FOREST

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FOREST SECTION OUTLINE

LEARNING OBJECTIVES

I. MASSACHUSETTS ENVIROTHON FACT SHEET

II. GENERAL IDENTIFYING FEATURES OF TREES & SHRUBS

PATTERNS
LEAVES
TWIGS
BUDS
ACORNS
WINTER TREE INDENTIFICATION

III. FOREST ECOLOGY

A MASSACHUSETTS FOREST HISTORY
TRENDS IN MASSACHUSETTS FORESTS
FOREST STEWARDSHIP IN MASSACHUSETTS
FOREST ECOLOGY
FIRE AND THE FOREST
THE URBAN FOREST
FOREST SILVICULTURE AND MANAGEMENT OPTIONS

IV. MEASUREMENT

OVERVIEW
BOARD FOOT VOLUME
MEASURING INDIVIDUAL TREES

V. FOREST HEALTH

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WEATHER
ANIMAL DAMAGE
HUMAN DAMAGE

VI. FOREST LAWS & REGULATIONS

FOREST CUTTING PRACTICE (M.G.L. Ch. 132, SECTION 40-44)
FOREST TAX LAW (M.G.L. Ch.61, 61A, & 6

VII. REFERENCES & RESOURCE

LEARNING OBJECTIVES

Team members will be able to:

- Know forestry facts (state tree, forest products, forest measurements (acres, cords, MBF, percent forested)
- Apply methods of measurement including tree height, DBH, board foot volume
- Identification trees from the required tree list, during all four seasons using bark, cones, nuts, buds, leaves, leaf scars, lenticels, scent, branching pattern, etc.
- Describe the history of Massachusetts forests
- Explain forest ecology including: layers of a forest, succession, shade tolerances, fire, etc
- Describe urban forest ecology
- Describe forest silviculture and forest management options
- Discuss impacts to forest health, including identifying the various insects and diseases from the required list.
- Explain the environmental laws and rules and regulations of Massachusetts.

Test Format

Questions will reflect topics from the above outline. A resource kit will be provided containing a Peterson tree identification guide and tools for tree measurement. Students will be asked to identify up to 24 trees utilizing winter twigs, cones, acorns, bark, scent, individual leaves and also asked to identify standing trees at the site. Students will be able to identify and label various parts of a tree, and explain their functions. There will be hands on type questions on insects and diseases utilizing a dichotomous key. There will be written questions on Massachusetts forest history, current makeup, percentage forested, species composition, percentage of each species for this year, and volume figures on the various wood products and species associated with these facts. There will be hands on questions with actual on site measurement of a tree, and a few questions on the various silvicultural and management options that would be most appropriate for the site. Expect generic questions on the types of management, silvicultural applications and various state (Massachusetts) and federal laws, rules and regulation's that apply. There may be questions form other resources in this manual and how they apply to this particular site.

I. MASSACHUSETTS FORESTRY FACT SHEET

Even though Massachusetts is the sixth smallest state by area in the nation and 13th largest in population, its forests provide many amenities such as wood, clean air, clean water, wildlife and recreation. Therefore, it is in the best interest of our state to promote conservation and management of its forests.

STATE TREE:
American Elm (*Ulmus americana*)

% STATE FORESTED**:**
62% Forested (1998 USDA Survey)

FOREST PRODUCTS**:**
Maple syrup, fire wood, saw logs for lumber, veneer,
paneling, furniture, stock, landscape ties, wood pallets, flooring, wood chips, and other specialty products.

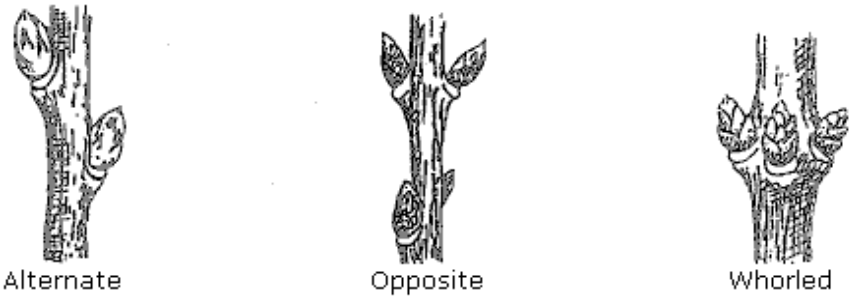
MEASUREMENTS:

1 Cord =	128 cubic feet (4' x 4' x 8')
1 Board Foot =	1 inch thick by 1 foot by 1 foot
MBF =	1 Thousand Board Feet or Roughly 2 cords
1 Acre =	43,560 square feet or 208.7 feet squared (*Roughly the size of a football field)
1 mile =	5280 feet, 1 Square mile = 640 acres
1 gallon of Maple Syrup =	40 gallons of Maple sap boiled down.

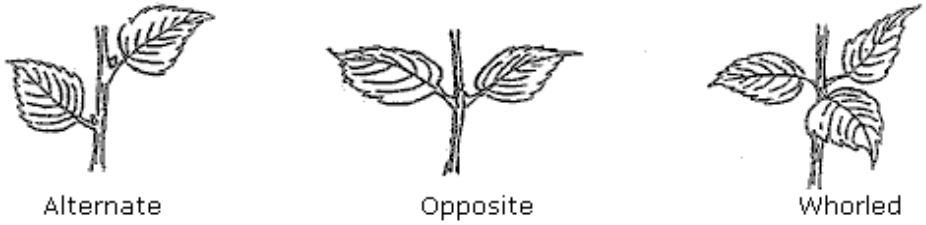
II. GENERAL IDENTIFYING FEATURES OF TREES & SHRUBS

BY PATTERNS

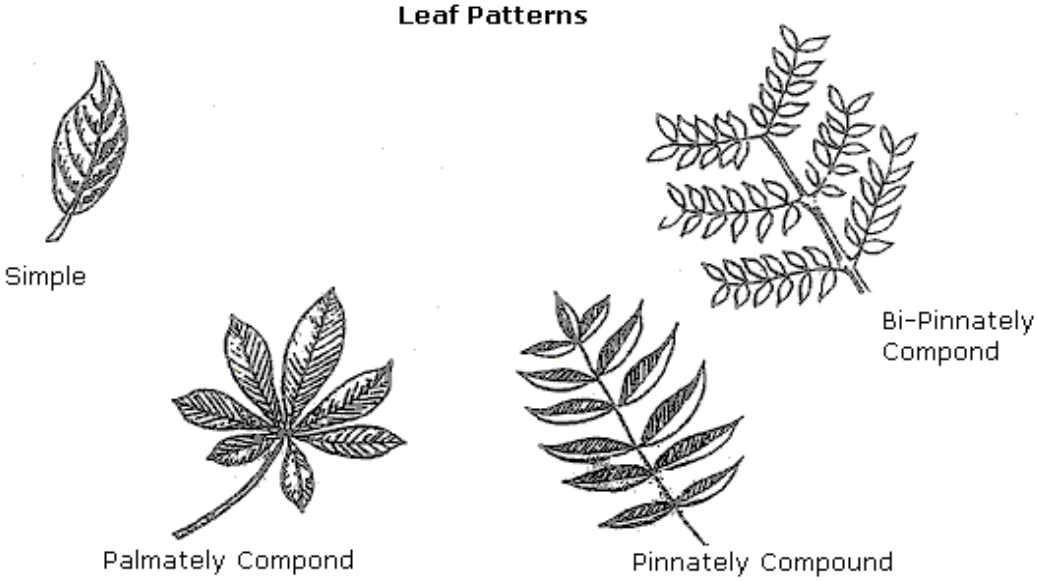
Patterns of Buds



Leaf Arangements



Leaf Patterns



BY LEAVES OR NEEDLES

American Beech

American Hornbeam

White Ash

American Sycamore

Bitternut Hickory

Black Cherry

Black Walnut

Horse Chestnut

Black Birch

Yellow Birch

Flowering Dogwood

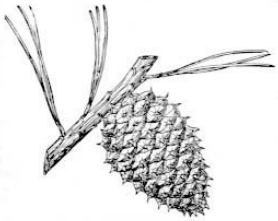
Northern Red Oak

Quaking Aspen

Red Maple

Sugar Maple

Sassafras



Pitch Pine

White Pine

Red Pine

Eastern Hemlock

Leave images from www.iloveny.com Needles images from http://uptreeid.com/Default.htm and http://www.nearctica.com/trees/conifer/index.htm

HOW TO BE A TWIG DETECTIVE

Have you explored the miracle of buds? Observing eyes quickly find them, large and small, on bushes and trees in a variety of sizes, shapes and colors.

To identify buds it is important to notice their arrangement on the twig. Are they in pairs or opposite from each other? A few trees have their buds so arranged- maple, ash, horse chestnut, and dogwood are the native eastern ones. Most buds are alternate, appearing first on one side of the twig and then on the other-elm, oak, birch etc.
,
Below the bud look for a leaf scar, left when the leaf fell off in the autumn. It differs for each kind of tree. In the leaf scar are tiny dots or bundle scars which are the ends of veins that transported food and water between the leaf and twig. These tiny dots may form a pattern, and even resemble a face in walnut and butternut.

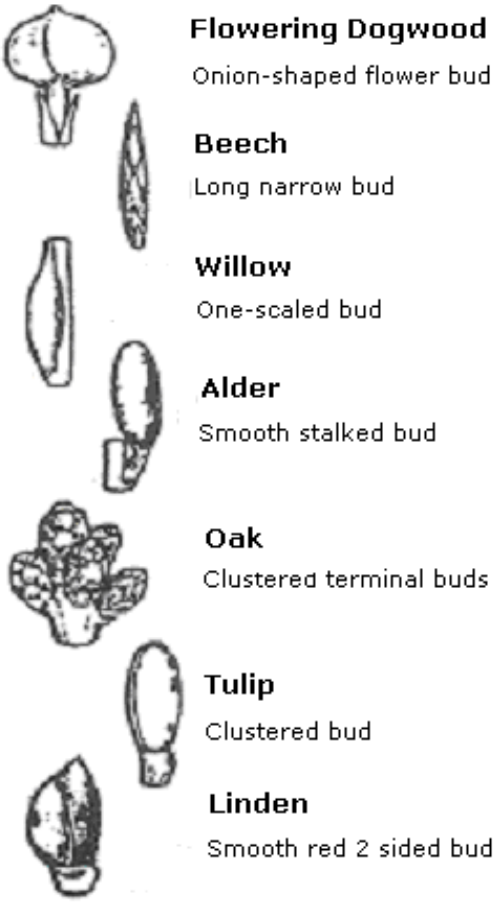
Buds are usually protected by scales. Willow is an exception and has a single, cap-like scale that covers the bud. This is easily seen in the pussy willow. Can you find the terminal bud of a twig when it has one? It is the largest bud at the very end, as in maple. Buds along the sides of the twig are called lateral buds. Usually the larger buds contain flowers, or leaves and flowers, while the small ones are leaf buds. Open a large bud and look for these things.

When the terminal bud is formed, that ends the growth for that season. Some trees do not have terminal buds. In these cases, the twig keeps growing until food supply falls off. The twig then dies back to the last lateral bud, which becomes a pseudo-(false) terminal bud with a small round scar (different from the leaf scars) at its base where the branch died back and fell off. These buds are usually set at an angle (ex linden, elm and sycamore).

Do you have little raised dots here and there along the twig? These are lenticels. The dark lines on white birch are lenticels.

A few inches from the tip of your twig you may discover several lines or rings close together. These growth rings were left when the bud scales of last year's terminal bud fell off. They show last year's growth or how much the twig grew in one year. Now look for the next ring further down. That marked the end of the twig two years ago. Starting at the tip of the twig, count the growth rings to get the age of the twig. Be a twig detective.

Some Distinctive Buds



TWIG ILLUSTRATION

HORSE CHESTNUT IN SPRING

TERMINAL BUD
Most twigs have a terminal bud or a cluster of buds. From this terminal bud will come the new growth that will lengthen the stem.

LAST YEAR'S GROWTH

LEAF SCAR
Where the stem of a leaf was attached last year.

BUD SCALE SCAR
Where the little bud scales protecting last year's terminal bud were located.

LENTICELS
These little dots are actually openings which allow the twig to take in carbon dioxide and release oxygen.

