TREE INVENTORY AND MANAGEMENT PLAN
FOR
THE ROBERT TREAT PAINE HISTORIC TRUST
ANN CLIFFORD, CURATOR

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SUMMARY

The inventoried trees on the grounds of the Robert Treat Paine Historic Trust tallied to 202 tree numbers listed on the inventory, which were selected for the purpose of this report, and represent 24 different species. Ten groves of trees comprising of the same species were listed as one number in the tree number column showing a total of 152 trees, with inventory criteria representing the average of all trees in the grove. These ten groves are shown as trees numbered 30, 34, 36, 37, 46, 87, 88, 89, 130, and 131. They add up to a total of 61 trees actually bringing the total count to 202 trees.

Most trees under twelve inches in diameter were not inventoried, but should be valued as developing replacements for the aging trees on the estate. Those that were included were selected to encourage their development because of their location and species interest. The three largest trees in the inventory are the copper beech 22, with a trunk diameter of 69 inches; the white pine 79, with a trunk diameter of 44 inches; and the oak 142, with a trunk diameter of 38 inches. Of the many trees selected for this inventory, the following, especially, show the diversity and maturity of the population: Carolina Silver bell 86 trunk diameter 15 inches, Sourwood 100, diameter 14 inches, Eastern red cedar 90 diameter 20 inches, Carolina Hemlock groves 36 and 134 average diameter 18 inches, Balsam Fir 132 diameter 22 inches, Douglas Fir 35 diameter 23 inches, Sweet Birch 59 diameter 25 inches, American Beech 140 diameter 37 inches, Black Walnut 49 diameter 6 inches, Ginkgo 50 diameter 18 inches, Sugar maple 38 diameter 40 inches, Black Oak 142 diameter 38 inches, and White Oak 76 diameter 39 inches.

The majority of the trees inventoried are in fair to poor condition. Principal limiting factors affecting growth are soil depth, low nutrition availability, age and environmental problems such as drought conditions the last nine years.

INTRODUCTION

The Robert Treat Paine Historic Trust is located in the center of one hundred thirty-four acres of woodlands and meadow, and has an extensive and species-diverse tree population, of which 202 trees generally having a trunk diameter of over twelve inches were selected to be managed under a five-year maintenance plan. Ms. Ann Clifford, director and curator of the historic trust, asked Carl A. Cathcart, Certified Arborist, to do a health assessment of the trees on the Trust grounds. The purpose of which was to identify immediate and long-term maintenance requirements to preserve these important trees.

The inspection was completed on March 13, 2000. An inventory and inspection was done to determine tree locations, species, size, condition, correction and maintenance needs, for the purpose of addressing the current need for tree health and condition for the spring of 2000 and with the objection of developing a long range Tree Management plan. Detailed inventory procedures are presented on page 3. Inventory data are analyzed and pertinent findings are presented in the conclusion on pages 9 and 10 Specific Tree Management objectives and Maintenance Specifications are detailed on pages 6, 7 and 8. Supporting documents are in other Tables such as, a tree location map, tree inventory sheets, Species diversity pie graph, Woolly Adelgid fact sheet, Lightening protection information, Pruning diagrams (4), a recommended list of trees for planting and a Summary report.

INVENTORY PROCEDURES

An inventory of 202 trees on the grounds of The Robert Treat Paine Historic Trust was undertaken in March of 2000. Most trees fewer than twelve inches in trunk diameter were excluded from the inventory because of their age and healthy condition. The objectives of the inventory were to develop a short and long-range management plan. The following was the criteria that was used to:

1. Determine the number, species, and location of all specimen trees, medium size trees and all mature trees.
2. Determine priorities.
3. Assess the health and condition each tree and grove of trees.
4. Assess the structural and cultural requirements.

Specific Information Collected In Inventory

Tree Location: The trees, numbered 1-152, are in three separate locations on the property, as shown in the Tree Location Map found in the Appendix. Tree numbers 44 to 126 are in area 1 also known as priority number 1 area. This is part of the south lawn, the terrace, east lawn, and entry circle and service area. Trees in number 2 area or priority 2 areas are numbers 1 through 43, which are located along the drive and in the lower south lawn area. Tree numbers 127 to 151 are is area number 3 or priority area 3 which are located in the west lawn and north of the west lawn.

Species: The common and botanical name of each tree species was recorded and listed on page?

Size: The diameter of the trunk at 54 inches above the ground was measured to the nearest inch, except in the case of multi-stemmed trees, where an average of each trunk diameter was taken and recorded as one trunk.

Condition/Vigor: An appraisal of tree health was based on the amount and size of deadwood, thinness of crown, bud size, yearly elongation of growth and wound compartmentalization. The total of these criteria was an indication of health and vigor and represents the good, fair, or poor category. 1-4= Poor, 5-7= Fair and 8-10= Good

Tree Maintenance: The need for tree maintenance was assessed, with the goal of addressing current condition and vigor. This helped to give us information to project the present and long-range tree maintenance requirements. Remediation was assigned a priority of II, III, or I.

Priorities

Priority I	Year 2000
Priority II	Year 2001
Priority III	Year 2002
Priority I	Year 2003
Priority I	Year 2004
Priority I	Year 2005

Pruning:

Year 2000:

Priority I Trees #s 97 to 126 including 152. (Area 1)

Year 2001:

Priority II Trees #s127 to 151. (Area 3)

Year 2002:

Priority III Trees #s 1 to 15, -21, 24 to 37 and 86 to 93. (Area 2+3)

Year 2003:

Priority I All trees in area 3 as needed.

Year 2004:

Priority I All trees in area 2 as needed.

Year 2005

Priority I All tree in area 1 as needed.

Fertilization:

Year 2000:

Priority I Trees #s 22,38,49,50,51,72,78,79,100,101,138,140, and 142

Year 2001:

Priority II All other trees in Area 1 and 2.

Year 2002:

Priority III. All other trees in Area 3.

Year 2003:

Priority I All trees in area 1

Year 2004:

Priority I All trees in area 2

Year 2005:

Priority I All trees in area 3

Support systems:

Year 2000:

Priority I Tree #s 1,5, 22,43,51,68,78,79,86,120,121, and 152

Year 2001:

Priority II Tree #s 21,36,90,93,128,134,135,140,149,150, and 151

Hazardous Tree Assessment:

Year 2000:

Priority I Tree #s 11,19,79 and 94

Root Collar Excavations:

Year 2000:

Priority I Tree #s 3-10,21,24,25,31,34,35,39-41,44,47,49,50,56,61-63,65-67,70,72,77,83,84,86-89,94-101,107,112-123,127-130,138and 140

Crown Cleaning (Pruning):

Before any work is started, safety cones or other barriers shall always be used to protect the public from entering the work site.

Pruning is recommended for removal of dead branches 2 inches in stem diameter and larger. Broken, torn, crossing or split branches should be removed, to reduce hazard and to improve vigor.

Debris removal: Daily removal of debris is to be practiced. Chips from trees can be dumped on site

Structural supports: Support cables were recommended to correct structural deficiencies including weak "V" crotches and multiple stems

Fertilization of trees: All trees on the inventory are recommended to be fertilized with a 3:1:1 or a 3:1:2 slow release liquid fertilizer with micronutrients made for woody plants which is injected into the soil at a depth of eight to twelve inches, and applied

at any time the ground is not frozen (spring and fall are optimum; apply in summer only if irrigation is present). The most important trees will be fertilized this year as listed in the priorities above. As many as possible of the remaining trees would benefit from surface application of a granular 10-10-10 fertilizer in early spring.

Mulch: Trees in the inventory 2-6, 21-32, 34-35, 39-41, 44, 46, 49-80, 82-89, 92-101, 106-116, 118, 119, 124-127, 138, and 140-152 would benefit from mulching of wood chips to a depth of 3 to 4 inches especially during this drought period.

Root collar excavation: Trees in the inventory 3-10, 21, 24, 25, 31, 34, 35, 39-41, 44-47, 49, 50, 56, 61-63, 65-67, 70, 72, 77, 83, 84, 86-89, 94-101, 107, 112-123, 127-130, 138, and 140 should have their root collars cleared. Proper soil level around the root collar of a tree is vital to prevent root collar disorders leading to decline and death. The flare at the tree's base should be exposed. Any girdling roots, which will eventually strangle a tree, should be removed.

TREE MAINTENANCE SPECIFICATIONS

The goals of Tree Management Plan for The Robert Treat Paine Historic Trust are base on the information collected during the tree inspection and inventorying. Specific recommendations for each tree are listed in the Tree Inventory, Table 1 under Priorities and in the Five Year Management Plan. Maintenance activities are grouped onto three separate priorities in a five-year plan: Maintenance activities for Priority I trees are to be completed in 2000, and Priority II and III as budget permits.

The broad objectives are to:

Manage the risk associated with tree population through practices that minimize failures such as pruning and installation of supports system and possibly lighting protection.

Maximize plant health and longevity through a corrective and preventative health program such as fertilization, mulching, pest management and irrigating as needed.

Specific Objectives

Hazardous Tree Assessment: Tree decline and wounds in the urban forest are often environmentally caused by such events as drought, lighting strokes, mechanical injury, lawn vehicle damage and snow damage caused by the storms such as the one of May 9, 1977) that break, twist, and split branches and roots, leaving the tree structurally injured. This allows the entry for disease and insects to weaken the tree, thus developing decay sections throughout the tree. The spread of decay within the tree structure is a slow process and can take many years to weaken the main stem or branches of the tree however when signs of mushroom and cracks appear on main portions of the tree it is wise to investigate further. Four trees have these signs and it is recommended that a complete examination be made to determine how much of a risk the tree may be to the pedestrian and vehicles which frequent the area. Trees number 11, 19, 79 and 94 should be assessed further for structural integrity. The large white pine tree number 79 close to the south side of the building was struck by lighting a few back that is evident from damaged bark in the upper crown of this tree. A climber needs to be put into this tree and inspect it up close. If not seriously damaged I have recommended the installation of five support cables and the installation of lightening protection.

Lightening protection: Trees numbered 79 and 102 are the tallest pine near the building. The installation of lightening protection would not only help protect the tree but the building and any pedestrian close to it in a lightening storm.

Crown cleaning ninety-six trees of the 202 trees need proper pruning to encourage proper growth and maintain optimal tree structure and vigor. Besides crown cleaning of the trees in this inventory, removal of a few selected root suckers beneath the crowns of American beech 138 and 140 should be considered and done over a five-year period. This would help the parent trees to adjust and develop their own canopies. The small American beech tree 141 needs to have the small diameter co-dominate branch removed so a future structural problem can be avoided. All pruning should consist of removing dead and dying branches 2 inches in diameter and larger to improve health and provide a safer environment. Proper pruning should be done as follows.

When removing a branch, pruning cuts shall be made in bark tissue, close, but outside of, the branch ridge and the collar, which is trunk tissue (fig. 1 – Table 8). If no collar is visible, the angle of the cut shall approximate the angle formed by the branch bark ridge and the trunk) fig. 2 – Table 8).

When removing a dead branch, the final cut shall be made outside the collar of live tissue. If the collar has grown out several inches around the branch stub, only the dead stub shall be removed. The live collar shall remain intact and uninjured (fig 3 – Table 8). The finish cut surface must be smooth and in one place with no jagged or torn bark.

When pruning back ends of large branches, all cuts are to be made to a healthy lateral branch approximately three (3) times the size of the branch being removed (Lateral A and B cut - Table 8). In removing the end of a limb to a large lateral branch, the final cut is made along a line that bisects the angle between the branch bark and a line perpendicular to the limb being removed (fig. 4 – Table 8).

The following guidelines apply to all new pruning procedures:

Pruning should encourage the development of the natural shape of the plant. Where crown reduction is necessary, a tree-like form should be maintained with the top higher than the sides.

