TIMBER MANAGEMENT FOR SMALL WOODLANDS

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Introduction

The Northeast is one of the nation's most urbanized regions, yet nearly one-half of this area is forested. Despite its timber producing potential, the region produces only a fraction of the wood products it uses. New York State's forest productivity could be increased by nearly one-third if an additional 13 percent of its better commercial forestland were managed for timber production.

Currently, only about one-third of New York's annual forest growth is harvested. In the absence of proper management, most growth occurs in areas of low productivity or in low-quality trees. Unfortunately, a damaging practice called **high-grading** has been used by some forest owners. High-grading removes all the trees of reasonable commercial value from a woodland, leaving only low-value or noncommercial trees. This practice has greatly reduced the long-term, high-quality timber production of many woodlands.

About 85 percent of New York's **commercial** forestland is held by private, nonindustrial owners. Each parcel is typically associated with either the owner's permanent or second home. These woodlands are thus valued more for their isolation, solitude, and recreational benefits than for their timber potential.

Many forest owners do not realize that timber production can be compatible with and even enhance other values of a forest while helping to defray rising expenses. In fact, for many owners, **timber management** and production may be the only way to maintain ownership. The Northeast's fairly young forests usually offer a good selection of valuable tree species and respond well to management activities. Because of high energy costs, even low-value trees can be marketed for fuelwood.

Proper management of small woodlands involves many important steps. This bulletin is designed to help private, nonindustrial woodland owners become familiar with these steps, with the concepts of forest management, and with ways to integrate timber production into their current land-use activities.

Forestry terms in **boldface** type in the text are defined in the Glossary. The appendices contain forestry-related exercises and additional information on managing woodlands. The Suggested References section lists supplementary publications that will further advance the reader's skills and knowledge.

In addition to providing an overview of the terms, concepts, and results of forest and timber management, this publication will help woodland owners to:

- Decide whether managing for timber is a good choice for them,
- Communicate clearly with professional foresters and timber harvesters,
- Determine the extent to which they wish to become actively involved in planning and carrying out a timber management plan,
- Locate further information and assistance.

What is Forest Management?

Before deciding to manage a woodland, it is important to know what management entails. In general, management is an orderly plan for reaching specific goals. Forest management involves first deciding how to use forestland by evaluating the property's potential in consideration of the specific purposes for ownership and then making plans for reaching the goals.

All forest owners, as stewards of the land, have an obligation to keep the forest healthy and productive. Depending upon one's goals, productivity can be measured by the amount or diversity of wood products, wildlife, recreational opportunities, and personal enjoyment the woodlands provide. A woodland can provide many benefits, but proper management requires knowledge, imagination, thoughtful planning, and hard work (Fig. 1).

Unless forests are properly managed, many benefits can be lost for decades. Poor management can not only harm the trees but also result in erosion, poor water quality, destruction of natural beauty, lowered timber value, loss of recreational opportunities, and loss of wildlife habitat, all of which can reduce the future value of the forestland.

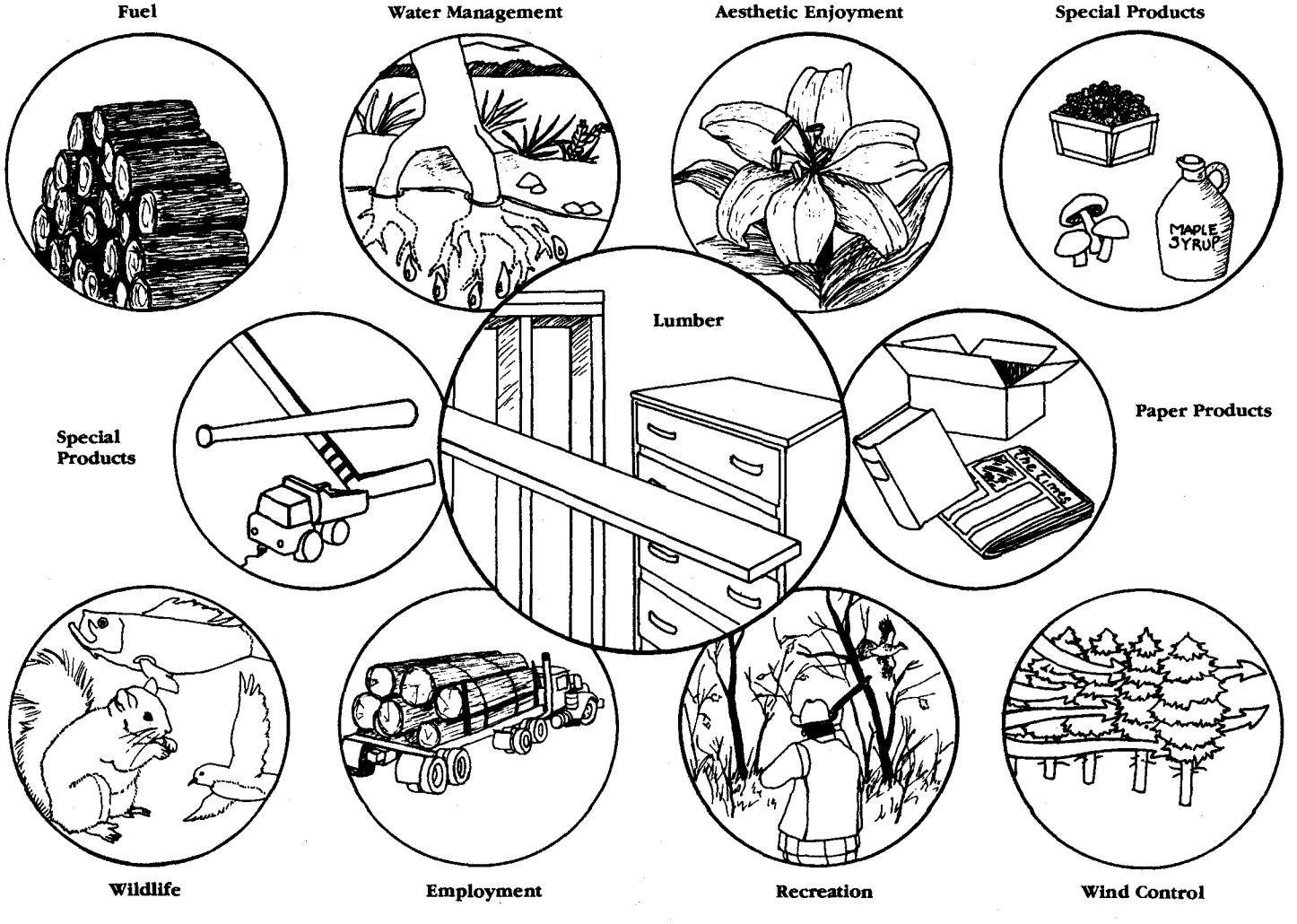


Figure 1. A wisely managed forest can provide many resources and benefits.

Timber Management

Timber management is defined as the planned activity necessary to produce **sawlogs** and **veneer** logs. These tree crops are used in such solid wood products as construction lumber, furniture, flooring, tool handles, toys, and sporting equipment (Fig. 2).

Sawmills are located throughout New York State and generally provide a commercial outlet for forest owners interested in selling quality logs. Specialty mills in New York and nearby states can use some timbers for such products as log homes, utility poles, fence posts, and baseball bats. Firewood, **pulpwood**, and some specialty wood products are often by-products of woodlands managed for sawlogs and veneer logs.

The forests of the Northeast must be carefully managed if they are to produce healthy, high-quality trees. As in a vegetable garden, proper care increases the rate of growth and the quality of the crop. A new crop of vegetables is planted and harvested each year, whereas trees may take 75 to 100 years to reach optimal timber value. Hence, timber management requires foresight and patience.

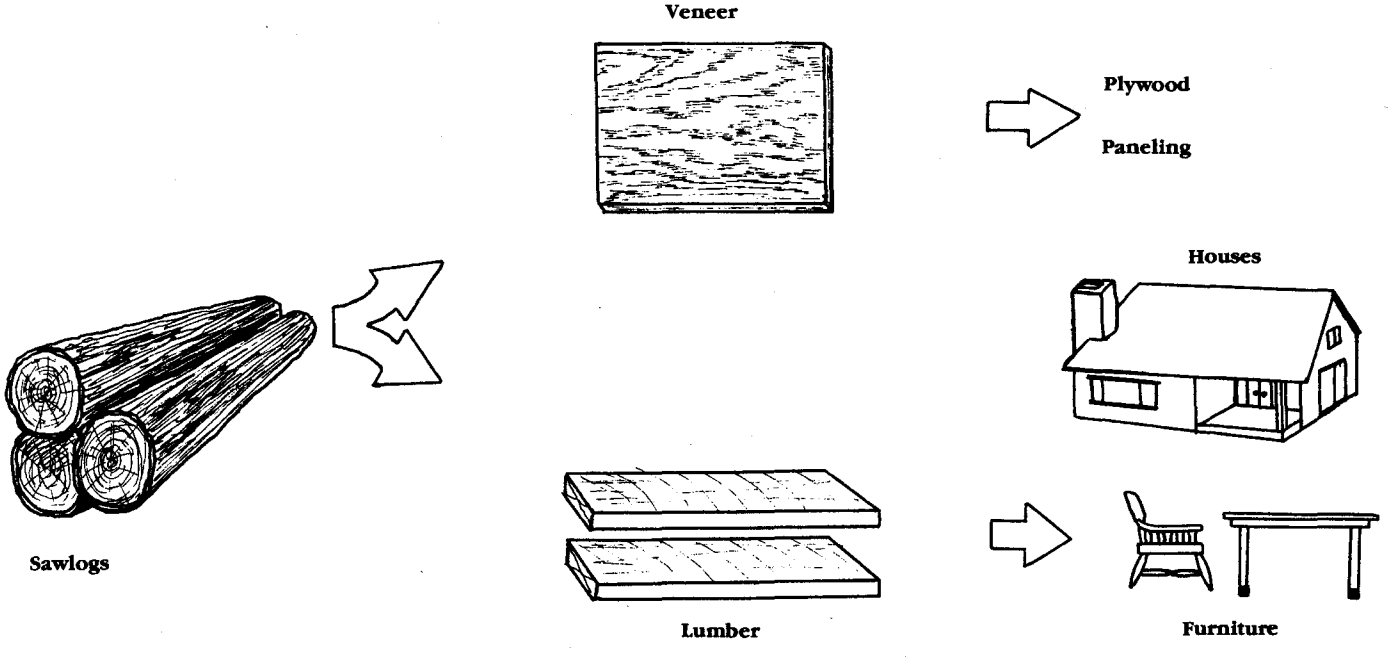


Figure 2. The main goal of timber management is to produce high-quality logs suitable for lumber or veneer.

Know Your Woodland

The first and most important step in forest management is to become familiar with your woodland. Woodlands are more than just trees. They are interacting systems of plants, animals, microorganisms, soil, water, and climate. Together, these parts make up what is called the forest **ecosystem**. Trees play a major role in the forest ecosystem in that they affect both the kinds and numbers of organisms in the forest. In turn, all components of the forest ecosystem affect the kinds of trees that are present, their number, growth rates, and quality (Fig. 3).

Getting to know your forestland can be a rewarding experience, especially if you are interested in nature. First-hand experience also helps woodland owners plan and meet their management goals. Forest owners who know their woodlands well can take a more active role in choosing goals and in developing and carrying out management plans. These forest owners also have a better understanding of the outcomes of management practices.

It is important to know your woodland even if you do not wish to physically participate in such management activities as **felling** trees. Spend time getting to know the **topography** of the forest and the kinds, sizes, and locations of **stands** of trees. A few hours of scouting can make a big difference when you develop your management plan.

Use your senses as you explore the woodland: sight, hearing, touch, and smell. Be open-minded, ask yourself questions, and think about the effects that removing, pruning, or planting trees could have on the forest ecosystem.

Selective reading also will enhance your understanding of woodland ecology and management. Start by reading at least one book about forest ecology, woodland management, fish and wildlife management, or natural history (see Suggested References).

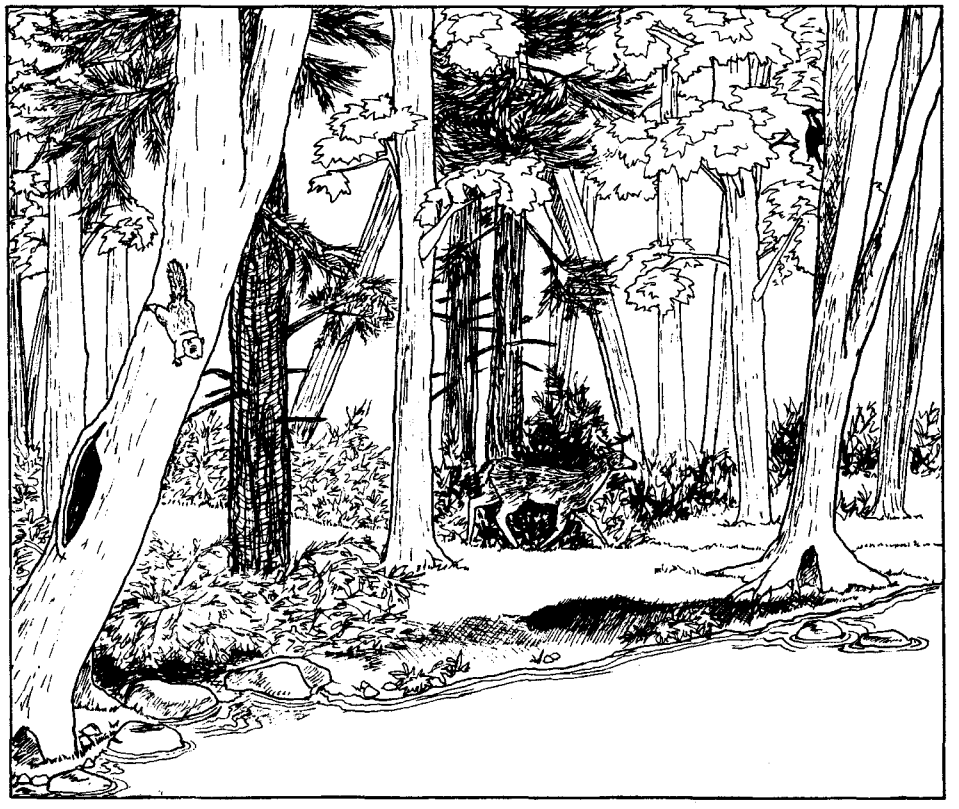


Figure 3. All the components of a woodland interact with each other to form a forest ecosystem. Become familiar with the unique characteristics of your woodland.

Some of the popular pocket guides to trees, shrubs, insects, birds, and other animals are extremely helpful and easy to use. Most of these books are available at libraries or bookstores.

Timber management involves making choices about how components of the forest should be used to promote rapid growth of desired trees (Fig 4). As you consider the management of your woodlands for timber production, ask yourself the following:

- What tree species are present?
- Are there sawlogs or potential sawlogs?
- How rapidly are the trees growing?
- Are the boundaries well marked?
- Is there adequate access to the woodlot for harvesting?
- How will wildlife be affected by timber management?
- What impact will timber management have on the ecology of the region?
- What measures may have to be taken to prevent erosion during and following timber harvesting?

Further specific information must then be gathered concerning the trees in the woodland. This process is called taking a **forest inventory**.

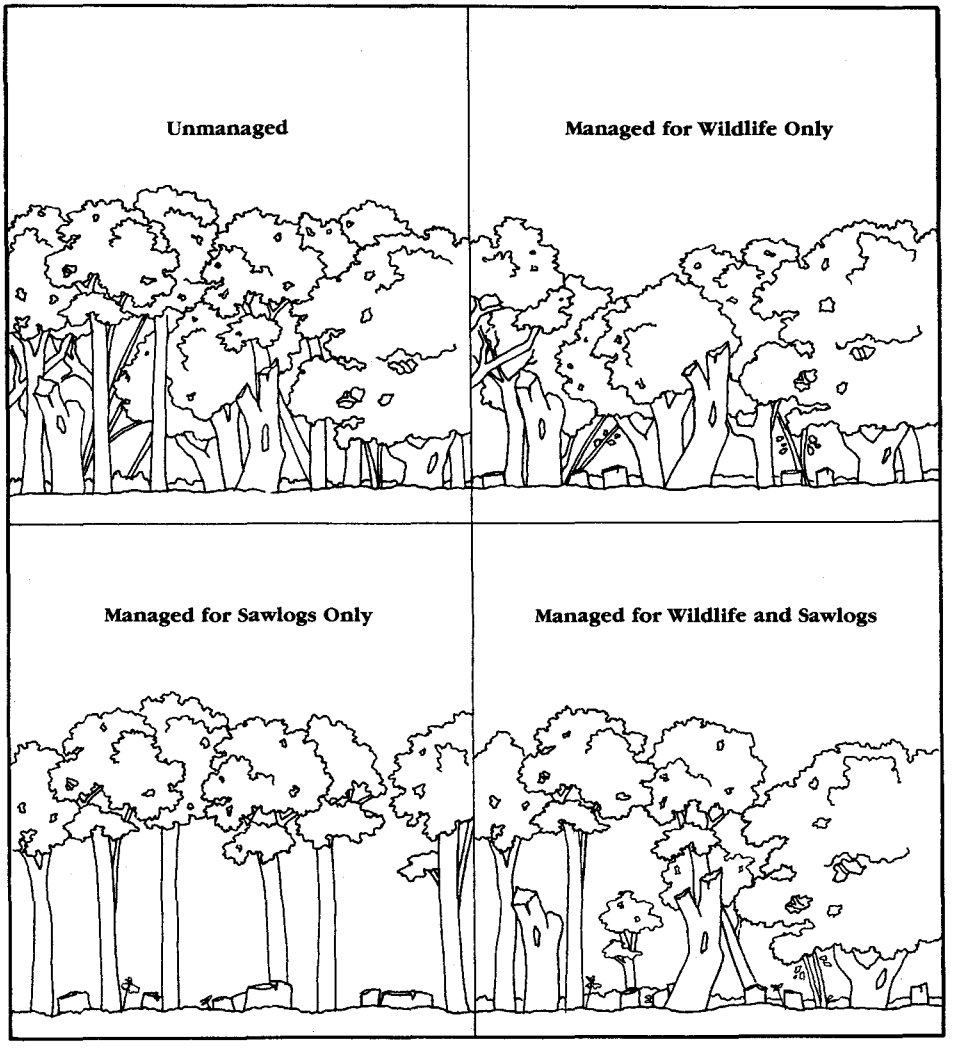


Figure 4. Timber management practices may be adapted to include special interests or goals. These examples illustrate the results of management activities for specific timber or wildlife goals.

Taking Inventory

Just as store owners must periodically inventory their merchandise, so must woodland owners inventory their trees. This procedure should be done before any management activities are begun. A typical timber inventory includes information on the size of the area that is forested; the number, size, quality, and species of the trees; and the general vigor or health of the stand.

Once the inventory is done, it is possible to evaluate the woodland's current state and potential, and to begin thinking about management options. The decision to do the inventory yourself or to use the services of a forestry professional should be based on how the inventory will be used and on your ability to do the task satisfactorily. An inventory that will be the basis for a timber sale, for example, should be quite accurate and may require the services of a professional to ensure a fair sale. On the other hand, you may be able to conduct the inventory yourself if all you need to determine is whether the forest stand is overcrowded.

The first step of a forest inventory is to define and mark the property boundaries. This step prevents accidental trespass and potential conflicts with adjacent landowners. In New York State, trees on property boundaries belong equally to adjoining landowners. Such trees, held in joint ownership, cannot legally be destroyed without the consent of both owners.

Locating and marking property boundaries can be done with little effort, provided there are at least the remains of previous markers. You need only a compass, some bright paint,* and the property deed. The county clerk's office can provide a copy of the deed, and the property taxation office can provide a simple map of your land and its location with respect to surrounding holdings (Fig 5). The soil maps for some counties have aerial photographs that often show old fence lines, lanes, and other geographic features that are referenced in deeds. Topographic maps help determine slope, aspect, and access.

Follow these steps to mark property boundaries:

1. Use your deed to locate a corner of your property. Corners can be marked with a pile of stones, a pipe, a cement piling, a wooden stake, or some other durable structure.
2. Next, walk along the boundaries and find the other corners by following the topographic features and bearings described in the deed. (See Appendix 5.)

* Petroleum-based paints can injure young, smooth-barked trees, so paint only rough-barked and low-value trees, or use a water-based paint

3. Once you have located all the corners, make them more obvious by clearing away brush or making new corner markers. Boundary trees can be marked with a bright, exterior, water-based house paint.