SOME CLUES FOR TWIG DETECTIVES

Massachusetts Audubon Society,
South Lincoln, Massachusetts

TREES WITH OPPOSITE BRANCHING

BUDS 1. Smooth buds; crescent-shaped leaf scars with 3 bundle scars

- SUGAR MAPLE — brown buds on brown twigs
- NORWAY MAPLE — green and red buds; keeled scales
- RED MAPLE — red buds; no fetid odor
- SILVER MAPLE — red buds, fetid odor when crushed
- BOX ELDER — buds whitish, downy; purple twigs with bloom that rubs off

2. Rough, dry buds

- THE ASHES — bundle scars forming crescent

3. Large terminal bud

- HORSE CHESTNUT — buds sticky

4. Onion-shaped flower bud

- FLOWERING DOGWOOD

5. Often 3 buds at a node

- CATALPA

TREES WITH ALTERNATE BRANCHING

BUDS 1. Single scale

- WILLOW — hood-like scale

2. Clustered terminal buds

- BLACK OAK GROUP — sharp-pointed buds
- WHITE OAK GROUP — blunt buds

3. Large end bud with loose dark outer scales

- SHAGBARK HICKORY — brownish twigs with light-colored lenticels

4. Flattened, yellowish buds

- BITTERNUT HICKORY — granular; mustard-yellow buds
- WITCH-HAZEL — tawny, stalked, naked buds

5. Long, narrow buds

- SHADBUSH — scales fringed with hairs
- BEECH — lateral buds divergent

TWIGS 1. Thick twig, thick pith

- TREE OF HEAVEN
- STAGHORN SUMAC — leaf scar almost encircles bud

2. Line encircling twig at each node

- TULIP — "duck-bill" terminal bud
- SYCAMORE — leaf scar encircles bud

3. Knob-like twigs

- GINKGO — twigs peeling in silky fibres

4. Green twigs

- SASSAFRAS — only one bundle scar

CATKINS in winter

- GRAY BIRCH — single catkin at end of twig
- WHITE BIRCH — white, peeling bark
- YELLOW BIRCH — dark, peeling bark
- SPECKLED ALDER — mahogany-colored catkins

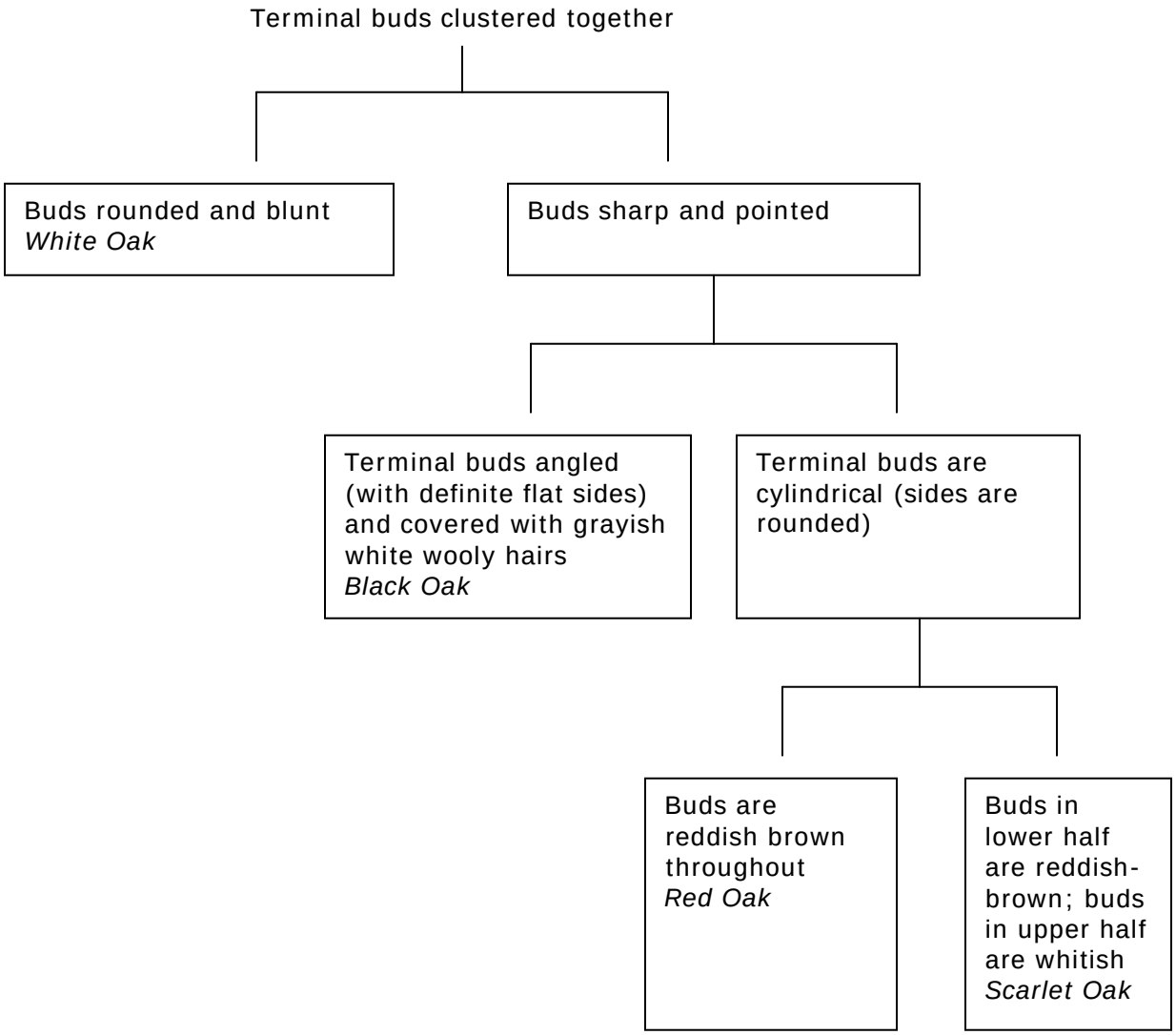
THORNS

- HONEY LOCUST — minute winter buds; zig-zag twig
- BLACK LOCUST — paired prickles; minute winter buds
- HAWTHORN — round, red buds

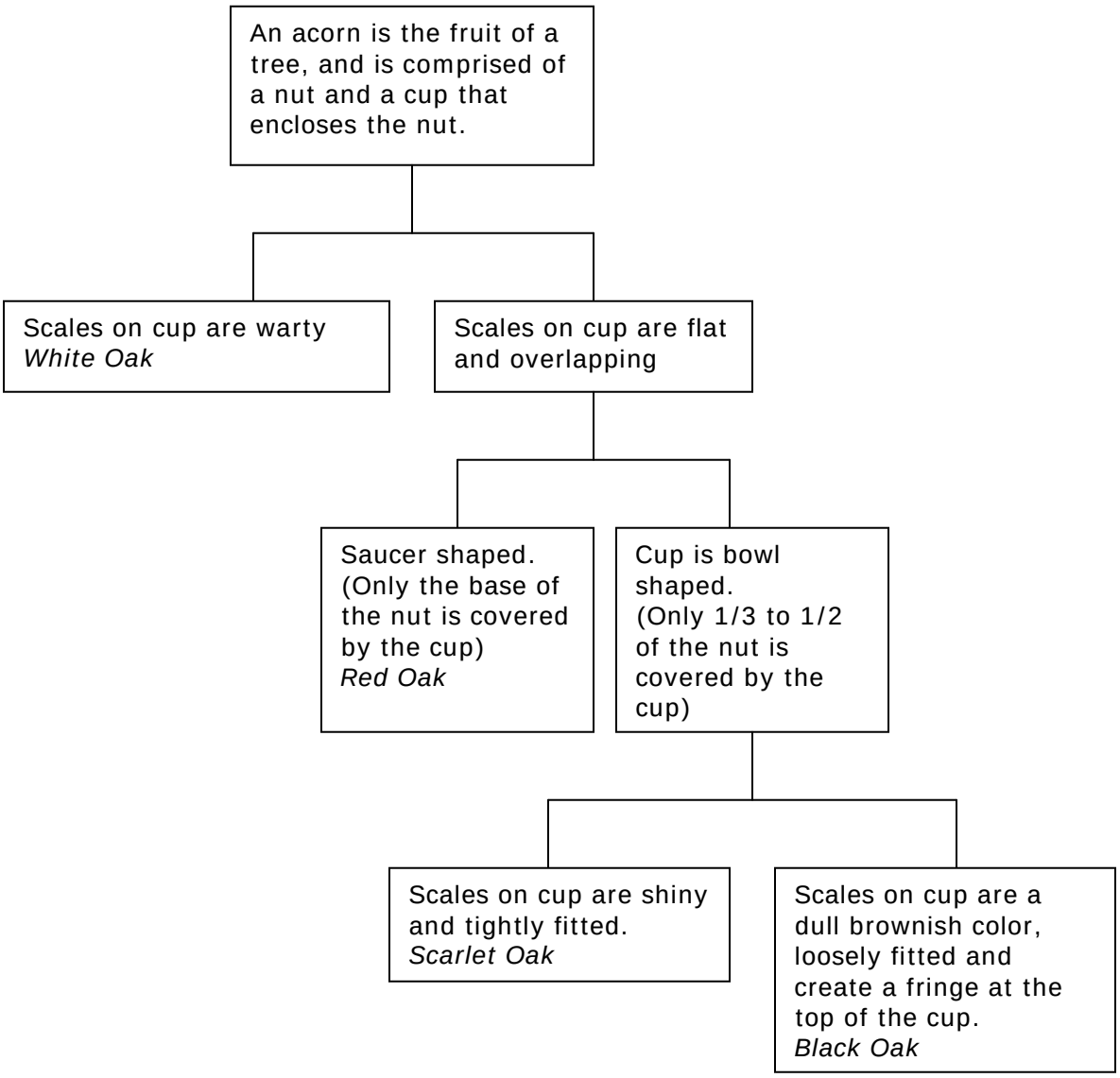
BUNDLE-SCAR U-shaped; chambered pith

- BLACK WALNUT — dull gray, with blunt terminal bud
- BUTTERNUT — yellow-brown with elongated terminal bud

Key to Oaks Using Buds



Key to Oaks Using Acorns



Students should be able to identify the following common species by learning the unique and different characteristics of each one. It is suggested you obtain a good tree identification guide to supplement the information in this section. See suggested references at the end of this unit.

1. White Pine
2. Red Pine
3. Pitch Pine
4. Eastern Hemlock
5. Balsam Fir
6. White Spruce
7. Red Oak
8. White Oak
9. Black Oak
10. Scarlet Oak
11. Pignut Hickory
12. Shagbark Hickory
13. Bitternut Hickory
14. Butternut
15. Black Walnut
16. White Ash
17. Black Cherry
18. Choke Cherry
19. Yellow Birch
20. Gray Birch
21. White Birch
22. Black Birch
23. Eastern Cottonwood
24. Quaking Aspen
25. Big Tooth Aspen
26. Horse Chestnut
27. American Elm
28. American Sycamore
29. Red Maple
30. Sugar Maple
31. Norway Maple
32. Striped Maple
33. Sassafras
34. American Beech
35. Flowering Dogwood
36. American Chestnut
37. American Basswood
38. American Holly
39. Tupelo or Black Gum

WINTER TREE IDENTIFICATION

When trees lose their leaves many people feel they also lose their identity, but a bare tree has its own stark beauty when its branching pattern and individual twigs become visible. Careful examination of its winter twigs reveals many distinguishing features about each kind of tree. The wide variety of shapes, colors, textures, and patterns are exciting to see and to learn about.

Twigs give a miniature account of the trees past, present, and future. At the tip of the twig or close to it, there should be a bud. Buds, formed the previous summer, are miniature branchlets containing next spring's leaves and flowers. These are protected by bud scales. The arrangement of which is characteristic for each tree species. Bud scales are really modified leaves serving to protect the delicate growing point within from drying out or from injury. Willows characteristically have only one bud scale, which unzips and comes off like a hood in spring. Maples have several overlapping scales while oaks have many scales arranged in five rows.

Buds at the tip of the branch are called terminal buds. They mark the end of one season growth and contain the embryonic stages of the *next* season's growth. Last year's bud scales are also evident. Look for a narrow band of markings around the twig: the distance between the new terminal bud and last year's bud scale rings show how much the twig grew in one year.

Oaks have a cluster of terminal buds. Aspens have a single terminal bud. Some trees like staghorn sumac and elms have pseudoterminal* buds. These are actually the final lateral or side buds formed on the twigs during the growing season and are thus not centered at the end, but pointed slightly to one side.

Buds on the side of the twig are called lateral buds and may contain flowers or leaves. When two sites of lateral buds occur on one twig, the larger usually contains flowers and the smaller leaves. The location of these buds in an opposite, alternate, or whorled pattern is useful in identifying specific trees. Opposite buds for example, will open to become twigs, growing opposite each other. These patterns are reflected in the branching pattern of the entire tree.

Only a few trees have opposite branching: an easy way to remember them is the acronym MADCAP HORSE. The letters stand for families: M-maple: A-ash: D-dogwood: CAP – Caprifoliacea (family including honeysuckle, elderberries, viburnums): and HORSE – horse chestnut.

Before leaves are shed each autumn, a corky layer develops across the leaf stem where it joins the twig. This is called the abscission layer; it gradually cuts off the supply of water and food. When the leaf drops off, only a scar is left behind on the twig. The shape of the leaf scar reflects the shape of the end of' the leaf petiole or stem. In most trees it is an oval, a crescent, or a triangle, but in a few trees such as sycamore and staghorn sumac it is almost circular, enclosing a lateral bud. The veins that serve to conduct food and water between the leaf and the twig also leave scars (within the leaf scars). Referred to as bundle scars they vary in numbers and patterns specific to different types of trees. In examining twigs carefully, one can find very interesting leaf scars (ex. the butternut scar resembles a monkey face, with the bundle scars forming the monkey's eyes and mouth).

Lenticels are the corky vents through which gases are exchanged between the tree tissues and the outside air. The size, color, and density of these marks vary: on white birches lenticels appear as dark horizontal lines, on cherry trees the horizontal lenticels are light colored and smaller than those of the birches, and on maple and alder twigs they are light colored dots. Color is another characteristic of different twigs. Some are red (dogwoods and striped maple), others golden yellow (weeping willows), and some vary from soft grays/browns to deep purples and bronze greens.

Twigs have one distinguishing feature that can only be seen by cutting through the twig itself. The very center, called the pith, is soft, food storage tissue. It varies in color, shape, and structure. Years ago the large central pith used to be pushed out of the twigs of some trees, such as elderberry and staghorn sumac, to make spouts for sugaring or whistles. Sometimes the odor of a bruised twig is a nose worthy feature. Spicebush, sassafras, and tulip tree twigs have an extremely spicy odor. Both black birch and yellow birch smell and taste like wintergreen. Cherry twigs have a strong bitter almond like odor and taste. Winter trees may appear as lifeless skeletons against a somber landscape, but careful examination of their twigs reveals the prophecy of spring and the history of seasons gone by.

III. FOREST ECOLOGY

To understand the forest we must know about the history of the forest; what forces have shaped it and the interactions between man, the forest, and nature.

The Massachusetts forest provides us with clean air, clean water, wildlife, food, wood products, and a variety of recreational opportunities. In order to obtain these benefits we must understand what factors influence the forest, as well as the impacts of man's activities.

Silviculture is the management of the forest to produce a desired benefit. This can be the production of wood products, clean water, wildlife, recreation, control of pests, and aesthetics.