Excessive thinning of the interior portions of the crown should be avoided. Instead, emphasis should be given to removing branches from the ends of the limb and leaders. One half of the foliage must be maintained to the lower two thirds of the limb or leader. Selective thinning of the ends of the limbs will reduce the weight of the crown, which will help prevent breakage during storms. This form of pruning also tends to discourage sucker growth on the interior portion of the limbs. Removing major limbs or leaders (more than six inches in diameter) should be avoided unless declined or storm-damaged beyond repair. Subsequently, large pruning wounds will not callus rapidly and severe decay in the remaining limb or trunk will result. Debris shall be removed on a daily basis, and safety cones or other barriers shall be used to protect the public from entering the work site, Warning signs or other forms of safety equipment shall be used when performing any work on the property to protect persons from injury or damage to their personal property

Structural supports: Twenty-three trees need support cables as listed on the inventory and the priorities. Such support will be achieved by cabling (supporting or strengthening tree structure by the use of anchoring devices and cable connecting two or more limbs within the same tree) or bracing (using wood screws or bolts connecting two areas of sound wood, where crotches or trunks are split or weak and to support limbs). All cables will be of seven-strand wire cable installed 2/3 or 3/4 of the distance from the origin of the fork, and will be attached through eyebolts with a thimble.

Fertilization: For this first year, trees numbered 22, 38, 49-51, 72, 78, 79, 100, 101, 127-129, 138, 140, and 142 will be fertilized using the injection method outlined below, with the remaining trees recommended in the inventory to receive a broadcasting of a 10-10-10 granular fertilizer applied in the spring of 2000. Thereafter, all trees in the inventory trees should be fertilized on a yearly schedule as budget permits. The fertilizer will be a slow release, 3:1:1 or 3:1:2 liquid slow release fertilizers with micronutrients, injected into the soil at a depth no greater than 8 to 12 inches, to improve the health and vigor of the trees.

Root Collar Care: Root collar disorders are conditions that help to weaken a tree and increase the risk of root and lower stem diseases. Root collar disorders are a major limiting factor on many of the trees in the inventory. Soil and/or mulch were present on the root collar. There are sixty trees which should have the soil removed from their root collars and examined for girdling roots. Soil or mulch should be not replaced.

Mulch:

One hundred and nine trees as per inventory should have as big of a mulch ring under the canopy as possible. It should be applied 3 to 4 inches deep and kept 6 to 12 inches away from the base of the tree.

CONCLUSION

Considerable ledge areas exist on the property, and in most cases the trees growing atop ledge are stressed by the shallowness of the soil. A particular example is the beech trees 138 and 140. These two trees have developed considerable root suckers in an effort to compensate for canopy decline The insufficient water-holding capacity caused by the shallow soil beneath and around these two trees will be improved with the application of fertilizer and mulch.

On the whole property, mulching is particularly important to offset increased evapo transpiration brought about by the recent extensive necessary clearing of competing trees and undergrowth.

The largest white pine has been struck by lightening in the past that is evident from the old scars in the middle of the upper crown. Other large white pine around the building are also candidates to be struck and should be considered to be protected with lighting cables. This not only protects the trees but people within the area if a lighting blot strikes. Tree number 102 in the circle is one of the tallest and tree number 79 on the south side nearest the building that has already been struck and should be considered for an inspection to see if it warrants the cost for supports cables and lightening protection. Decline in the trees abutting the road on the conservation-land side of the drive near Beaver Street to the circle is probably due to the impact of utility wire installation several years ago. These trees need the support of fertilizer and mulch to help reduce stress.

The large white pine number 81 is in a poor condition both health wise and structurally. It appears that this tree is out of the main area where people don't walk and visit to often and if this is the case I personally would allowed it to stand for the habitat it provides to wildlife and for the example it represents of the last phase of a forest tree. Although it is clearly visible and well back on the property, warning signs of potential instability should be present. It should be noted that this tree represents a risk if left standing. Keeping people from the area is important and necessary because one ever knows when a tree will fail especially one in structural decline as this one. Personally I would keep this tree and not let anyone near. However it the people whom are responsible for the Paine Trust grounds need to make that decision. One other tree, 45 located at the edge along the entry drive, leaning backward away from the road and showing a large cavity at the base is also another tree prone to failure and should be a restricted area. Any tree can fail at any given time if the environmental conditions are favorable. How much risk is The Robert Treat Paine Historic Trust willing to except is really the question and not my concerns for trees, animal and birds.

Some areas of poison ivy exist on and about the trunks of a number of trees, and they are noted in the comment section of the inventory sheets as PI. Cutting it to the ground, letting it sprout with a good set of leaves between June and August and then treating it with an herbicide such as Roundup will control it.

The need for structural support was noted in twenty-three trees. In addition, a number of trees contain deadwood as noted in the priorities, which undermines the tree's health and poses risks; they require crown cleaning.

Specific recommendations were developed to address the current need for tree health and safety for the spring of 2000, and to prepare a long range Tree Management plan, and include:

Hazardous Tree Assessment: Identify and correct hazardous tree conditions.

Tree Risk Management: Schedule regular periodic observation of wildlife tree 81 and tree 45 if allowed to stand.

Pruning: Crown clean: 87 trees to eliminate deadwood and undesirable branches.

Structural Supports: 23 trees are designated for support cables, to be installed as soon as funds permit.

Fertilization: Fertilize, on a yearly basis, all trees with a 3:1:1or 3:1:2 slow release liquid fertilizer for woody plants, containing micronutrients and injected 8 to 12 inches into the soil. Except for this year 2000, due to budget restrictions, fertilize only mature trees such as the copper beech 22, sugar maple 38, white pine 79, canoe birch 78, sourwood 100, sourwood 101. Ginkgo 50, black walnut 49, Carolina silverbell 51, Flowering dogwood 72, American beech 138, American beech 140, Black oak 142, and columnar white pines 127 -129, selected on the basis of age and condition. If budget permits others in the first year should receive at least a 10-10-10 granular fertilizer broadcast in spring. This fertilizing would help these trees overcome the stresses for the drought we are and have been experiencing.

Pest Management: Light infestation of the Hemlock Woolly Adelgid was observed on the Hemlocks throughout the property. Gypsy moth egg masses were seen on the copper beech 22. These need to be monitored and treated as necessary. Hemlock Woolly Adelgid can be treated in the early spring and the fall for best control. The Gypsy moth caterpillar needs to be treated around mid May and the first part of June.

Root Collar Excavation: Designated trees are to have earth at the base of the trunk removed to properly expose the flare, and are to be examined for girdling roots and decay at the same time.

Mulch: All trees noted in the inventory trees should receive three to four inches of mulch beneath their branch spread to help conserve soil moisture.

RESULTS AND RECOMMENDATIONS

A total of 202 selected trees representing 24 species were inventoried on the grounds of The Robert Treat Paine Historic Trust.

Table 1 is a summary of all the trees inventoried which lists the common name, botanical name, the number of trees in each species as identified in the inventory, and the percent of total trees each species represents. Also groves are listed and all the recommendations

A listing of each tree and all data collected in the survey are presented in the Tree Inventory in the Appendix.

Location of each tree by area map is presented in the Tree Location Map in the Appendix.

Forty-one percent of the selected trees on the site are specimens with a trunk caliper twenty-four inches or larger. The Mature trees in this group are more sensitive to adverse conditions such as drought or pests, and require a higher level of maintenance than young plants to assure survival.

The majority of the trees are in fair to poor condition. Problems exhibited by these trees include root collar disorders such as buried root collars and girdling roots, decay in the upper and lower structures, the need for mulch to conserve moisture, excessive amount of deadwood, hazardous limbs and minimum annual growth.

Maintaining tree vigor through periodic fertilizing and mulching will help the trees to resist disease and drought stress. Avoiding unnecessary wounds and proper pruning will reduce the number of infection sites. Exposing the root flare, removal of girdling roots, and continued mulching will support sound growth.

Eastern Hemlock should be monitored for the presence of Hemlock Woolly Adelgid, native dogwood for anthracnose, and copper beech 22 for Gypsy Moth Caterpillar infestation.

FIVE-YEAR MANAGEMENT PLAN

Year 2000:
Priority

Crown clean all trees to prune out deadwood 2 inches in diameter and larger and any storm damaged branches from number 97 to 126 including 152. Check and clear root collars in these trees

Fertilize with a slow release fertilizer injected into the soil on tree numbers 22,38,49,50,51,72,78, 79,100,101,138,140 and 141.
Surfaces apply a granular fertilizer with a ratio of 10-10-10 in early April to trees in area 1 and 2.

Install support cables in the following trees: 1,5,22,43,51,68,78,79,120,121 and 152
Monitor for Hemlock Woolly Adelgid and Gypsy moth and only treat if necessary.

Mulch as many trees as possible as noted on tree inventory

Year 2001:
Priority

Crown clean all trees to prune out any deadwood 2 inches in diameter and larger and storm damage from numbers 127 to 151. Check and clean root collars in these trees.

Fertilize with a slow release fertilizer injected into the soil on all trees in area 1 and 2.

Install support cables in the following trees:
21,128,134,135,140,149,150 and 151

Maintain mulch depth 3 to 4 inches.

Monitor for Hemlock Woolly Adelgid and Gypsy moth. Treat only if necessary.

Year 2002:
Priority

Crown clean all trees to prune out deadwood 2 inches in diameter and larger and any storm damage from numbers 1 to 15,21,24 to 37 and 86 to 93. Check and clean root collars in these trees.

Fertilize all trees in area 3 with a slow release fertilizer injected into the soil.

Maintain a mulch depth of 3 to 4 inches

Monitor for Hemlock Woolly Adelgid and Gypsy moth. Treat only if necessary.

Year 2003:
Priority

Crown clean all trees in area 3 to prune out deadwood 2 inches in diameter and larger and any storm damage in these trees. Check all root collars in these trees.

Fertilize all trees in area 1 with a slow release fertilize injected into the soil.

Maintain a mulch depth of 3 to 4 inches.

Monitor for Hemlock Woolly Adelgid and Gypsy moth and only treat if necessary.

Year 2004:
Priority

Crown clean to prune out deadwood 2 inches in diameter and larger from trees in area 2. Check all root collars in these trees.

Fertilize all trees in area 2 with a slow release fertilizer injected into the soil.

Maintain a mulch depth of 3 to 4 inches

Monitor for Hemlock Woolly Adelgid and Gypsy moth and only treat as necessary.

Year 2005:
Priority

Crown clean all trees in area 1 to remove deadwood 2 inches in diameter and larger. Check all root collars on these trees.

Fertilize all trees in area 3 with a slow release fertilizer injected into the soil.

Maintain a 3 to 4 inch mulch depth under all trees.

Monitor for Hemlock Woolly Adelgid and Gypsy moth and only treat as necessary.

Table 1 Summary Report
The Robert Treat Paine Historic Trust

Tree Species

Botanical Name	Common name	No.	% of Total	Common name	Total	% of Total
Fagus, Purpurea	Beech, Copper	2	1.0%			
Fagus, Grandifolia	Beech, American	3	1.5%	Beech	5	2.5%
Betula lenta	Birch, Sweet	5	2.5%			
Betula papyrifera	Birch, Canoe	7	3.5%	Birch	12	5.9%
Juniperus Virginiana	Cedar, Eastern Red	26	12.9%	Cedar	26	12.9%
Cornus Florida	Dogwood, Flowering	5	2.5%	Dogwood	5	2.5%
Ulmus Americana	Elm, American	1	0.5%	Elm	1	0.5%
Pseudotsuga Menziesii	Fir, Douglas	2	1.0%			
Abies Balsamea	Fir, Balsam	1	0.5%			
Abies Concolor	Fir, White	1	0.5%	Fir	4	2.0%
Ginkgo Biloba	Ginkgo	1	0.5%	Ginkgo	1	0.5%
Tauga Canadensis	Hemlock, Eastern	6	3.0%			
Tauga Carolinana	Hemlock, Carolina	11	5.4%	Hemlock	17	8.4%
Carya Ovata	Hickory, Shag Bark	5	2.5%	Hickory	5	2.5%
Robina Pseudoacacia	Locust, Black	6	3.0%	Locust	6	3.0%
Acer Rubrum	Maple, Acer - Red	2	1.0%			
Acer Saccharum	Maple, Sugar	4	2.0%	Maple	6	3.0%
Quercus Velutina	Oak, Black	58	28.7%			
Quercus Rubra	Oak, Red	8	4.0%			
Quercus Alba	Oak, White	17	8.4%	Oak	83	41.1%
Pinus Rosinosa	Pine, Red	3	1.5%			
Pinus Strobus	Pine, White	20	9.9%	Pine	23	11.4%
Halesia Tetraptera	Silverbell, Carolina	4	2.0%	Silverbell	4	2.0%
Oxydendrum Arboreum	Sourwood	3	1.5%	Sourwood	3	1.5%
Juglas Nigra	Walnut, Black	1	0.5%	Walnut	1	0.5%
	Totals	**202**	**100%**		**202**	**100%**