If you cannot locate all the corners or if you are unsure of the boundaries, do not guess. A boundary dispute could lead to a lawsuit. Neighbors are often interested and would be willing to help you locate property boundaries. Consult a land surveyor if necessary. He or she can do an accurate, professional job for a reasonable fee.

Detailed maps of your woodland are helpful in conducting an inventory and are an important tool for management planning. If a professional forester is developing the management plan, be sure to get a copy of all the maps used. Aerial photographs also are useful and are available through county offices of the United States Department of Agriculture, Farm Services Agency (USDA-FSA). These photographs usually are detailed enough to identify forest types, roads, buildings, fences, and water features. Sketching in property boundaries on maps and photographs will provide accurate references from which to work.

Organizing the Woodland into Compartments

Once you have determined and marked the property boundaries, and have accurate maps and photographs, it is possible to organize the woodland into specific compartments. A **compartment** is a distinct management unit. Each compartment requires specific management practices based on the characteristics of the **site**, the tree species present, and the stage of tree growth. Ideally, compartment boundaries should correspond to natural or constructed land features such as streams, ridges, roads, fences, or fields (Fig. 6). It may be helpful to define compartments by painting, chalking, or flagging the boundary trees of each in a different color.

There are three basic reasons for creating compartments. First, some stands require specific management activities. Thus, each compartment is managed to meet the requirements of both the site and the owner's management goals. For example, a stand of **pole**-size hardwoods would be managed differently than a stand of nearly mature **conifers**. Second, some stands may have greater timber-producing potential. Labor and capital should be concentrated on those compartments that will yield the greatest amount of high-quality timber and therefore the highest financial return. County soil surveys often categorize soils by suitability for growth of various tree species groupings based on soil depth, fertility, and drainage. Third, dividing the forest into compartments makes it easier to keep financial and work progress records. It also allows the owner to set up a reasonable schedule for work in each unit and to set realistic goals.

The size of the compartments is determined by the amount of work needed and the size and efficiency of the work force. If management activities will be performed by professionals, the compartments can be large. In this case, size can be determined by the area of various uniform stands. On the other hand, most owners who manage forests only in their spare time find that 2 to 3 acres is about all they can handle in a year. Hence, a woodlot of 20 acres might be divided into 7 to 9 compartments. In general, some management activity is needed every 10 years if the forest is being managed for timber production.

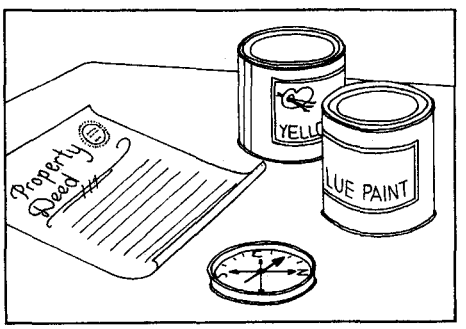


Figure 5. A detailed, descriptive deed, a compass, and some bright paint are the only tools needed to locate and mark property boundaries.

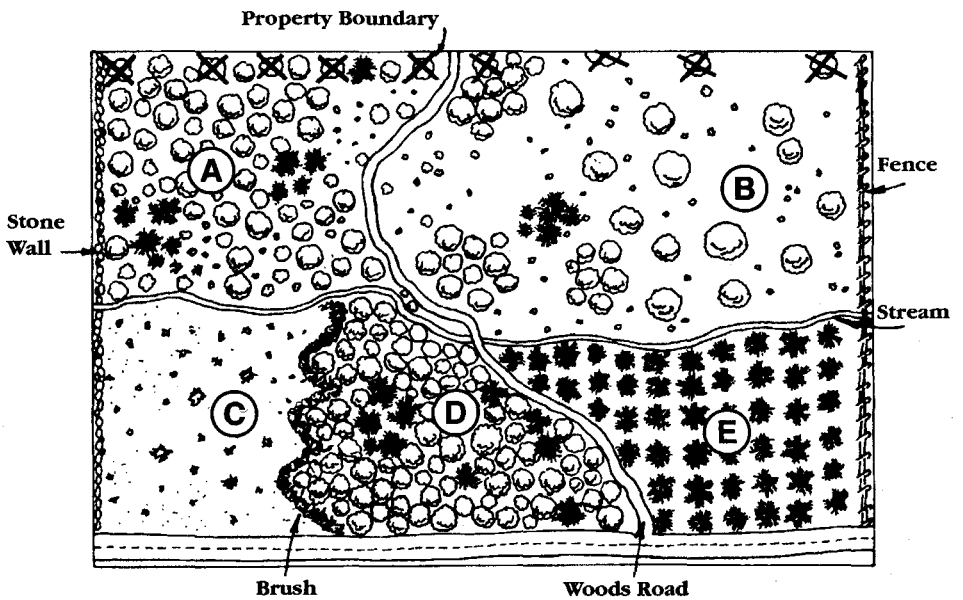


Figure 6. By creating compartments, it is possible to match management activities to specific woodland characteristics.

Estimating Standing Timber

Once the property boundaries have been clearly marked and the compartments established, the next step is to estimate the volume and value of the standing timber. This process is called cruising or making a **timber cruise**. A cruise is conducted for each compartment to determine the tree species present, the number of trees in the compartment, the quality of the trees, and the amount of usable wood present.

Using this information, the owner can decide which management activity is best for each compartment. For example, a compartment composed of young, densely stocked trees should be "weeded," whereas a compartment with many large, mature trees may warrant a timber harvest.

Timber Products and Units of Wood

The method and terms used to describe the amount of wood in a forest vary, depending on how the wood will be used. In most cases, a compartment has a variety of trees suitable for different products such as lumber, pulpwood, and firewood. Trees should therefore be examined with these products in mind.

Wood used for either lumber or veneer is measured in board feet. A **board foot** is a unit of wood 1 foot by 1 foot by 1 inch. (See Appendix 1.) The volume of trees or logs is the number of board feet of lumber that the logs would produce when sawed (Fig. 7).

Trees best suited for use as pulpwood or firewood usually are measured in standard cords. A **standard cord** is a stack of wood 4 feet high, 4 feet wide, and 8 feet long (128 cubic feet), but because logs are irregularly shaped, the actual solid wood content of a standard cord varies from about 75 to 100 cubic feet (Fig. 8).

Firewood is often measured in face cords. A **face cord** is a stack of wood 4 feet high and 8 feet long. The width (the length of the firewood sticks) varies depending on the length needed for specific stoves. Therefore, no standard volume is associated with face cords.

Pulpwood and firewood are also measured by weight. The weight of a standard cord varies greatly, depending on the tree species and the moisture content of the wood. For example, a standard cord of freshly cut sugar maple weighs 5,000 pounds, but only 3,900 pounds when air-dried. By comparison, a standard cord of air-dried aspen weighs 2,400 pounds.

Specialty products such as posts, poles, and crossties are bought and sold by the piece. The dimensions of a piece are determined by the product the wood will be used for, its market, and local customs.

Measuring Trees

By measuring a tree's diameter and height, it is possible to estimate the volume or amount of wood in the tree. A simple tool, the **tree scale stick**, was developed specifically for this purpose and can be purchased from a forest equipment dealer. These sticks generally have scales and tables used to estimate the volume of wood in board feet of both standing trees

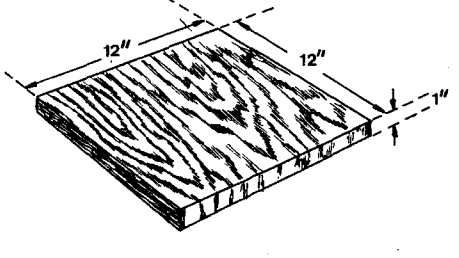


Figure 7. A board foot is the volume of wood in a board 1 inch thick by 1 foot wide by 1 foot long.

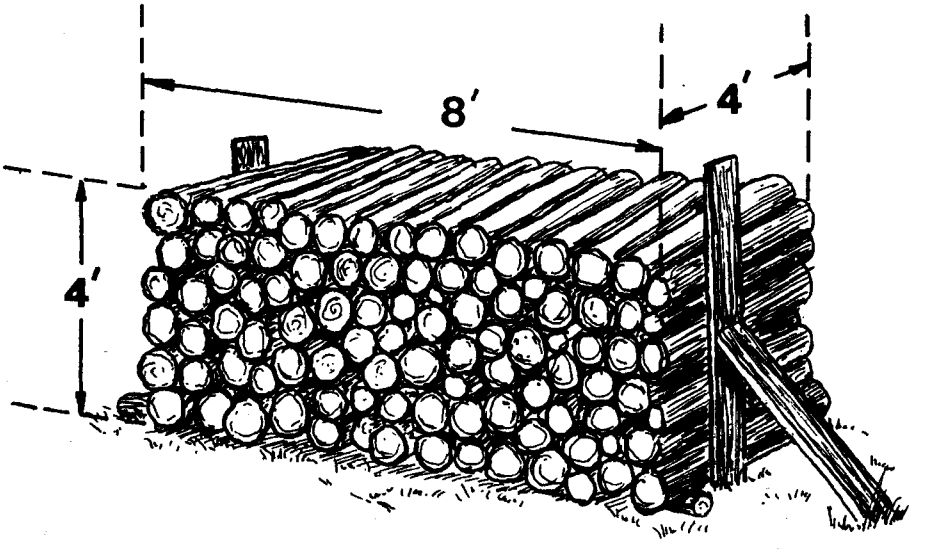


Figure 8. A standard cord is the volume of wood in a stack 4 feet by 4 feet by 8 feet.

and **bucked** logs. The scales on one side of the stick are used to estimate the number of 16-foot sawlogs in the tree and its diameter at breast height **(DBH)** (4½ feet above the ground). The reverse side of most sticks can be used to measure log length and diameter. Some sticks also have a scale for measuring the number of 5-foot pulpwood logs in a tree. Estimating the number of sawlogs in a standing tree takes practice. In addition, a potential sawlog must meet the following requirements:

- Be a desirable timber species.
- Have minimum diameter of 6 to 12* inches at the small end.
- Be at least 8 to 10 feet* long.
- Be generally free of large branches.
- Have acceptable **form**.
- Be generally free of major **defects** (rot, knots, seams, and foreign materials such as nails or fence wire).

It takes an experienced eye to detect damage from partially healed defects. Trees with minor defects are tallied during the cruise, and the total volume of the stand is decreased proportionately to account for wood that is not **merchantable** because of defects. Trees that are not merchantable for sawlogs can sometimes be used for pulp- or firewood. Pulpwood can have a minimum diameter of 4 inches at the small end. Appendix 6 describes how to use a tree scale stick.

The Tally Sheet

A tally sheet is used to estimate the volume of timber in a forest compartment. Tally sheets are easy to make and can be adjusted to the characteristics of a woodland. Each compartment must be checked to determine which tree species to include on the tally sheet. If the tally is to represent future sawtimber, for example, a minimum DBH tally of about 6 inches is necessary. The volume of current sawtimber is represented on the tally sheet by trees with a DBH of 12 inches or more. Appendix 7 explains how to construct and use a tally sheet.

Sampling

Generally, it is not practical to measure every tree in woodland compartments larger than about 3 acres. For larger acreages, a sampling technique is required. Sampling is much more time-efficient than doing a complete tally, and the results may be nearly as accurate. Two sampling techniques are commonly used: the **plot sample cruise** and the **point sample cruise**. Both are based on measurements taken from representative areas. Readers interested in conducting sample cruises should refer to a recent forestry textbook for specific instructions.

Plot sampling involves tallying every tree of a certain DBH or higher within sample plots in each compartment (see Appendix 8). Generally, 10 to 40 percent of the area of a compartment is sampled. How much to sample depends upon how accurate the tally needs to be. For example, a cruise that will become the basis for a sale of valuable trees should be more accurate than a cruise used to estimate young growing stock.

The degree of uniformity or homogeneity within a compartment determines the total area to be sampled and the number and size of the plots. To provide an accurate assessment of a stand with several tree species of various sizes, the sample should be taken from a relatively large percentage of the area divided into many small plots. In contrast, a uniform stand with only one or two tree species can be inventoried by sampling from a relatively small percentage of the area divided into a few plots.

Point sampling is more difficult to understand than plot sampling and requires special equipment and exact measurement techniques. For these reasons, few woodland owners use this method. Point sampling is more efficient than plot sampling, however, because it is not necessary to establish plot boundaries and less time is spent measuring trees of small diameter. Professional foresters frequently use this technique. Point sampling is especially useful for large compartments (see Suggested References).

*Sawmill specifications vary.

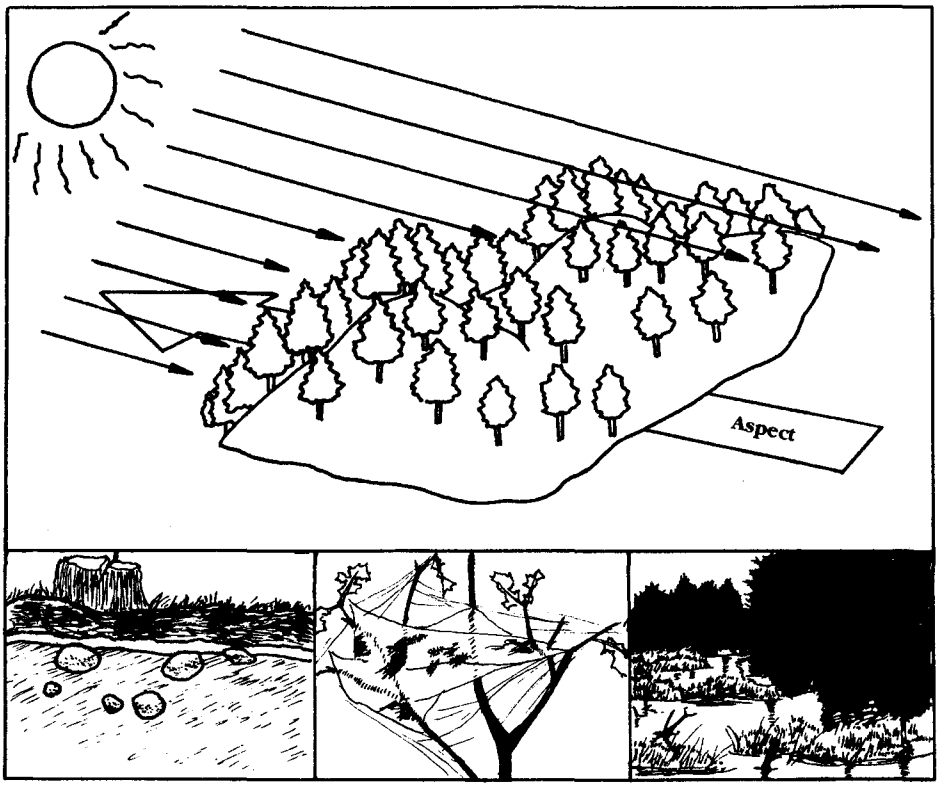


Figure 9. Tree growth at a particular site is influenced by a number of environmental and biological factors.

Using the Inventory

Information collected during the forest inventory reveals three important features about a woodland. These features help the owner calculate the current and potential value of the woodland to determine when trees should be cut. First, with a little effort it is possible to determine the **site index** of a stand, or how well various tree species are growing on a particular site. Second, the tally sheets provide an accurate estimate of the volume of wood and the **stocking density** in each compartment. Third, the tally sheets show which tree species are most common in various compartments. The site index, stocking density, and potential value form the basis for determining which activities are most appropriate to reach the management goals.

Site Index

Just as some farmlands are better than others for growing various crops, forestlands also vary in their ability to grow certain tree species. The rate of growth of a tree species at a specific location is its site index and is affected by the following variables (Fig. 9):

- Tree species;
- Fertility, depth, and texture of the soil, and its moisture-holding capacity;
- Availability of water, determined by rainfall, soil drainage, and **aspect** (slopes facing south or west tend to be drier than slopes facing north or east);
- Forest pests (disease organisms, insects, wildlife) present;
- Shading by the **overstory;** and
- Air characteristics, such as pollution, temperature, humidity, and wind exposure.

It would be extremely difficult to analyze the effects of any one variable on tree growth. Instead, foresters have devised a simple system, site index, to estimate the overall effects

of these variables. This system is based on the height to which each species grows in a fixed number of years. In the Northeast, tree growth is most often measured over a period of 50 years.

To calculate the site index of a particular area for a specific tree species, a forester first selects a sample of several trees in the upper **canopy.** Next, the height of each sample tree is measured with a scale stick. The tree's age is then determined by using an **increment borer** to extract a pencil-size core along the radius of the trunk. The number of annual growth rings can be counted along the core just as one would count the rings on a stump (Fig. 10). Unfortunately, annual rings are difficult to see in some species of hardwoods.

Next, a site index value is determined for each sample tree by plotting its height and age on a chart specific for the species. The average of all the trees sampled represents the site index for the stand. The higher the site index figure, the better suited the trees are to the area. For example, a stand of sugar maples that averages 60 feet tall at age 50 is growing on an area classified at site index 60, whereas a stand averaging 42 feet tall at age 45 is growing on an area classified at site index 47 (see Appendix 9).

A site index provides an assessment of an area's ability to grow trees, and thus its timber-producing potential. An area with a low site index has little timber-producing potential and therefore does not warrant as much money, time, and effort invested in management as an area with a higher index.

Site index charts or curves have several limitations, however, and should be used with caution because:

- Small errors in sample measurements (height, age) can lead to relatively large errors in site index classification.

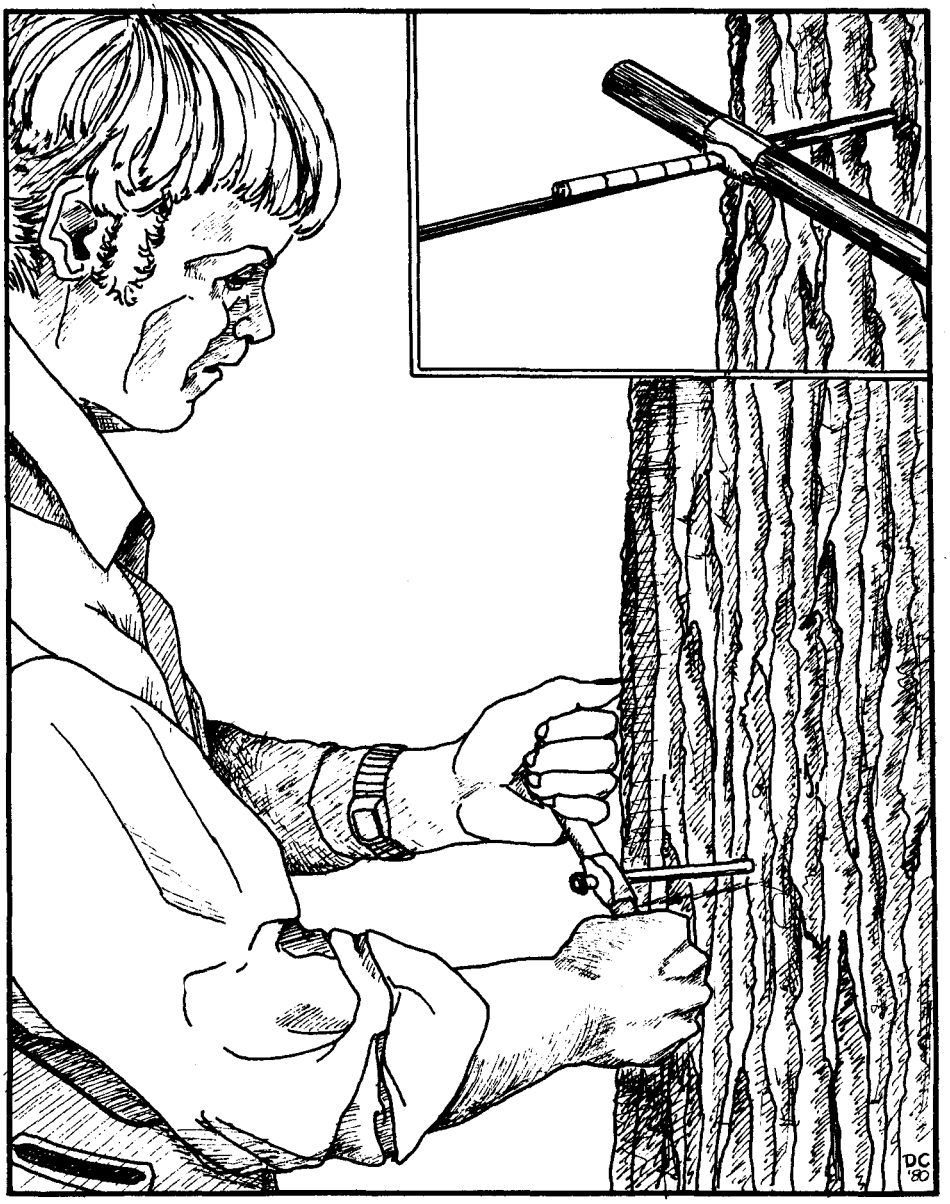


Figure 10. An increment borer is used to determine tree age and growth rate.