A MASSACHUSETTS FOREST HISTORY

Before European settlers arrived in Massachusetts, natural disturbances played the dominant role in shaping the age and composition of forests. Hurricanes and other windstorms, outbreaks of disease and insects, and periodic fires caused dramatic and subtle changes to woodlands. Native Indian tribes burned the forest to stimulate growth favored by game species, cleared land around major lakes and rivers for settlements, and harvested wood for cooking fuel. Because the native population was small, the forests of Massachusetts were not greatly influenced by these practices. After Europeans arrived, the impact from human activities on the development of forests surpassed the effects from natural disturbance.

THE FIRST FOREST

European settlers found forests dominated by red oak, white pine, and hemlock. Elk, caribou, moose, mountain lion, and timber wolves roamed the woodlands. Species that prefer small trees and shrubs like deer, quail, skunk, grouse, and hare, were largely confined to settlement areas or younger forests that had been affected by natural disturbance.

For the next 200 years, forests were cut to establish farms and to harvest wood for houses, barns, forts, furniture, fuel, charcoal, and potash*. By the early 1800s, only 20% of the land in Massachusetts was forested. Elk, caribou, and mountain lion had disappeared. Hunting and trapping decimated wild turkey and beaver populations. Removal of the forest canopy encouraged small trees and shrubs and the population of wildlife favoring that habitat increased. One particularly ubiquitous legacy of this period is stone walls. Most were constructed between 1810 and 1840 as stone fences (wooden fence rails had become scarce) to enclose sheep within pastures, or to exclude them from croplands and hayfields. Clues to their purpose are found in their construction. Walls that surrounded pasture areas were comprised mostly of large stones, while walls abutting former cropland accumulated many small stones as farmers cleared rocks turned up by their plows.

During the 1800s, reports of fertile farmland to the west, the opening of the Erie Canal, the California Gold Rush, and the offer of free land to Civil War veterans were situations too tempting for the Massachusetts farmer to refuse. Many abandoned their farms and moved west.

THE SECOND FOREST

Trees with seeds capable of establishment in grassy pastures, like white pine and grey birch, began to form a forest in Massachusetts. By the early 1900s, the earliest farmland to be abandoned had grown into pine stands ready for harvest. The opening of the Panama Canal and improved railroads expanded the marketplace from New England to the rest of the nation and the world. Containers were needed to ship commercial goods, and the white pine forests of Massachusetts provided wood for the manufacture of shipping crates. The heaviest commercial exploitation of the Commonwealth's forests to date followed, in 1908, at the peak of the "boxboard boom", when the sawmills of Massachusetts produced almost 400 million board feet of lumber. Today, production is about one quarter of that figure.

After the pine was harvested, the young oaks and maples already established grew quickly to form the next forest. This was a great boon to deer, and in 1910, a century-long ban on deer hunting was lifted. Populations of black bear, wild turkey, and beaver were still in decline.

THE THIRD FOREST

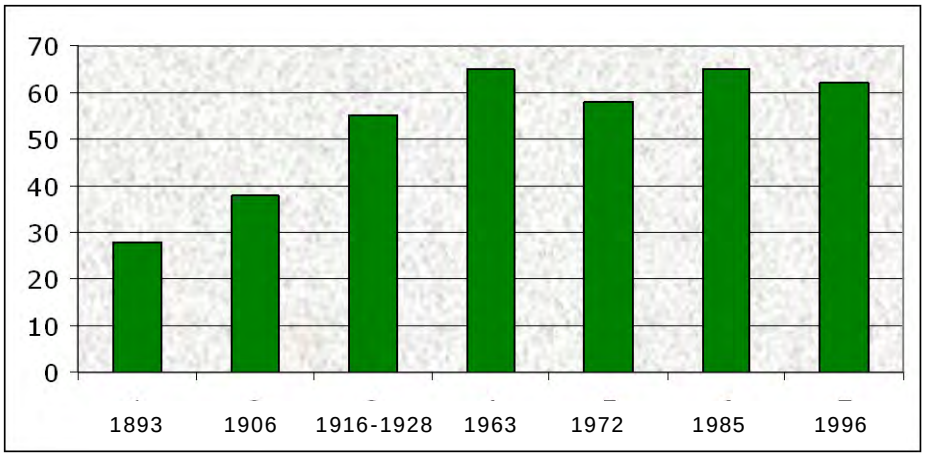
Exploitation of forests nationally and within the Commonwealth during the turn of the 20th century stimulated the conservation movement. In Massachusetts, The Trustees of Reservations and the Massachusetts Forestry Association were formed to address public concern over the fate of forest resources. These groups raised public and private funds to acquire large parcels of land including the Mt. Greylock, Middlesex Fells, and Blue Hill Reservations. In 1904, the legislature created the office of the State Forester, and by 1910 staff was in place to work on the gypsy moth epidemic, create a scientific system for forest management, and raise tree seedlings in plant nurseries. A State Forest Commission was established and in 1915, the first state forest, the Otter River State Forest in Winchendon and Templeton, was purchased.

Insects, diseases, and natural disasters changed the composition of the forest at this time. A fungus imported from England introduced the chestnut blight and within 15 years, that tree was virtually eliminated from the eastern United States. American chestnut had been one of the primary components of the Massachusetts forest, providing durable lumber and food for wildlife. Dutch Elm disease was also established in the early 1900s, and has slowly killed most American Elms, the state tree of Massachusetts. The population of gypsy moths reached epidemic proportions at this time, defoliating thousands of acres of white and red oak. The Great Hurricane of 1938 roared through Massachusetts and blew down 880 million board feet of timber, eight times the current annual harvest.

The wood products industry languished during the Depression. Mobilization for the war effort brought renewed activity for forest industries, but generally, this was a period of low exploitation. Hardwood stands that were established after the white pine was cut were not mature enough for harvest and the abundance of natural gas and oil made cordwood less popular.

After the war, many people left urban areas to move to the country. As farming became less profitable, farmers sold cropland and forests for housing development. This trend continues today as development pressures on forestland intensify.

% of Total Area in Forest Land in MA 1893-1996



FOREST STEWARDSHIP IN MASSACHUSETTS FORESTS

Massachusetts is a small state, but it contains a tremendous variety of ecosystems, plant and animal species, management challenges, and opportunities.

Biological diversity is, in part, a measure of the variety of plants and animals, the communities they form, and the ecological processes (such as water and nutrient cycling) that sustain them. With the recognition that each species has value, individually and as part of its natural community, maintaining biodiversity has become an important resource management goal.

While the biggest threat to biodiversity in Massachusetts is the loss of habitat to development, another threat is the introduction and spread of invasive, non-native plants. Non-native, invasive species like European Buckhorn, Asiatic Bittersweet, and Japanese Honeysuckle, spread quickly, crowding out or smothering native species and upsetting and dramatically altering ecosystem structure and function. Once established, invasive species are difficult to control and even harder to eradicate. Therefore, vigilance and early intervention are paramount.

Another factor influencing biodiversity in Massachusetts concerns the amount and distribution of forest growth stages. Wildlife biologists have recommended that, for optimal wildlife habitat on a landscape scale, 5-15% of the forest should be in the seedling stage (less than 1” in diameter). Yet we currently have no more than 2-3% early successional stage seedling forest across the state. There is also a shortage of forest with large diameter trees (greater than 20”).

Rare species* include those that are threatened (abundant in parts of its range but declining in total numbers), those of special concern (any species that has suffered a decline that could threaten the species if left unchecked), and endangered (at immediate risk of extinction and probably cannot survive without direct human intervention). Some species are threatened or endangered globally, while others are common globally but rare in Massachusetts.

Of the 2,040 plant and animal species (not including insects), in Massachusetts, 424 are considered rare. About 100 of these rare species are known to occur in woodlands. Most of these are found in wooded wetlands, especially vernal pools. These temporary shallow pools dry up by late summer, but provide crucial breeding habitat for rare salamanders and a host of other unusual forest dwelling invertebrates. Although many species in Massachusetts are adapted to and thrive in recently disturbed forests, rare species are often very sensitive to any changes in their habitat.

Indispensable to rare species protection is a set of maps maintained by the Division of Fisheries and Wildlife's Natural Heritage & Endangered Species Program (NHESP) that show current and historic locations of rare species and their habitats. The maps of your property will be compared to these rare species maps and the result indicated on the upper right corner of the front page of the plan. Prior to any regulated timber harvest, if an occurrence does show on the map, the NHESP will recommend protective measures. Possible measures include restricting logging operations to frozen periods of the year, or keeping logging equipment out of sensitive areas. You might also use information from NHESP to consider implementing management activities to improve the habitat for these species.

In order to protect wetlands and riparian areas and to prevent soil erosion during timber harvesting activities, Massachusetts promotes the use of "Best Management Practices" or BMPs. Maintaining or reestablishing the protective vegetative layer and protecting critical areas are the two rules that underlie these common sense measures. Department of Conservation & Recreation (DCR) details both the legally required and voluntary specifications for log lands, skid trails, water bars, buffer strips, filter strips, harvest timing, and much more.

The two Massachusetts laws that regulate timber harvesting in and around wetlands and riparian areas are the Massachusetts Wetlands protection Act (CH 131), and the Forest Cutting Practices Act (CH 132). Among other things, CH 132 requires the filing of a cutting plan and on-site inspection of a harvest operation by a DCR Service Forester to ensure that required BMPs are being followed when a commercial harvest exceeds 25,000 board feet or 50 cords (or combination thereof).

Soil and Water Quality: Forests provide a very effective natural buffer that holds soil in place and protects the purity of our water. The trees, under story vegetation, and the organic material on the forest floor reduce the impact of falling rain, and help to insure that soil will not be carried into our streams and waterways.

To maintain a supply of clean water, forests must be kept as healthy as possible. Forests with a diverse mixture of vigorous trees of different ages and species can better cope with periodic and unpredictable stress such as insect attacks or windstorms.

Timber harvesting must be conducted with the utmost care to ensure that erosion is minimized and that sediment does not enter streams or wetlands. Sediment causes turbidity which degrades water quality and can harm fish and other aquatic life. As long as Best Management Practices (BMPs) are implemented correctly, it is possible to undertake active forest management without harming water quality.

Forest Health: Like individual organisms, forests vary in their overall health. The health of a forest is affected by many factors including weather, soil, insects, diseases, air quality, and human activity. Forest owners do not usually focus on the health of a single tree, but are concerned about catastrophic events such as insect or disease outbreaks that affect so many individual trees that the whole forest community is impacted.

Like our own health, it is easier to prevent forest health problems than to cure them. This preventative approach usually involves two steps. First, it is desirable to maintain or encourage a wide diversity of tree species and age classes within the forest. This diversity makes a forest less susceptible to a single devastating health threat. Second, by thinning out weaker and less desirable trees, well-spaced healthy

individual trees are assured enough water and light to thrive. These two steps will result in a forest of vigorously growing trees that is more resistant to environmental stress.

Fire: Most forests in Massachusetts are relatively resistant to catastrophic fire. Historically, Native Americans commonly burned certain forests to improve hunting grounds. In modern times, fires most often result from careless human actions. The risk of an unintentional and damaging fire in your woods could increase as a result of logging activity if the slash (tree tops, branches, and debris) is not treated correctly.

Adherence to the Massachusetts slash law minimizes this risk. Under the law, slash is to be removed from buffer areas near roads, boundaries, and critical areas and lopped close to the ground to speed decay. Well-maintained woods roads are always desirable to provide access should a fire occur.

Depending on the type of fire and the goals of the landowner, fire can also be considered as a management tool to favor certain species of plants and animals. Today the use of prescribed burning is largely restricted to the coast and islands, where it is used to maintain unique natural communities such as sandplain grassland and pitch pine/scrub oak barrens. However, state land managers are also attempting to bring fire back to many of the fire-adapted communities found elsewhere around the state. Fire management is discussed in greater detail in the Fire and Forest chapter.

Wildlife Management: Enhancing the wildlife potential of a forested property is a common and important goal for many woodland owners. Sometimes actions can be taken to benefit a particular species of interest (e.g. put up Wood Duck nest boxes). In most cases, recommended management practices can benefit many species, and fall into one of three broad strategies. These are managing for diversity, protecting existing habitat, and enhancing existing habitat. Your woodland is important because it contributes to the surrounding landscape and has the potential to increase diversity and protect or enhance wildlife habitat. Wildlife management is discussed in greater detail in the wildlife section of this manual.

Wood Products: If managed wisely, forests can produce a periodic flow of wood products on a sustained basis. Stewardship encompasses finding ways to meet your current needs while protecting the forest's ecological integrity. In this way, you can harvest timber and generate income without compromising the opportunities of future generations.

Massachusetts forests grow many highly valued species (white pine, red oak, sugar maple, white ash, and black cherry) whose lumber is sold throughout the world. Other lower valued species (hemlock, birch, beech, red maple) are marketed locally or regionally, and become products like pallets, pulpwood, firewood, and lumber. These products and their associated value-added industries contribute significantly to the Massachusetts economy.

By growing and selling wood products in a responsible way you are helping our society's demand for these goods. Harvesting from sustainably managed woodlands – rather than from unmanaged or poorly managed forest – benefits the public. The sale of wood provides income that you can reinvest in the property, increasing its value. Producing wood products helps defray the costs of owning woodland, and helps private landowners keep their forestland undeveloped.

Cultural Resources: Cultural resources are the places containing evidence of people who once lived in the area. Whether a Native American village from 1,700 years ago, or the remains of a farmstead from the 1800's, these features all tell important and interesting stories about the landscape, and should be protected from damage or loss.

Recreation and Aesthetic Considerations - Recreational opportunities and aesthetic quality are the most important values for many forest landowners, and represent valid goals in and of themselves. Removing interfering vegetation can open a vista or highlight a beautiful tree, for example. When a landowner's goals include timber, thoughtful forest management can be used to accomplish silvicultural objectives while also reaching recreational and/or aesthetic objectives. For example, logging trails might be designed to provide a network of cross-country ski trails that lead through a variety of habitats and reveal points of interest.