Groves

Black locust # 30	6
Eastern red cedar # 89	6
Eastern red cedar # 88	3
Eastern red cedar # 87	6
Eastern red cedar # 34	9
Eastern hemlock # 37	6
Carolina hemlock # 36	6
Canoe birch # 46	5
White pine # 130	10
	Total 61

Table 1 continued

Trees Size By Diameter

Trees 24 inches and larger	63	41%
Trees 23 inches or smaller	89	59%

Tree Size by Small and Large

Small 1- 20 feet	14%
Medium 25 to 40 feet	18%
Large 45 to 100 feet +	68%
	100%

Tree Condition

Poor	15%
Fair	65%
Good	20%
	100%

Priorities:

Pruning:

Priority I Trees #s 97 to 126 including 152. Area 1
Priority II Trees #s127 to151. Area 3
Priority III Trees #s 1to15, -21, 24 to 37 and 86 to 93. Area 2+3
Proirity I All trees in area 3 as needed
Proirity I All trees in area 2 as needed
Priority 1 All trees in area 1 as needed

Fertilization:

Priority I Trees #s 22,38,49,50,51,72,78,79,100,101,138,140, and 142
Priority II All other trees in Area 1 and 2.
Priority III. All other trees in Area 3.
Priority I All trees in area 1
Priority I All trees in area 2
Priority I All trees in area 3

Support systems:

Priority I Tree #s 1,5, 22,43,51,68,78,79,86,120,121, and 152
Priority II Tree #s 21,36,90,93,128,134,135,140,149,150, and 151

Hazardous Tree Assessment

Priority I Tree #s 11,19,79 and 94

Root Collars Excavation

Priority I Tree #s 3-10,21,24,25,31,34,35,39-41,44-47,49,50,56,61-63,70,72,77,83,84,86-89, 94-101,107,112-123,127-130,138 and 140

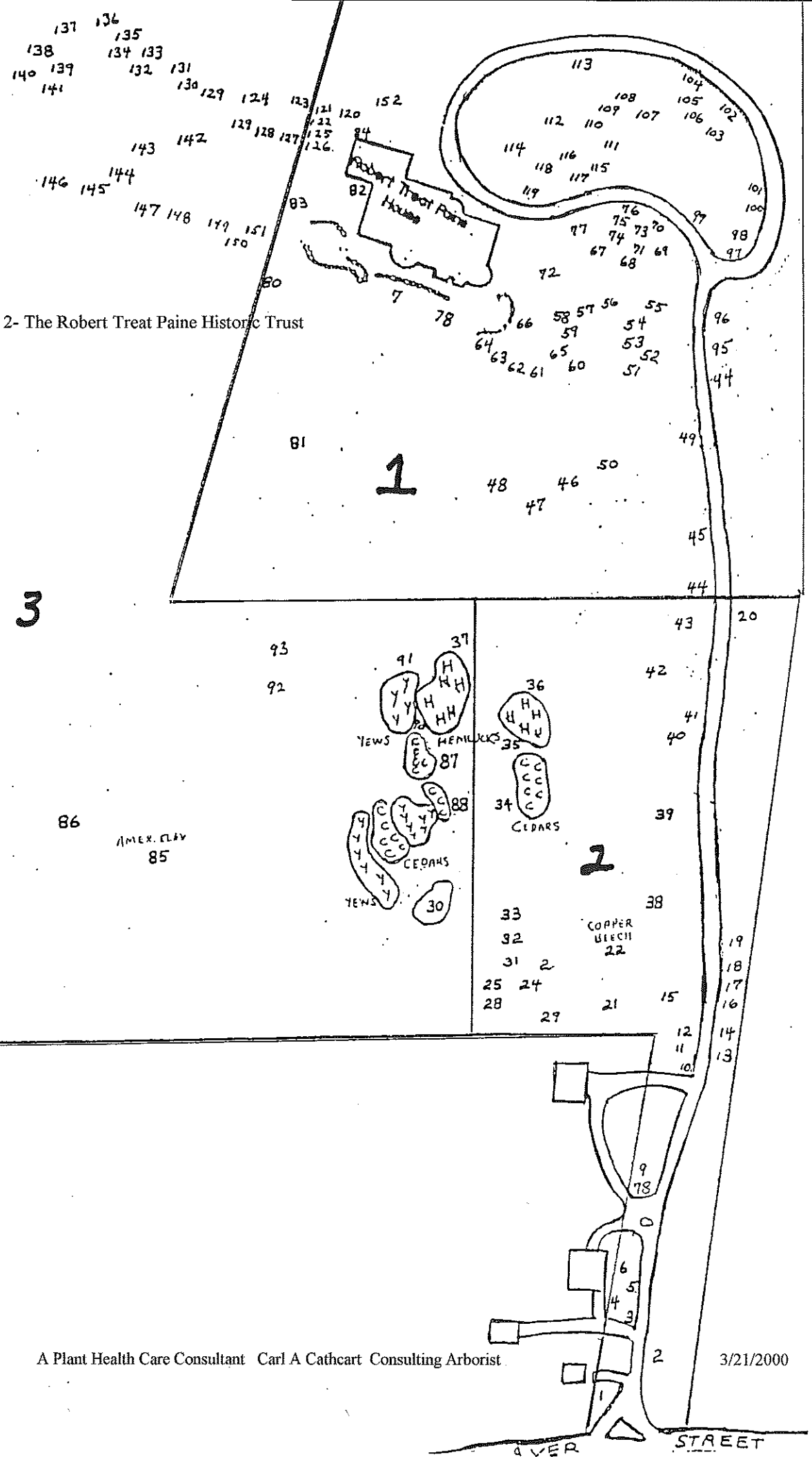

Table 2- The Robert Treat Paine Historic Trust

Table 3

The Robert Treat Paine Historic Trust

Tree Inventory Sheet

Tree No.	Species	Diameter-54 inches from ground	Height	Health Conditions 1-10	Priority 1-2-3	Crown Clean + Hrs.	Crown Thin	Crown Reduction	Remove Tree	Replace Tree	Support Systems	Fertilization	Recommend 3 to 4" Mulch	Root Collar Examination	Pest Management	Other	Comments
1	Black Oak	7	S	10	3	1					1c	x		x			MS
2	White Oak	25	L	5	1	1						x	x				
3	Black Oak	20	M	7	1	1						x	x	x			
4	Shagbark Hickory	17	M	6	2	1						x	x	x			
5	Sweet Birch	22	M	8	1	1	0.5				1c	x	x	x			MS
6	Black Oak	32	L	4	1	3						x	x	x			
7	Red Oak	34	L	6	1	3						x		x			
8	Black Oak	31	L	6	1	3						x		x			
9	Black Oak	24	L	5	1	2						x		x			
10	Black Oak	34	L	6	1	3						x		x			
11	Black Oak	25	L	3	1	3						x					HTA
12	Black Oak	29	L	5	1	3						x					
13	White Oak	24	L	7	2	3						x					
14	Red Oak	25	L	3	1	2						x					HTA Main stem
15	Red Oak	24	L	7	1	3						x					
16	Red Oak	25	L	7	1	1						x					Root Collar decay
17	Red Oak	31	L	5	1	1						x					Cavity
18	Red Oak	25	L	8	3	x						x					
19	Red Oak	34	L	4	1	1						x					HTA-Cavity
20	Red Oak	33	L	4	1	1						x					Main stem crack
21	Flowering Dogwood	6.5	S	5	1	1						x	x	x			MS
22	Copper Beech	69	L	4	1	1					2c	x	x				Gypsy moth/ canker
23	Copper Beech	14	M	8	1	1						x	x				
24	Black Oak	37	L	4	1	1						x	x	x			
25	Flowering Dogwood	6	S	5	1	2						x	x	x			
26	Black Oak	14	M	8	1	1						x	x				
27	Black Oak	14	M	8	1	1						x	x				
28	Black Oak	13	M	8	1	1						x	x				
29	Black Oak	27	L	3	1	1						x	x				
30	Black Locust	7	M	8	3	3						x	x				Grove of (6)
31	Carolina Silverbell	6	S	7	1	1						x	x				
32	Black Oak	16	M	8	1	1						x	x				
	Plant Height= 1' to 20' Small- 25' ot 40' Medium- 45' to 100' Large																
	Plant Condition - 1 to 4 = Poor- 5 to 7= Fair - 8 to 10 = Good																

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The Robert Treat Paine Historic Trust

Tree Inventory Sheet

Tree No.	Species	Diameter-54 inches from ground	Height	Health Conditions 1-10	Priority 1-2-3	Crown Clean + Hrs.	Crown Thin	Crown Reduction	Remove Tree	Replace Tree	Support Systems	Fertilization	Recommend 3 to 4" Mulch	Root Collar Examination	Pest Management	Other	Comments
33	Black Oak	15	M	7	1	1						x					
34	Eastern Red Cedar	10	S	5	3	3						x	x	x			Grove of (9) PI
35	Douglas Fir	23	L	8	2	2						x	x	x			PI
36	Carolina Hemlock	15	L	4	2	2			1hr		5c	x	x				Grove (6)-Remove 1
37	Eastern Hemlock	23	L	8	2	6						x	x				Grove of (6)
38	Sugar Maple	40	L	7	1							x	x				
39	Shagbark Hickory	16	M	7	1							x	x	x			PI
40	White Oak	20	L	8	1							x	x	x			PI
41	Black Oak	29	L	6	1							x	x	x			
42	Black Oak	41	L	4	1				16hrs								Remove
43	Black Oak	30	L	6	1						1c	x					PI
44	Black Oak	28	L	7	1							x	x	x			PI
45	Black Oak	42	L	7	1							x	x				Med.Risk Cavity PI
46	Canoe Birch	5	S	8	1							x	x	x			Grove of 5
47	Canoe Birch	7	S	8	1							x	x				
48	White Pine	25	L	8	3	2						x					
49	Black Walnut	6	S	8	1							x	x	x			PI
50	Ginkgo	18	L	8	1							x	x	x			PI
51	Carolina Silverbell	12	M	7	1						1c	x	x				PI - MS
52	Sugar Maple	22	L	7	1							x	x				
53	Sugar Maple	23	L	7	1							x	x				
54	Sugar Maple	18	L	8	1							x	x				
55	Red Maple	10	M	8	1							x	x				
56	Sweet Birch	19	L	4	3				12hr								Cankers
57	Canoe Birch	10	M	8	1							x	x				
58	Black Oak	36	L	7	1							x	x				
59	Sweet Birch	25	L	7	1							x	x				
60	White Oak	30	L	4	1							x	x				PI
61	Black Oak	30	L	6	1							x	x	x			PI
62	White Oak	23	L	6	1							x	x				PI
63	White Oak	20	M	5	1							x	x	x			PI
64	Black Oak	13	S	6	1							x	x				
65	Black Oak	32	L	7	1							x	x	x			
66	White Oak	26	L	7	1							x	x	x			
	Plant Height= 1' to 20' Small- 25' ot 40' Medium- 45' to 100' Large																
	Plant Condition - 1 to 4 = Poor- 5 to 7= Fair - 8 to 10 = Good																

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The Robert Treat Paine Historic Trust