- Site index curves apply only to stands in which the trees are about the same age **(even-aged)** and of only one or two major species.
- Previous unknown cutting practices, insect attacks, and diseases may have had a significant effect on the stand's growth.
- A site index can change with time as a result of environmental and climatic conditions.

Stocking Density

Information from the tally sheet can be used to determine the stocking density of a stand. However, it is not possible to determine whether a stand is **overstocked** (containing too much wood volume for optimal timber production) or **understocked** (containing too little) simply by counting the number of trees in each acre. Just as the number of plants that can grow and prosper in a flowerpot is affected by the size of the plants, the number of trees that can grow well in a forest stand depends upon the size of the trees. Two factors must therefore be taken into account to determine whether an even-aged stand is adequately stocked: 1) the average DBH or **mean stand diameter,** and 2) the number of trees per unit area.

Mean stand diameter at breast height is calculated by dividing the sum of the diameters of the individual trees sampled by the total number of trees sampled. The number of trees per acre is calculated by dividing the total number of trees sampled by the combined area of the plots sampled. (Appendix 10 shows how this information can be used in a standard stocking guide for even-aged hardwood stands.)

The stocking guide also gives the estimated **basal area** of the stand, which is the cross-sectional area of all the trees in the stand. It is an indicator of the degree of competition in a stand and can be used to determine the number and diameter of trees that should be cut to maintain optimal growth rate. Basal areas for typical forest stands in the Northeast range from about 60 to 150 square feet per acre (see Appendix 11).

Tree Value

The timber value of individual trees varies greatly depending upon a number of factors. Trees that exhibit desirable characteristics or have good potential for developing desirable characteristics should be chosen as **crop trees** and favored in management decisions and practices. Timber value is determined by:

- *Tree species* – the wood of various species differs greatly in strength, density, appearance, flexibility, and durability. Such characteristics determine the suitability of specific woods for various purposes and thereby their potential value. Some common uses for northeastern tree species and their relative values are given in Table 1.
- ***Defects** and form* – **knots,** rot, and **shake** weaken the structural strength of veneer or lumber; **sweep** and **taper** limit the amount of lumber that can be sawed from a log.
- *Size* – it is more efficient to work with large trees. Also, logs must be a minimum diameter to be used for saw timber or veneer. Veneer logs must have a larger minimum diameter than sawlogs, but veneer logs are often several times more valuable than comparably sized sawlogs.
- *Harvest and markets* – the volume of the merchantable timber per acre, the distance the timber must be **skidded** and trucked to a mill, the topography of the woodland, the season of the year, the efficiency and skill of the loggers, and local log supply and demand all influence a tree's value.

Table 1. Use and relative value of several common Northeast trees

Tree species	*Common use*	*Relative value*[a]
Commercial timber species		
Softwood (conifer)		
Pine	construction lumber, siding, millwork,[b] furniture, woodenware, pulpwood	L+[c]
Hemlock	construction lumber, pallets,[d] pulpwood	L
Balsam fir	pulpwood, construction lumber	L
Spruce	pulpwood, construction lumber, millwork, crates	L
Hardwood (deciduous)		
Black walnut	veneer, furniture, gun stocks	H++
Red oak	veneer, furniture, flooring, cooperage,[e] timbers, railroad ties, caskets	H++
White oak	veneer, furniture, flooring, cooperage, timbers, railroad ties, caskets	H+
White ash	veneer, tool handles, baseball bats, hockey sticks, furniture	H
Black cherry	furniture, veneer, woodenware, caskets	H
Sugar maple	flooring, furniture, timbers, pulpwood	M+
Red maple	flooring, furniture, timbers, pulpwood	M
Basswood	corestock,[f] veneer, boxes, cooperage, woodenware, caskets	M
Tulip poplar (yellow-poplar)	veneer, siding, crates, pulpwood	M
Yellow birch	furniture, veneer, interior finish, railroad ties, woodenware, crates	M
Paper birch	veneer, spools, bobbins, toys, pulpwood	M
Beech	flooring, furniture, veneer, woodenware, railroad ties, pallets, pulpwood	L
Aspen (poplar)	crates, rough lumber, corestock, pulpwood	L

Noncommercial species

Gray birch	Dogwood	Sumac
Shadbush	Crab apple	Chokecherry
Blue beech	Boxelder	Fire cherry
Hophornbeam	Alder	Sassafras
Striped maple	Witch-hazel	Willow

Based on 1994 values as published in NYSDEC Stumpage Price Report.
[a]H = high; M = moderate; L= low; + indicates value somewhat higher than the average for the category.
[b]Sash, doors, interior trim.
[c]Fast growth rate and high basal area on suitable sites result in higher value to forest owner.
[d]Platforms used with forklifts.
[e]Barrels, tubs, casks.
[f]Furniture frames.

Woodland Management Practices

The success or failure of a timber management plan depends on several factors:

- *Timber quantity.* How much timber will be produced is largely determined by the number of trees present and their growth rates.
- *Timber quality.* The value of the timber depends on the species, form, defects, size, and overall health (amount of mechanical and biological injury) of the trees.
- *Forest management investments.* A forest owner should try to make financial investments based on the woodland's timber-producing potential.
- *Long-term productivity.* A forest site can continue to produce merchantable timber as long as the soil remains fertile, the land is not severely eroded, and the stocking remains optimal.

The quantity and quality of the timber from most woodlands can be increased through management practices, but every woodland is capable of producing only a limited amount of timber. The ideal management plan should increase the quantity and quality of the timber only to the point where further investments of time, money, and effort would fail to yield adequate economic returns. A good management plan should not increase current timber production or cut costs when such actions would decrease the long-term productivity of the site.

- *Site suitability.* Although many tree species can grow on a wide range of sites, most valuable timber species will achieve optimal growth rates and form only on a narrow range of sites.

All trees need sunlight, soil nutrients, and water to grow and to maintain their structures. At any one time and place, however, only a limited amount of these resources are available. Vegetation in a stand is in continuous **competition** for these necessities, and hence only a finite number of trees of a specific size can grow. Forest management activities for timber production should therefore aim to control stand density so that valuable crop trees are favored in their competition for resources.

Overstocked Stands

Trees in an overstocked forest have poor overall growth rate because of excessive competition. Many northeastern forests have not been properly managed and have become overstocked, resulting in slow growth and reduced vigor.

Stocking is not a concern until the majority of the trees in a stand have reached a DBH of about 6 inches. Until then, competition is desirable for two reasons: 1) healthier and faster-growing trees crowd out the inferior ones, and 2) competition for sunlight causes the trees to grow straight, with few side branches. As the trees grow taller, the lower side branches are shaded out and eventually die and fall off.

By the time most of the trees in a stand have reached a DBH of 6 inches, the first 16 feet of the trunks of the superior trees are relatively straight, evenly tapered, and branch-free. This portion of the trunk will be the **butt sawlog,** which is usually the most valuable.

The stocking level of a forest stand can be determined by calculating the number of trees per unit area (usually acres) in relation to the average size of the trees (expressed as mean DBH), or by calculating basal area. As the average size of the trees in a stand increases, the stand should have fewer trees, but the basal area should increase. For example, an even-aged hardwood stand that has a mean DBH of 7 inches can contain as many as 425 trees per acre and have a basal area of about 110 square feet per acre. In contrast, a stand with a mean DBH of 16 inches should contain no more than 100 trees per acre, but would have a basal area of about 125 square feet. Further comparisons can be made by examining the stocking guide shown in Appendix 10.

It is more difficult to determine proper stocking levels for **uneven-aged stands.** As a general rule, however, an uneven-aged stand of **northern hardwoods** at midpoint in a **cutting cycle** of 10 to 20 years ideally should have a basal area of 80 to 100 square feet per acre to maintain optimal growth rate. (See Appendix 11 for an exercise on basal area.)

Recommended Management Practices

Competition in an overstocked stand can be reduced by conducting a harvest. In a stand of even-aged, pole-size trees, harvesting competing trees is called **thinning.** Harvesting larger and overtopping trees (including some saw timber) to reduce competition with less-mature trees is called **releasing,** since the remaining trees are released from competition and can grow at a faster rate. The correct selection of crop and **cull** trees requires experience and is based on an evaluation of several factors. Figure 11 shows examples of crop and cull trees.

Select 100 to 150 crop trees per acre in even-aged stands that have an average DBH of 6 to 12 inches. These crop trees should share the upper canopy, have relatively full **crowns,** be desirable species, and have straight trunks free of major branching and surface blemishes.

Cull trees typically are of an undesirable species, have crooked or forked trunks, show evidence of disease, injury, or loss of vigor, or are crowding or shading a desirable crop tree. A noncrop tree should not be removed until it crowds crop trees. Trees growing on inaccessible or poor sites such as rock ledges can also be left. Such "fillers" help reduce **windthrow**, the drying effects of wind, and excessive branching of

crop trees. Cull trees for which there is no firewood market or that are inaccessible can be killed by **girdling** or applying an herbicide in a **frill** (Fig. 13).

The characteristics that make a cull tree undesirable for timber (cavities, an excessively wide and deep crown, species) frequently make it valuable to wildlife. Such trees are called **wolf trees**. A large, hollow beech tree, for example, provides wildlife with nesting cavities and a mast (nut) crop. There is no need to remove all **snags** (dead or dying trees). Once the crown has died, the tree no longer competes with crop trees. The insects and fungi associated with snags generally do not harm healthy trees, and many species of wildlife use snags as a source of food and shelter.

Each crop tree should be given space to develop a full crown, which will occupy a height equal to approximately one-third of the tree's total height. Generally, crop trees should be released on at least three sides. After each thinning, each crop tree should ideally have about 4 to 5 feet of space for its crown to grow outward. Excessive space between crop trees can be harmful to a stand because:

- Some tree species develop branches along the trunk when they are exposed to sunlight, reducing the value of the sawlogs.
- The stems of thin-barked trees, such as maples, may be injured by **sunscald.**
- Overthinned stands on exposed sites may be damaged from **blowdown;** winds may also have a drying effect.
- Excessive thinning allows sunlight to penetrate the canopy; thus, weeds, briars, and shrubs can flourish and eventually compete with the crop trees for water and soil nutrients.

As indicated in the stocking guide in Appendix 10, an even-aged stand of northern hardwoods with an average DBH of 6 inches should contain about 300 trees per acre after thinning. Only 100 to 150 of these trees are crop trees, however. The remainder are "fillers" to maintain proper stocking density. These fillers should be removed during periodic thinnings until only the best crop trees remain.

To determine the average distance that should separate the trunks of crop trees from those of other trees in an even-aged stand (with an average DBH of 6 to 10 inches), multiply the DBH of the crop tree by 1.8. This figure is the distance in feet that should be cleared between the crop tree and other trees. For example, trees with a 10-inch DBH should have about 18 feet of growing space. Trees that do not compete with crop trees—that is, those that are in the **understory** or beyond the specified distance—need not be removed (Fig. 12).

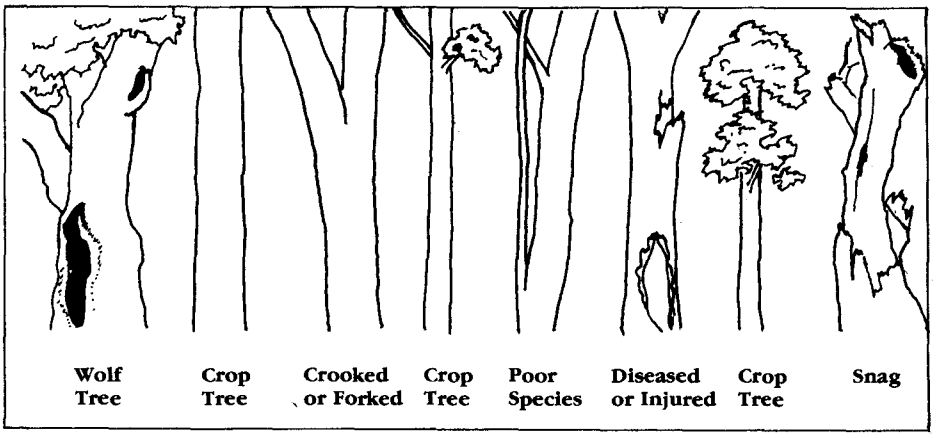


Figure 11. Representative cull and crop trees in a hardwood forest.

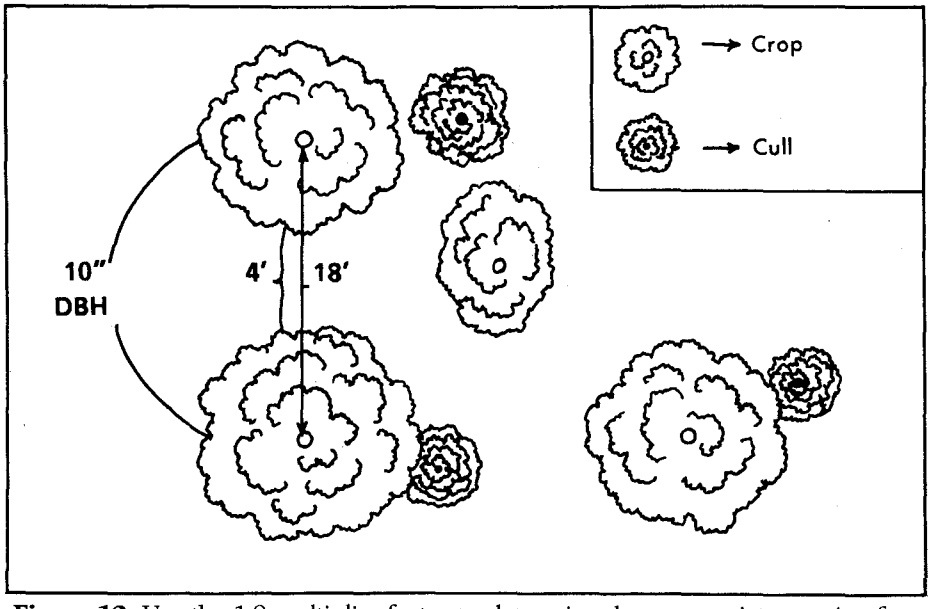


Figure 12. Use the 1.8 multiplier factor to determine the appropriate spacing for crop trees.

Spacing can only be approximated, and sometimes theory must be sacrificed to save a valuable tree. If two exceptional crop trees are crowding each other, it may be best to keep both and release the remaining sides.

Once the DBH of the crop trees is more than about 10 inches, thinning is best accomplished by working with crop trees individually. This is done by releasing the crown on at least three sides. This procedure works well for thinning uneven-aged stands.

Properly thinned stands will probably need rethinning about every 10 years. This schedule allows the stand to produce intermediate crops of firewood, pulpwood, or posts. As the crop trees approach sawlog or veneer size, the last thinnings may produce some sawlogs of fair quality.

Sometimes, an overstocked stand does not warrant the expense of thinning. Such cases include stands stocked with species of little or no market value or sites with such a low site index that growth will be poor whether or not it is thinned.

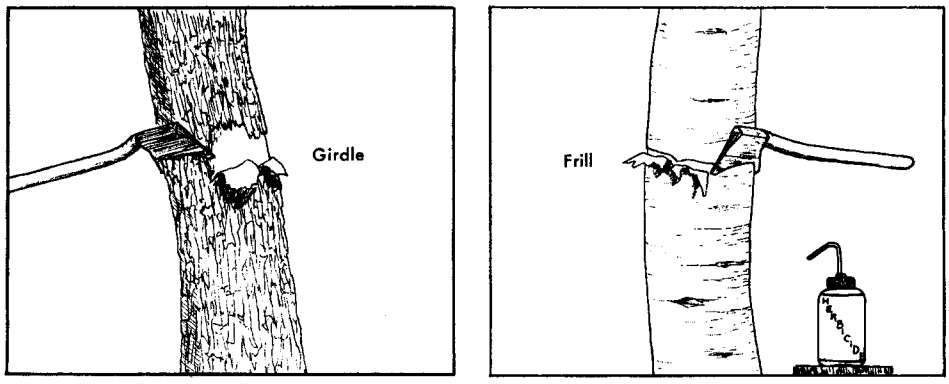


Figure 13. Cull trees can be killed by girdling or by applying herbicide into a frill.

Understocked Stands

An understocked stand does not have enough trees or wood volume to reach its full timber-producing potential. Individual trees are likely to be growing at maximum rates because little competition exists, but the overall total growth rate for the stand will be less than optimal. Understocked stands do not use resources fully and tend to be composed of trees with short trunks, severe taper, and many limbs. These are not desirable characteristics for sawlogs and therefore greatly reduce the market value of the stand.

To determine if an even-aged stand is understocked, compare your timber cruise information with the standards given in Appendix 10. An even-aged, northern hardwood stand with a mean DBH of 7 inches, for example, should have at least 240 trees per acre with a basal area of about 60 square feet. An uneven-aged stand should have a basal area of at least 70 square feet midway between harvests to maintain an adequate growth rate.

Recommended Management Practices

The appropriate management practices to remedy an understocked stand depend on the extent of the understocking. Forest stands tend to become overstocked, so slightly understocked stands can be ignored. If it will take more than 10 years for a stand to reach the B-line in the figure in Appendix 10, the trees are likely to develop poor form, resulting in greatly reduced timber value. In most cases, the forest owner can wait until the site has been stocked through natural regeneration. It seldom pays to plant hardwood seedlings to increase the stocking of understocked stands due to the cost of seedlings and their relatively low survival rate. Using specially designed plastic tubes to shelter natural or planted seedlings can increase growth and survival rates, however, making this practice feasible in some circumstances.

Areas that are relatively barren as a result of fire, agricultural abandonment, or landfill activity develop forest cover naturally through **succession.** Abandoned farm fields in the Northeast typically change from a grass and shrub cover to a mature hardwood forest in 100 to 200 years. **Regeneration** generally occurs from tree seeds from adjacent woodlands.

Natural regeneration in forests and recently harvested areas occurs from seeds and stump or root sprouts. Partially stocked stands regenerate quickly if the trees are mature and produce seeds or if the species harvested from the site are prone to sprouting. If the species are undesirable, it may be best to cut the trees and treat the stumps with an herbicide to prevent sprouting.

To establish a large-scale plantation on old fields, it is generally best to plant conifer rather than hardwood seedlings. Not all open areas should be planted with trees, however. Landowners frequently wish to leave some land open for recreation or to maintain a scenic vista. In addition, many wildlife species are dependent upon open areas, clearings, old fields, or brushlands during part or all of their life cycle.

Herbicides

Chemical herbicides are used in timber management to reduce competition between undesirable vegetation and valuable crop trees. Competitive vegetation includes grasses, ferns, shrubs, and mature trees. Consequently, herbicides are designed for specific purposes and application procedures. Herbicides can be particularly useful in controlling weeds and grasses in young plantations. They are available in either liquid or pellet form and can be applied by aircraft, ground power equipment, or by hand.

Where woody vegetation is a problem, foliar or basal spray treatments are most appropriate. Foliar sprays are misted onto the leaves of undesirable plants. Basal sprays are applied with a brush or nozzle sprayer to the stem base. The poison then moves up and down the stem, normally killing the plant within two or more years.

Herbicides require careful handling for personal safety and to prevent poisoning of pets, wildlife, livestock, and nearby vegetation. Pellets can move down a slope with rain runoff, aerial mists can drift with winds, and all herbicides that move into root systems can affect trees whose roots are intermingled with poisoned plants.

When herbicides are used to kill larger trees, the chemical is injected directly into the stem. The herbicide is squirted into a frill that encircles the stem. Kerosene or a light fuel oil works well for this purpose except during spring sap flow. A frill is made by cutting once with an axe or chainsaw through the bark and around the stem. A girdle is a bit more extensive and requires that a band of bark and living tissue 3 to 5 inches wide be peeled away in a circle around the tree. Girdled trees usually die without application of an herbicide. Trees treated in either manner die within a few years; thus the remaining trees gradually receive more sunlight (Fig. 13).