FOREST ECOLOGY

FOREST LAYERS

The forest plants form several layers. The overstory or topmost level is made up of the large dominant tree species. These species usually grow best when they are in full sun. The understory or second level down is shaded by the overstory. This level may be made up of smaller overstory tree species and shade-tolerant (can grow well under low light conditions) species such as dogwood or hornbeam. The shrub layer is made up of woody shrubs such as gooseberry and highbush cranberry. The herbaceous layer is the most diverse and contains mostly non-woody species. Grasses, sedges, and wildflowers all grow in the herbaceous layer. Vines, such as Virginia creeper and poison ivy, climb from this layer to the overstory to reach the sunlight. The ground layer or forest floor holds the soil builders and stabilizers: the fungi, mosses, liverworts, and lichens.

FOREST SUCCESSION

Succession in a plant community can be defined as a process of changes in the species composition of the community over time. Succession usually begins after some type of disturbance occurs and creates open ground. This disturbance could be caused by natural events such as a fire, flood, storm, or glacier. Humans cause disturbances by clearing land for agriculture or urban development. If disturbed areas are left to re-vegetate on their own, pioneer species appear first. These species have colonizing characteristics such as rapid growth, abundant seed production, and seeds that are easily dispersed. Pioneer species are not well adapted to sites where root competition and shading may hinder their growth.

The pioneer species may give way to shrubby vegetation, after having added organic matter to the soil and stabilizing the site. Shade intolerant tree species, which do not grow well under low light conditions, may grow with shrubby vegetation. Under the shrubs, elm, ash, and juniper seedlings (more shade tolerant tree species) begin to appear. Their seeds are kept moist and protected by the leaf litter layer produced by the shrubs and sun loving trees.

Then oaks, hickories, and other hardwoods begin to appear. These trees are semi-shade tolerant as they can grow in low light, but do better in full sun. Sugar maples and basswoods which are shade tolerant can reproduce under their own shade. Both

groupings are considered mature forest species or a climax community. In the shade of these mature trees, the shrub layer becomes less dense and the herbaceous layer develops. Mature forest species are usually long-lived, produce seeds that are not easily dispersed, but provide extra energy for seedlings growing under an established canopy.

Many factors influence what type of stable plant community (climax community) develops on a certain site. The soil type, climate, and animals in the area all influence the vegetation. It takes hundreds of years for a climax community to develop. A climax community experiences slight fluctuations in species composition throughout time. The health of the system can be affected by changes in just one of these working forest pieces.

FIRE AND THE FOREST

Since time began, fire has been part of the Earth's natural cycle. Periodic lightning fires and volcanic activity caused disturbances that effected plant evolution and natural selection. Over time, plants adapted to periodic fires, developing various mechanisms that enabled them to survive and reproduce in a fire-prone environment. As a result, some types of forests, as well as other natural ecosystems (grasslands, deserts, and so forth) have developed because of fire and depend on fire as part of their life cycles. The importance of fire and its life-sustaining properties were not lost on early inhabitants. The earliest signs of human use of fire may date back as far as 1.5 million years to South Africa, where fire was probably used for warmth, for light, and for frightening away predators. Considered one of the four basic elements, fire (along with wind, earth, and water) was revered by ancient races.

From an ecological standpoint, fire is an integral part of the life cycle of many forests. Fire clears dead and dying trees and understory litter, opening up the forest floor for new growth. In addition, fire aids in recycling nutrients as its mineral-rich ash (containing potassium, phosphorus, and calcium) is deposited across the forest floor. Ash nourishes the soil and provides an ideal environment for germination of many seeds and regeneration of post-pioneer-fire plants, such as fire-weed and fire cherry. Fire supports the process of natural selection, improving growth opportunities for stronger, healthier trees by thinning small trees and removing weak

and insect or disease-ridden trees. Fire is considered a primary agent in preparing seedbeds for many forest species. Certain species of conifers that produce closed, or serotinous, cones rely on heat from fire to open the cones and release seeds. The fire-opened cones help reseed the area following a fire.

Fires begin either through natural causes such as lightning strikes or through accidental or intentional human activities. Nationally, 9 out of 10 (90 percent) fires are caused intentionally or by human carelessness.

Cedars-Sinai Website

THE FIRE TRIANGLE

Fires need heat, fuel, and oxygen to burn. These three components are known as the "fire triangle." Cut off any one and the fire will not burn.

HEAT

The initial heat, or ignition, is provided by the ignition source, whether human or natural. A lightning bolt can easily generate temperatures in excess of 20,000 degrees Fahrenheit (11,093 degrees Celsius). This temperature provides sufficient heat to literally vaporize a tree's fluids, causing the tree to burn as superheated gases expand.

The East has fewer fires set by lightning than the West because eastern lightning storms are usually accompanied by rain, whereas many of the storms in the West produce only dry lightning. Although lightning-caused fires are less frequent in the East than in the West, the highest incidences of wildfires in the country are in the Southeast primarily because of higher population density and higher incidences of people-caused fires.

In the southeastern United States, the months of March, April and May are called the "fire season." when 75 percent of forest fires occur. Fire season in the West usually

runs from June through October, during the very dry months of the year. In the Northeast, it is March through May and then again in the fall, corresponding to the leaf drop. Wildfires do not generally occur when the fuels (trees, shrubs, and grasses) are wet and cold. By far the most common sources of ignition heat for a forest fire result from human activity such as setting fires (arson), failing to put out campfires, using matches improperly, burning debris, and using construction and logging equipment within or adjacent to flammable forest fuels.

FUEL

Natural fuels include dry or dead trees and limbs, leaf litter and dry grass. Introduced fuels include human-made structures, such as cabins, barns, fences, and exposed sources of petroleum (leaking gas or oil tanks, abandoned automobiles).

OXYGEN

Oxygen is available in the air. When windy conditions prevail, the supply of oxygen available to a fire is replenished more quickly than in still air because a greater volume of air flows over the fire. The rising column of hot air generated by a fire draws in cooler, oxygen-rich air from the surrounding air mass, creating a fire-driven wind that helps a fire sustain itself as long as fuel is available.

Weather has a great influence on when fires occur and how they spread. Hot temperatures and dry winds can dry out trees and grasses in a forest, making them available as fuel for a fire to consume. The stronger the winds, the more quickly moisture evaporates from the vegetation, and the faster the fire can spread.

BENEFITS OF FOREST FIRE

Despite the apparent devastation that follows a forest fire, the natural order of forest succession could not progress without fires. Even in the largest fires, not everything burns. A forest fire usually creates an ecologically healthy mosaic of burned and unburned trees. Where there is a large accumulation of deadfall and dry litter restraining new growth, fire can clear a space for seeds and sprouts to thrive. Certain coniferous trees, which depend on extreme heat to open their cones, literally spread new life in a fire's aftermath. Depending on its intensity, a fire can recharge mineral-poor soil. In addition, because recently burned forests contain very little deadfall and litter, they are less likely to burn again soon. Fire is a necessary

component of forest longevity because it promotes a healthy forest consisting of trees of mixed ages, which reflect a self-sustaining cycle of life and death.

DRAWBACKS OF FIRE

For all their benefits to the ecosystem, wildfires do pose a threat to communities, individuals, and forests if the fire is catastrophic. Catastrophic fires usually occur in areas where fire has been excluded for many years, causing a large build up of fuel. Preventing, controlling, and suppressing wildfires is becoming more vital all the time as more people seek woodland settings for their homes and recreation. As the number of people looking to "get back to nature" grows steadily each year, more and more homes, property, and lives are endangered by fire along the wildland-urban interface (woodland, natural areas between country and city). This trend has placed an enormous burden on land management agencies and their ability to fight fires.

The effects of forest fires on air quality is of growing national concern. The smoke pollution associated with fires raises many concerns about effects on air quality and human health. Smoke is a public health problem that concerns both air quality regulators and citizens.

Today, fire has become a useful tool to help state and federal agencies manage their wildlands, which include forest, grasslands, and other ecosystems. Over the years, fire management policies and techniques have changed. A prescribed burn (one that is ignited and managed by trained personnel with predetermined fuel and weather conditions) can prepare a logged area for reforestation, enhance wildlife habitat, protect native plant species, control insect populations or disease, or reduce fire hazard by reducing burnable fuels.

Most agencies emphasize fire prevention through public awareness of fire safety and through clearing vegetation around homes and businesses near the wildland-urban interface. Some agencies will allow naturally started fires to burn if, and only if, they correspond with identified prescriptions for fuel and weather. However, when such a fire is no longer in prescription or threatens life or property, fire suppression begins. Suppressing unwanted wildfires is expensive, but often necessary.

In areas where fire is suppressed, the build-up of fuel may be controlled by harvesting trees to keep the forest healthy. Fire managers are employed to observe, monitor, and record fuel and weather conditions that may increase the likelihood of a forest fire. Firefighters are often stationed with firefighting equipment in areas with high fire danger. The issue of when, where, how, or whether to control forest fires through preventive strategies, methods of suppression, or prescribed burns has been the subject of debate at the local, state and national level for many years.

THE URBAN FOREST

MANAGING THE URBAN FOREST

Urban forestry contrasts starkly with traditional forest management for the production of timber and wood products. Though a basic understanding of tree biology and cultivation is necessary to ensure the health of urban trees, the factors involved in maintaining and expanding the urban forest are more diverse than these concerns. While forestry practice remains an element of urban forestry, other professional disciplines including sociology and community administration play roles.

The urban forest, as one element of the community infrastructure, must be designed and managed according to the needs of the urban residents. The functioning of a healthy urban forest and that of a well-run human society are synergetic; all living elements of the community share the benefits.

Caring for community trees began as a grassroots effort. Community members are the most reliable motivating forces for implementing successful urban forestry programs; citizens' involvement will ensure the continued existence of this important resource in overall management programs that fit community needs and interests.

The success of urban forestry programs is based in effective local activities that depend on a coalition of efforts involving professionals, agencies and volunteers. With expansion in urban forests will come even greater improvements in the health of the urban environment and in the quality of life for all urban and community residents. The term “urban forest trees” refers to trees in residential areas, parks, common areas and along streets. Street trees have an average life span of only 7 years.

THE EARLIEST EFFORTS

The urban and community forestry tradition may have begun as early as 1646, when a planting of public shade trees was completed along the highway between Boston and Roxbury, Massachusetts. Another forest visionary was William Penn, who in 1680, required that for each four acres of land cleared one acre should remain forested in Pennslyvania.

In 1791 Major Pierre L'Enfant, borrowing ideas from French landscape design, laid out the streets of Washington. D.C. with trees as major design elements. An 1807 Act of Territory in Michigan stated that Detroit should have tree-lined avenues and town squares ornamented with city trees. Similarly, Frederick Law Olmsted's design for New York's Central Park in the 1850s emphasized the importance of open space in cities. Olmsted's purpose was to give city workers a chance to experience the beauty and serenity of trees – a privilege only those with greater means could experience in the remote forests of the Adirondacks or the White Mountains. By pursuing this goal, Olmsted demonstrated a clear social concern, offering trees as antidotes to the crowded, dispiriting conditions of urban life.

Arbor Day was created in 1872, to celebrate and, commemorate the contributions of trees to the urban environment and the benefits of proper community tree maintenance. Urban forestry had its formal beginning in the United States. In the late 1800s several states, (Massachusetts, Pennsylvania, New Jersey, and New York) passed enabling legislation allowing local governmental bodies to spend public funds on the planting and maintenance of shade trees.

THE URBAN AND COMMUNITY FORESTRY RESOURCE

The Society of American Foresters at one time defined urban forestry as the cultivation and management of trees for their contribution to the physiological, sociological, and economic well being of the urban society. Other definitions include community forestry as the application of forest management principles to the ecology of densely populated human environments.

One could accurately describe the urban forest as "trees in trouble." The trees that are in trouble now are not those in remote areas; imperiled trees stand outside our windows and line our streets. The urban forest consists of the trees in and around

the places we live: cities, suburbs, and rural communities. For the purposes of federal funding through urban and community forestry programs, the definition of community forests includes all tree resources associated with population centers of 100 or more people (of which there are more than 40,000 in the United States).

Some say that when European settlers first encountered North America, a squirrel could travel from the Atlantic Coast to the Mississippi River without ever touching ground. By the late 1800s, however, the state of Connecticut had no timber of commercial value left standing. While the enactment of legislation in several northeastern states to enable use of public funds in planting and maintenance of shade trees has marked a fortunate acknowledgment of the importance of community trees, the devastation of native forests remains a sad commentary on the place our natural environment holds in our value system.

FEDERAL LEGISLATION FOR URBAN FOREST MANAGEMENT

Early in the nation's history, tree care and concern for the urban forest were very much a part of the urban managers and dweller's philosophy. Two modern developments have helped reverse that attitude: first, the automobile enabled city dwellers to escape to the rural environment; and second the advent of air conditioning reduced the discomfort of urban summers. The shading and cooling benefits of the urban canopy were then less appreciated. Urban forestry came to be considered politically valueless, and trees were often seen only as liabilities. Even today forestry fails to win public support at budget allocation time.

In 1990, Congress appropriated $2.7 million for use by the Forest Service in managing urban and community forestry programs nationwide. Then, in conjunction with new authorities given to the Forest Service in the 199O Farm Bill to work with states in developing and implementing urban and community forestry programs, Congress raised the appropriation for urban and community forestry nearly ten-fold, to $21 million in 1991.

These funds have helped to create a urban forestry coordinator position in all *50* states plus the District of Columbia, Puerto Rico, the Virgin Islands, and the islands of the Pacific; to set up state urban forestry councils in all 50 states, the District of Columbia, Guam, and Puerto Rico; and to establish an official or an organization in

32 states to help promote volunteer activities related to planting, maintaining, or protecting the urban forest resource.