Tree Inventory Sheet

Tree No.	Species	Diameter-54 inches from ground	Height	Health Conditions 1-10	Priority 1-2-3	Crown Clean + Hrs.	Crown Thin	Crown Reduction	Remove Tree	Replace Tree	Support Systems	Fertilization	Recommend 3 to 4" Mulch	Root Collar Examination	Pest Management	Other	Comments
67	Shagbark Hickory	11	S	7	1							x	x	x			
68	Black Oak	23	L	7	1						1c	x	x				MS
69	Shagbark Hickory	22	L	5	1							x	x				PI
70	Flowering Dogwood	7	M	8	1							x	x	x			
71	Sweet Birch	21	L	7	1							x	x				
72	Flowering Dogwood	8	S	7	1							x	x	x			
73	White Oak	21	L	7	1							x	x				
74	White Oak	21	L	7	1							x	x				
75	White Oak	19	M	7	1							x	x				
76	White Oak	39	L	7	1							x	x				
77	Shagbark Hickory	13	M	7	1							x	x	x			
78	Canoe Birch	21	L	8	1						2c	x	x				PI
79	White Pine	44	L	8	1	6					6c	x	x				HTA-Lighting+Protect
80	Black Oak	38	L	7	1							x	x				
81	White Pine	48	L	2	1							x					Wildlife Tree
82	Flowering Dogwood	18	M	5	1							x	x				
83	Black Oak	35	L	6	1	6						x	x	x			
84	Black Oak	30	L	7	1							x	x	x			Berm
85	American Elm	7.5	S	7	1							x	x				
86	Carolina Silverbell	15	L	5	1	1					1c	x	x	x			
87	Eastern Red Cedar	10	S	4	1							x	x	x			Grove of 6
88	Eastern Red Cedar	10	S	4	1							x	x	x			Grove of 3
89	Eastern Red Cedar	8	S	6	1							x	x				Grove of 6
90	Eastern Red Cedar	20	L	5	1	3					3c	x					3-Stems
91	Eastern Red Cedar	17	L	5	3	2						x					
92	Black Oak	16	M	8	1	2						x	x				
93	Black Oak	15	M	8	1	2					3c	x	x				Multi-Stem
94	Sweet Birch	25	L	4	1							x	x	x			HTA Main stem seam
95	White Oak	21	L	7	1							x	x	x			
96	Red Maple	25	L	4	1							x	x	x			
97	White Oak	17	L	6	1							x	x	x			
98	Black Oak	30	L	7	1							x	x	x			
99	Black Oak	28	L	7	1							x		x			
100	Sourwood	14	M	8	1							x	x	x			PI
	Plant Height= 1' to 20' Small- 25' ot 40' Medium- 45' to 100' Large																
	Plant Condition - 1 to 4 = Poor- 5 to 7= Fair - 8 to 10 = Good																

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Tree Inventory Sheet

Tree No.	Species	Diameter-54 inches from ground	Height	Health Conditions 1-10	Priority 1-2-3	Crown Clean + Hrs.	Crown Thin	Crown Reduction	Remove Tree	Replace Tree	Support Systems	Fertilization	Recommend 3 to 4" Mulch	Root Collar Examination	Pest Management	Other	Comments
101	Sourwood	7	M	6	1							x	x	x			PI
102	White Pine	27	L	8	1							x					Lighting protection?
103	Black Oak	28	L	6	1	4						x					
104	Black Oak	32	L	6	1	4						x					Tel-Cross arms
105	Black Oak	19	L	5	1							x					
106	Black Oak	25	L	4	1	3						x	x				
107	Sourwood	5	S	6	1							x	x	x			
108	Black Oak	26	L	5	1							x	x				MS
109	Black Oak	25	L	5	1							x	x				
110	Black Oak	21	L	5	1							x	x				
111	Black Oak	17	L	6	1							x					
112	White Pine	31	L	6	1	4						x	x	x			
113	Black Oak	19	L	5	1	1						x	x	x			
114	White Oak	26	L	6	1	4						x	x	x			
115	Black Oak	24	L	6	1	4						x	x	x			
116	Black Oak	18	L	4	1	2						x	x	x			
117	Black Oak	17	L	4	1	1						x		x			
118	Black Oak	23	L	5	1	3						x	x	x			
119	White Oak	17	L	4	1	1						x	x	x			
120	Black Oak	24	L	6	1	2					1c	x		x			Place betweem trees
121	Black Oak	22	L	6	1	2					1c	x		x			
122	Red Pine	15	L	6	1	1						x		x			
123	Red Pine	12	L	6	1	1						x		x			
124	Red Pine	18	L	6	1	1						x	x	x			
125	Black Oak	16	L	5	1	1						x	x				
126	Black Oak	30	L	6	1	4						x	x				
127	White Pine	11	S	5	1	5						x	x	x			
128	White Pine	4	S	4	1	5					3c	x	x	x			MS 3 cables
129	White Pine	12	S	4	1	1						x		x			Mass pitch borers
130	White Pine	10	M	6	2	5						x		x			Grove of 10
131	Carolina Hemlock	12	M	6	2	5						x					Grove of 4
132	Concolor Fir	21	L	5	2	3						x					
133	Balsam Fir	22	L	5	2	3						x					
	Plant Height= 1' to 20' Small- 25' ot 40' Medium- 45' to 100' Large																
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A Plant Health Care Consultant Carl A Cathcart Consulting Arborist

The Robert Treat Paine Historic Trust

Tree Inventory Sheet

Tree No.	Species	Diameter-54 inches from ground	Height	Health Conditions 1-10	Priority 1-2-3	Crown Clean + Hrs.	Crown Thin	Crown Reduction	Remove Tree	Replace Tree	Support Systems	Fertilization	Recommend 3 to 4" Mulch	Root Collar Examination	Pest Management	Other	Comments
134	Carolina Hemlock	21	L	7	2	1					1c	x					Wood Bolt (twist)
135	Douglas Fir	20	L	5	2	1					1c	x					
136	White Pine	24	L	7	2	2						x					
137	White Pine	30	L	7	2	2						x	x				
138	American Beech	25	M	4	2	3						x					Cut root suckers
139	Black Oak	8	S	8	2	1						x	x				
140	American Beech	37	L	5	2	2					1c	x	x				Cut root suckers
141	American Beech	7	S	8	2	5						x	x				Prune side branch off
142	Black Oak	38	L	7	2	5						x	x				Pl
143	Black Oak	24	L	4	2	2						x	x				
144	Black Oak	18	L	7	2	1						x	x				
145	Black Oak	20	L	7	2	1						x	x				
146	White Oak	10	S	8	2	3						x	x				
147	Black Oak	13	S	7	2	1						x	x				
148	Black Oak	29	L	7	2	3						x	x				
149	Carolina Silverbell	10	M	7	2	2					3c	x	x				MS-(5)
150	Black Oak	25	L	6	2	4					1c	x	x				MS
151	Black Oak	28	L	5	2	4					1c	x	x				
152	White Oak	33	L	7	2	3					1c	x	x				
	Plant Height= 1' to 20' Small- 25' ot 40' Medium- 45' to 100' Large																
	Plant Condition - 1 to 4 = Poor- 5 to 7= Fair - 8 to 10 = Good																

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Table 4--The Robert Treat Paine Historic Trust

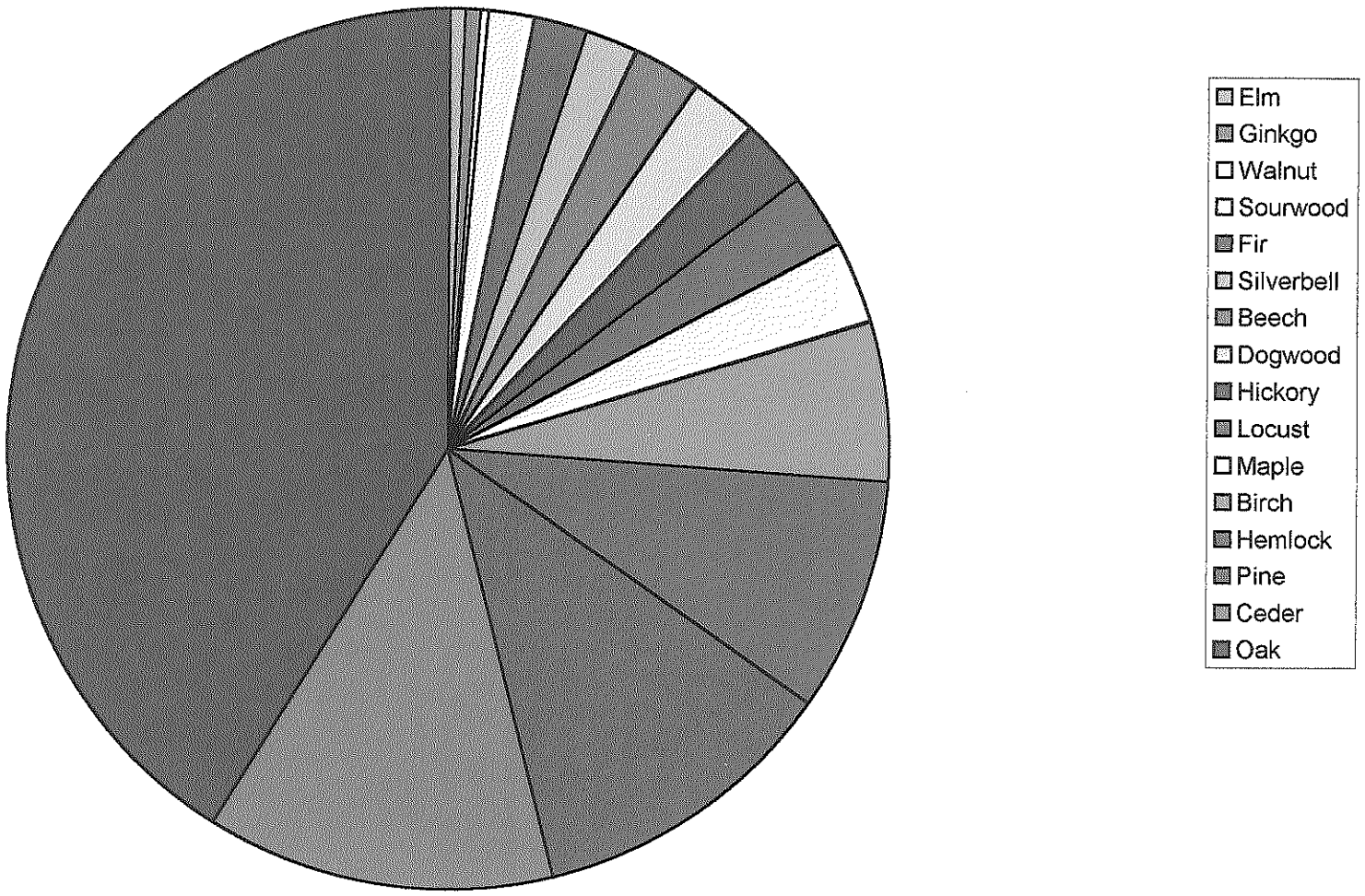


Table 5. List of recommended species

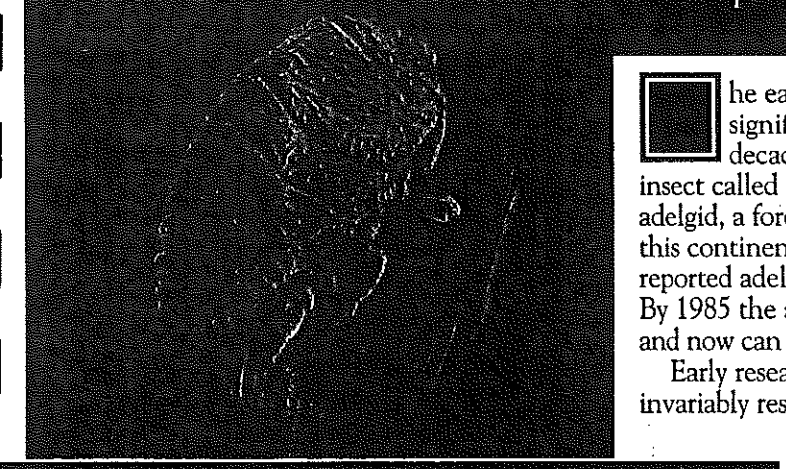
Recommened List of Trees for Planting

Common Name	Botanical Name	Height	Width
Rivers purple beech	Fagus Sylvatica (riversii)	60 ft.	110 ft.
Sugar maple (Green mountian)	Acer saccharum selection	50 ft.	75 ft.
Red maple (October glory)	Acer rubrum	50 to 60ft	40 to 50ft
Paperbark maple	Acer griseum	30ft	15 to 30ft
Serviceberry (Autumn brilliance)	Amelanchier x grandiflora	2o to 25ft	15 to 18ft
River birch (Heritage)	Betula nigra	40 to 50ft	30 to 35 ft.
Eastern Red bud	Cercis canadenesis	25 to 30ft.	25 to 30ft.
Fringetree	Chionanthus viginicus	20 to 25ft.	20 to 25ft.
Gingko (Autumn gold)	Gniko biloba	45 to 55ft.	30 t0 40ft.
Kousa dogwood(Rutgers hybrids)	Cornus kousa	25 to 30ft.	15 to 20ft.
Tuliptree	Liriodendron tulipifera	80 to100ft.	60 to 80ft.
Dawn redwood	Metasquoia glyptostroboides	60 to 90ft.	45 to 55ft.