Another common use of herbicides is to suppress stump sprouting. Kerosene or a light fuel oil also works satisfactorily. Once cut, such species as red maple and beech are prolific stump sprouters but frequently are undesirable for timber production. In addition, their sprouts tend to grow in clusters and often develop crooked and weak lower trunks. Herbicides should not be used indiscriminately, however. Clustering may be ideal for those owners interested in producing firewood, and the sprouts provide deer browse.

The myriad of brand names and active ingredients available makes it impossible to list specific herbicides in this publication. Also, federal and state government safety restrictions on herbicide use and availability are revised periodically. Before deciding upon a particular herbicide, check its suitability and its safety status. For this information, contact a consultant or regional state forester, Cooperative Extension agent, or state Cooperative Extension forester.

Forest Protection

The protection of your timber resource should be a major management consideration. Although the likelihood of a catastrophe such as a fire, flood, or windstorm in any one year is small, woodlands are exposed to these risks during the several decades before a commercial harvest occurs. Woodlands also are subject to several less obvious, often long-term destructive forces, including disease, insect, or wildlife damage, which can be as disastrous to a forest as more obvious catastrophes (Fig. 14).

Fire Prevention and Control

Although the northern hardwood forests of the Northeast are not as likely to burn as the conifer forests of the South and West, there are times in the spring and fall when drought can make **leaf litter (duff)** and ground vegetation dangerously dry. Fires seldom spread into the tree crowns, but they can damage or kill large trees and destroy soil conditions essential for healthy, vigorous growth.

Accidental fires are caused by careless campers, smokers, or people burning debris. Natural fires most frequently result from lightning. State forestry organizations such as the New York State Department of Environmental Conservation (DEC) monitor fire hazard potential daily during droughts. It is wise to limit recreational and woodland management activities during such critical periods. Watch for fires for a few days after lightning storms. A fire may smolder for days in tree trunks or underground before spreading.

Three practices can greatly reduce the likelihood or damaging effects of fire: 1) Be sure that there are strategically placed, vegetation-free **fire lanes;** 2) Cut conifer tops and branches **(slash)** left from a timber harvest and lay them on the ground to decay; and 3) Be sure that there are adequate access roads.

During periods of high fire hazard, be sure hand tools such as axes, saws, shovels, fire rakes, and a backpack fire pump (Indian™ tank) full of water are centrally located. The fire-fighting equipment to have on hand depends partly on how long it takes firefighters to arrive. State regional foresters can provide advice on tool selection and use.

Know the telephone number of your local fire department. The fire department is the fastest source of help and can mobilize other personnel and equipment if necessary. If

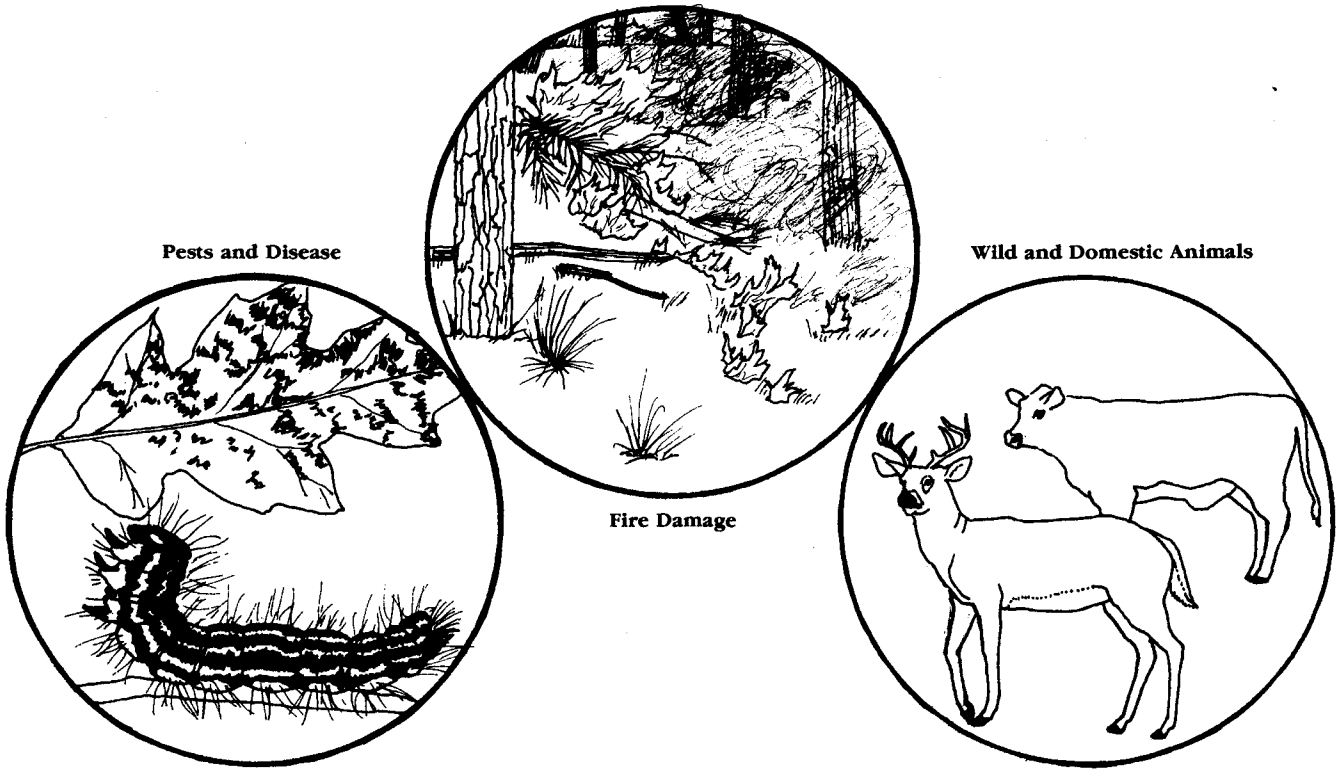


Figure 14. Many factors can adversely affect timber productivity.

you are an absentee woodland owner, ask neighboring landowners to contact you and the local fire department immediately upon discovering a forest fire. Have posters on your property that give your name, address, and telephone number. Know how to direct help to your property; know its exact location, and the names of access roads.

Insects and Diseases

The forest is home to both beneficial and harmful insects and disease organisms. The harmful ones pose a problem only when their damage becomes extensive, primarily when natural ecological checks and balances are disrupted. For example, a major outbreak of insects can damage stands until biological (birds, other insects, or diseases) or climatic checks naturally control insect populations.

Healthy, vigorous trees are not as likely to be damaged by insects or fungi. By maintaining stands composed of diverse species with adequate growing space, and by removing weak and diseased trees, major epidemics can normally be avoided. Snags pose less of a hazard because they support organisms that use dead wood.

If they are in otherwise good condition, hardwood trees such as maples, oaks, and ashes can stand defoliations as the result of insect attack; however, these attacks cannot occur in too rapid succession. Two or three defoliations in successive years can kill these trees.

Even if the best care is provided, gypsy moths, white pine weevils, blister rust, heart rot, diebacks, and declines can do considerable damage to a woodland. Control is accomplished with chemical sprays or by removing the plants on which the disease organisms live. Unfortunately, complete control on private, nonindustrial woodlands is not economical. Losses can be reduced, however, by salvaging trees before the decay becomes severe. For example, many of the Northeast's beech forests have been infected by beech bark disease and are being salvaged.

State and college plant pathologists and entomologists in New York monitor the spread of forest pests and are involved in efforts to control them. These professionals are in Albany (New York State Department of Environmental Conservation), Syracuse (SUNY College of Environmental Science and Forestry), and Ithaca (Cornell University). They can be contacted directly or through your county Cornell Cooperative Extension agent.

Wild and Domestic Animals

Many creatures inhabit woodlands. Landowners may see mice, rabbits, deer, woodchucks, porcupines, squirrels, raccoons, and a variety of birds, amphibians, and reptiles. Many of these animals eat seeds, seedlings, twigs, and bark and are thus potentially damaging, especially when their populations become unusually large. Because the populations of many small mammals such as mice and porcupines tend to be cyclic, attempts at poisoning, trapping, or hunting them usually have little long-term effect on their numbers.

Of all wildlife, the white-tailed deer probably has the greatest influence on timber production. Deer are **browsers,** and where their numbers are high they can stunt the growth of some tree species and severely limit regeneration. Unfortunately, many tree species preferred by deer also are valuable for timber. One way to reduce the effect of deer browsing is to choose timber management methods that promote vigorous regeneration of desirable species. Also, it is a good idea to leave slash in loose, jumbled piles to discourage access by deer to seedlings. These practices will permit a number of stems to grow beyond the reach of the deer. In New York State, doe harvest permits are adjusted annually to keep regional deer populations in balance with their habitat and residents' interests.

Cattle and other livestock can damage a woodland by compacting the soil and eating tree seedlings, thereby changing the composition of the stand. Once woodlands have been grazed, they are more prone to disease and insect problems. In addition, livestock do not benefit greatly because forest forage contains few of the nutrients found in a pasture. A fence prevents this damage. Once livestock are excluded, natural processes can reestablish seedlings in about 10 years, unless soil compaction and erosion are severe.

Harvest and Sale of Timber

The final goal of timber management is the harvest and sale of trees suitable for lumber or veneer. Specialty wood products—poles, log cabin logs, posts, or **bolts** for baseball bats or hockey sticks—may be the primary objective, but regardless of the product, forest owners must make some critical decisions concerning the harvest and sale of their timber: timing of the harvest, which trees to harvest, the harvest system to use, the buyer and terms of sale, markets for the timber, appearance of the woodland following harvest, and the best way to ensure future productivity of the woodland.

Harvesting and selling timber is the payoff for years of timber management or, at the very least, the culmination of decades of forest growth. It is important to plan and proceed carefully. It may be years before a forest recovers from improper harvesting practices. Likewise, an unfair sale may result in a significant financial loss.

When to Harvest

As soon as a tree has enough wood fiber to meet the costs of felling, limbing, bucking, skidding, loading, transporting, and processing, it has a positive dollar value to the forest owner and is merchantable. It is usually financially unwise to harvest trees as soon as they reach merchantable size, however, because they are not yet at their optimum value. Table 2 illustrates a number of important timber management considerations:

- At 12 to 14 inches DBH, hardwoods have a low value, but the rate at which they are increasing in value is high, especially for fast-growing trees with proper growing space.
- As a hardwood tree increases in diameter from 14 to 24 inches, it may nearly double in height, increase 5½ times in volume (110 to 628 board feet), and increase more than 15-fold in dollar value ($22 to $345). If a market is available for veneer, its value may be substantially more.
- At 14 to 20 inches DBH, hardwoods may nearly double in value for each 2 inches of growth in diameter as **log grade** improves with size and as growth in height continues. At a growth rate of 2 inches in diameter every 10 years (10 growth rings/inch), a tree will nearly double in value in 10 years (a compound growth rate of 7 percent, not including inflation).
- At 20 to 24 inches DBH, hardwoods increase substantially on a dollar basis, but because the grade has peaked, the rate at which their value is increasing may slow to a compound growth rate of 3 percent or less. The increase in dollar value is mostly the result of the increase in volume.
- At 24 to 28 inches DBH, the dollar value continues to increase, but change in grade and height are unlikely. Also, growth in diameter is typically slower as the tree reaches biological maturity. These two factors could reduce the compound growth rate to 2 percent or less.

Table 2. Stumpage value of sugar maple trees based on size and grade.

DBH[a] *(inches)*	*No. of 16-foot logs*	*Volume (board feet)*[b]	*Grade*[c]	*Dollar value/ 1,000 board ft.*[d]	*Age of tree*	*Dollar value per tree*
12	1.0	58	3	$125	50	$ 7
14	1.5	110	2–3	200	60	22
16	2.0	183	2	300	70	55
18	2.0	240	1–2	400	80	96
20	2.5	360	1	550	90	198
24	3.0	628	1	550	110	345
28	3.0	877	1	600	135	526

[a] Diameter at breast height or 4½ feet above ground.
[b] International ¼-inch Rule.
[c] Grade classification of butt log: 1 = highest value. These are typical grade changes with size.
[d] Based on the quantity and quality of expected yield of 1-inch lumber, 1994 stumpage value.

Table 2 illustrates the *potential* value of high-quality 14- to 20-inch crop trees. These trees are merchantable but definitely not "financially" mature. They are the true money makers in a woodland and therefore should not be harvested during this prime growth period unless they are crowded.

The timber value of individual trees regardless of species, logging costs, and current market trends, is largely a function of the total amount of wood fiber they contain and the quality of their lumber or veneer. Log grade is determined by size (diameter and length), form, and defects such as knots, ingrown bark, and worm holes. In general, as a tree increases in size, its logs increase in grade; as grade and size increase, so does value. Diseased trees, in contrast, may lose value and grade faster than they grow in volume. A timber harvest should therefore occur when the rate of tree growth and value have peaked.

Hardwoods such as sugar maple, on good sites, reach **financial maturity** at about 20 to 24 inches; on poor sites it may be reached at 16 to 20 inches. As indicated in Table 3, the age at which trees reach financial maturity varies significantly depending on the species, site index, damage from insect and disease attacks, and management.

Throughout the timber management process, a forester should strive to maintain a yearly basal area growth rate of at least 2½ or more square feet per acre for a stand. At this growth rate (allowing for some mortality), a fully stocked sawlog-size stand on a good site will produce about 250 board feet of sawlogs plus one-sixth of a standard cord of pulpwood or firewood per acre annually. This total yield is equivalent to at least half a standard cord per acre.

If the forest stand is composed of relatively young, vigorously growing trees, it is possible to maintain the above growth rate by thinning. In time, however, a managed stand becomes dominated by large, slow-growing crop trees and it becomes impossible to maintain the desirable growth rate without a harvest. Periodic harvests are therefore part of a continuous management program.

By using the cruise information on basal area and the number of trees per acre in various DBH size classes, and stand vigor in conjunction with stocking guides, professional foresters can determine when a harvest is appropriate. The number of trees and amount of wood to be harvested depend on the stocking density of the stand, the minimum volume that must be harvested to show a profit, and the management goals.

Which Trees to Harvest

Once the decision has been made to conduct a commercial harvest in a stand, the landowner or a forester marks the trees that will make up the sale. Size, vigor, species, and form influence this decision.

The size of the trees to be harvested varies, depending upon the quality of the site, the species, and the demands of the market. Sawmills generally cannot use logs from trees with a DBH of less than 12 inches. The value of most hardwood species; however, increases dramatically as the species grows larger than this minimum marketable DBH.

Trees that have reached financial maturity should be marked for harvest, and salable trees of low vigor that will not survive until the next harvest (generally 10 to 20 years later) also should be removed. Signs of obvious loss of vigor are deeply grooved or loose bark, slowly healing wounds, a sparse crown, discolored leaves, or premature leaf-fall in the autumn. Loss of vigor may be caused by advanced age, crowding, damage from ice, wind, drought or flood, and insects or diseases.

Landowners should take advantage of temporary price fluctuations by selling a species when its market demand is high. **Timber stand improvement (TSI)** may be coordinated with commercial harvests. For example, low-value timber species or trees of little value to wildlife should be harvested to promote regeneration or growth of more desirable species. Trees of poor form, such as those that have no potential for producing more than one 16-foot log, should be harvested as soon as they interfere with the regeneration or growth of more valuable trees.

Table 3. Average age at which timber species reach financial maturity (24 inches DBH*) in managed stands** on good sites.

65–75 years	*75–95 years*	*95–124 years*	*125 years or more*
White pine	Black oak	Hemlock	White oak
Tulip poplar	Black cherry	Sugar maple	Chestnut oak
Red oak	White ash	Red maple	
Red pine	Basswood	Yellow birch	
		Hickory	
		Beech	

* DBH = diameter at breast height or 4½ feet above ground.
** Growth rate may be one-third less in unmanaged stands.

A large-scale harvest of crop trees is not only the last management act of a timber **rotation** but also the first important activity of a new rotation. Regeneration is largely related to the harvest system used; new **seedlings** and **saplings** determine the timber potential of the next forest stand. It is crucial, therefore, that landowners consult a professional forester before conducting a timber harvest.

The size, species, and distribution of **residual trees** can affect the composition of the stand in the next generation.

Shade tolerance is the ability of a tree species to grow satisfactorily in the shade. Species that thrive in abundant sunlight but that do very poorly in shade are called intolerant. Such species must at least share the upper canopy or their vigor and growth will be reduced. Intolerant trees that are left in the shade of overstory trees usually die. Intolerant species do best in open or recently disturbed areas and are called **pioneer successional species.** Species that are shade-tolerant grow slowly beneath an overstory but do best when they share the upper canopy. Table 4 shows the relative shade tolerance of some common northeastern timber species.

Some species, including pines, regenerate best after an abundant seed crop falls on bare or somewhat disturbed soil. The process of disturbing the forest floor cover is called **scarification.**

Except in the winter, scarification often occurs during the harvesting process. On some sites, however, it may be necessary to scarify further to break down slash and brush and prepare a proper seedbed for some species.

Harvest Systems

Selection System

Selection harvesting involves removing individual or small groups of trees at about 10-year intervals. Trees are selected for harvest on the basis of their financial maturity and relative contribution to the long-term productivity and value of the stand. Both low-value and high-value trees are harvested to achieve proper stocking density and to promote the regeneration and growth of future crop trees. High-grading, or harvesting just the best trees in a stand, results in a high immediate return but reduces the return on future harvests. It is therefore not cost-effective (Fig. 15).

Selection harvesting is uneven-aged management and generally promotes tolerant and intermediate shade-tolerant species (Fig. 16). Because only a few trees are harvested at a time, selection harvesting does not drastically change the appearance of a stand—an important consideration if the stand is in public view. In addition, the new stand will contain trees of diverse age and size and therefore can support a wide variety of wildlife. Unfortunately, deer can have a devastating effect on the often rather limited regeneration associated with selection harvesting.

The frequent small sales from selection harvesting provide the forest owner with a steadier income than the larger, less-frequent sales from harvest systems for even-aged stands. Small-scale selection harvests are less efficient, however, and therefore less profitable. Also, the crop trees left behind may suffer some damage from repeated harvesting activities.

Shelterwood System

The shelterwood system establishes a new stand under the shelter of older trees (Fig. 17). This method is used for many intermediate or shade-intolerant species that need direct sunlight to become established and grow well, but it can also work well with shade-tolerant species.

The shelterwood system is the most complex of the common harvest systems, and consequently must be applied carefully to achieve desired goals. Two to three cuts of varying intensity are usually made. The first cut scarifies the site and opens the stand to increased sunlight, which stimulates seed production and promotes regeneration and growth of seedlings. Overstory trees shade most of the area for at least part of the day and thereby protect tolerant and intermediate-tolerant species from excessive sunlight.

The second cut increases the exposure to light, which promotes the rapid growth of seedlings. Adequate numbers of saplings with terminal buds and leaders above the deer-browse level are crucial at this stage. The final cut removes the remaining mature trees and creates an even-aged young stand.

Table 4. Relative shade tolerance of common northeastern timber species.

Tolerant	*Intermediate*	*Intolerant*
Hemlock	Oak	Aspen
Beech	White pine	Tulip poplar
Sugar maple	Yellow birch	Black locust
Red maple	White ash	Paper birch
	Shagbark hickory	Black cherry
	Red pine	Black walnut
	Basswood	

Some disadvantages of this system include the possibility of damaging young trees, the need for patience and **silvicultural** knowledge, and the relative inefficiency of logging, which may lower the purchase offer.

Seed Tree System

The seed tree system removes most of the trees in one cut, leaving only a few scattered trees to produce seed for the new crop (Fig. 18). This system is used primarily to regenerate shade-intolerant conifer species in the southern and western United States.

Clear-cut System

Clear-cutting removes all trees, including culls and those of low quality, with a DBH of more than 2–3 inches. The intensive logging activity and the virtual removal of the entire stand leave the site well scarified (unless the process is conducted when there is a snowpack) and open to direct sunlight. These conditions are ideal for the establishment of shade-intolerant species. Seedlings regenerate from seeds in the ground litter or from adjacent trees. Regeneration may also result from root and stump sprouting (Fig. 19).

Because all the trees are removed at one time, clear-cutting is one of the most efficient ways to harvest a stand. This system can also be used with specialized harvesting equipment designed for high production rates.

In areas with large populations of deer, large-scale clear-cutting may be the only way to establish some tree species. The vigorous and profuse regeneration following correctly conducted and timed clear-cutting normally allows a number of trees to escape major damage from deer. When clear-cutting is done during the summer, there should be an adequate source of seeds in an adjacent stand or seed trees within approximately four tree heights horizontal to the clear-cutting. In years of fair-to-good seed crops, cutting during the rest of the year usually will result in adequate seed from the harvested trees.