BENEFITS OF URBAN TREES

Energy Conservation

According to researchers, tree planting is the most cost-effective way to conserve energy resources in both winter and summer. In winter, properly placed trees can help reduce heating costs by serving as windbreaks, conserving between 10 and 50 percent of the energy needed for heating a home. In summer, shade trees on the south and west sides of a house can reduce air conditioning costs by 30 percent.

Economic Vitality

Planting trees around a house increases property value. According to numerous studies, landscaping, especially with trees, can increase property values as much as 20 percent - an increment greater than most family's savings. Studies also show that people linger and shop longer along streets lined with trees, than on those without, that apartments and offices rent faster in wooded areas than in non-wooded locations, and that tenants in wooded neighborhoods stay longer than elsewhere.

Because trees can increase the economic vitality of any community by attracting residents, businesses, and tourists, many cities are engaged in beautification projects that include, for example, the restoration of vacant lots. When local government managers encourage the development of new community parks and gardens, citizens are given a vehicle for community service and the locality is made most attractive to developers.

Air Quality

Trees mitigate air pollution 1) directly, by absorbing and neutralizing pollutants and 2) indirectly, by cooling communities. This indirect effect, besides saving energy, slows the accumulation of smog, which forms faster in higher temperatures. Particulate pollutants - dust, ash, pollen, and smoke - are trapped and filtered by the leaves, stems, and twigs of trees, then are washed to the ground by rainfall. Gaseous pollutants - such as carbon dioxide, one of the major culprits in global warming, or the greenhouse effect - are absorbed through the pores in a tree's leaf

surface; the tree replenishes the air with oxygen, while using the carbon dioxide to make food (photosynthesis).

Stormwater Control

According to the Department of Agriculture, the United States loses *5.4* billion tons of soil annually from croplands, pasture, and rangeland. Trees are effective in saving soil because their roots hold it in place and increase water infiltration, there by reducing soil erosion, sedimentation of streams, amounts of chemicals transported to streams, and wind erosion. Soil scientists estimate that the erosion factor in developed areas is ten times greater than that on cropland, 200 times greater than that on pasture, and 2,000 times greater than that on forests. In some localities, planting and maintaining trees may be the only steps necessary to avoid building new sewer channels for runoff or erecting new waste treatment facilities.

OTHER BENEFITS

Other benefits of trees include blocking noise pollution, and providing wildlife habitat. Many animals such as birds use trees for nests, food, and shelter from inclement weather. Finally, the presence of tree's directly affects human health. Trees have significant restorative benefits, physiological and psychological.

URBAN FORESTS AS ECOSYSTEMS

Stresses affecting trees in urban environments include air pollution, soil compaction, drought, urban "heat islands," poor nutrition, and attacks by "killer humans." City and community dwellers are often completely unaware of the effects their own activities can have on the health and vigor of community trees.

By tying ribbons or wires around trees, hammering nails or spikes into trees, dumping hot charcoal at the base of trees, or taking maintenance into their own hands, community members can cause serious, perhaps irreversible, harm to trees. Breaking off damaged limbs or carving out bumps can open wounds that cause stress to a tree and that may increase the risk of disease or insect attack. Only trained individuals should try to maintain trees through fertilizing, pruning and the like.

Perhaps the most significant effects about tree biology that citizens need to know are the existence and importance of the “cambium layer" and the inability of trees to heal their own wounds. All woody plants except palms and bamboo’s have a single cell layer called the cambium that lies just below the bark and contains the living cells that allow trees to grow, and stripping bark, pulling off branches, and so on, causes permanent damage, and depending on the extent may even cause death.

The plants we know as trees include the hardwoods or broad-leaved trees (deciduous in temperate climates, evergreen in tropical or subtropical climates), softwoods or needle-leaved trees (evergreen), and woody monocots (palms and bamboos). Woody monocot plants possess no cambium and are actually more closely related to the grasses than to hardwood or softwood, deciduous or conifer tree species.

Trees and Global Warming

The average global temperature for 1990 was the highest since record keeping began in the 1880’s. Average temperatures have risen 5.4 degrees Fahrenheit in the past 110 years. Research sponsored by the United Nations indicates we can expect additional increases from 2 to 6 degrees Fahrenheit by the end of the century, if carbon dioxide emissions continue to accumulate at projected rates. Indeed, each of the 250 million people living in the United States contributes to the amount of carbon dioxide in the atmosphere. Fortunately, however, nearly 6.5 million tons of carbon (from carbon dioxide) is currently stored in the urban forests of the United States. According to Forest Service estimates an amount that helps to improve air quality and slow global warming. Tree planting is considered the most cost-effective way to reduce the effects of carbon dioxide accumulation and to conserve energy resources.

FOREST SILVICULTURE & MANAGEMENT OPTIONS

AESTHETICS

Each of you reading this section are future potential landowners of varying acreages. As a landowner, you will have decisions to make on what you want your forest or woodlot to look like. A park-like area? Thick woods? Or as it is the moment you are looking at it? Whichever you choose, the forest will change with time. Trees will grow and shade out others, and they will eventually die. You can control or alter this process by managing your forests. Cutting trees can expose a view to a stream, pond, mountain, or a unique tree.

You can create a low or high screen of brush by altering the amount of sunlight in an area. If an area is cut heavily, there will be more sun, the vegetation will be denser, and the visual or noise screen will be low. If only 50% of the trees are cut, less sun will reach the forest floor; the vegetation and consequently the screen will not be as dense, but it will be more complete; low, moderate, and tall vegetation will grow.

In addition to providing access for vehicles, roads in a forested area are beneficial as visual corridors, walking paths, and for maintenance, fire protection, and wood production. A curved ("S" shaped) road in the woods near the highway will provide a visual barrier, and the road or houses will not be easily seen from within the forested area. If wood is harvested from this area the landing can be kept some distance from the main road to limit the view. To maintain the wooded appearance of an area, buffer strips can be left along streams and roadways by allowing only light cuts of 20-30% of the trees.

The important thing to remember is to keep your woodland "healthy." Forests will change with time and you can influence the way they change. Set goals and work towards them with the knowledge of what is happening.

MANAGING LAND FOR WILDLIFE

Wildlife or game management is the art of making land produce sustained annual crops of wildlife for recreational use. Wildlife benefits the sightseer, the photographer, the hunter or trapper, and those who derive pleasure from a sense of good resource conservation.

Since the majority of the woodland is privately owned, individual landowners have the more important role in determining the production of wildlife. You control the range or habitat of wildlife with respect to available food, and shelter on your land. Most of the development of good game habitat has been the result of other good land practices such as timber, agricultural or water management. There are five major kinds of habitat commonly found in Massachusetts:

1. Active agricultural fields
2. Abandoned fields and pastures
3. Forest lands
4. Aquatic habitat (ponds, lakes, streams)
5. Swamps and marshes

The place where the two meet is called the "edge," and this is where the greatest concentration of wildlife will be found. Where all the ranges occur in a relatively small area is the most productive situation for wildlife. Some animals may use all five ranges, like the whitetail deer. Others will only use one, like brook trout.

WHAT YOU CAN DO TO IMPROVE HABITAT

The first step is to decide what species of wildlife you want to attract and what your woodland might be able to support. There will be limiting factors but you can make the most of what you have.

- Carry out good agricultural, forestry, and wetland use practices. This improves the habitat for all wildlife.
- Plan for and set aside special areas for wildlife, for example, deer-wintering areas that are used every year. These locales require special forestry practices to maintain or improve the area for deer. To favor birds and small mammals leave 3-5 den trees per acre. Planting wildlife shrubs or releasing old apple trees present on your woodlot will provide a much needed food source.
- If you are interested in a particular wildlife species, or in a special group of wildlife, land use practices should be aimed at improving their regular habitat. Develop an over-all "game plan" for your lands, and work it into your land management plans.
- Game or wildlife management requires technical knowledge of species and their habitat. You should make use of all resources available. The Massachusetts Division of Fisheries and Wildlife, the USDA Soil Conservation Services and Massachusetts Audubon Society can assist you. Your county forester can recommend a local agency to work with on wildlife management problems.

FOREST LAND FOR RECREATION

Forest land has been used for recreational purposes for a long time. Hunting, fishing, cross-country skiing, snowshoeing, bird watching, and snowmobiling are a few of the uses. They are generally compatible with other forest land uses such as growing timber.

Forestland owners benefit from determining whether their land can be used for recreation and whether it can provide an income from such uses. The use can vary from the more passive forms listed above to the intensive uses such as camping, picnicking, or swimming. The landowner will have to consider many factors before venturing into any recreational development plan:

- Do you have the ability to meet and serve the general public?
- Is your land close enough to major transportation routes and population centers?
- What is the demand in your area for this type of recreation development?
- Are you willing and able to build, manage, and maintain such a development?
- What is the cost of constructing such a development?
- Can you finance the operation on the anticipated rate-of-return from the business?

Whether you have active or passive recreational uses in mind, your forest land should be managed to stay healthy and grow vigorously.

CHRISTMAS TREE MANAGEMENT

Christmas tree production is a special type of forest management. Forest land owners have seen that in 8 to 12 years trees can be harvested from areas which may have produced nothing for decades. Cut-over areas, abandoned fields and pastures make good areas to plant trees. These areas should have some site preparation done on them prior to planting, which aids in the caring for the trees, so that quality trees will be produced to maximize the dollar return. Many varieties of Christmas trees are grown in Massachusetts. Balsam Fir, Fraser Fir, White Spruce, and Scotch Pine are the most common species, but White and Red Pine, Austrian Pine, Douglas Fir, Black Hill Spruce and Concolor Fir are also raised.

Christmas trees can also be produced in some cases from wild stands of trees which are three to six feet tall. They have to be weeded and thinned to allow better growing conditions, and shearing will improve the tree quality. Working with a wild

stand of trees is good because a harvest can begin in two to three years, and the area usually has trees of varying ages and sizes to produce a continuous crop.

If no suitable trees are present on your land and you want to plant Christmas trees, it is best to start with an open field on a small scale and expand from there. It will take 8 to 12 years (depending on the species) to produce a quality tree. You will have to make a commitment to controlling competing vegetation, insects, and diseases, and make provisions for fertilizing, and shearing your stand of trees.

The produce of all the work is the mature Christmas tree, which can be sold in various ways; individually or by volume, on a retail or wholesale basis, made available to the buyer at the roadside, delivered, or on the stump ("cut your own"). Depending on where the trees are, each method has merits and many places use several methods to market their trees. The urban character of much of Massachusetts has made "cut your own" marketing technique very successful in most of the state.

MAPLE SAP AND SYRUP PRODUCTION

Certain areas of Massachusetts are capable of growing Sugar Maples, which are the only resource for the production of Maple Sugar. Tree farming of this kind can range from a hobby to a large scale business. Small farm-type setups are the trend, where its farming activity helps to tap the optimum potential of the forest.

Syrup production is "labor intensive" and can only take place during late winter to early spring, when the days are warm and nights get cold and the sap "runs" in the maples. The tin bucket hanging on the tree to plastic tubing, where possible, to collect the sap is the current situation. Also, gasoline-powered pumps, vacuum pumps, and pressure-filter presses are used to reduce labor costs, and they produce a better quality syrup.

To manage a stand for sap production, it is important to take a close look at the trees. All maples will produce sap, but Sugar (Rock) Maple is the best. It produces the lightest syrup and has the least amount of sugar sand. Red Maple produces a darker syrup, but the tree will also bud out sooner and shorten the collection time.

To maximize sap quality and quantity, the land owner has to manage the "sugar bush" properly. Trees of other species should be thinned, to allow for the development of large maple tree crowns, which results in more and sweeter sap.

A small farm attempting to produce syrup for an income should be able to put out at least 500 taps. The trees should be at least 10 inches in diameter at 4.5 feet above the ground. For additional taps a rule of thumb is one more tap for each additional six-inch increase in diameter. Sap production might be as far as you want to go with the process. There are syrup producers who will pay for your sap, or in some cases, lease your trees for their syrup production.

WOOD PRODUCTION

The care and treatment of a stand of trees is referred to as "silviculture", which means forest culture and the application of knowledge to control the establishment, composition and growth of the forest. Silviculture makes it possible for the manager to produce the best quality product in the shortest amount of time. For example, it takes approximately 120 years to grow White Pine to 24 inches diameter breast high (DBH) without management, but about 100 years with management. When managing stand of trees for wood production, you are either applying a thinning to improve the existing growing stock or you are treating the stand for regeneration and harvesting the growing stock.

The silvicultural treatment of a forest stand during the growth period is referred to as "timber stand improvement" (TSI) or woodland improvement of the growing stock. Three kinds of work are involved; weeding, releasing and thinning. They are carried out at successive age periods.

Practice	Age of Stand	Type and Diameter of Trees
Weeding	5-20 years	Seedlings & saplings less than 4"
Releasing	10-40 years	Pole 4-10"
Thinning	25 plus years	Pulp and saw logs 8"

Although weeding, releasing, and thinning are distinct activities there is no exact timetable to indicate just when one should end and another begin. Often the natural

forest growth is such that all these practices may be carried out simultaneously on the same acre. You may hear the terms used interchangeably.

Weeding

Weeding is the first management practice in a stand of very young trees, which are from 5 to 20 years of age. The objective is to remove undesirable species, which are crowding and overtopping the potential crop trees. Weeding improves the species composition of the stand

Releasing

Releasing is the second step in timber management, when stands are 15 to 40 years old. The goal is to further remove inferior trees, which improves growing conditions for the crop trees and helps to select desirable species for later growth.

Thinning

Thinning is the removal of trees from dense stands to gain faster growth of trees that will be held another 30 to 50 years. Thinnings every 5 to 10 years are needed to maintain maximum growth and continually improve quality until final harvest is reached.