Table 6

THE IMPACT OF HEMLOCK WOOLLY ADELGID ON THE HEALTH OF EASTERN HEMLOCK:

An Update From Connecticut



The eastern hemlock *(Tsuga canadensis)* has suffered significant decline in southern Connecticut over the past decade. Much of the decline has been attributed to an insect called the hemlock woolly adelgid *(Adelges tsugae)*. The adelgid, a foreign invader from the orient, was first observed on this continent in the 1920s in British Columbia. The first reported adelgid siting on the East Coast was in Virginia in 1955. By 1985 the adelgid had progressed northward to Connecticut and now can be found throughout most of southern New England.

Early research reports indicated that adelgid infestations invariably resulted in widespread hemlock mortality within three to four years. This has led some loggers and professional foresters to recommend harvesting hemlocks at the first sign of the adelgid. A recent study, completed at the University of Connecticut Department of Natural Resource Management and Engineering in cooperation with the U.S. Forest Service, has found that **some hemlocks can withstand long-term exposure to adelgid infestations**. In addition, site characteristics were found to play an important role in the health of the hemlocks and their susceptibility to damage caused by the adelgid.

The Hemlock Woolly Adelgid: Some Background

The hemlock woolly adelgid is a small, 0.3-mm to 1.4-mm long, aphid-like insect with piercing/sucking mouthparts. It attacks hemlocks from the base of the needles. The adelgid extends its tube-like mouthparts into the twig where it feeds on nutrients stored in cells. At the same time, it secretes a substance into the hemlock that may be toxic to the tree.

Because an individual adelgid is so small, the first indication of infestation is usually the discovery of egg sacs. These white, cottony sacs contain on average 50 adelgid eggs each. In addition to protecting the eggs, the fibrous sacs help transport the adelgid by sticking to bird feathers or mammal hair. Wind also carries the sacs between trees, spreading infestations further.

Because the hemlock woolly adelgid is an exotic species, it has no effective natural predators in our region. Researchers have looked for natural predators of the adelgid in Japan and China in an attempt to find a biological control. Dr. Mark McClure, Connecticut Agricultural Experiment Station, Windsor, CT, and Dr. Michael Montgomery, USDA Forest Service, Hamden, CT, are currently conducting experiments with beetle predators imported from Asia. Insecticidal soaps and horticultural oils provide effective control if branches are thoroughly soaked, including the undersides of each branch. While this form of spraying is virtually impossible in most forest applications, it can be used to protect infested hemlock hedges or individual ornamental trees.

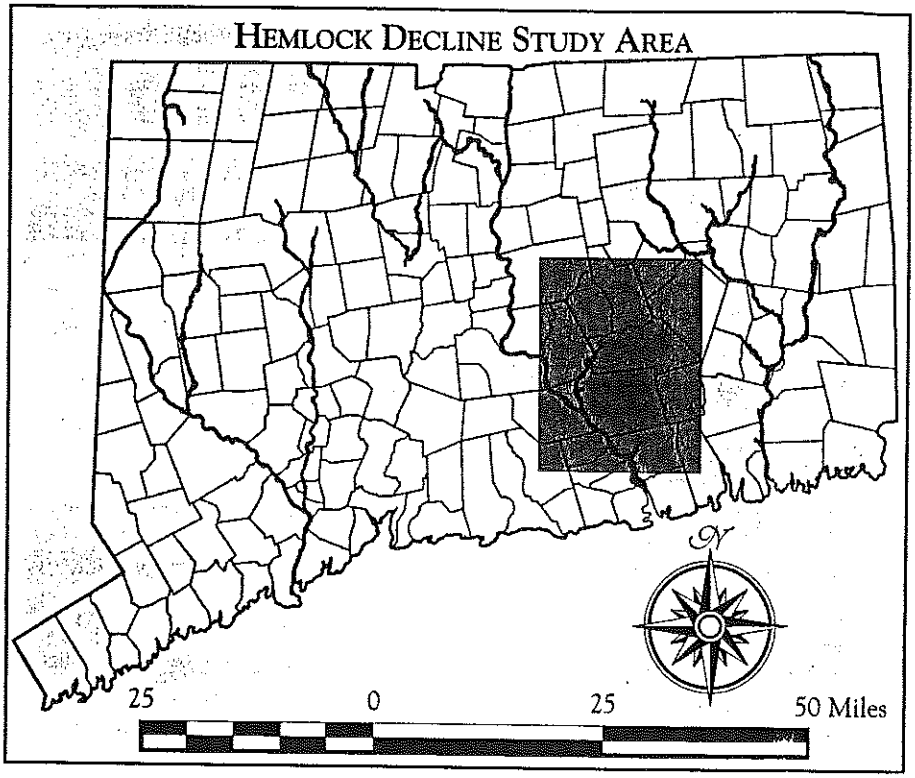
UNIVERSITY OF CONNECTICUT
COOPERATIVE EXTENSION SYSTEM
DEPARTMENT OF NATURAL RESOURCES MANAGEMENT AND ENGINEERING
• *College of Agriculture and Natural Resources* •

Trends in Hemlock Health in Connecticut: 1985 to 1995

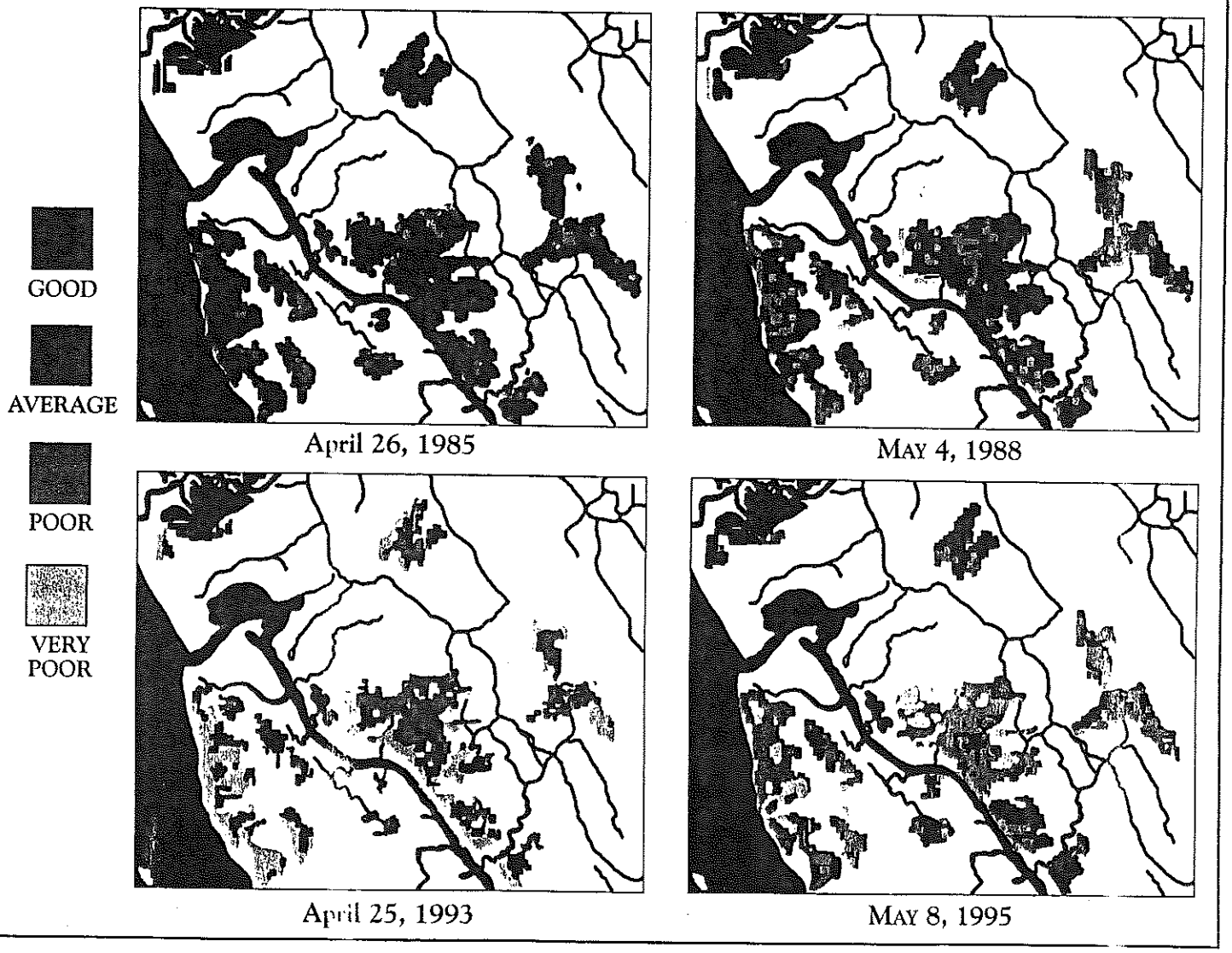
Study Methods

This study examined changes in hemlock health over an eleven-year period. The study area contained 428 square miles of the lower Connecticut River watershed in south-central Connecticut. Springtime satellite images of the study area were used to identify hemlock forests and classify their health.

Field data were then collected at 150 sites to rate hemlock health using the U.S. Forest Service Crown Condition Rating Guide. The guide classifies health by measuring the size, density, dieback, and transparency of the foliar portion or "live crown" of a tree. The field data then were used to refine the health classification of the 1995 satellite image. Once completed, this health classification technique was applied to additional satellite images of the study area from 1985, 1988, and 1993. This provided a "look back in time" at hemlock forests in the study area so trends in their health could be analyzed.



Hemlock health classification of the study site at Selden Neck Preserve and State Park