Clear-cuts should not be conducted on easily eroded soil or where a drastic change in the appearance of the forest would be objectionable. The initial impact can be tempered by regulating the size, shape, and location of clear-cut areas so that they blend naturally with the landscape. A patchwork of clear-cuts arising from harvests conducted at different times provides a diverse habitat for wildlife.

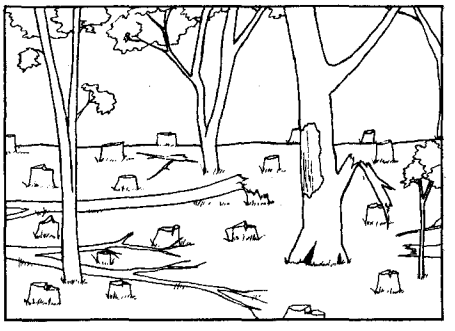


Figure 15. High-grading removes all but the poorest quality trees, thereby greatly reducing the future timber value of a woodland.

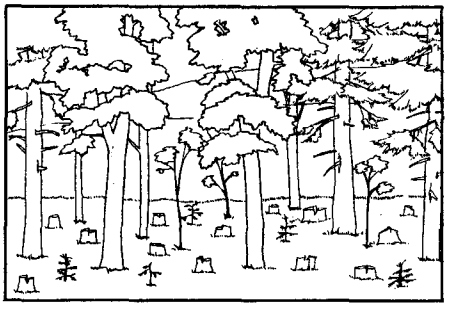


Figure 16. Selection system.

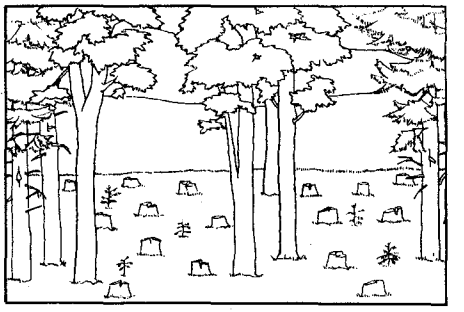


Figure 17. Shelterwood system.

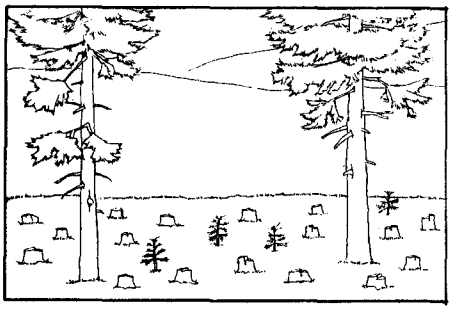


Figure 18. Seed tree system.

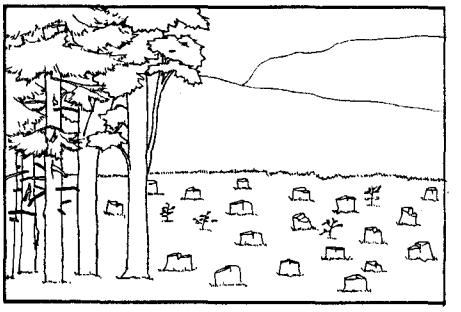


Figure 19. Clear-cut system.

Most forest owners who have more than 50 acres find that no one regeneration or harvesting system is appropriate for all their holdings. The woodlands of the Northeast are diverse and can be best managed by compartmentalization. In this way, each compartment is subjected to the most appropriate harvesting strategy. For example, a readily accessible and highly visible woodland might be managed best as an uneven-aged stand, using selection harvesting. Such a harvest would not drastically change the stand's appearance, and frequent harvests would provide some wood products for personal use or income. Other sites might be particularly well suited to tree species that require shelterwood systems. Still other sites that are more remote might be managed by clear-cutting adjacent 5- to 15-acre compartments at regular intervals. Wildlife are thus provided with a diverse habitat in the variously aged stands.

In summary, forest owners should consider the merits of various harvesting systems to ensure that their ownership objectives will be met.

Harvesting Timber

Cutting timber and either skidding it to the roadside or delivering it to a mill may increase the landowner's profits substantially, but it requires time, expertise, equipment, and physical endurance that relatively few landowners have. Professional logging is a strenuous, hazardous occupation.

In addition to the personal risks involved in timber harvesting, logging costs must be carefully considered. Direct costs include the purchase of such special equipment as a professional-size chain saw, a crawler tractor or four-wheel-drive tractor/skidder, and perhaps a log loader and truck. Equipment maintenance, increased personal insurance, and Worker's Compensation insurance for hired help are other direct costs. Indirect costs may include loss of income from other activities, damage to machinery not well suited to logging, and lower timber value resulting from improper practices in felling, bucking, handling, storage, marketing, and transporting.

Many publications dealing with logging equipment and techniques are available. A few are listed in the Suggested References section. If you wish to do some of your own logging, keep the following suggestions in mind:

- Have a buyer and a contract before you invest time and money in harvesting.
- Know the buyer's wood-product specifications and requirements (log size, species, quantity, quality).
- Know your legal responsibilities for Worker's Compensation, landowner liability, federal labor laws, minimum wage, Social Security, state and federal income taxes, and occupational safety and health.
- Use equipment designed for logging and keep it in good working condition.
- Know your limitations and plan to do only a reasonable amount of logging yourself, leaving the remainder for professionals.

Measuring Sawlogs

Although many activities associated with logging preclude direct involvement by landowners, you may find that measuring the volume of sawlogs **(log scaling)** at the **landing** or sawmill yard is easy and interesting. Log scaling provides a more accurate estimate of volume than the standing-timber cruise tally and, in some instances, may be the basis for the timber sale.

Log scaling provides only an estimate of the amount of lumber that can be produced because some of the gross volume is lost in the form of **slabs** and **saw kerf.** Loss to slabs and kerf will vary depending on the length of the log, its diameter and taper, saw width, and the **sawyer's** skill. Various **log rules** have been calculated to account for these losses. The Doyle, Scribner, and International ¼-inch log rules are commonly used in the Northeast.

The Doyle Rule is the most common, and the least accurate because it significantly underestimates the actual volume of logs that are less than 23 inches in diameter at the small end—an inaccuracy that theoretically compensates a sawmill for handling small logs. The Scribner Rule is somewhat more accurate than the Doyle Rule, but it also underestimates volume for logs under 21 inches in diameter. The International Rule is quite accurate and not biased by log length or diameter. Regardless of the log rule used, sellers can be assured of a fair purchasing price if they get competitive bids from several prospective buyers.

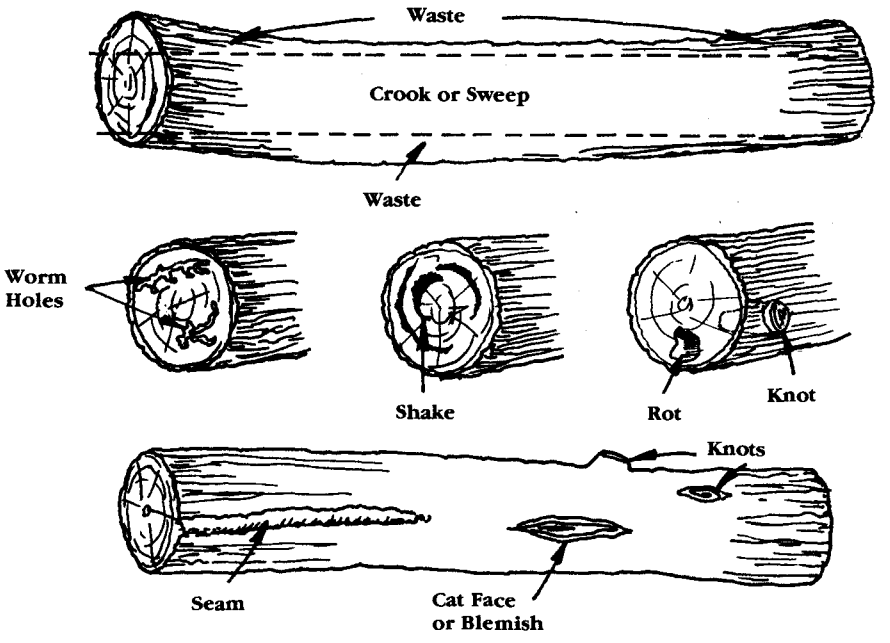


Figure 20. Defects reduce the total sawtimber log volume and value.

The diameter of each log is measured inside the bark at the smaller end. The face of an oblong-shaped log is measured across its longest and shortest diameters, and the average of the two is calculated. Logs are usually cut to the nearest even foot (between 8 and 16 feet) plus 3 or 4 inches to allow for trim. If there is no allowance for trim, the log must be scaled at the next lowest acceptable length. Once the log is measured, its diameter and length are noted on a tally sheet and written on the face of the smaller end with a log crayon to prevent remeasurement and to facilitate a quick final check of the tally figures.

To determine log volume from the measurements, refer to a log rule volume table (see Appendix 3). Appendix 12 is an exercise on log scaling and shows a simple log scale tally sheet that can be made on notebook paper.

An accurate log tally must account for log defects that reduce the gross volume of the log. Figure 20 illustrates crook or sweep, insect damage, shake (caused by wind), rot (resulting from fire or other wounds), seams (caused by lightning or frost), and knots. Formulas are used to calculate the percentage of a log that is waste. If a log scale is being used to check a logger's or sawmill's tally, it may not be necessary to calculate cull on a log-to-log basis. A simple 10 to 15 percent deduction of the gross total usually suffices.

Arranging the Sale

A timber sale represents the major payoff for years of management. To get the best price possible, familiarize yourself with the markets for timber products a few years before an anticipated harvest. Because market values can fluctuate considerably, it is often better to wait a year or two than to sell when prices are down. Unless they are diseased, trees store well on the stump and, in fact, continue to grow.

It is advisable to use the services of a professional forester to help arrange a sale. These professionals generally have more experience, skill, and contacts than do forest owners, and they can be hired on either a commission or daily basis.

Unless the forest owner has decided to do the harvesting, the trees are sold to a logger on a **stumpage** basis in a lump-sum sale, a sale by unit, or a percentage sale. Of the three types of sales, a lump-sum sale is the easiest and is most often recommended by professional foresters. In a lump-sum sale, the buyer offers the seller a single payment for the estimated standing wood. This arrangement has three primary advantages: 1) the landowner receives money in advance of harvesting; 2) confusion and doubt over scaling volume and grade is eliminated; and 3) because the logger is by legal definition harvesting his or her own logs, the seller's liability for property damage, personal injury, and Worker's Compensation insurance is greatly reduced.

In a sale by unit, the buyer offers the seller a dollar value for each unit of wood (e.g., 1,000 board feet, a standard cord, an agreed-upon number of poles or posts) measured at the log landing or upon delivery at the sawmill. This method ensures an accurate tally of the volume of wood harvested, but it requires complete trust between the seller and the buyer. Logs are usually sold according to grade, a practice that further complicates the sales agreement. In addition, some buyers harvest only the best of the marked trees in an effort to increase their profit margin per unit. Such a practice essentially results in high-grading.

In a percentage sale, the buyer offers the seller a percentage (typically 30 to 55 percent) of the price the buyer will receive at the sawmill. The value of the timber fluctuates with market demand and receipts, but the buyer strives for the best price possible to receive the greatest income. This type of agreement also requires trust between the seller and buyer.

Once the timber has been cruised, marked, and the type of sale determined, the forest owner and forester decide how to select a buyer. When the timber sale is relatively large, a number of buyers may be interested, and competitive bidding will give the seller the highest return. The terms of the proposed sale and the estimated value and volume of the timber, as well as an invitation to view the standing timber, are sent to prospective loggers and sawmill owners. In addition, advertisements may be placed in local newspapers, lumber trade journals, and marketing bulletins.

It is usually worthwhile to contact a previous seller and visit a logging site before accepting a logger's bid. A high bid may reflect a logger's tendency to cut costs by forgoing erosion control or protection of the residual stand. A high sale price does not warrant sacrificing future timber productivity by damaging land and trees. When the proposed sale is small, the timber value low, or both, the inconvenience of open bidding may not be warranted. In such cases the seller may wish to negotiate a fair price with a single reputable buyer.

The Contract

Regardless of the type of sale or the method of notifying potential buyers, the personal interests and legal rights of both the seller and the buyer should be protected by a written contract. Because timber sales and harvesting contracts are rather complex, many forest owners find it advisable to hire a professional forester to prepare and administer these contracts.

Provisions regarding economic or environmental aspects of the harvest can be identified in the contract (see Appendix 4). For example, the future productivity of the woodlands should be protected by specific provisions concerning damage to residual trees and severe soil erosion caused by careless skidding and improper placement and grading of **skid trails.** Special provisions in the contract can cover such activities as the limbing and piling of felled tops and the clearing and seeding of landings and skid trails. In addition, special management activities for wildlife and recreation can be identified. The forest owner should be aware that such activities increase the timber harvester's costs and reduce returns from the sale. Ultimately, it is the owner who incurs the additional costs of special management activities during the timber harvest.

In addition to the contract, the timber harvester should be required to post a bond to be used if the terms of the contract are violated. The landowner, a forester, or both should periodically inspect the cutting operation and talk to the logger to ensure that all the provisions of the contract are being met. If misunderstandings arise, they should be resolved as soon as possible with the logger, or the logging activities should be stopped and legal proceedings initiated.

A contract also protects the interests of the logger. The logger should not hesitate to agree to a fair contract. Once the contract is finalized, only those provisions identified in writing are binding; a forest owner should not expect the logger to engage in activities to improve the timber stand or to build roads or do landscaping without adjusting the stumpage price downward.

Economics of Forest Ownership

The majority of the Northeast's private, nonindustrial forest owners cannot expect large, continuous profits from timber production. The timber revenue from most small woodlands, even those that are excellently managed, can usually only partially defray ownership costs. Timber management should not be viewed as a "get-rich-quick" venture; profits are modest considering the long-term commitment necessary. Nevertheless, prudent investments in timber management can be the means by which forest owners can afford to own forestland and possibly achieve other ownership objectives.

As the cost of land and public services rise and as property taxes increase, forest owners will have more difficulty meeting ownership costs. Land taxes in New York are levied on the basis of the land's highest value for its best use rather than its current use. Forestland that could be used as a valuable building site, for example, can be taxed on the basis of that use. Normally, the selling price also reflects the land's highest value, a value that is realized only when the land is sold. Timber production usually cannot compete economically with alternative land uses such as agricultural, commercial, industrial, residential, or recreational development.

To determine if forestland is affordable solely for timber production, estimate the forest's net monetary return, which is its total income minus its total costs over a period of time.

Income arises primarily from the sale of wood products such as veneer, sawlogs, pulpwood, and firewood. Typical **fixed costs** include the purchase price of the land, mortgage costs and interest rates, taxes, and the insurance associated with ownership. Costs directly incurred from timber production include forest protection and management activities. Because costs are spread over a period of years while the trees are growing, both fixed costs and the cost of long-term management should be included in the overall expenses. At an annual inflation rate of 5 percent, a $100 investment must yield $265 after 20 years to break even. Inflation, like interest rates on savings accounts, is compounded, based on the principal.

A managed and well-stocked hardwood forest on a good site in the Northeast can grow approximately 250 board feet of lumber per acre per year over a 90-year rotation from seedling to mature timber. This growth rate represents a value of about $60 to $70 a year at 1994 timber prices, which may be $10 to $20 more than the annual fixed ownership costs. Several factors can detract from this hypothetical profit margin:

- Land prices vary greatly. Few stands on land costing more than $1,000 per acre will generate enough income to meet all fixed costs, including mortgage payments.
- Relatively few forest parcels have a uniformly high site index and are uniformly well-stocked with high-value species.
- Timber is a long-term crop, and it is not possible to meet costs on a yearly basis. Thus, annual and periodic costs must be compounded until a timber sale provides income. Escalating land taxes in particular are large annual cash expenses that are very expensive to absorb over decades while waiting for a timber harvest.

In recent decades, prices of quality timber have kept ahead of inflation, but there is no assurance that this pattern will continue. Few individuals who own small tracts could meet all fixed ownership costs through timber production alone. One solution to this dilemma is to assign all fixed ownership costs to the primary land-use objective, that is, to the land's use as a permanent or second homesite, and to view timber production as a fortunate by-product of ownership. Prudent investments of time and money in timber management yield a net profit upon the sale of timber, therefore justifying the expenses of timber management. Of course, timber management would have to be compatible with the primary objectives.

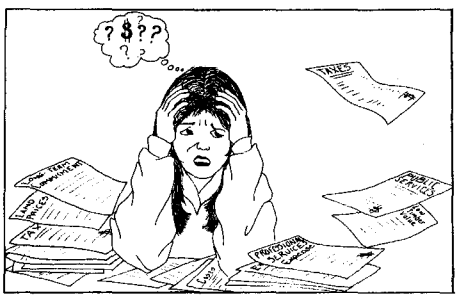


Figure 21. Forest owners must take into account many economic variables.

Although investments in timber management practices (discounting the fixed cost of the land) generally yield a net positive return even when woodlands have a modest timber-producing potential, the costs of management should roughly coincide with the potential value of the timber.

The three factors that determine a woodland's value for timber production are: 1) the quality of the site (reflected in its site index), 2) the potential market value of the timber, and 3) the management practices. These factors are interrelated, but the first two largely determine the amount of time, money, and effort the landowner should invest in timber management. High-quality sites located near strong timber markets are worthy of substantial management investments; the forest stands will respond dramatically to wise management, and an outlet for production exists. On the other hand, woodlands with little potential timber value or those that are isolated from markets may not warrant any timber management activities (Fig. 21).

Capital for Long-term Investment

Although capital investments for timber management activities are often small, the money is tied up for years and the returns are realized only periodically. Cash-flow difficulties can result. Several public assistance programs, however, provide incentives for landowners to invest in timber production. Owners of small holdings are eligible to receive advice or on-site technical assistance from public foresters, either free or for a small fee. Forestry loans and **cost-sharing** programs, through government agencies are also available. Under these programs, landowners receive a percentage of the average cost of carrying out prescribed forestry measures that improve timber growth and value. The Stewardship Incentive Program (SIP), as an example, provides cost-share assistance to eligible forest owners for approved practices undertaken for a wide variety of objectives, including: management plan development, reforestation, timber stand improvement, windbreak management, soil and water protection, wetlands protection, fisheries enhancement, wildlife enhancement, and recreational enhancement. Contact your regional state forester, Farm Services Agency (FSA) office, or county Cooperative Extension office for information on cost-share programs.

Taxes

A variety of taxes are associated with owning woodlands. Upon acquiring a parcel of land, some forest owners pay an inheritance tax based on the selling price or value of the land. All woodland owners are faced with annual real property taxes, which unfortunately often reflect potential rather than actual use as a woodlot.

Upon harvesting, forest owners are subject to capital gains or income tax, depending upon the nature of the timber sale. Consequently, high inheritance taxes and property taxes, in addition to taxes levied on income from the sale of timber, can be a heavy burden on forest owners. There is help available, however.

New York Forest Tax Law

Many states have a real property tax law that provides some relief for private woodland owners. New York State, for example, has the Forest Tax Law, Section 480-a of the Real Property Tax Law. Forest owners who meet minimum qualifications and agree to abide by fairly stringent regulations, including producing a commercial timber crop, are entitled to significant property tax reductions under this program. Annual property taxes are reduced, and **yield taxes** are paid at the time of commercial timber harvests, as detailed in a New York State-approved forest management plan. Landowners interested in certifying their land under Section 480-a should contact their regional DEC forester.

Capital Gains

Under the capital gains provision, substantial federal income tax savings can be realized upon the sale of timber. The provision encourages woodland owners to hold timber and accumulate **growing stock.** Expenses for management practices and equipment depletion allowances are subtracted from the sale of the timber and only the remainder is taxed. Careful bookkeeping is required to document management expenses adequately.

The long time it takes for trees to grow to marketable size is often a major drawback to sound forest management activities. Some landowners are hesitant to commit money to forest management practices and yearly taxes because of the low rates of return and the risks of fire, storm, and insect damage. Other landowners realize that they may not own the land long enough or live long enough to see the timber harvested. Yet, a well-managed woodland should increase in value 50 percent faster than an unmanaged woodland, and a preharvest sale should reflect this increase. Furthermore, even though a woodland may take decades to produce sawlogs or veneer logs, several other timber products—poles, posts, pulpwood, log cabin stock, or firewood—can be harvested through thinnings. These intermediate products may produce a modest return and give owners an opportunity to realize the fruits of their labor.