Cull Tree Removal and Stand Improvement

Remove cull trees or kill them. The better quality trees that remain will have more room to grow. A cull tree has usually been left from earlier logging operations. It is old, large, often very limby, crooked, or rotten and has little or no economic value. It may cost you less to kill them than to cut them down for usable products, and trying to fell them may cause extensive damage to adjacent valuable trees.

Slow killing is often better than an immediate kill. Too sudden a change from shade to direct light may damage adjacent desirable trees. This is often the case with White Pine. Shade trees, with thin and tender bark, will “sunscald” if they are suddenly exposed to direct sunlight. Sunscald or sunburn can kill a vertical strip of bark and expose the tree to disease and rot. Another benefit in addition to releasing new growth, the decaying tree frequently provides a den for wildlife.

Pruning

Pruning is the removal of limbs from young trees to provide first quality logs. Trees chosen for pruning will be the crop trees harvested at the end of the long growing period. The proper time for pruning is when trees are pole size, 4 inches to 10 inches DBH. The trees selected should be straighter, healthier, and more vigorous than their neighbors otherwise the financial advantage of rapid growth will be lost.

White Pine is the species pruned most often. In a pure pine forest as many as 100 to 150 trees can be pruned per acre. One hundred pruned trees per acre gives a spacing of approximately 20 by 20 feet.

Selected hardwood can also be pruned. Usually there are fewer hardwood crop trees per acre that qualify for pruning. Hardwoods have fewer limbs to remove per tree because, if a limb dies, it tends to fall off soon after.

Forest Harvest Cuttings

Harvest cuttings have three timber management objectives:

1. to harvest the mature crop;
2. to replace the trees cut with a new crop, known as the regeneration of the stand;
3. to improve and protect the growing stock reserve in uneven-aged forests.

Deciding which trees to cut and which to leave is the most critical decision facing the landowner contemplating a timber sale. The importance of selecting a suitable harvest-cutting method cannot be overemphasized if the forest is to be developed. The technical assistance of a professional forester should be employed in most cases. Here are the five most common management systems used in Massachusetts forests. They are selection cuttings, clear-cutting, shelterwood cuttings, seed tree cutting, and crop tree management (which is a non-system harvest method).

Selection Cuttings

This is the only management application that is an un-even aged system. In a true un-even aged system there are three age classes of trees. One third (or 30%) of all trees should be harvested as they mature in an uneven-aged stand. Trees of all ages are present in such a forest. The older trees ready for harvest are cut every 10

to 15 years. If they are of good quality and healthy, the young and middle-aged trees are left to grow for future cuts. New seedlings later become established where the mature trees were removed. Mature trees are cut either singly here and there, or in small groups or patches, in an area from 1 to 3 tree heights in diameter. Single tree selection favors shade-tolerant species, while group selection is better adapted to the less shade-tolerant.

The uneven-aged selection forest provides a continuous periodic yield of products. Only a small part of the forest is cut at any one time, which promotes aesthetics, recreation, and wildlife values, and enhances the management of watersheds. Hardwoods, mixtures of Hemlock and hardwoods, White Pines, and Spruce are well suited to selection cuttings, if the stands are uneven-aged.

Not only are the good mature trees harvested in a selection cutting, poor trees and less desirable species are also cut or killed. Middle-aged groups may be simultaneously thinned to improve the forest.

Clear Cutting

Clear-cutting (which removes all of the trees in the cutting area in one operation) is the simplest and most economical harvesting method however, and it is suitable for even-aged stands in which most of the trees have reached marketable size. This is an even aged management system.

Since this system removes all trees from the stand, careful thought must be given to regenerating it, which is usually accomplished by: clearcutting in narrow strips or small blocks to allow natural seeding from adjacent stands, tree planting, or sprouts coming from hardwood stumps.

Clearcutting should be used with caution. It takes a long time to get the next stand to marketable size and the initial stand may regenerate to less desirable species. These are some reasons why expert opinion is worth seeking out. Finally, only rarely is just one cutting system used exclusively on an entire lot. Our complex forests do not lend themselves to such uniform management, and it is often necessary to use more than one technique in a given area.

Shelter Wood Cuttings

Shelter wood cuttings remove the mature forest in several steps (usually two or three) over a period of 5 to 15 years. In each cutting operation, trees are removed uniformly throughout the stand, similar to a severe thinning. The opened stand provides seed for the new crop of seedlings, which germinate and develop in the shade of the protective overstory (the shelterwood). This shelterwood is removed eventually when the new stand underneath is well established. About half of the trees would be removed in each part of a 2-cut shelterwood, about one-third in a 3-cut. Usually the best trees are left to increase the diameter and height until the final cut. Shelterwood cuttings are adapted to even-aged stands of most species except the very shade-tolerant. Even-aged White Pine and Northern Red Oak are best managed by this technique, and for most even-aged stands, shelterwood is a better method than clear-cutting. This is an even aged management system.

Seed Tree Cutting

This system leaves only widely scattered trees of excellent crop trees to serve as a seed source; but, unlike the shelterwood system, the sparse canopy cover has little effect on conditions of the environment near the ground. The seed trees must be light-seeded species with a full healthy crown, superior crop trees, prolific in seeding, and sturdy and healthy enough to withstand wind and exposure and remain alive until the removal cutting. The number of seed trees per acre retained will depend upon the target species and their regeneration requirements. The trees removed in the seed cuttings are the least desirable remaining in the stand. It is particularly important that trees other than target species be cut or killed regardless of crown class*. Seed cuttings should be carried out during a year in which the desirable species bear seed in abundance. The residual seed trees* should be spaced to provide an adequate amount of seed to assure regeneration of the desired species. This is an even-aged management system.

Crop Tree Method

Has no precise definition, except for the emphasis on crop tree release and is best classified as an intermediate treatment. In applying a crop tree method, crop trees must first be identified based on landowner objectives. In general crop tree characteristics include: dominant/co-dominant trees*, high- value commercial species*, expected longevity of 20+ years, species well-adapted to the site. A crop

tree simply represents the best main canopy trees available. Crop trees should be in a dominant or co-dominant crown position, with good tree form*, and well-spaced from other crop trees. In addition to the above crop tree attributes, crop trees may also have additional characteristics for objectives other than timber. For example, wildlife objectives include crop trees that can produce mast and cavity/den trees. Spacing between crop trees will depend on landowner objectives and the location of available crop trees in the stand. The number of crop trees/acre should assure full site utilization. Only trees in direct competition with the crop trees should be removed. The thinning frees space around all sides of the crowns, and promotes rapid diameter increase. In crop tree management overtopped trees may be removed or retained, and even some intermediates may be as trainers. This is an even-aged management system.

Regenerating the Woodlot

When you harvest timber from your forest, you usually will plan to establish a new crop of trees. If special provisions are not made for regeneration, nature will do it her own way. What you do, or do not do, will largely determine what you get for a new crop of trees, and the future of your forest.

Forest trees periodically produce variously sized crops of seeds. Often, less preferred species produce the heaviest crops. The parent seed trees may be single trees or groups of trees. The more numerous and vigorous the seed trees, the greater probability of securing a good crop of seedlings. Seed trees of weed or unwanted species should be removed. Seeds vary in size from the very small ones of birches and poplar, to heavy nuts produced by oak and hickory. Some of the smaller and lighter seeds will be blown away for considerable distances. Many will be carried by wildlife, which may account for why in forests there are small, scattered clumps or single trees different from their neighbors. The survival of the seedlings growing from these seeds will depend on adequate soil moisture being available to their roots, protection from extensive sun or drying winds, and the wildlife present. Fortunately, most trees produce sufficient seeds to insure the survival of the species, even though birds and animals may consume a large portion of the seed crop. Other trees and shrubs may act as “nurse” trees and provide the shade and wind protection that will permit the seedlings to become established.

A serious obstacle to germination and survival is a thick, dry layer of needles or leaves covering the ground, which prevents the germinating seeds from reaching mineral soil and an adequate water supply. You can keep your new tree crop by preparing the site so that the seeds will find a favorable environment. A good method is to scarify the soil, which will expose mineral soil and make a better seedbed. Logging operations on bare ground sometimes serve this purpose. Where there is a dense grass or shrub ground cover, mowing or prescribe burning* can be used to suppress the competition. Natural seeding or regeneration obviously is the lease expensive alternative. It yields trees that are already adapted to the area, and usually results in an excess of seedling, which permits a wide choice later on from which to select the new crop trees.

Artificial Regeneration

Certain forested areas lack seed trees that can provide for natural regeneration. In these areas it may be necessary to plant trees. Planting gives you the opportunity to establish an even-age crop of preferred and genetically superior trees. Soil and site conditions should be considered when choosing the species of tree to plant.

IV. MEASUREMENT

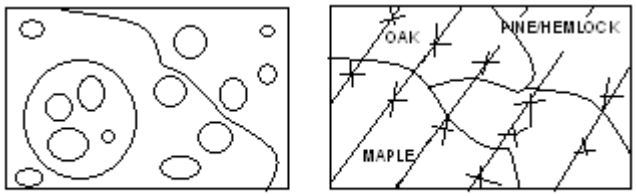
OVERVIEW

Forest Mensuration / Statistics and Probability

This covers methods of obtaining information (numbers, species, size, value or health) on natural populations (ex. trees, chipmunks, mushrooms), when it is impossible or impractical to measure the entire population.

FOREST INVENTORY

Usually is concerned with characteristics of the trees within the forest, but may also deal with fire hazard, wildlife habitat, understory vegetation, etc. Data is collected from randomly located plots and extrapolated to yield information on the whole forest. They can be permanent plots periodically re-measured, or a one-time measurement of randomly located plots.

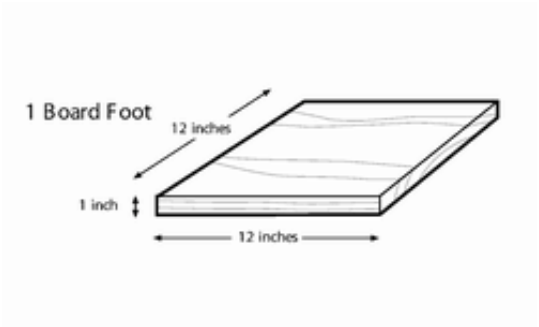


1/4 acre

Most commonly, we are looking for information on volume, size, health and density, factors which will influence our management of the forest. The person collecting the data needs to be knowledgeable about tree species, forest types, aerial photogrammetry*, and the use of forestry tools.

BOARD FOOT VOLUME

The board foot is a common measurement of wood volume. One board foot is equal to a piece of wood 1 foot long, 1 foot wide, and 1 inch thick.



It is relatively easy to determine the board foot volume of lumber, but much more difficult to determine the board foot volume of standing trees. By measuring the actual volume of sawlogs milled at a sawmill from measured trees, foresters develop equations, or log rules. There are many different log rules in use today. In Massachusetts, we commonly use the International ¼ inch log rule:

$$\text{Volume} = .0460436 \times DBH^{2.2312} \times HT^{.75951} \times F^{2.34055}$$

DBH = diameter at breast height in inches

HT = merchantable height in feet

F = 0.78 (form class)

From these equations, we develop volume tables, such as the one on most Biltmore sticks.

MEASURING TREES FOR BOARD FOOT VOLUME

In order to use the volume table, we need to be able to determine DBH and merchantable height. DBH-Diameter at breast height - 4.5 feet above ground level. Tools used to obtain this measurement are: diameter tapes which convert circumference to diameter ($C=\pi r$); calipers which measure diameter directly; and Biltmore sticks which are based upon the angle of vision.

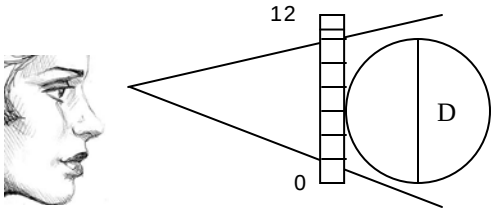
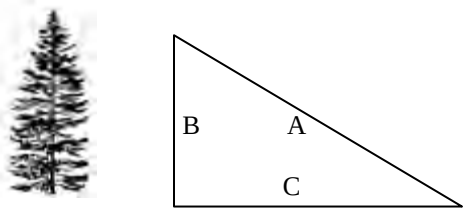
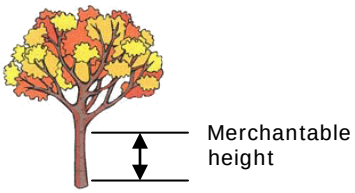


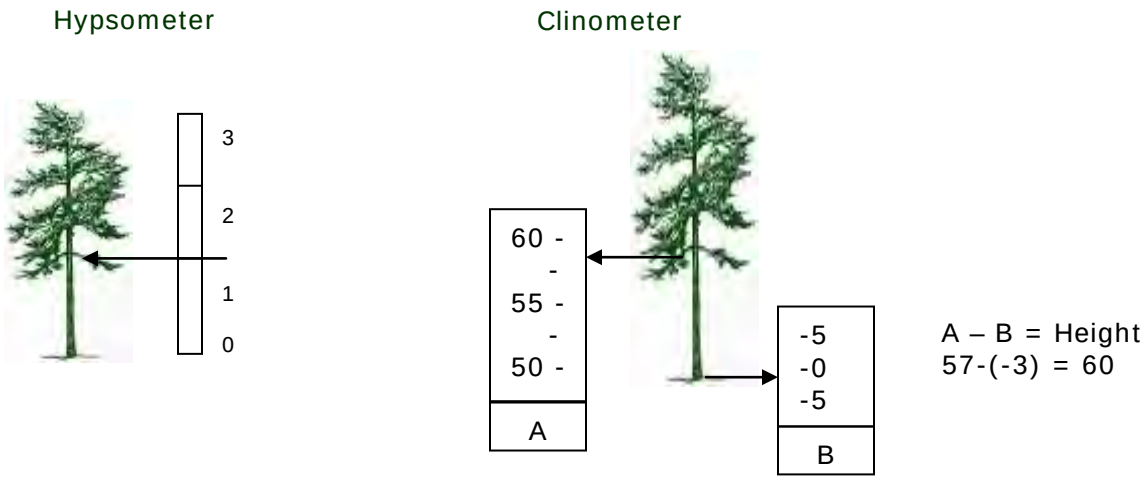
Figure 1

Merchantable Height – This is the highest point at which the tree is still useable for lumber. It is at the point where either a minimum diameter is reached, or, because of branching or defects, the tree no longer has the proper form above that point.





