 and 1986 surveys indicate that chemical applications were the most widely used means of pest control in U.S. municipalities. City tree managers appear to have concentrated their control efforts on insect, rather than disease pests.

Small trends can be seen between surveys in urban forest species, urban forest pests, and pest control measures. Most notable is the decrease in elm bark beetles as important pests, along with methoxychlor as an important insecticide and the American elm as an important urban forest species. All three are key elements in the Dutch elm disease.

With increasing public awareness of pest management in cities the need for integrated pest management becomes apparent. We believe that IPM will continue to gain in importance as city tree managers and arborists utilize all technical resources to combat pests that threaten our cities' great tree assets.

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Résumé. La gestion des insectes et des maladies sur les arbres de rues aux États-Unis s'efforce de protéger un capital valant près de 30 milliards de dollars en plus d'un investissement annuel de plus de 425 millions de dollars, ou 10,62 dollars par arbre géré. L'entretien des arbres compte pour seulement 0.49% du budget des villes et l'arrosage, une méthode majeure de contrôle des parasites, compte pour seulement 4% de ce nombre. Seul 36% des villes répondantes contrôlent les insectes et les maladies. La méthode la plus courante est la plainte des résidents (26%), suivi par la valeur en arbres endommagés (23%) et le nombre d'arbres endommagés (22%). Les résultats sont fournis par région, mais, à l'échelle nationale, les insectes les plus souvent rapportés en 1986 étaient les insectes suceurs, la spongieuse, le galéruque de l'orme, les perceurs et les chenilles à tentes, alors que les maladies étaient la maladie hollandaise de l'orme, l'anthracnose, la flétrissure des verticilles, *le dépérissement de l'érable et la flétrissure du chêne*. Les insecticides les plus communément employés sont le Sevin®, le malathion, le diazinon, l'Orthene® et les huiles au stade dormant, alors que les fongicides sont le benomyl, le bordeaux, le zineb et le captan. Seul le quart des villes font usage de l'un ou l'autre des traitements systémiques ou des méthodes biologiques de contrôle.

Zusammenfassung: Die Schädlingsbekämpfung von Straßenbäumen in den USA versucht einen Vermögenswerte von fast 30 Milliarden Dollar und eine Investition von über 425 Millionen Dollar pro Jahr, also 10.62 Dollar pro behandelter Baum, zu schützen. Baumschutz verbraucht nur .49% von Stadthaushalten und das Baumsprühen als wichtiger Teil der Schädlingsbekämpfung nur 4% davon. Nur 36% von Städten, die eine Antwort gegeben haben, kontrollieren Schädlinge. Die meist angewendete Methode ist Einwohnerbeschwerde (26%), danach kommt die Verbreitung von Baumschaden (23%) und zuletzt, die Menge von geschädigten Bäumen (22%). Die Ergebnisse sind ortbezogen, aber in 1986 in den ganzen USA sind die meist beschwerdeten Insekten, Aphididae, Zigeunermotten, Ulmeblattkäfer, Bohrwürme und Zeltraupe, während die Krankheiten von "Dutch Elm" Krankheit, Anthraknose, Verticillium, "Maple Decline" und "Oak Wilt" (*C. fagacearum*) die meist beschwerdeten. Die meist-üblich verwendeten Insektiziden waren Sevin, Malathion, Diazinon, Orthene und Dormant öl und die Fungiziden waren Benomyl, Bordeaux, Zineb und Captan. Nur ein-Viertel von den Städten anwenden entweder systemische Bekämpfungen oder biologische Kontrollemethoden.