Marketing Concerns

Although the price of high-quality hardwood timber has been generally high for the past decade, market values fluctuate widely in response to supply and demand in the lumber industry, especially the demand for building supplies. It is therefore difficult to predict which species will be most valuable at a future harvest date. Because timber is expensive to transport, its value to the woodland owner is affected by the distance to the processing mill. Also, harvests on small tracts of land tend to be inefficient; harvesting costs are increased, and net timber value further decreased (Fig. 22).

Forest owners can combat low prices and uncertain markets. In selecting crop trees during thinning activities, pick species that traditionally have been in high demand. Moreover, the best buyer is often the owner. Owners who use their poles, posts, firewood, and lumber on a farm or estate can drastically cut their expenses. Management practices do pay off. High-quality timber is worth two to three times more than poor-quality timber, and managed stands also grow faster than unmanaged stands. The expense of small-scale logging can be reduced considerably if an owner performs some of the labor or synchronizes harvests with adjacent owners to increase overall efficiency. Also, as previously mentioned, well-advertised sales sold through competitive bidding will ensure good price offers.

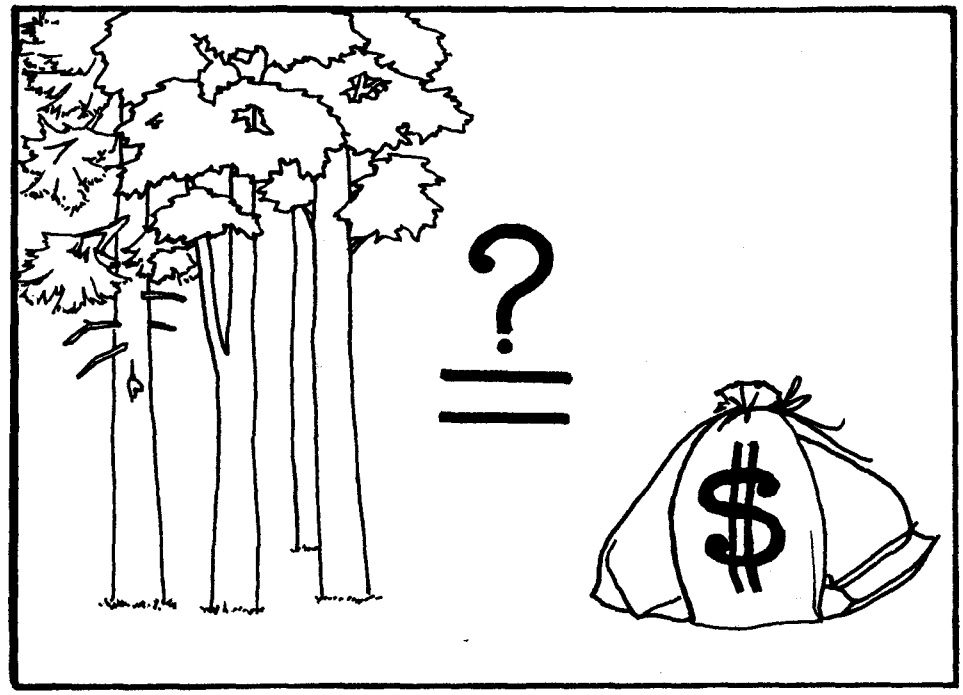


Figure 22. Timber values depend upon several interrelated variables.

Obtaining Assistance

Even the most experienced forest owners use the services of public and private organizations offering management assistance. Many forest owners indicate that much of the success and satisfaction they derive from their forest resources is directly linked to the assistance they have obtained. Many of the woodland owner's needs, from the most general advice to the most specific on-site assistance, can be met by one or more of these organizations. See Appendix 14 for some useful addresses.

The New York State Department of Environmental Conservation (DEC) and the USDA Farm Services Agency (FSA) administer publicly funded programs that provide eligible forest owners with partial funding or on-site assistance in carrying out forest management activities. These activities include developing management plans, wildlife management, establishing forest plantations, caring for and thinning immature stands, and marking trees for harvest. (These programs do not include timber sales.) Most states throughout the Northeast have similar cost-sharing programs. Forest owners who do not qualify for public cost-sharing programs (usually because of acreage requirements) may still receive on-site advice from their regional state forester.

The New York Master Forest Owner (MFO)/COVERTS program, started in 1991, now has over 100 volunteer MFOs. MFOs are experienced forest owners who have completed a three-day workshop given by Cornell Cooperative Extension. The goal of the program is to provide private, nonindustrial forest owners with the information and encouragement necessary to manage their forest holdings wisely. Typically, the volunteers arrange a half-day woodlot visit with interested neighbors to get a firsthand look and then discuss sources of information and assistance. A listing of MFOs may be obtained from Cornell Cooperative Extension county offices or NYSDEC Regional Forestry offices. Most northeastern states have similar programs, sponsored in part by the Ruffed Grouse Society.

Forest owners requiring assistance with large-scale timber management, specialized woodland management, or timber sale arrangements may be interested in hiring a consulting forester. The use of consultants usually results in increased profits, which offset the consultant's fees. A list of qualified consultants working in New York State may be obtained from the New York Institute of Consulting Foresters or the region's DEC forestry offices.

Some timber companies will perform on-site management services for private, nonindustrial woodland owners. Such assistance is often free in return for allowing the company first-refusal rights on a future timber sale. Individuals who own woodlands near land owned by large timber companies may find it helpful to examine company policies concerning such practices.

In addition, the New York Forest Owners Association and the American Tree Farm System are two nonprofit organizations that forest owners may wish to join. Both organizations are dedicated to promoting wise timber management of private, nonindustrial forests. Members receive free advice and assistance on woodland management through meetings, inspections of forests, informational mailings, and periodic publications.

Appendix 1. Standard Measures and Conversions

English and Forestry Terms[1]

Length
1 rod = 16.5 ft.
1 chain = 66 ft. = 4 rods
1 furlong = 10 chains = 660 ft.
1 mile = 5,280 ft. = 8 furlongs = 80 chains = 320 rods

Area
1 acre = 43,560 sq. ft. = 4,840 sq. yds. = 10 sq. chains
1 sq. chain = 1/10 acre
1 sq. mi. = 640 acres = 1 section
1 forty = 40 acres

Volume[2]
1 standard cord = 128 cu. ft. of air space and wood = approximately 85 cu. ft. of solid wood = approximately 500 board feet (bf)

Metric Conversions[3]

Length
1 in. = 2.54 cm
1 yd. = 0.914 m
1 rod = 5.029 m
1 mi. = 1.609 km
1 cm = 0.39 in.
1 m = 39.37 in. = 3.28 ft. = 1.09 yd.
1 km = 0.621 mi.

Area
1 acre = 4,047 sq. m = 0.405 hectare (ha)
1 sq.mi.= 2.59 sq. km = 259 ha
1 ha = 2.47 acres
1 sq. km = 0.386 sq. mi.

Volume[4]
1 cu. ft. = 0.028 cu. m
1,000 bf (MBF) sawlogs measured in International 1/4-inch Log Rule = 3.48 cu. m
1 cord (approx. 85 cu. ft. of wood) = 2.42 cu. m
1 cu. m = 35.31 cu. ft.
1 cu. m = 0.287 MBF (International ¼-inch Rule)

Weight
1 oz. = 28.349 gm
1 lb. = 0.454 kg
1 ton = 2,000 lbs. = 0.907 metric ton
1 metric ton = 1.1 tons

[1]Many specific measures have been historically associated with forestry.

[2]Calculated volume will vary with log rule; these figures are based on the International ¼-inch Log Rule.

[3]cm = centimeter; m = meter; km = kilometer; ha = hectare; kg = kilogram.

[4]Calculated volume will vary with log rule.

Appendix 2. Tree Volume Tables

Number of trees required to yield one cord (128 cubic feet)

Diameter of trees (inches)	*Hardwood (deciduous)*	*Softwood (coniferous)*	*Diameter of trees (inches)*	*Hardwood (deciduous)*	*Softwood (coniferous)*
5	35		18	1.5	1.9
6	20		19	1.3	1.6
7	15	20	20	1.2	1.5
8	11	13	21	1.0	1.4
9	8	10	22	.9	1.2
10	6	8	23	.8	1.1
11	5	7	24	.7	1.0
12	4	6	25	.6	.9
13	3.5	4.5	26	.58	.8
14	3.0	3.7	27	.5	.77
15	2.5	3.0	28	.44	.7
16	2.0	2.5	29	.43	
17	1.7	2.1			

Source: Bulletin 148, University of Maine.

Gross volume of tree, International ¼-inch Log Rule (in board feet)

Tree diametter	*Number of usable 16 -foot logs*					
(inches)	*1*	*1½*	*2*	*2½*	*3*	*3½*
10	38	50	61	69	77	
11	48	63	78	89	100	
12	58	77	96	110	124	132
13	70	94	117	135	153	164
14	82	110	138	160	182	196
15	95	128	160	187	214	233
16	108	146	183	214	246	269
17	124	168	212	249	286	313
18	140	190	240	282	325	356
19	158	215	272	321	370	406
20	176	240	305	360	414	455
21	196	269	342	403	464	511
22	216	297	378	446	514	568
23	238	328	418	494	571	629
24	260	359	458	543	628	690
25	282	390	499	592	685	756
26	305	422	540	641	742	820
27	331	460	588	699	810	895
28	357	496	635	756	877	969
29	385	536	686	817	948	1,048
30	413	575	737	878	1,020	1,128

Note: Form class 79.

Tree volume (in rough standard cords)

	Number of 16-foot lengths					
*DBH**	*½*	*1*	*1½*	*2*	*2½*	*3*
6	.017	.028	.040	.047		
8	.031	.050	.068	.087	.106	.116
10	.049	.082	.111	.133	.160	.188
12	.070	.121	.165	.198	.225	.260
14	.095	.167	.228	.273	.311	.353
16	.122	.220	.300	.367	.42	.47
18	.155	.280	.382	.47	.55	.60
20	.194	.353	.48	.59	.68	.76
22	.240	.44	.60	.73	.84	.93
24	.298	.52	.72	.88	1.00	1.12
26	.340	.62	.84	1.04	1.19	1.33
28	.388	.72	.97	1.20	1.38	1.55
30	.43	.80	1.10	1.37	1.59	1.7

Source: Technical Bulletin 1104, Lake States Forest Experiment Station.
Note: Rough, with bark.
*DBH = diameter at breast height (4½ feet above ground).

Appendix 2. (continued)

Gross volume of tree, Doyle Log Rule (in board feet)

Tree diameter	*Number of usable 16 -foot logs*					
(inches)	*1*	*1½*	*2*	*2½*	*3*	*3½*
10	15	18	21	22	24	
11	22	28	33	36	40	
12	30	38	45	50	55	57
13	40	51	62	70	77	80
14	50	64	79	89	99	104
15	62	80	99	112	126	135
16	74	96	119	136	153	165
17	89	117	145	166	188	203
18	104	138	171	198	224	242
19	122	162	202	234	266	288
20	139	186	233	270	308	334
21	160	214	269	314	358	389
22	180	242	305	356	407	444
23	202	274	346	405	464	505
24	225	306	386	453	520	566
25	248	338	428	503	578	631
26	272	471	471	554	636	697
27	300	410	521	614	707	774
28	328	450	571	674	778	852
29	358	492	626	740	854	936
30	388	534	680	804	929	1,018

Note: Form class 79.

Gross volume of tree, Scribner Log Rule (in board feet)

Tree diameter	*Number of usable 16 -foot logs*					
(inches)	*1*	*1½*	*2*	*2½*	*3*	*3½*
10	29	37	45	50	55	
11	38	50	61	68	76	
12	48	62	77	88	98	104
13	60	79	98	112	126	134
14	72	96	119	136	154	165
15	84	112	141	163	185	200
16	97	130	163	190	216	234
17	112	151	190	222	254	276
18	127	172	217	254	291	318
19	144	196	248	291	334	365
20	161	220	278	327	376	412
21	180	246	312	368	424	465
22	199	273	347	409	471	518
23	221	304	386	456	526	578
24	243	334	425	503	581	638
25	265	365	465	550	636	700
26	287	396	505	598	691	763
27	312	432	551	654	756	835
28	337	467	597	710	822	907
29	366	507	648	770	892	985
30	394	546	699	830	962	1,062

Note: Form class 79.

Appendix 3. Log Volume Tables

Log volume, International Log Rule (in board feet)

Diameter	*Length of log in feet*					
(small end)	*6'*	*8'*	*10'*	*12'*	*14'*	*16'*
6	5	10	10	15	15	20
7	10	10	15	20	25	30
8	10	15	20	25	35	40
9	15	20	30	35	45	50
10	20	30	35	45	55	65
11	25	35	45	55	70	80
12	30	45	55	70	85	95
13	40	55	70	85	100	115
14	45	65	80	100	115	135
15	55	75	95	115	135	160
16	60	85	110	130	155	180
17	70	95	125	150	180	205
18	80	110	140	170	200	230
19	90	125	155	190	225	260
20	100	135	175	210	250	290
21	115	155	195	235	280	320
22	125	170	215	260	305	355
23	140	185	235	285	335	390
24	150	205	255	310	370	425
25	165	220	280	340	400	460
26	180	240	305	370	435	500
27	195	260	330	400	470	540
28	210	280	355	430	510	585
29	225	305	385	465	545	630
30	245	325	410	495	585	675

Log volume, Scribner Log Rule (in board feet)

Diameter	*Length of log in feet*				
(small end)	*8'*	*10'*	*12'*	*14'*	*16'*
6	6	10	12	14	18
7	12	16	18	24	28
8	15	20	24	28	32
9	20	25	30	35	40
10	24	31	40	45	50
11	32	40	50	55	65
12	40	49	59	69	79
13	48	61	73	85	97
14	57	71	86	100	114
15	71	88	107	125	142
16	79	99	119	139	159
17	93	115	139	162	185
18	106	133	160	187	213
19	120	150	180	210	240
20	140	175	210	245	280
21	152	190	228	266	304
22	167	209	251	292	334
23	188	235	283	330	377
24	202	252	303	353	404
25	229	287	344	401	459
26	250	313	375	439	500
27	274	343	411	479	548
28	291	363	436	509	582
29	305	381	450	533	609
30	328	410	493	575	657

Appendix 3. (continued)

Log volume, Doyle Log Rule (in board feet)

Diameter	*Length of log in feet*					
(small end)	*6'*	*8'*	*10'*	*12'*	*14'*	*16'*
6	2	2	3	3	4	4
7	3	5	6	7	8	9
8	6	8	10	12	14	16
9	9	13	16	19	22	25
10	14	18	23	27	32	36
11	18	25	31	37	43	49
12	24	32	40	48	56	64
13	30	41	51	61	71	81
14	38	50	63	75	88	100
15	45	61	76	91	106	121
16	54	72	90	108	126	144
17	63	85	106	127	148	169
18	74	98	123	147	172	196
19	84	113	141	169	197	225
20	96	128	160	192	224	256
21	108	145	181	217	253	289
22	122	162	203	243	284	324
23	135	181	226	271	316	361
24	150	200	250	300	350	400
25	165	221	276	331	386	441
26	182	242	303	363	424	484
27	198	265	331	397	463	529
28	216	288	360	432	504	576
29	234	313	391	469	547	625
30	254	338	423	507	592	676

Appendix 4. Sample Contract for Sale of Standing Timber

This contract entered into this _____ day of _____, 19_____, between _____ (Seller) of _____ (Post Office)

_____ (State), hereinafter called the Seller, and _____ (Purchaser) of _____ (Post Office)

_____ (State), hereinafter called the Purchaser.

Whereas said Seller desires to sell certain designated trees standing and lying on a tract of land owned by her or him,

located _____

without impairing the productivity of the woodland.

Now, therefore, this contract witnesseth:

I. The Seller agrees to sell and the Purchaser agrees to buy for THE TOTAL SUM of_____

Dollars ($_____) under the conditions set forth in this contract all of the designated trees on the above tract.

II. Trees designated for cutting include those marked by the Seller, or his or her agent, with_____ (paint, blaze)

at 4½ feet and below stump height.

III. The total number of trees conveyed is _____ (Number), composed of _____, _____, _____ (Species), _____, _____

IV. The Seller further agrees:

A. To guarantee title to the forest products covered by this contract and to defend it against all claims at his or her expense.

B. No concurrent contract involving the area or period will be entered into by the Seller without written consent of the Purchaser.

C. The Purchaser and his or her employees shall have access to the area at all reasonable times and seasons for the purpose of carrying out the terms of this contract.

D. All designated trees must be cut but the Purchaser shall retain the right to leave felled such designated trees as she or he may consider not to contain merchantable material worth removing from the area.

V. The Purchaser further agrees:

A. To pay to the Seller THE TOTAL SUM OF _____ Dollars ($ _____) for the designated trees in advance of cutting. (See Paragraph I).

B. Unless an extension of time is agreed upon in writing between the Seller and the Purchaser, all timber shall be cut and removed on or before and not later than the _____ day of _____, 19_____, and any material not so removed shall revert to the Seller.

C. To remove all equipment and structures built by the Purchaser and used during the operation within ninety (90) days after completion of this contract. If not removed, the items remaining become the property of the Seller.

D. To show proof of adequate coverage by Workers' Compensation Insurance prior to and during completion of this contract.

E. Not to assign this contract in whole or in part without the written consent of the Seller.

F. To use his or her entire force to prevent and suppress forest fires on or threatening the sale area.

G. To leave all woods roads and streams clear of tops, logs, brush and other obstructions, and to reduce to acceptable dimensions all tops and other logging residue.

H. The Seller will retain title to tops and other materials not considered merchantable for logs or pulp to dispose of as Seller sees fit.

I. To protect from unnecessary injury young growth and other trees not designated for cutting.

J. To pay the Seller damage and penalty for each tree that is cut in violation of the terms of this contract, a stumpage price of _____ Dollars ($ _____) per thousand board feet, but this shall not be construed as permission to cut any tree not designated. The Purchaser understands and agrees that the average diameter of the stump, outside bark, shall be used as DBH (diameter 4½ feet above ground) of the tree, and the tree shall be presumed to have contained _____ (length) feet of clear, sound merchantable stem. Volume to be based on _____ (log rule).

K. To clear necessary logging roads only after their locations have been definitely agreed upon with the Seller or his or her agent.

L. To repair damage caused by logging to ditches, fences, bridges, roads, trails, or other improvements damaged beyond ordinary wear and tear.

M. To comply with the State's silvicultural best management practices which are incorporated in the State Water Quality management plan.

N. Special Provisions _____.

O. Any liability for damage, destruction, or restoration of private or public improvements occasioned by or in the exercise of this contract shall be the sole responsibility of the Purchaser.

VI. The Seller and the Purchaser further agree:

A. The Seller or his or her agent shall make inspection of the cutting operations from time to time and may order their complete cessation if they are found to be violating the terms of this contract.

B. All modifications of this contract will be reduced to writing, dated, signed and witnessed and will be attached to this contract.

C. In case of dispute over the terms of this contract, final decisions shall rest with a reputable person to be mutually agreed upon by the parties to this contract. In the case of further disagreement, an arbitration board of three persons will be selected, one by each party, and the third by those two selected; and the decisions of the majority shall be final with respect either to acts to be done or compensation to be paid by either party to the other.

In witness whereof, the parties hereto have set their hands and seals, this _____ day of _____, 19_____.

WITNESSES:

_____ (For the Purchaser)

_____ (Purchaser)

_____ (For the Seller)

_____ (Seller)

Appendix 5. Pacing

The ability to pace off a distance with reasonable accuracy is useful for a variety of woodland management practices and is easy to master. A tape measure should be used when exact distances are critical, such as when one needs to know the radius of a plot sample or determine exact property boundaries. Pacing can be used to find boundaries easily and reliably, to create transect lines for a sample cruise, to pace off 66 feet when calculating tree height with a scale stick, to check the width of buffer zones, and to estimate the sizes of compartments.

Follow these steps to determine the length of your pace:

1. With a measuring tape or length of rope, mark off 100 feet in a moderately dense forest stand.
2. Starting with one foot, count a pace every time the opposite foot is put down (2 steps = 1 pace). Using a normal, comfortable stride, pace the 100 feet about 4 times, noting each time the number of paces it takes to cover the distance. *(Note:* An exaggerated pace is less standard in length and impossible to maintain through forest cover.)
3. Divide the sum of the total number of paces by the number of times you paced the distance. This figure represents the average number of paces it took to walk the 100 feet.
4. The length of your pace will be equal to 100 feet divided by the average number of paces it took to travel the 100 feet (calculated in step 3).