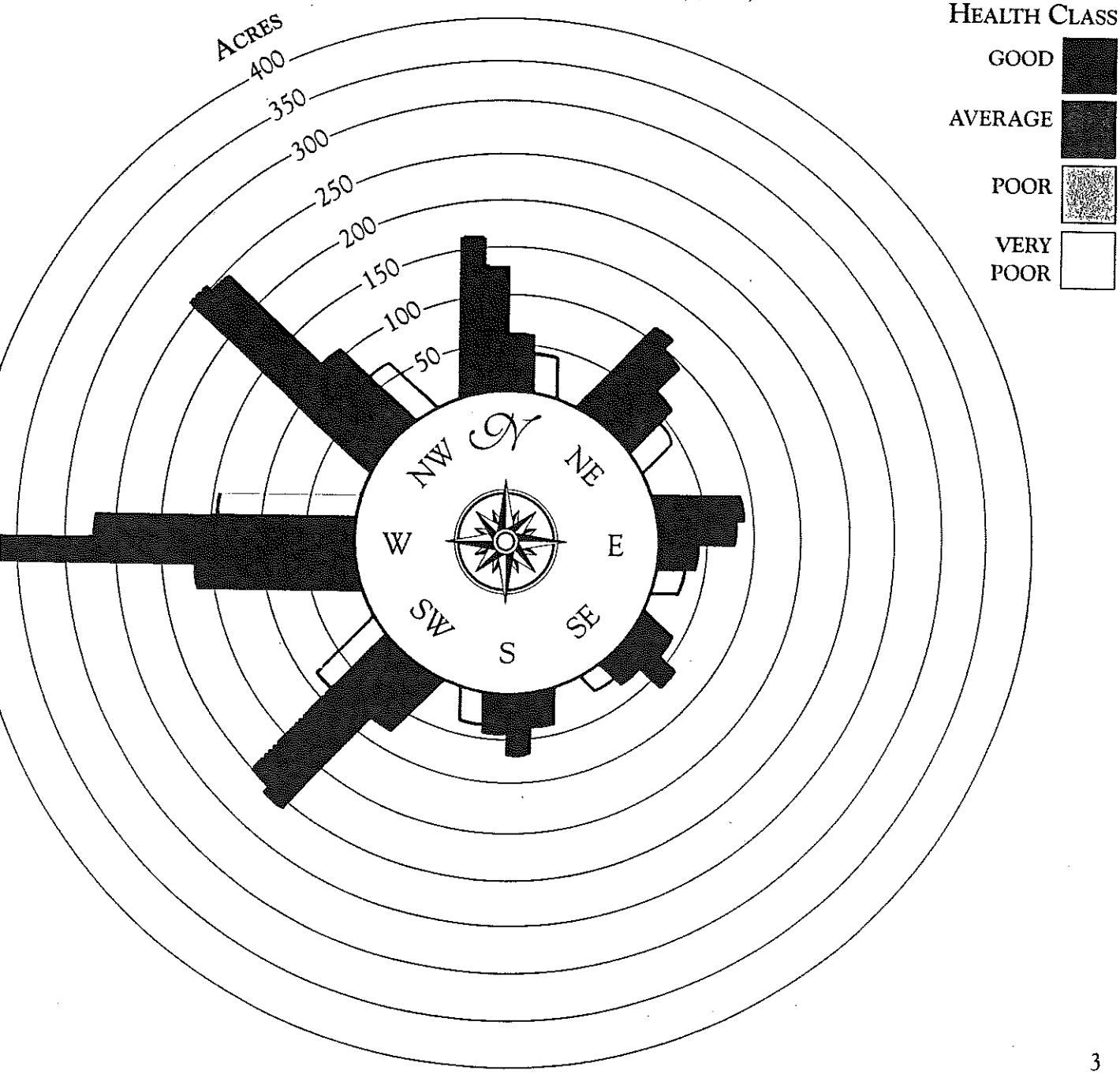
ESULTS

Overall there was a modest decline in hemlock health
m 1985 to 1995 for the entire study area. Between 1988
d 1993 hemlock health declined dramatically but was fol-
wed, in most areas, by improved hemlock health in 1995.
e characteristics apparently influenced the degree of
pact that adelgid infestation has had on hemlocks. The
mlocks along the banks of the Salmon River, for example,
re healthier in 1995 than at any time in the prior ten
rs, even though the adelgid was first observed there in the
80s and is still present in the immediate area. The health
the hemlocks at Devil's Hopyard State Park and Selden
ck Preserve has declined during this same time period.
A statistical analysis of data from the study area indicates
t both the direction a slope faces, and the position of the
mlock on a slope, affect hemlock health over time.
mlocks on northwest through east facing slopes appear to have suffered much less damage from the adelgid than hemlocks on southwest and west facing slopes. The northerly slopes are cooler and moister than slopes facing other directions, which may result in healthier hemlocks that are less susceptible to stresses caused by the adelgid.

Hemlocks located on ridge tops and upper slopes showed a greater decline in health than did hemlocks in adjacent valleys or riparian zones. Ridge top sites are generally drier and hold thinner, more acidic, and less fertile soils than sites lower down the slopes. Hemlocks on such sites, already stressed from the poorer growing conditions, may be more susceptible to damage from adelgid attack.

Hemlocks that became infested with the adelgid *in combination with other insect pests showed the greatest decline in health*. In Devil's Hopyard State Park a hemlock looper, *Lambdina fiscellaria fiscellaria* and *L. fiscellaria athasaria*, infestation coincided with the woolly adelgid attack. Many dominant and co-dominant hemlocks along the ridges died

HEMLOCK HEALTH BY ASPECT (1995)



because they were completely defoliated. In the Selden Neck Preserve, shown on page 2, most of the hemlocks were rated in poor health in 1995. The elongate hemlock scale, Fiorinia externa, was prevalent along with the woolly adelgid. While the Selden Neck hemlocks showed some improvement from 1993 to 1995, it is still uncertain whether they will survive this combined attack.

Site differences may also affect the adelgid's susceptibility to cold, which may contribute to the changes observed in hemlock health over time at some sites. During the winter of 1993-94, scientists observed relatively high mortality of adelgids that were not protected by snow cover. This may have been caused by the severe winter storms in February and March when the adelgid adult matures and begins to lay eggs. There is evidence that adelgid mortality may have been greater in valleys where late winter daily temperature remains cooler for longer periods of time. Along the Eight Mile River in Devil's Hopyard State Park, hemlocks heavily infested by adelgids in 1993 produced new growth in 1995 and 1996, and there was little evidence of reproducing populations of adelgid. On adjacent slopes, adelgids were easily found in 1995 and 1996 and new growth was limited.

Conclusions

We have found that *hemlock forests can survive prolonged infestation by the hemlock woolly adelgid*. Hemlocks in valleys and on northwest through east slopes appear to be less susceptible to adelgid damage. While such sites should be monitored regularly, pre-emptive salvage harvesting at the first sign of adelgid infestation appears to be unwarranted.

Hemlocks located on ridge tops and upper slopes are most susceptible to severe damage from adelgid and looper infestations. If adelgid nymphs or egg sacs are found on these sites, two courses of action are advisable. First, have sample branches analyzed at your local Cooperative Extension System office for hemlock looper and/or elongate scale, as the presence of either or both in conjunction with the adelgid has been shown to hasten decline symptoms. Second, consult a certified professional forester for advice on management options, including potential salvage harvesting. Infested hemlocks die at different rates and deteriorate rapidly after death. Proper timing of salvage harvests is crucial if loss of timber value is to be minimized.

The hemlock woolly adelgid has been responsible for varying degrees of hemlock defoliation throughout the Mid-Atlantic States and is now found in Southern New England. While it remains a very real threat to our hemlock forests, infestation by the adelgid is not always fatal. At some sites infestations have not increased to damaging levels, and at other sites hemlocks have shown no adverse affects from substantial adelgid infestation. At still other sites hemlocks have declined temporarily but then produced robust new growth in the following years. It is still too early to predict the long-term impact of the adelgid on the hemlock forests of Southern New England. As our knowledge increases, good forest stewardship on the part of foresters and forest landowners can help sustain this important component of our ecosystem.

The U.S. Forest Service is continuing research in this area. In cooperation with the State of Connecticut and The Nature Conservancy, research plots have been established in Devil's Hopyard State Park, Selden Creek Nature Preserve, Burnham Brook Nature Preserve, and Salmon River State Forest. Scientists are measuring several abiotic and biotic factors that may contribute to progressive decline of health of hemlocks infested by the hemlock woolly adelgid.

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Photomicrographs provided by Kathleen S. Shields, USDA Forest Service, Northeastern Center for Forest Health Research.

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DEP Service Forestry Areas

Western Connecticut	Central Connecticut	Eastern Connecticut
Larry Rousseau Western District Headquarters 230 Plymouth Road Harwinton, CT 06791 860-485-0226	*Robert Rocks* Eastern District Headquarters 209 Hebron Road Marlborough, CT 06447 860-295-9523/9524	*Sherwood R. Raymond* Goodwin State Forest 23 Potter Road North Windham, CT 06256-1616 860-455-0699

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http://www.lib.uconn.edu/canr/ces/forest

NATIONAL ARBORIST ASSOCIATION

Lightning Protection Installation Systems Standard

(Revised 1970)

SPECIFICATIONS FOR STANDARD DOWN CONDUCTORS

Copper consisting of 32 strands of 17 gauge copper wire, weighing a minimum of 187½ lbs. per thousand feet of cable, shall be used from the air terminal at top of the main trunk or branch, down the trunk of the tree to the grounding connections.

On trees with trunks up to 3 ft. in diameter, one standard down conductor and ground is required. Trees with trunks exceeding 3 ft. in diameter, with long and widespread branches, shall be provided with two standard down conductors placed on opposite sides of the trunk extending out to the ground connections.

Note! On trees with broad heads, conductors shall be extended into the highest parts of side branches in order to fully cover the spread of the crown.

The junction of ground and conductor shall be protected from contact with lawn mowers, snow blades, etc.

Sharp bends shall be avoided – not less than 90 degrees, nor shall they have a radius of the bend less than 8 inches.

SPECIFICATIONS FOR MINIATURE SECONDARY CONDUCTORS

Copper-consisting of 14 strands of 17 gauge copper cable, weighing not less than 30 lbs. per thousand feet, shall be extended from accessible heights of a minimum of three or more main branches on small trees up to a maximum of seven or eight main branches on larger trees, down to the main trunk and connection made to the standard tree conductor at this point with specially designed fittings.

ON EXTREME ENDS OF STANDARD AND MINIATURE SECONDARY CONDUCTORS

Place copper and copper bronze tree air terminals or points at desired locations and fasten them to the trees for permanency. Position of air terminal should be examined every two years for tree growth. Extension of the air terminal should be examined every two years for tree growth. Extension of the air terminals is important to the proper function of lightning protection systems. Tree points shall have a minimum length of 8 inches and be fastened near terminals of main branches by barbed copper nails, approximately 1½ long.[1]

WHEN ATTACHING STANDARD AND MINIATURE SECONDARY CONDUCTORS

They shall be fastened securely by trunk attachment at 4-ft. intervals with especially designed fasteners. These fasteners allow for slack and continued growth of the tree. They may also be spliced together using an approved type end-to-end cable splicer.

CABLES OR GUY CABLES IN TREES

Many trees, or groups of trees, are supported with metal bracing or guying cables. These cables shall be connected to the lightning protection system at, at least, one end or both ends when practicable. Bolt-type clamp connectors are designed for this purpose and should be used.

GROUNDING

Adequate and properly made low resistance groundings are important for the efficiency of the lightning protection system.

PROCEDURE FOR GROUNDING

Depends upon the character of the soil and surrounding conditions. The spread of the root system is usually equal to the spread of the branches above. The standard down conductor shall extend down the trunk and out a way from the base of the tree in a shallow trench (from 3 inches to 12 inches in depth) or in a slashed pocket-type opening made by a deep spade in which the cable is wedged down in approximately 10 inches to 12 inches and the sod tapped back into place. This conductor shall extend out beyond the main root area, terminated at the grounding connections.

In sandy soils a fork-type grounding system is preferred. The fork-type grounding system provides three lateral runs out from the base of the tree, each terminating with a grounding connection and secured by a grounding connection.[2]

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[1]Code Comment #1 – In general practice, many air terminals have been made by untwisting the top end of the conducting cable. Individuals have stated that this method is satisfactory.

[2]Code Comment #2 – When in doubt of grounding efficiency, use additional ground rods.

SPECIFICATIONS FOR GROUND CONNECTIONS

Shall be a minimum ½ inch diameter x 10-ft. length, copper-clad or copperweld ground rod.

Shall connect to the grounding connection with an approved 2-bolt type bronze ground rod and cable clamp fitting.

EXCEPTION

When it is impossible to drive depth ground rods to a distance of 10 ft. due to shale or rock and soil, two to four multiple grounds are driven as deep as possible, separated at least 6 ft. apart and interconnected with standard copper cable.

Where base is mostly rock, lay rods in rock shelf – or seams – where there is moisture and cover with soil.

CAUTION

If the lightning protection grounding system of a tree is within 25 ft. of a lightning protection system in another tree, the two systems shall be interconnected. If a lightning protection grounding system of a tree is within 25 ft. of a lightning protection system on a building or within 25 ft. of a water pipe, sprinkler system, or a deep well casing, interconnection shall be made, to provide common grounding and increase the grounding virtue.

GROUPS OF TREES

Only the major trees need be protected in order to provide ample protection for the smaller trees. If there are several trees in a row (all major trees), the grounding may be made by "common grounding" by trenching from the base of each protected tree to the driven grounding connection as long as these depth ground locations are not more than 80 ft. apart. Depth groundings shall be added as required. This avoids the practice of making independent groundings for each tree, thus reducing the cost of the lightning protection, without decreasing the grounding efficiency.

DEFINITIONS

Air Terminal – the highest point of a lightning cable.

Cable – a number of wires twisted or braided to form a conductor.

Cabling – to support or strengthen a tree structure by the use of anchoring devices and cables connecting two or more limbs within the same tree.

Conductor – the portion of a lightning protection system designed to carry the discharge from the air terminal to the ground terminal.

Branch Conductor – a conductor which branches off from the main cable such as to lateral air terminals or to bracing cables.

Down Conductor – the vertical portion of a run of conductor which ends at the ground.

Guying – to support or strengthen an established tree by cabling to another tree or trees or to an approved ground fixture. To support or strengthen a newly transplanted tree by wiring to stakes, posts or ground anchors.