Heights are usually measured using hypsometers or clinometers. Both are based upon the measurement of angles and triangles. If you know 2 angles and 1 side, you can determine the height of another side. A hypsometer works at distances of 66 or 132 feet and measures 16 foot logs. A clinometer works at 66 or 100 feet and measures feet.



MEASURING INDIVIDUAL TREES

The two most basic measurements of individual trees are diameters and heights. The tables used later in this manual for calculating volumes of individual trees are based on these two measurements. Our discussion starts with diameters.

DIAMETERS

Tree diameters are measured at breast height. Since breast height varies for each of us, by convention it is defined as 4.5 feet above the ground. The term “DBH” is an abbreviation for “diameter at breast height”.

There are different tools that may be used to measure a tree’s DBH. A diameter tape can be wrapped around the tree at breast height. A large caliper can be placed on the tree, often taking two or more measurements and averaging these multiple measurements to arrive at DBH. A common tool for measuring DBH’s is a Biltmore stick (Figure 1). The Biltmore stick is the least precise of the three tools, but it is regarded by many as the most convenient to use.

In an ideal measurement situation, a tree is perfectly round and is growing on level ground. Frequently we encounter situations that are less than ideal.

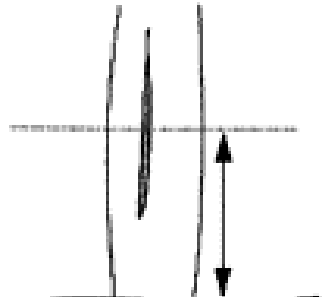
- Trees that are growing on slope require DBH measurements taken on the uphill side of the tree.

- In measuring the DBH of a leaning tree, the 4.5 feet (1.3 m) is measured perpendicular to the upper most side of the tree.

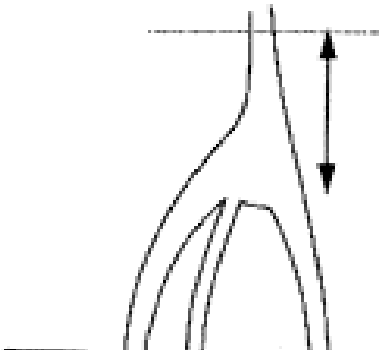
- Trees with a deformity that causes an unnaturally large diameter at 4.5 feet (1.3 m) above the ground are measured at a point above the deformity where the stem is unaffected.

- Some species of trees are prone to forking, which leaves us with the dilemma of whether to measure each merchantable stem individually.

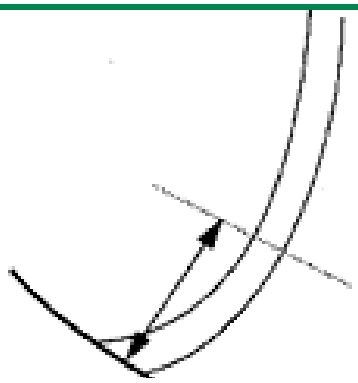
- Some species of trees are prone to forking, which leaves us with the dilemma of whether to measure each merchantable stem individually. Trees that fork below a point 4.5 feet (1.3 m) from the ground have the stem's diameters measured individually, at a point 3.5 feet (1.0 m) above where the tree begins to swell before the fork. Trees that fork at or above 4.5 feet above ground are measured as a single stem, at a point just below where the tree begins to swell before the fork.



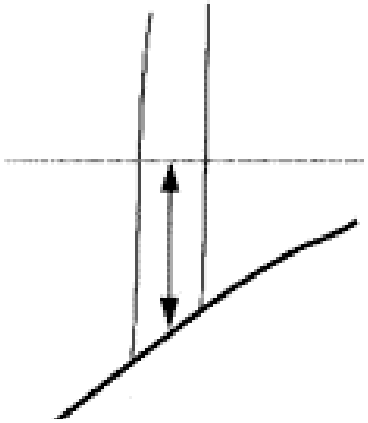
A. major crack or seam



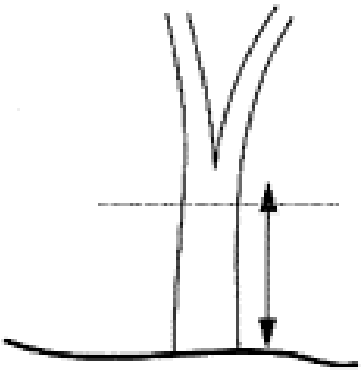
B. Elevated root system: measure 4.5 feet (1.3 m) above root collar



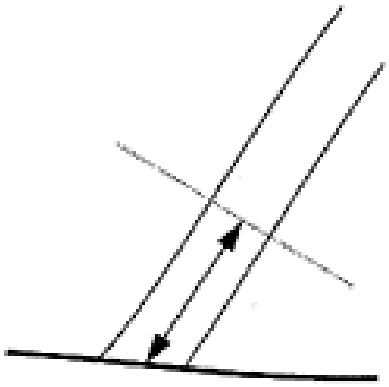
C. “Hockey stick”: measure perpendicular to stem at 4.5 feet (1.3 m)



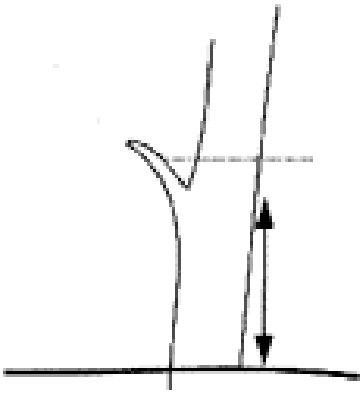
D. Tree on slope



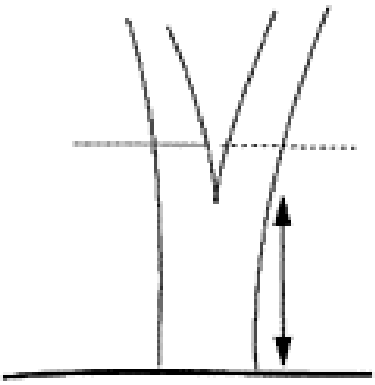
E. Tree forks at 4.5 feet (1.3) to 5 feet (1.5m): measure at 30 cm below fork



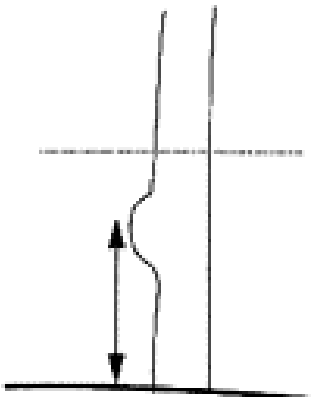
F. Tree is leaning



G. Branch at 4.5 feet (1.3 m): measure 30 cm above



H. Tree forks at 3.5-4.5 feet (1.0-1.3m): measure each stem 30 cm above



I. Swelling at 4.5 feet (1.3 m): measure 30 cm above

Image from: www.eman-rese.ca/.../arnews/images/3-5fig5.gif

MERCHANTABLE TREE HEIGHT

In addition to DBH, the other measurement essential in estimating the saw timber volume of a standing tree is the tree's height. In volume estimation, we are interested in the merchantable height of the tree. Merchantable height is both difficult to define and difficult to judge when making measurements in the field.

Utilization standards for trees vary by region and by consumer. For example, a sawmill owner purchasing standing timber may use all of the hardwood logs down to a minimum diameter of 8 inches. A logger in the same area may only be able to sell logs down to a diameter of 10 inches. In this case, the sawmill owner makes tree height measurements to a higher point in a tree than the logger would.

The cruiser's* view of where the merchantable portion of a tree ends is often obscured by other trees. Even when the merchantable top of the tree is clearly visible, proper judgment of the usable height comes only with experience. For the purpose of this manual, the minimum standard of merchantability at the small end of the last sawlog is eight inches in diameter with at least three clear sides

As with diameters, there are several different tools which can be used to measure merchantable height. Clinometers, Abney levels, and Spiegel relaskop are all used in measuring heights. A very common tool used in height measurement is the Merritt Hypsometer. One side of the Biltmore stick is graduated as a Merritt Hypsometer. Even though the hypsometer is graduated in 16 foot log lengths, it is common practice to measure heights down to a half log interval (½, 1, 1 ½, 2, 2 ½, etc.). Volume tables contain saw timber volume estimates for heights in this fashion.

The Merritt hypsometer is calibrated for measurements taken one chain (66 feet) from the tree. As with the Biltmore stick, the hypsometer is held out 25 inches from your eye. The bottom of the stick is held even with the potential stump height and the stick is held even with the tree in your line of vision.

The merchantable height measurement is taken by reading the number of logs (in full and half log intervals) from the hypsometer at the point where it is even with the uppermost usable portion of the tree.

MEASURING TREE HEIGHT

Measuring height is somewhat difficult in a dense forest, but when you can see the tree's crown you can use a clinometer* to estimate the tree's height. You may want to ask a forester to show your students how to use a professional clinometer. Or, you can make your own clinometer by using a protractor, a pen tube, some string, and a small weight. (See diagram).

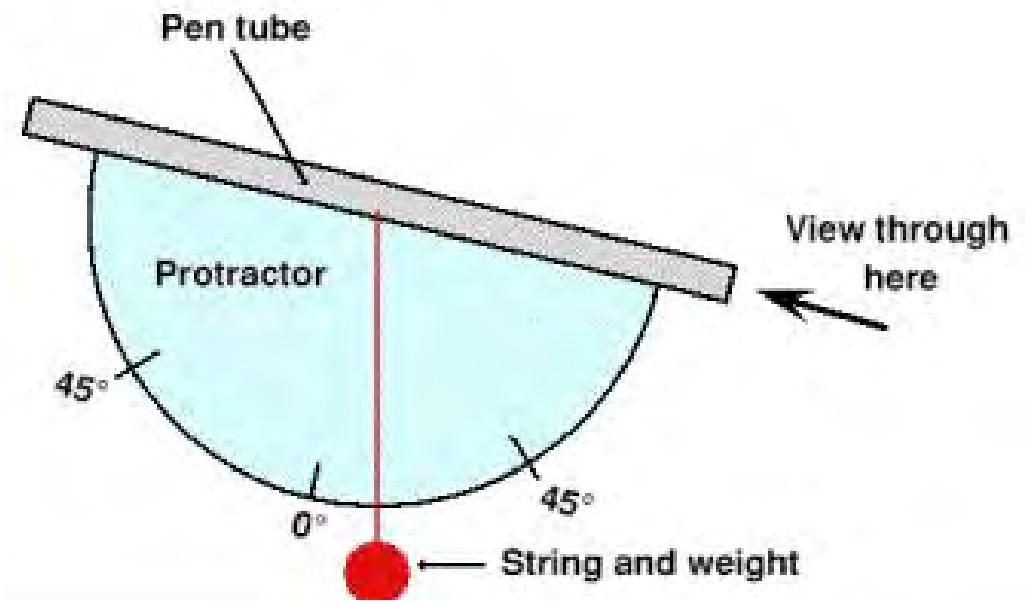
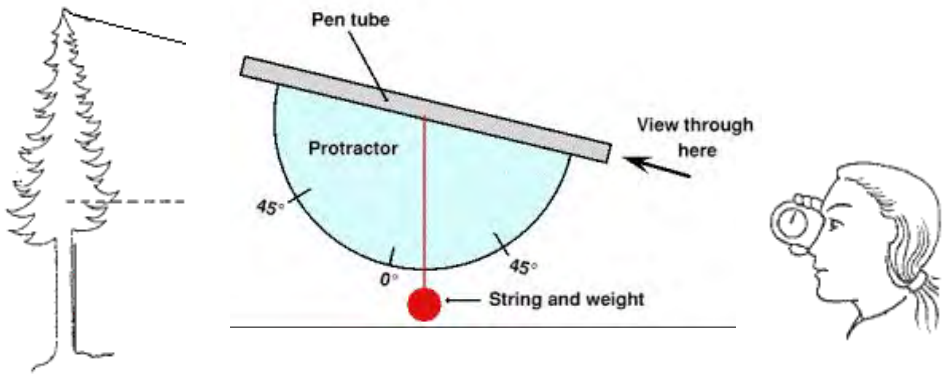


Diagram from www.geography-site.co.uk/.../statimage/prot.jpg

To use the instrument, (a) find a tree on fairly level ground and stand far enough away from it to see the top of the tree looking through the straw, (b) have a partner steady the weight and string against the protractor and read the number where the string crosses the protractor, (c) obtain ("A," the angle of elevation, by subtracting 90 from the number read on the protractor, and (d) have your partner measure in feet the horizontal distance "ab" from where you are to the base of the tree.



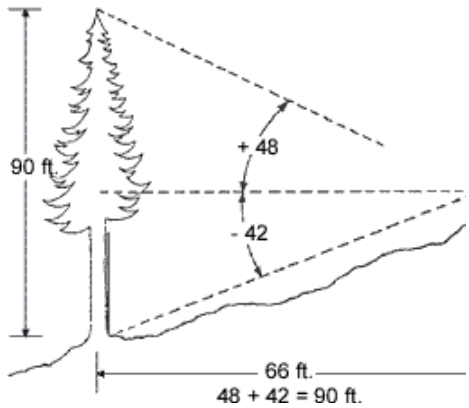


Image from College of Natural and Agricultural resources

Note: the protractor should be held with the 180° mark next to the person's eye.