Example 1

A person with an average pace of 5 feet wishes to find a boundary marker 138 yards away. How many paces will it take to cover this distance?

1. First convert 138 yards to feet:

   138 yd. x 3 ft. = 414 ft.
2. Then divide the distance (in feet) by the pace length: 414 ft. ÷ 5 ft. = 83 paces (rounded to the nearest whole pace).

Example 2

A person with an average pace of 5.6 feet found that a rectangular compartment measured 64 paces by 97 paces. What is the area (in acres) of the compartment?

1. First convert paces to feet: 64 paces x 5.6 = 358.4 ft., and 97 paces x 5.6 = 543.2 ft.
2. Next calculate the area of the compartment in square feet: area of a rectangle = length x width, so area = 358.4 ft x 543.2 ft. = 194,683 sq. ft.
3. Then divide the area of the compartment by the number of square feet in an acre (43,560): thus, 194,683 sq. ft. ÷ 43,560 sq. ft. = 4.5 acres.

Appendix 6. Using a Scale Stick

A scale stick is used to measure the diameter of a tree (DBH) in inches and the height in number of 16-foot logs or 4- or 5-foot pulpwood sticks. A scale stick is similar to but shorter than a yardstick. One commonly available scale stick is designed as follows. On the tree scale side of the stick, one edge measures the tree's DBH in inches. The opposite edge of the stick measures the number of 16-foot logs in the tree. On the log scale side, one edge measures the number of 5-foot pulpwood sticks. Tables on the scale stick also can be used to calculate the volume of a log or tree in board feet. Sticks are designated for different log scales (Scribner, International, etc.).

To measure the diameter at breast height (DBH), follow these steps:

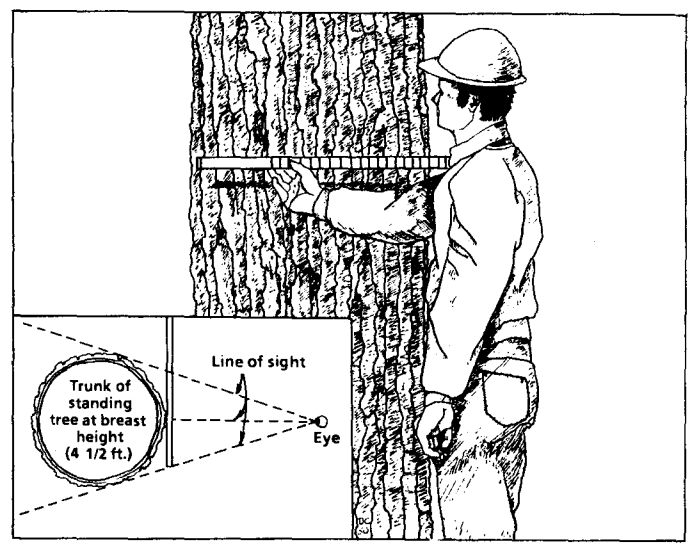
1. Holding the scale between your forefinger and thumb, hold the stick horizontally against the tree, 4½ feet from the ground and 25 inches (length of stick) from your eyes. Make sure the tree scale side is facing you.
2. Look directly at the center of the tree. Without moving your head, shift your eyes to the left and line up the zero end of the stick with the left edge of the tree.
3. Without turning your head, look at the other edge of the tree and read the number nearest this edge of the tree (see accompanying figure). This is the DBH in inches.
4. If the tree trunk does not have a uniform diameter, measure the diameter at both the widest and the narrowest points and determine the average of the two.

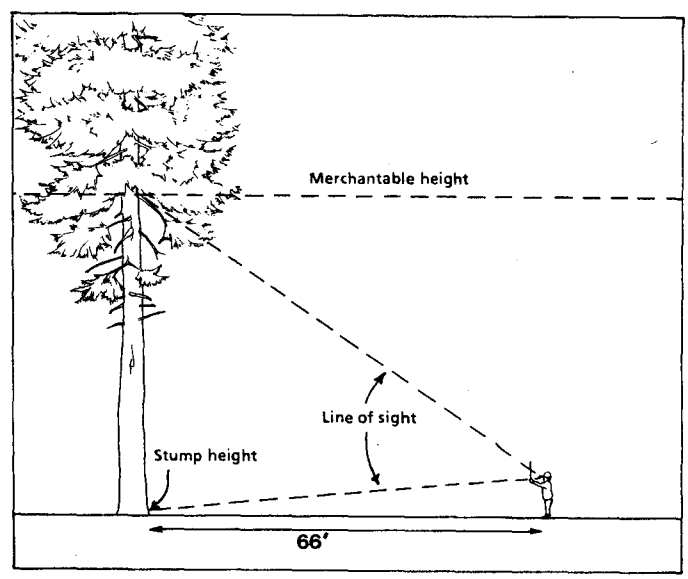
To measure the height of a tree, follow these steps:

1. Stand 66 feet from the tree, level with its base.
2. If you are measuring the number of 16-foot logs in the tree, hold the tree scale side of the stick facing you. If you are measuring the number of 5-foot pulpwood sticks, hold the log scale side facing you.
3. Facing the tree, hold the stick vertically, 25 inches from your eyes.
4. Line up the zero end with the stump height (where the tree will be cut), usually about 1 foot above the ground.
5. With your head steady, shift your eyes up and look at the point where the trunk diameter becomes too small or large branching occurs. This is the merchantable height (see accompanying figure).
6. From the right edge of the scale stick, read the height measurement to the nearest full half-log (8 ft.) or pulpwood stick.

The DBH and the height of a tree, measured with a scale stick, can be used to estimate the volume of the tree. This process is discussed in Appendix 7.

Forestry supply catalogs list scale sticks for sale, or contact your local state forester or county Cooperative Extension office to find out where you may purchase a tree scale stick.





Appendix 7. Conducting a Cruise Tally

One purpose of a cruise tally is to estimate the volume of lumber that can be sawed from standing trees. Appendix 6 explains how to obtain the two measurements necessary to estimate wood volume in a tree, namely DBH and merchantable height. The accompanying sample tally sheet can be used to record wood volume as trees are measured in a forest stand. Because the tally is just an estimate and precise measurements are difficult to make in a woodlot, DBH is often calibrated only to even inches. The merchantable height is often calibrated only to 8-foot or half 16-foot log lengths. When the diameter or the number of sawlogs falls between values on the tally sheet, always tally to the lower value. For example, a tree with a 17-inch DBH with 1⅔ 16-foot logs should be recorded as a 16-inch tree with 1½ logs.

Once all the trees within a compartment or sample plot have been entered on the tally sheet, use a tree-volume table to determine the total estimated volume (see Appendix 2). Specially calculated log rules are necessary because logs taper from end to end and some wood is lost to slabs and saw kerf as the log is sawed into boards. For example, a 16-foot log with a diameter of 18 inches that has no taper or other defects contains about 340 board feet of wood and bark before it is sawed. On the other hand, a tree with an average DBH of 18 inches that contains one 16-foot butt log will yield only 135 board feet of lumber.

Example

Using the International ¼-inch Log Rule gross volume tree table presented in Appendix 2, determine the estimated wood volume represented in the accompanying sample tally sheet. (Answers are printed upside down at the bottom of this page.)

Sugar maple _____

Basswood _____

Black cherry _____

White ash _____

TOTAL _____

Compartment Name: **Date:**

Diameter of Tree at Breast Height (in inches)	Kinds of Trees and Number of 16-Foot Logs																				
	Sugar maple					Basswood					Black cherry					White ash				
	1	1½	2	2½	3	1	1½	2	2½	3	1	1½	2	2½	3	1	1½	2	2½	3
8																				
10											⋅ [1]									
12		⁚ [4]															□ [8]			
14		⋅⋅ [2]						⁚ [5]					⁚ [3]							
16			⊠ [10]											⋅⋅ [2]						
18																				
20																				
22						1 2 3 4 5 6 7 8 9 10															
24						Dot and Line Method of Tallying by Tens															

Answers:

Sugar maple: 2,358

Basswood: 690

Black cherry: 880

White ash: 616

Total: 4,544

Appendix 8. Conducting a Plot Sample Cruise

The accompanying illustration depicts a 5¼-acre compartment bounded by a state highway, a woods road, and a stream. The stand is composed of four major crop-tree species with a large number of trees in each of several DBH size categories, from 8 inches to 18 inches. Thus, the stand is fairly diverse, and approximately a 30 percent cruise consisting of ⅛-acre sample plots is desirable.

The following calculations are conducted to determine the number of plots to sample:

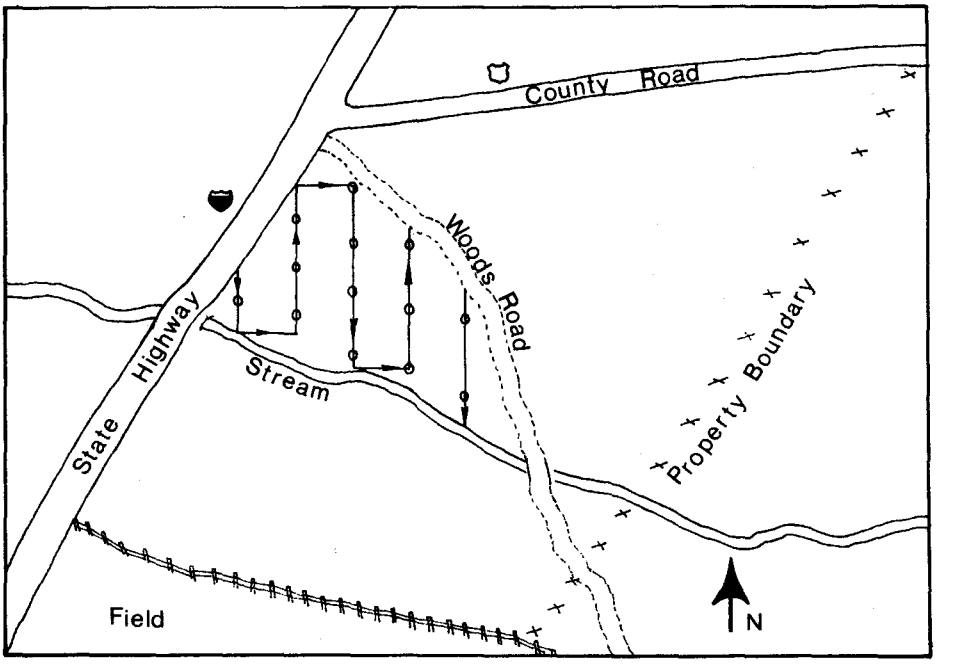
1. 5.25 acres x 0.30 = 1.575 total acres to be sampled. This is only an approximation of the total acreage, however, as shown in the next calculation.
2. 1.575 acres ÷ ⅛-acre sample plots = 12.6 sample plots; rounded to the nearest whole number = 13 sample plots.

In this example, 13 ⅛-acre sample plots will be tallied for an actual total sample area of 13 x 0.125 (decimal fraction from accompanying table) = 1.625 acres. The actual percentage of the compartment tallied will be 1.625 acres sampled ÷ 5.25 acres = 31 percent.

The total estimated standing timber volume of this compartment would be represented by sum board feet of all sample plots ÷ 0.31.

The centers of sample plots are determined by pacing along transect lines, which systematically divide the compartment as illustrated. It is better to run transect lines up and down slope, rather than along a contour.

Using a tree or sapling as the center of each compartment, use a tape to measure the appropriate radius length of the plot, as determined in the accompanying table. Measure several radii from the center like spokes on a wheel, and mark boundary trees of the plot with either chalk or plastic flagging. Then, using a tally sheet similar to the one shown in Appendix 8, tally the plot by working in a clockwise direction and mark tallied trees with an X.



Sample Plot Dimensions

Plot Sizes (in acres)		*Circular Plot Radius (feet)*
Fraction	*Decimal*	
1	1.0	117.8
½	.5	83.3
⅓	.33	68.0
¼	.25	58.9
⅕	.20	52.7
⅙	.167	48.1
⅐	.143	44.5
⅛	.125	41.6
⅑	.111	39.3
⅒	.10	37.2

Appendix 9. Site Index

An area's site index is a direct assessment of the area's ability to grow trees. It reflects the rate of growth (height) of a tree species at a specific location. An area with a high site index has high timber-producing potential. Each species has its own specific set of site index curves. Index values are usually based on tree height at age 50. Values in parentheses in the graph below are heights based on age 75.

The accompanying site index curve can be used to determine the ability of a specific area to grow sugar maples. To calculate the site index, select a sample of several trees (8–10) of the same species that occupy the upper canopy at the site. Next, measure the total height of each sample tree by using a scale stick. Then determine the age of the trees by taking an increment core 4½ feet above the ground. (If concerned about degrading the butt log, take the core sample at stump height, just above the butt swell.) Count the number of rings along the core just as one would count the rings on a stump.

Next, plot the average height and age of the sample trees on the appropriate site index graph by following these three steps:

1. Draw a horizontal line that represents average tree height.
2. Draw a vertical line that represents average tree age.
3. Follow these two lines to their point of intersection.

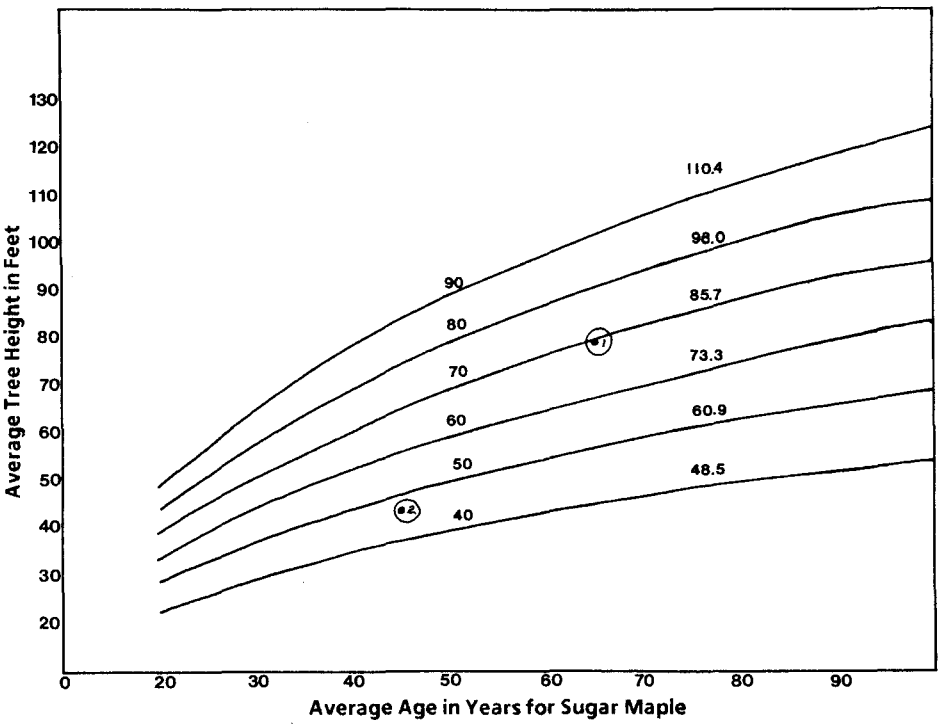
The index value of the site is the position of the intersection in relation to the established curves. A point halfway between the curves marked 50 and 60, for example, represents an index value of 55.

Example 1

A stand of sugar maples that average 80 feet tall at age 65 is represented by point 1, which falls on the curve marked 70. Thus, this area has a site index value of 70.

Example 2

A stand of sugar maples averaging 42 feet tall at age 45 is represented by point 2. This site has an index value of approximately 47.



Appendix 10. Stocking Density*

The number of trees per unit area in a stand is defined as its stocking density. An overstocked stand (one that contains too many trees) can result in slow-growing crop trees of poor vigor. Trees in an understocked stand grow rapidly but acquire poor form for sawtimber objectives. Fast-growing trees of good form result when a stand is adequately stocked.

The accompanying stocking chart can be used to determine whether a stand of even-aged northern hardwoods is sufficiently stocked and also to estimate basal area (basal area is discussed in Appendix 11). Calculate the number of trees that share the upper canopy per acre and their average DBH (mean stand diameter), using a timber cruise (refer to Appendices 6, 7, and 8) before using this chart. To determine stocking density, follow these steps:

1. Draw a solid vertical line that represents the number of trees per acre. Extend the line until it intersects with the diagonal dashline that represents the mean stand diameter.
2. Draw a horizontal line to the left to determine the basal area of the stand.

Stands that plot out above line A are overstocked and in need of thinning. Stands between lines A and B are adequately stocked. Stands between lines B and C should become adequately stocked within 10 years as the average DBH increases 1–2 inches. Stands below line C are definitely understocked. The quality line represents the density required to produce high quality stems of beech, sugar maple, yellow birch, and red maple. Line B represents a desirable stocking density for stands above 6 inches DBH.

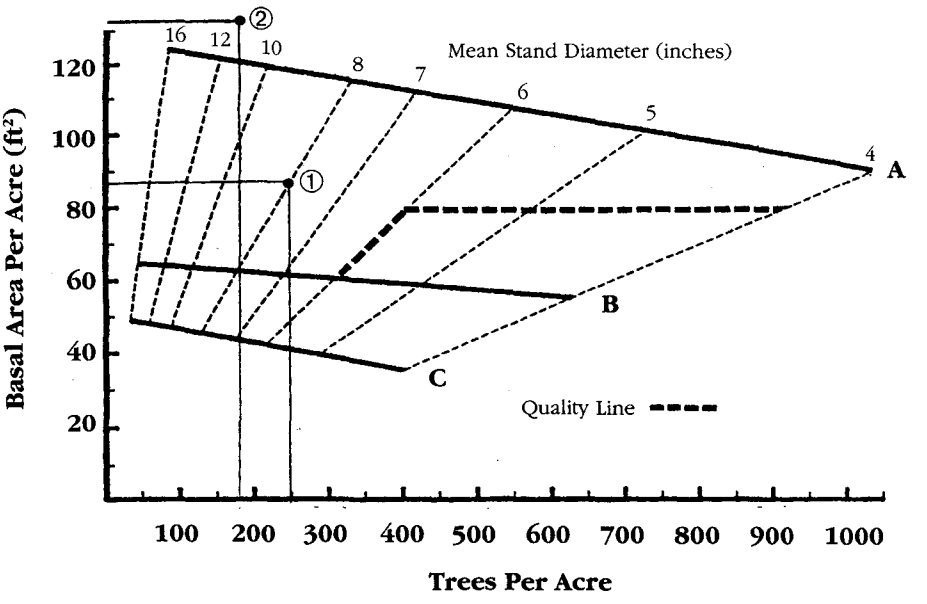
Stands that contain either a mixture of conifers or the hardwood species of black cherry, white ash, and tulip poplar should generally be more heavily stocked. For example, both a stand composed of 25–65 percent conifers and a stand composed of 80 percent of the above hardwood species, should have B-line values of about 500 trees and a basal area of 95 at a mean stand diameter of 6 inches DBH.

Example 1

An even-aged northern hardwood stand that contains 250 trees per acre and has a mean stand diameter of 8 inches is represented by point 1. The stand is therefore adequately stocked and has a basal area of 87.

Example 2

A stand that contains 180 trees per acre and has a mean stand diameter of 11.8 inches is represented by point 2. The stand is therefore overstocked and has a basal area of 132.



*Source: Solomon, D., and R. Hosmer. 1989. Modeling northern hardwood stand development. IN Martin, et al. USDA NE For. Exp. Sta. GTR NE-124.

Appendix 11. Basal Area

Basal area is defined and calculated in two ways.