Ground Rod Clamp – screw clamp to bring the ground terminal and the ground conductor into electrical continuity.

Ground Rod or Terminal – a buried rod of metal connected at the end of the ground conductor by means of a ground rod clamp to bring the lightning system into electrical continuity with the earth.

Radial Conductor – the horizontal portion of a conductor extending from the lower end of a down conductor to a ground rod.

Vertical Portion of the Down Conductor – is the main portion that goes to the ground and connects with the grounding connection.

CODE SUPPLEMENT

Recommendations

1. Trees of historical interest or of unusual value, shade trees within ten feet of a building, with branches overhanging buildings, all tall main trees in a recreational or park area, particular trees under which children might play or people congregate during a lightning storm, isolated trees on a golf course where golfers may seek shelter during a rainstorm, isolated trees within a pasture under which animals may gather during a thunderstorm, and similar trees, should be equipped with lightning protection systems set forth herein.

2. Fork-type grounding systems are also recommended when nearness of trees to buildings, concrete sidewalks, property lines, etc., make it impossible to ground out beyond the drip of the tree.

3. Copper lightning protection equipment has set a standard and has developed fixtures for its application to tree use. These materials should be used in preference to other materials available.

4. Due to the nature of movement in trees through storms, etc., lightning protection systems should be examined at the beginning of each dormant season, to see if all connections are intact and that air terminals have not been overgrown.

5. Leading authorities state that trees do not afford protection from lightning to nearby buildings. In like manner, a building equipped with a lightning protection system does not afford protection from lightning to nearby trees.

6. Lightning protection material and equipment used on tree installations shall be of standard design as manufactured by a lightning protection equipment manufacturer and approved by the Underwriters' Laboratories, Lightning Protection Institute and other leading authorities. It is understood that this association does not recommend makeshift equipment, sub-standard cables, inadequate groundings.

NATURE OF LIGHTNING

There has been, and continues to be, a great deal of disagreement on this subject. One theory holds that electricity of opposite polarity (positive and negative) is mutually attractive, and we know further that to cause a lightning discharge, the clouds and earth must be charged with electricity of opposite polarity. Experiments have shown that thunderclouds are bipolar in nature, the upper part of the cloud usually being positive, and the lower part negative. The earth normally carries a negative charge, but the overhead passage of the thundercloud usually induces a positive charge beneath it. The source of these charges is now understood to be largely due to precipitation and air currents. Each time a drop of water breaks, a separation of electricity takes place, the water receiving a positive charge, and the air currents a corresponding negative charge. A given mass of water may be broken up many times before it reaches the ground, and consequently may obtain a high positive charge.

TREES LIKELY TO BE STRUCK

Observations by various people have indicated that there is considerable difference in susceptibility to lightning attack among trees of different species and in different environments. It is thought that trees standing alone or above their fellows and trees along avenues, streams, and lakes are struck more frequently than others. Studies made abroad tend to show that Oak, Elm, Pine, Poplar, Maple, Ash, and Spruce are struck frequently—while Beech, Birch, Horsechestnut, and Holly appear to be relatively free from lightning attack. Deep-rooted trees are generally believed to be more liable to lightning injury than those with shallow wide-spreading root systems, and as a general rule decayed or rotten trees are greater sufferers from lightning than sound undecayed specimens. (This information was taken from a survey made on lightning-struck trees and observations brought forth therein.)

AVAILABILITY OF LIGHTNING PROTECTION SUPPLIES

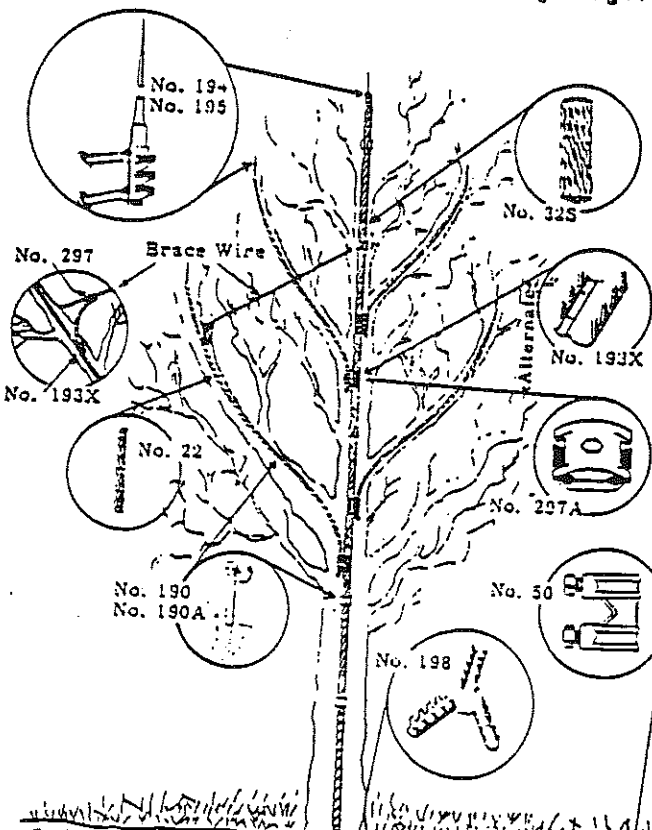
Independent Protection Company, Inc., Goshen, Indiana; Electra Protection Company, Albany, NY

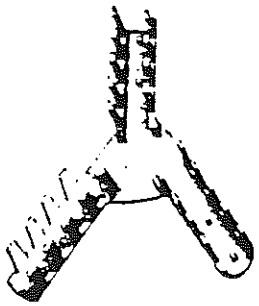
CREDITS

Robert E. Cripe
A. Winslow Dodge
Robert Thompson
National Bureau of Standards
National Fire Protection Association
(Lightning Code-Booklet #78)
National Park Service (Lightning Protection for Trees-Booklet #5)
Underwriting Laboratories, Inc. (Master Labeled Lightning Protection Systems)

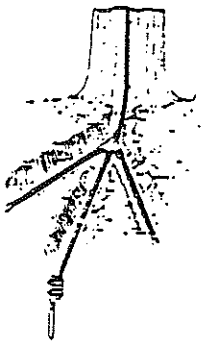
National Arborist Association
3537 Stratford Rd., Wantagh, N.Y. 11793

Modern Tree Lightning Protection Materials Available

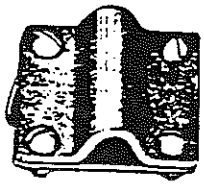




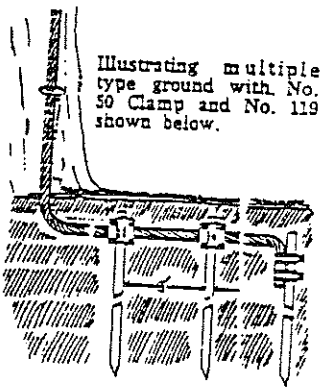
No. 198—Fork Type Ground Connector. For standard conductor



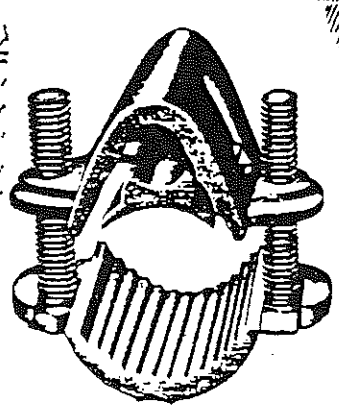
In sandy, rocky, or very dry soils, an extensive ground system may be necessary.

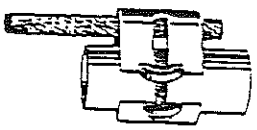


No. 119—Right angle ground rod and conductor clamp.

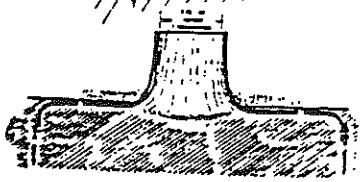


Illustrating multiple type ground with No. 50 Clamp and No. 119 shown below.





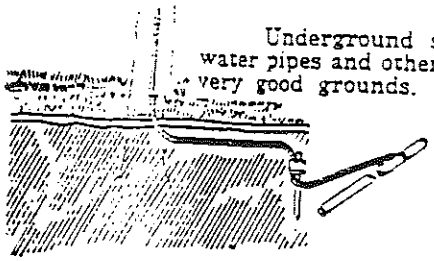
Illustrating Perfection Clamp with cable attached to pipe.



No. 306 — Perfection Water Pipe Clamp made of copper bronze. Fits 1/2", 3/4" and 1" iron water pipes, also 1/4", 1/2", 5/8", 3/4" and 1" copper water pipes and rods.

No. 306X—Large Perfection Water Pipe Clamp, made of copper bronze. Fits 1¼" and 1½" iron water pipes.

325	Standard Copper Cable
22	Miniature Copper Cable
194	Standard Tree Point for main trunk of tree
195	Miniature Tree Point for main branches
190	Standard Tree Drive Fasteners
190A	Miniature Tree Drive Fasteners
193X	Standard to Miniature Cable Fastener
297	Miniature Cable to Brace wire connector
198	Bronze Fork Type Ground cable connector
138	½" x 10" Copper clad ground rod
50	½" Bronze Ground Rod Clamp



Underground sprinkler systems, water pipes and other metal objects are very good grounds.

NATIONAL ARBORIST ASSOCIATION

Lightning Protection Installation Systems Standard

(Revised 1970)

SPECIFICATIONS FOR STANDARD DOWN CONDUCTORS

Copper consisting of 32 strands of 17 gauge copper wire, weighing a minimum of 187½ lbs. per thousand feet of cable, shall be used from the air terminal at top of the main trunk or branch, down the trunk of the tree to the grounding connections.

On trees with trunks up to 3 ft. in diameter, one standard down conductor and ground is required. Trees with trunks exceeding 3 ft. in diameter, with long and widespread branches, shall be provided with two standard down conductors placed on opposite sides of the trunk extending out to the ground connections.

Note! On trees with broad heads, conductors shall be extended into the highest parts of side branches in order to fully cover the spread of the crown.

The junction of ground and conductor shall be protected from contact with lawn mowers, snow blades, etc.

Sharp bends shall be avoided – not less than 90 degrees, nor shall they have a radius of the bend less than 8 inches.

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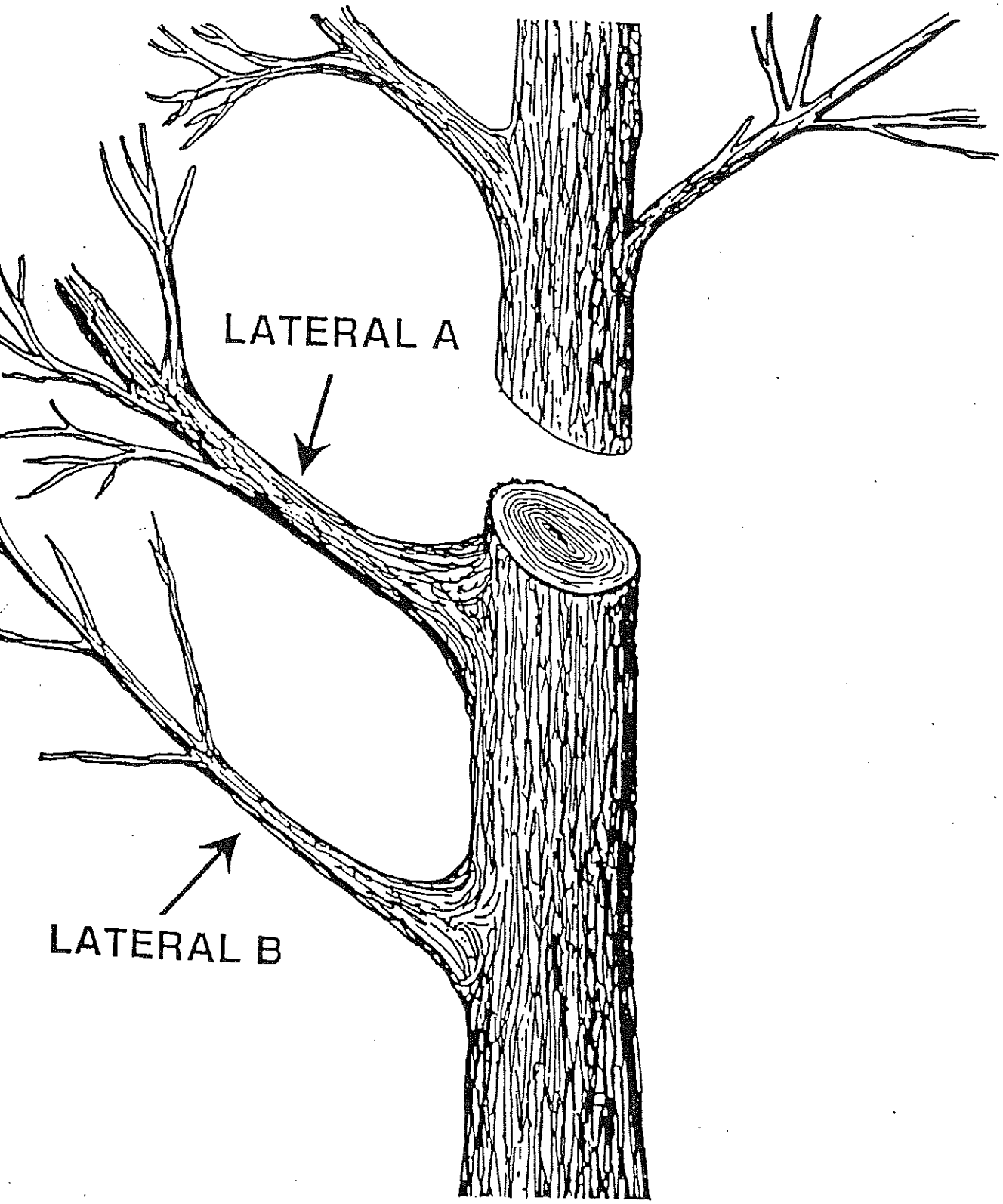