These directions assume that you are lying down on the ground and looking through the straw. If you are standing, you will have to subtract your height from the final calculation to get a more accurate estimation of the tree's height.

1. The tangent of 45° is 1. hence, if you are measuring a tree that happens to have a 45° angle of elevation, the height of the tree will be equal to the distance between a and b.
2. As the height of the tree increases, so does the angle of elevation. (The greater the angle of elevation, the greater the tangent.)
3. Before you try this in the field, you may want to practice by measuring heights of buildings or other tall objects near your school.

FOREST MEASUREMENT GUIDE

By using the formula ab x Tangent A=X, we can determine the height of the tree, where:

Ab = the distance from the tree

A = the angle of elevation

X = the height of the tree

Tangents are determined by using tangent charts (See the chart below.)

Example 1:

If ab = 35 feet, and A = 34", then the tangent of A = 0.6745

35 x 0.6745 = X

23.62 = X (the height is approximately 24 feet, or 7.3 m)

Example 2:

If ab = 35 feet and A = 60°, then the tangent of A = 1.7321

35 x 1.7321 = X

60.6235 = X (the height is approximately 61 feet, or 18.6 m)

TANGENT CHART (a = ANGLE)

A	Tangent	A	Tangent	A	Tangent	A	Tangent
1	0.0175	24	0.04452	47	1.0724	70	2.7475
2	0.0349	25	0.4663	48	1.1106	71	2.29042
3	0.0524	26	0.4877	49	1.1204	72	2.0777
4	0.699	27	0.5095	50	1.1918	73	2.2709
5	0.0875	28	0.5317	51	1.2349	74	3.4874
6	0.1051	29	0.5543	52	1.2799	75	3.7321
7	0.1228	30	0.5774	53	1.370	76	4.0108
8	0.1405	31	0.6009	54	1.3764	77	4.3315
9	0.1584	32	0.6249	55	1.4281	78	4.7046
10	0.1763	33	0.6494	56	1.4826	79	5.1446
11	0.1944	34	0.6745	57	1.5399	80	5.6713
12	0.2126	35	0.7002	58	1.6003	81	6.3138
13	0.2309	36	0.7265	59	1.6643	82	7.1154
14	0.2493	37	0.7536	60	1.7321	83	8.1443
15	0.2679	38	0.7813	61	1.8040	84	9.5144
16	0.2867	39	0.8098	62	1.8807`	85	11.4301
17	0.3057	40	0.8391	63	1.9626	86	14.3007
18	0.3249	41	0.8093	64	2.0503	87	19.0811
19	0.3443	42	0.9004	65	2.1445	88	28.6363
20	0.3640	43	0.9325	66	2.2460	89	57.2900
21	0.3839	44	0.9657	67	2.3559	90	undefined
22	0.4040	45	1.0000	68	2.4751		
23	0.4245	46	1.0335	69	2.6051		

TREE SCALE – International Rule

Board Foot Content of Trees

D.B.H. Inches	Height - Number of 16 foot logs - to 6" top						
	1	1.5	2	2.5	3	3.5	4
6	10	15					
7	10	25	40				
8	20	35	50				
9	30	45	60				
10	40	55	70	85	95		
11	50	65	80	95	110		
12	60	75	95	110	125	145	165
13	70	90	115	130	145	165	190
14	85	110	135	150	165	190	215
15	95	130	160	180	200	220	250
16	110	150	190	215	240	260	285
17	125	165	215	250	280	300	325
18	140	195	245	285	320	345	370
19	160	220	275	320	360	390	420
20	180	245	310	355	400	435	465
21	200	270	345	400	450	490	525
22	220	300	380	445	505	545	585
23	245	330	420	490	560	605	655
24	270	365	460	540	615	670	730
25	295	400	505	590	675	735	800
26	320	435	550	645	735	805	875
27	345	470	600	700	800	875	955
28	370	515	655	760	870	950	1035
29	400	555	705	820	940	1030	1120
30	430	595	760	885	1010	1110	1205

To determine the board foot volume of a tree, measure the tree's DBH and merchantable height, (to the nearest half log). Locate the DBH on the left side of the chart and read across the volume from the column indicating the merchantable height.

EXAMPLE: If a White Pine had a DBH of 20 inches and a merchantable height, (not the total height) of 3 logs, it would have a total volume of 400 board feet.

V. FOREST HEALTH

Like all worthwhile things in life, owning and managing forestland involves some risks. Your forest is vulnerable to damage or destruction by many natural and man-made threats. Forest destroyers include fire, insects, disease, wind, ice, snow, grazing and, not least of all, man. Let's consider some of these hazards and how you can minimize them.

INSECTS AND DISEASE

Insects and diseases destroy more timber each year than all the other hazards combined. Each species of native tree has its insect and disease predators. You cannot rid your forest completely of insects and disease, of course, but you can minimize their destructive effects.

INTEGRATED PEST MANAGEMENT

Integrated Pest Management or IPM is the most recent approach to the control of forest and other crop pests. IPM is a system of pest control to maintain pest populations at levels below those causing economically important injury in as ecologically sound a manner as possible. The approach involves management of the entire pest complex of a forest, including damage inflicted by birds and mammals. IPM involves these approaches:

Biological

a) releasing parasites or predators that prey on the pest population,

b) using biological insecticides containing nucleopolyhedral virus, or the bacterium *Bacillus thuringiensis*.

Chemical

a) conventional pesticides

b) pherome behavior modifiers (attractants, repellents, confusants, inhibitors and sex attractants)

c) fumigants.

Mechanical and Manual

a) eliminating tree debris, used by pest populations as feeding, breeding, and over-wintering sites.

b) eliminating alternative host species.

c) reducing undesirable seed sources.

Silvicultural

a) harvesting of mature and over-mature stands,

b) cutting lightning-struck, wind-thrown, or trees susceptible to insect attack,

c) thinning overstocked stands to maintain tree vigor,

d) using risk-rating schemes to determine degree of susceptibility to insect attack and prescribe appropriate preventive action

Wildlife

a) reducing the quality of the land as a habitat for wildlife species causing tree damage.

Regulatory

a) abiding by quarantine regulations.

(The above list is constantly changing. New methods become available and older methods become obsolete. Not all of the methods are appropriate to the control of a given pest; nor is any one method usually a satisfactory control used alone. But used wisely and in combination, they do the job. Your forester will be able to advise you which methods are appropriate for your situation.)

Common Insect and Disease Pests in Massachusetts

Pest	Host	Damage	West	Central	East
Gypsy Moth	Hardwoods/Softwoods	Defoliates trees	x	x	x
Saddled Prominent	Hardwoods	Defoliates trees	x	-	-
Cankers	Hardwoods	Defoliates trees	-	x	x
Forest Tent Caterpillar	Hardwoods	Defoliates trees	x	x	-
Oak Leaf Tier-Roller Complex	Red Oak	Defoliates trees	-	x	-
Fall Webworm	Hardwoods	Defoliates trees	x	x	-
Birch Leaf Miner	Gray & White Birches	Defoliates trees	x	x	x
Pine Looper	Pines	Defoliates trees	x	x	x
Nantucket Pine Tip Moth	Pitch Pine	Defoliates trees	-	-	x
White Pine Weevil	E. White Pine & Spruce	Kills leader of trees	x	x	x
Oak Skeletonizer	Oaks	Defoliates trees	x	x	x
Spruce Gall Aphid	Spruce	Defoliates twigs/limbs	x	x	x
Mites and Aphids	Hardwoods/Conifers	Yellowing leaves/needles	x	x	x
Pine Needle Scale	Pine and Spruce	Yellowing/browning needles	x	x	x
Woody Adelgid	Eastern Hemlock	Defoliates trees	x	x	x

Diseases	Host	Damage	West	Central	East
Beech Bark Disease	Beech	Kills trees	x	x	x
Pine Tip Blight	Pines	Kills terminal growth	x	x	x
Shoestring Root Rot	Hardwoods/Conifers	Rots roots & root collar	x	x	x
Annosus	Conifers/Hardwoods	Kills trees	x	x	x

A recent pest addition to Massachusetts is the Winter Moth, which defoliates hardwoods and favors Maples. It is currently only a problem in eastern Massachusetts.

Western Massachusetts = west of the Connecticut River
Central Massachusetts = between the Eastern & Western regions
Eastern Massachusetts = Plymouth County, Cape Cod and the Islands

X = can be a problem
- = not usually a problem

(This information courtesy of Douglas Trefry, Bureau of Shade Tree Management)

Serious insect and disease attacks can often be prevented by recognizing their symptoms in your woodlot at an early stage. Your District Service Forester, Forest Health Specialist and other professional Town Tree Wardens are always on the watch for insect and disease damage. If you have a question about your forest lands, contact them.

WEATHER

Protecting your forest from damage by climatic forces is very difficult. No one knows when nature will become a destroyer of property. Whether you own a few trees on an acre and a half in a suburban town, or dozens of acres in a rural area, you by now know that excessive wind, snow, ice, and water do damage to trees. Maintaining a healthy forest will help to lessen damage from natural causes. Less healthy stands are the ones most seriously damaged by natural causes. Maintaining correct stand density, and other techniques can minimize damage from wind and snow loads.

ANIMAL DAMAGE

WILDLIFE

Damage to the forest stand is common from a variety of wild animals. Mice girdle young saplings and seedlings, particularly when there is a heavy snow cover. Squirrels also girdle young plants by feeding on the cambial layer of the bark. Porcupines often damage the upper portions of larger conifers by feeding on the cambial layer of the bark. Deer browsing is often a serious problem in hardwoods, when there is a hard winter it is evident on conifers. Rabbits, and birds such as the yellow-bellied sapsucker, damage hardwoods; the grosbeak can cause damage by feeding on the buds of young conifers. Beavers may build dams in wetter areas of the woodlot, the water backing up behind them may flood areas and permanently damage valuable species. Of course, many additional species of wild animals are capable of damaging your forest. If you suspect that they are at work, contact your District Forester or Forest Health Specialist for advice.

DOMESTIC ANIMALS

When pastured in the woodlot, domestic animals, can kill young trees and herbaceous vegetation by grazing on foliage and stems and by trampling the root systems, but grazing in the woodlot can be beneficial in controlling unwanted vegetation at certain periods in the life cycle of a forest. A forester can advise you of the appropriateness of pasturing animals in your woodlot.

HUMAN DAMAGE

Man has run a close second to insects and disease as the greatest destroyer of forests. He is careless with fire and the more that forestland is used by man, the greater the risk of damage. Machinery of all types can cause damage.

SNOW VEHICLES

Indiscriminately driving these popular vehicles across your plantations in open fields, where the young tree tops are at or near snow level, damages the trees: not just at the tops, but also below the snow level.

You can legally prohibit the use of these vehicles on your property. It may be more realistic though, and even to your advantage to contact the local snowmobile clubs and work with them to plan trails. Require the club to be responsible for maintaining them in return for using them. Require the club to advise local snowmobile groups of the fact that you are cooperating. Before opening your property for public use, check to see what your liability will be.

SOIL EROSION

Exposed soil on steep slopes can cause erosion, making forest land management difficult. Proper planning and location of logging and access roads will keep most soil erosion problems from occurring in the first place.

SOIL COMPACTION

Heavy vehicle traffic in a concentrated area, over a period of time, can compact the soil covering tree roots, which keeps air and water from percolating through the soil to the roots. This slows growth and can cause permanent damage.

GENERAL TREE DAMAGE

Man is continually breaking branches, peeling bark, and hacking trees with his axe while he is in the forest. It's a hazard that a woodlot owner encounters sooner or later, but it can be minimized by good public relations. Plan to protect your forestland at the same time you plan to manage it.

VI. FOREST LAWS & REGULATIONS

- FOREST CUTTING PRACTICES (M.G.L. Ch. 132, sections 40-44)
- FOREST TAX LAW (M.G.L. Ch. 61, 61A, &61B)

Visit the following website for more information of the forest laws and regulations.

VII. REFERENCES & RESOURCES

REFERENCES

1. Peterson Field Guide: Trees and Shrubs

2. "A Woodland Management Guide for Massachusetts"
   Middlesex Conservation District, 1986

3. The Forest Stewardship Sourcebook
   The Mass. Forestry Association and the Mass. Stewardship Program 1996

4. Reading the Forested Landscape: A Natural History of New England by Tom Wessels

5. Stepping Back to Look Forward: A History of the Massachusetts Forests by Charles H.W. Foster, Editor

6. Envirothon Workshops held during the Winter & Spring

7. Fruit Key and Twig Key to Trees and Shrubs by William M. Harlow

8. Winter Botany: An Identification Guide to Native Trees and Shrubs by William Trelease

9. Rockcastle, Verne. Winter Twigs, Cornell Science leaflets, Volume58, No. 2 Ithaca, NY: Cornell Science Leaflets, Cornell University 14853. (25cents/copy)

10. Symonds, George W. D. The Tree Identification Book, NY: William Morrow, 1958.

11. Stokes, Donald W. A guide to Nature in Winter. Boston, MA. Little, Brown. 1976

12. Core and Ammons. Woody Plants in Winter. Pacific Grove CA. Boxwood Press 1973.

13. Harlow, Williams M., Fruit Key and Twig Key to Trees and Shrubs, New York: Dover, 1946.

RESOURCE PROFESSIONALS

- Project Learning Tree material provided by PLT workshops

- Joseph P. Perry Jr., Service Forester, Massachusetts Department of Conservation and Recreation, P. O. Box 66, South Carver, Ma. 02366 508-866-9245 [Various Forestry and Fire Control Material]

- Charles M. Burnham, Massachusetts Department of Conservation and Recreation Forest Health Program Manager, (508) 792-7716 x132

Additional links can be found at http://www.maenvirothon.org/forestry.htm

VIII. GLOSSARY

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Please look for the Forestry Glossary on the Massachusetts Envirothon website:

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