LATERAL A
LATERAL B

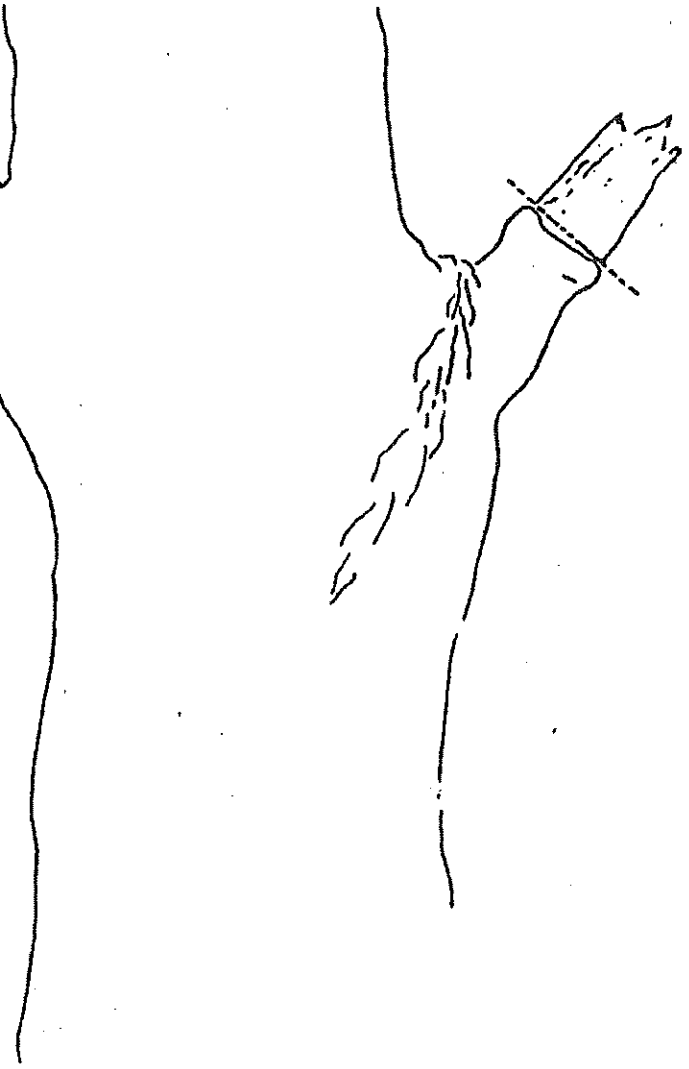
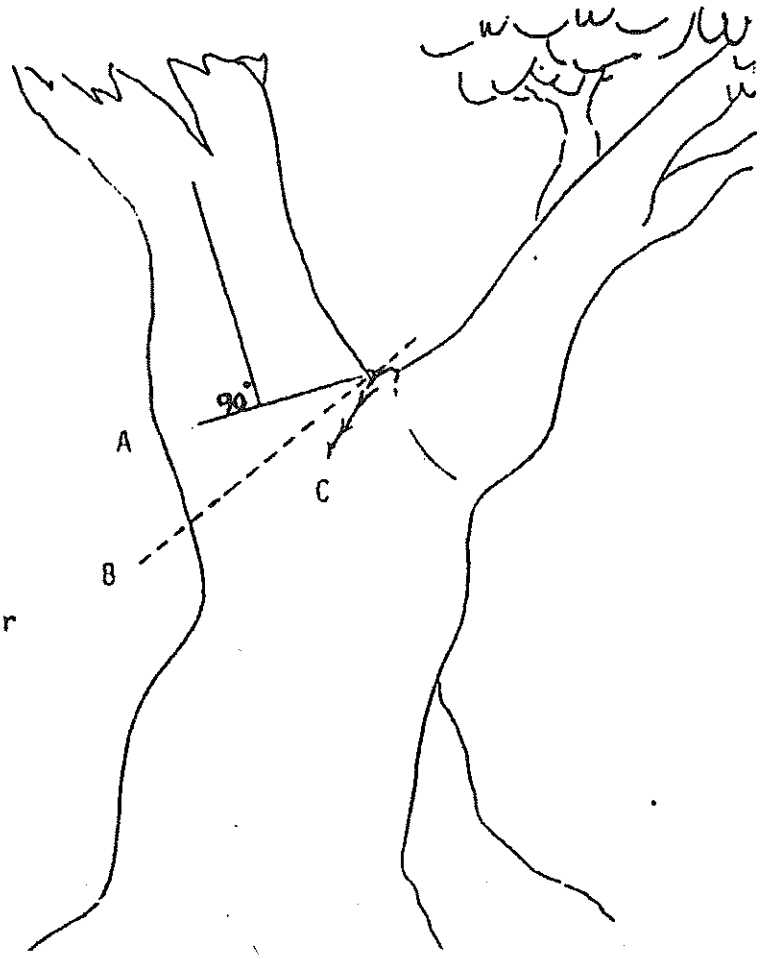


Figure 3. When removing a dead branch, cut outside the callus tissue that has begun to form around the branch.



ure 4. In removing the end of a limb to a large lateral branch, the final cut is made along a line that bisects the angle between the branch bark ridge and a line perpendicular to the limb being removed. Angle AB is equal to angle BC.

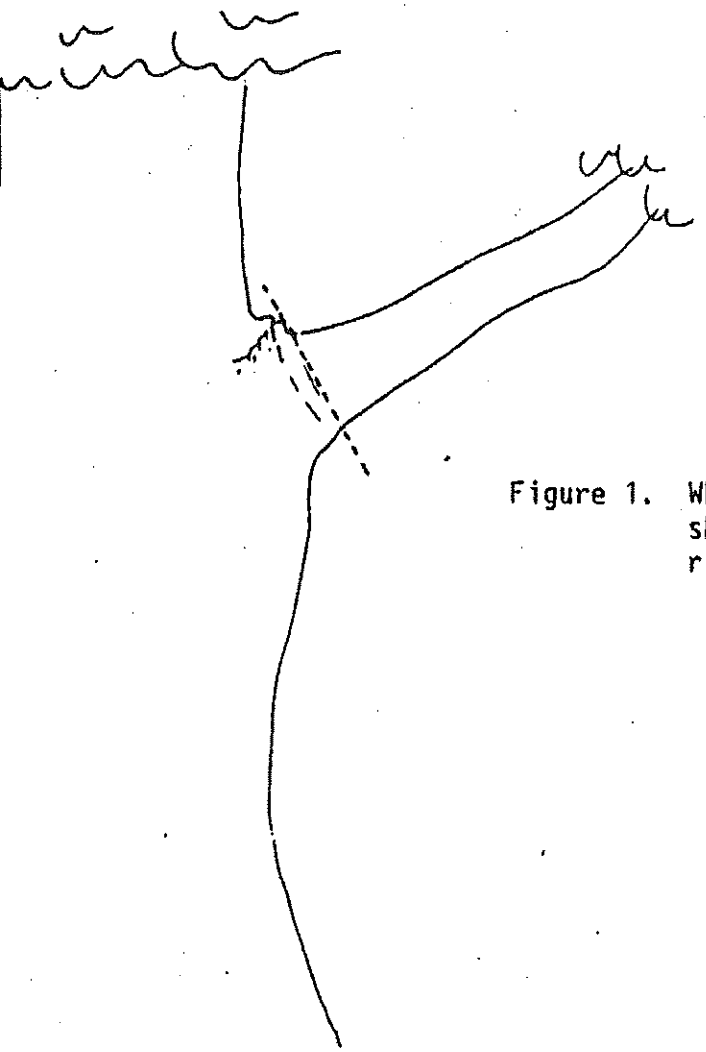
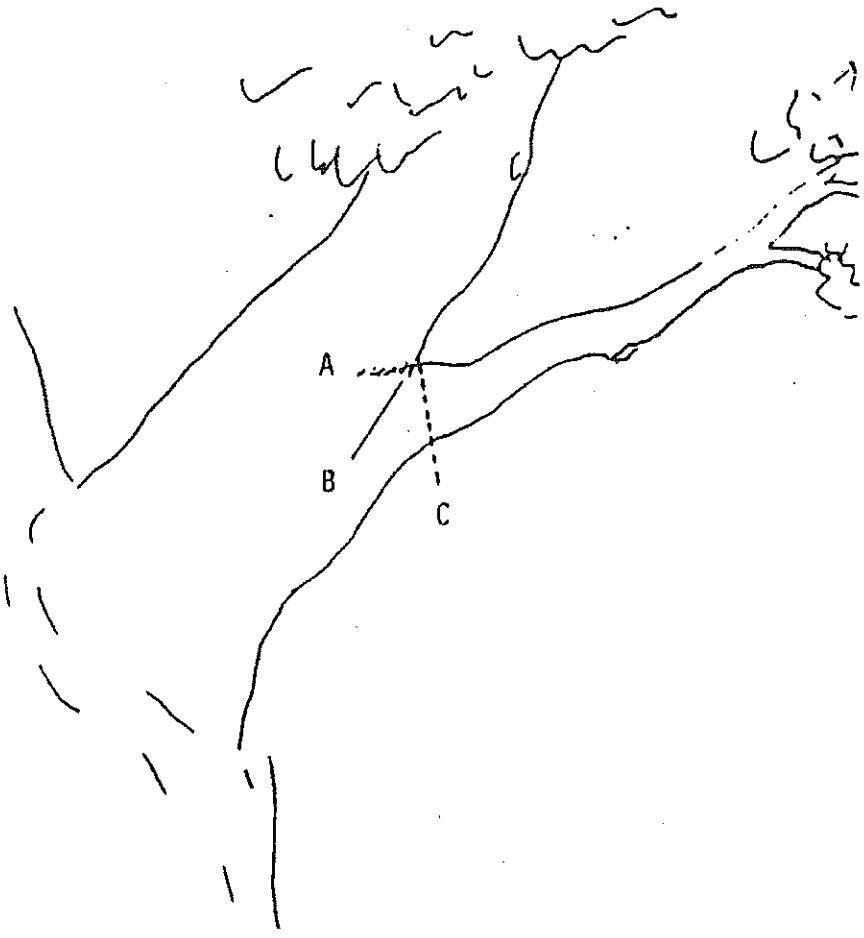


Figure 1. When removing a branch, the final cut should be just outside the branch bark ridge and collar.



re 2. In removing a limb without a branch collar, the angle of the final cut to the branch bark ridge should approximate the angle the branch bark ridge forms with the limb. Angle AB should equal angle BC