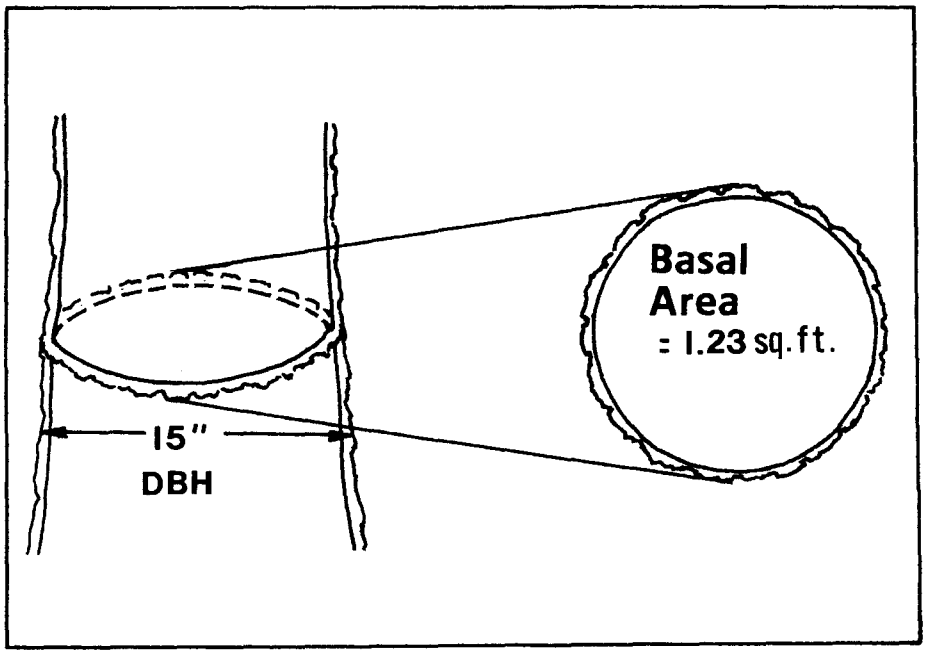
1. The basal area of an individual tree is the cross-sectional area of the trunk at breast height (4½ feet above the ground). In other words, if a tree were cut at breast height, the basal area would be the flat top of the stump. For example, the basal area of a tree with a 15-inch DBH is 1.23 square feet.

   To determine the basal area of an individual tree:

   a. Measure the tree's DBH with a scale stick (see Appendix 6).

   b. Basal area (in square feet) is equal to (DBH in inches)^2 x 0.00545 (a constant).

2. The basal area of a stand is the sum of the basal areas of the individual trees, and is expressed in square feet per acre. A well-stocked hardwood stand might have a basal area of 80–100 square feet per acre.



Example 1

What is the basal area of a tree with a 24-inch DBH?

Basal area = $(24)^2$ x 0.00545 = 3.14 square feet.

Example 2

A sample plot of ⅛-acre contained 9 trees with the following DBH measurements: 22, 20, 19, 16, 15, 24, 17, 20, and 18 inches. What is the basal area of an acre of this forest?

The average DBH for the 9 trees in the sample plot is 19 inches. The basal area for the sample plot is 9 (number of trees in the sample) x 1.969 (average basal area per tree) = 17.7 square feet. Thus, the basal area for an acre of this stand would be 8 (because the sample was ⅛ acre) x 17.7 = 141.6 square feet. The stocking chart in Appendix 10 shows that the stand is heavily stocked and that a harvest may be warranted soon.

Appendix 12. Conducting a Log Tally

The purpose of a log tally is to estimate the net volume of lumber that can be sawed from tallied logs. A log scale stick, a log tally sheet and clipboard, and a heavy logging crayon are the only equipment needed.

Follow these steps:

1. Obtain a log tally sheet or make one similar to the accompanying figure. Include all the diameter and species categories necessary.
2. Measure the length of a log by using the scale stick or a 4-foot stick marked at 2-foot intervals. All logs will probably be cut to the nearest even foot between 8 and 16 feet with 3–4 inches for trim. Logs without an adequate allowance for trim must be scaled downward to the next even foot.
3. Measure the diameter of the log inside the bark at the small end of each log. (Be sure to use the side of the scale stick marked for *log* tallying, not tree tallying!) An oval-shaped log should be measured across the diameter that represents a compromise between the longest and shortest diameter or the two diameters should be averaged.
4. Write the diameter and length of the log on the small end of the log (8/10 corresponds to a diameter of 8 inches and a length of 10 feet) and place a dot in the appropriate box on the log tally sheet. (The dot and line method illustrated in Appendix 7 works well for log tallying, too.)

After all the logs have been entered on the tally sheet, calculate the volume of the wood and subtract estimated allowance for defects. Most scale sticks contain a log scale rule (International, Doyle, or Scribner) such as those presented in Appendix 3.

Example

Determine the wood volume in board feet for each of the tree species below using the information given on the log tally sheet and the International ¼-inch Log Rule in Appendix 3. (The answers are printed upside down at the bottom of the page.)

Sugar maple _____

Beech _____

White ash _____

Total board feet _____

Location of landing:						Date:					Tallied by:				
Diameter of log at small end (inches)	Kinds of Trees and Length of Logs														
	Sugar maple					Beech					White ash				
	8	10	12	14	16	8	10	12	14	16	8	10	12	14	16
6															
7							•				⁝				
8	•													⁝	
9								⊠							
10		•	⁝											⁝	
11			⁝												
12								••					•		
13		•			⁝										
14															
15											⁝				
16		•						⊐							
17															
18															
19															
20															

ANSWERS:

Sugar maple: 1,175
Beech: 1,380
White ash: 690
Total board feet: 3,245

Appendix 13. Computerized Forestry*

The advent of personal computers has ushered in a new era of forest management for the owners of private, nonindustrial forest lands. Computers have not created new knowledge of silviculture, but they have empowered foresters and forest owners to use existing knowledge in a more efficient and practical manner. Computers can greatly assist the management and analysis of inventory data and provide a "realistic look" into the future by predicting the results of present and future management activities.

It is the ability of computers to manipulate, organize, and analyze large amounts of data quickly and accurately that has made them indispensable in today's business world. Forestry software programs allow managers to harness the ability to handle the huge amount of data (e.g., tree species, sizes, age classes, site characteristics, stocking density, etc.) that is necessary to accurately describe and manage a forest stand. It is the ability of computers to do complex, repetitive calculations in a fraction of a second that has allowed foresters to use computers to go beyond describing current stands to predicting future characteristics of stands. Programs that predict future forest growth and yield are called **growth simulation models.**

Although the advantages of using computers to make predictions about forest growth and timber value are substantial, like other tools, users should be aware of their limitations. *A key to the successful use of computers in forest management is consultation with a professional forester, both before and after running specific programs.*

Column A in the accompanying figure depicts a simple **flowchart** or format by which the operator and the computer interact in a prescribed, systematic manner to conduct data analyses. This program starts by giving the operator the option of conducting an inventory, management, or economic analysis. Option A (Inventory) is chosen here as indicated by the shading. Then the program requests specific information or **input** about the stand on which it will base its calculations and analysis. Next the processing unit calculates the current log volume by species and size class and gives a display of the results on the monitor.

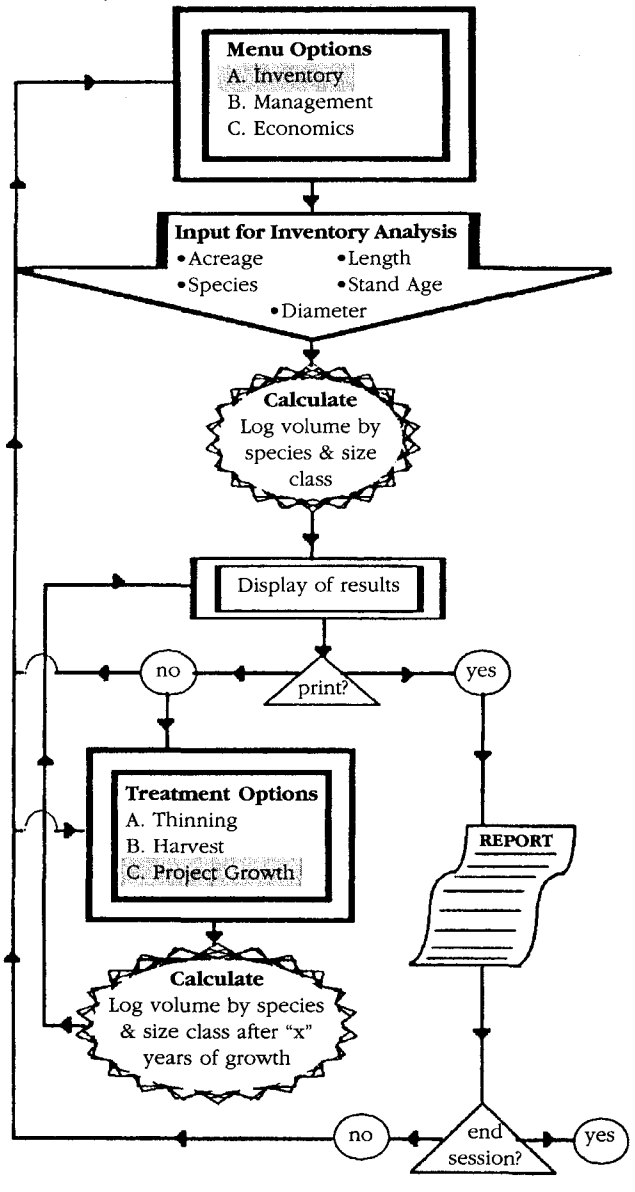
At this point in the program sequence the operator has to make the decision to: (1) instruct the computer to print the results, (2) choose a treatment option, or (3) return to the original menu. If decision (2) is chosen (treatment), the menu choices consist of having the computer calculate the effects of (A) thinning, (B) harvest, or (C) growth. In this example, the operator chose to have the computer project the results if the stand grew for "x" number of years. Based on the input data for the stand and utilizing formulas prescribed by the program, the processing unit computes the results expressed as tree log volume by species and size class. The results are displayed and once again the operator must decide whether to: (1) print the results, (2) choose a treatment, or (3) return to the original menu.

Column B shows a **printout** of **output** generated by the computer. This type of information could have resulted from either "calculation" stage in the flow chart in column A. The program documentation explains how to read and interpret the output. In this example, the top of the table identifies the stand and presents some basic statistics. The stand volume is given by species and size class. For example, the size class "small sawlog" (Sm saw), trees 12 to 16 inches DBH, has a total of 4 **MBF** (thousand board feet) composed of 0.3, 0.4, 1.1, and 2.2 MBF, respectively, for the species sm (sugar maple), ro (red oak), wa (white ash), and bc (black cherry). This kind of summary information is very useful when considering management plans.

* Refer to *Computerized Forestry for Private, Nonindustrial Forest Owners* in Suggested References for more information.

Appendix 13. (continued)

A. Analysis Flowchart



B. Results of analysis; report sent to printer as printout.

Owner: J. Doe
Stand: 4
County: Buck
Acres: 27
Stand Age: 68
Size: Sm Saw
Site Index: 70 for BC
Date Tallied: Aug/89

Timber Stand Volume

Species	>all sp.	SM	RO	WA	BC
	— Net log volume - MBF per acre —				
Sm Saw	4.0	.3	.4	1.1	2.2
Med Saw	2.7	.5	1.0	1.2	.0
Lg Saw	.8	.1	.4	.0	.3
TOTAL	7.5	.9	1.8	2.3	2.5
Species %	100.0	12.0	24.0	30.7	33.3

Appendix 14. Assistance Organizations

Cornell Cooperative Extension Offices

County	*Address*	*Phone*
Albany	P.O. Box 497, Martin Rd., Voorheesville, NY 12186-0497	518-765-3500
Allegany	RD 1, Box 226, County Rd. 48, Belmont, NY 14813	716-268-7644
Broome	840 Upper Front St., Binghamton, NY 13905-1542	607-772-8953
Cattaraugus	RR #2, Box 16A, (28 Parkside Dr.), Ellicottville, NY 14731	716-699-2377
Cayuga	248 Grant Ave., Auburn, NY 13021-1495	315-255-1183
Chautauqua	3542 Turner Rd., Jamestown, NY 14701-9608	716-664-9502
Chemung	425 Pennsylvania Ave., Elmira, NY 14904-1793	607-734-4453
Chenango	99 North Broad St., Norwich, NY 13815-1386	607-334-5841
Clinton	6064 Rte. 22, Plattsburgh, NY 12901-9601	518-561-7450
Columbia	RD 1, Box 90, (NY Rte. 66), Hudson, NY 12534-9706	518-828-3346
Cortland	P.O. Box 5590, 60 Central Ave., Cortland, NY 13045-5590	607-753-5077
Delaware	P.O. Box 184, NY Rte. 10, Hamden, NY 13782-0184	607-865-6531
Dutchess	P.O. Box 259, US Rte. 44, Millbrook, NY 12545-0259	914-677-8223
Erie	21 South Grove St., East Aurora, NY 14052-2398	716-652-3370
Essex	P.O. Box 388, 67 Sisco St., Westport, NY 12993-0388	518-962-4810
Franklin	63 W. Main St., Malone, NY 12953-1817	518-483-7403
Fulton	57 East Fulton St., Gloversville, NY 12078	518-725-6441
Genesee	420 East Main St., Batavia, NY 14020-2599	716-343-3040
Greene	Mountain Ave., HCR #3, Box 906, Cairo, NY 12413-9503	518-622-9820
Hamilton	P.O. Box 207, (County White House), NY Rt. 8, Lake Pleasant, NY 12108	518-548-6191
Herkimer	NY Rte. 5, RR 1, Box 234C, Herkimer, NY 13350-9721	315-866-7920
Jefferson	223 J.B. Wise Place, Empsall Plaza, Watertown, NY 13601-2597	315-788-8450
Lewis	P.O. Box 72, Outer Stowe St., Lowville, NY 13367	315-376-5270
Livingston	158 South Main St., Mount Morris, NY 14510-1595	716-658-3250
Madison	P.O. Box 1209, Eaton St., Morrisville, NY 13408-1209	315-684-3001
Monroe	249 Highland Avenue, Rochester, NY 14620	716-461-1000
Montgomery	P.O. Box 1500, County Annex Building, Park St., Fonda, NY 12068	518-853-3471
Nassau	Plainview Complex, Bldg. J., 1425 Old Country Rd., Plainview, NY 11803-5015	516-454-0900
New York City	16 East 34th St., 8th Floor, New York, NY 10016-4328	212-340-2900
Niagara	4487 Lake Avenue, Lockport, NY 14094	716-433-8839
Oneida	126 Second St., Oriskany, NY 13424-9799	315-736-3394
Onondaga	1050 West Genesee St., Syracuse, NY 13204-2243	315-424-9485
Ontario	480 North Main St., Canandaigua, NY 14424-1099	716-394-3977
Orange	Dillon Drive, Community Campus, Middletown, NY 10940	914-344-1234
Orleans	P.O. Box 150, 20 South Main St., Albion, NY 14411-0150	716-589-5561
Oswego	5869 Main St., Mexico, NY 13114-9596	315-963-7286
Otsego	123 Lake St., Cooperstown, NY 13326	607-547-2536
Putnam	Terravest Corporate Park, 10 Geneva Rd., Brewster, NY 10509-9809	914-278-6738
Rensselaer	Agriculture & Life Sciences Bldg., 61 State St., Troy, NY 12180	518-270-2781
Rockland	P.O. Box 1000, E. Kirkbride Rd., Thiells, NY 10984	914-429-7085
St. Lawrence	Univ. Shopping Ctr., 125 Main St. East, Canton, NY 13617-1477	315-379-9192
Saratoga	50 West High St., Ballston Spa, NY 12020	518-885-8995
Schenectady	1 Broadway Center, 8th Floor, Schenectady, NY 12305	518-372-1622
Schoharie	41 South Grand St., Cobleskill, NY 12043	518-234-4303
Schuyler	Rural-Urban Center, 208 Broadway, Montour Falls, NY 14865	607-535-7141
Seneca	321 East Williams St., Waterloo, NY 13165	315-539-9251
Steuben	3 East Pulteney Square, Bath, NY 14810	607-776-9631
Suffolk	246 Griffing Avenue, Riverhead, NY 11901-3086	516-727-7850
Sullivan	69 Ferndale-Loomis Rd., Liberty, NY 12754-2903	914-292-6180
Tioga	56 Main St., Owego, NY 13827-1588	607-687-4020
Tompkins	615 Willow Avenue, Ithaca, NY 14850-3555	607-272-2292
Ulster	74 John St., Kingston, NY 12401-3824	914-338-3494
Warren	HCR 2, Box 23B, Schroon River Rd., Warrensburg, NY 12885-9601	518-623-3291
Washington	County Office Bldg., Lower Main St., Hudson Falls, NY 12839	518-747-2861
Wayne	1581 NY Rte. 88N, Newark, NY 14513-9739	315-331-8415
Westchester	214 Central Avenue, White Plains, NY 10606-1102	914-285-4620
Wyoming	401 North Main St., Warsaw, NY 14569	716-786-2251
Yates	County Office Bldg., 110 Court St., Penn Yan, NY 14527	315-536-3381

Appendix 14. (continued)

DEC Regional Forestry Offices		
Region 1	**Counties — Nassau, Suffolk**	
	Bldg. 40, SUNY Campus, Loop Rd., Stony Brook, NY 11790-2356	516-444-0285
Region 2	**New York City**	
	1 Hunters Point Plaza, 47-40 21st St., Long Island City, NY 11101-5407	718-482-4942
Region 3	**Counties — Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster, Westchester**	
	Stony Kill Environmental Education Center	
	Rte. 9 D, Wappingers Falls, NY 12590	914-831-3109
	21 South Putt Corners Rd., New Paltz, NY 12561-1696	914-255-5453
Region 4	**Counties — Albany, Columbia, Delaware, Greene, Montgomery, Otsego, Rensselaer, Schenectady, Schoharie**	
	Jefferson Rd., Stamford, NY 12167	607-652-7364
	1150 North Wescott Rd., Schenectady, NY 12306	518-357-2066
Region 5	**Counties — Clinton, Essex, Franklin, Fulton, Hamilton, Saratoga, Warren, Washington**	
	Rte. 86, Ray Brook, NY 12977-0296	518-897-1277
	Main St. Extension, Northville, NY 12134	518-863-4545
	Hudson St. Extension, Warrensburg, NY 12885	518-623-3671
Region 6	**Counties — Herkimer, Jefferson, Lewis, Oneida, St. Lawrence**	
	State Office Bldg., Watertown, NY 13601	315-785-2236
	225 North Main St., Herkimer, NY 13350	315-866-6330
	RD 3, Box 22A, Lowville, NY 13367	315-376-3521
	30 Court St., Canton, NY 13617	315-386-4546
Region 7	**Counties — Broome, Cayuga, Chenango, Cortland, Madison, Onondaga, Oswego, Tioga, Tompkins**	
	Flood Control Maintenance Bldg., Rte 11, Kirkwood, NY 13795	607-773-7763
	Box 594, Rte. 80, Sherburne, NY 13460	607-674-4036
	1285 Fisher Ave., Cortland, NY 13045-1090	607-753-3095
Region 8	**Counties — Chemung, Genesee, Livingston, Monroe, Ontario, Orleans, Schuyler, Seneca, Steuben, Wayne, Yates**	
	7291 Coon Rd., Bath, NY 14810	607-776-2165
	6274 E. Avon-Lima Rd., Avon, NY 14414	716-226-2466
Region 9	**Counties — Allegany, Cattaraugus, Chautauqua, Erie, Niagara, Wyoming**	
	128 South St., Olean, NY 14760	716-372-0888
	215 S. Work St., Falconer, NY 14733	716-665-6111
	5425 County Rte. 48, Belmont, NY 14813-9758	716-268-5392
	Farm & Home Center, 401 N. Main St., Warsaw, NY 14569	716-786-2251
State Tree Nursery	**Saratoga Tree Nursery**	
	431 Rte. 50 South, Saratoga Springs, NY 12866	518-581-1439

Appendix 14. (continued)

Addresses of Public Organizations

Cornell Cooperative Extension

Contact: Your county Cooperative Extension office regarding general information requests or association membership; State Cooperative Extension Forester, Fernow Hall, Cornell University, Ithaca, NY 14853 concerning requests involving private nonindustrial use of New York forest land.

NYS Department of Environmental Conservation

Contact: Your Regional Forestry Office

SUNY College of Environmental Science and Forestry

Contact: Lawrence P. Abrahamson, Continuing Education Coordinator for the Faculty of Environmental and Forest Biology, 211 Marshall Hall, SUNY College of ES&F, Syracuse, NY 13210, 315-470-6562. Lawrence P. Abrahamson, Director, NE Petroleum-Forest Resource Cooperative, 211 Marshall Hall, SUNY College of ES&F, Syracuse, NY 13210, 315-470-6698. "Tree Pest Extension Service" contact is Lawrence P. Abrahamson, Continuing Education/Extension Coordinator for the Faculty of Environment and Forest Biology, 126 Illick Hall, SUNY College of ES&F, Syracuse, NY 13210, 315-470-6751 for 24-hour message service.

USDA Farm Services Agency

Contact: Olan Sharron, Program Specialist, USDA-FSA, 441 S. Salina St., Suite 356, Syracuse, NY 13202-2450, 315-477-6303, or your county FSA office listed under "U.S. Government" in the white pages of the telephone directory.

USDA Forest Service

Contact: Jorge Negron, District Ranger, USDA Forest Service, Finger Lakes National Forest, P.O. Box W, Montour Falls, NY 14865, 607-594-2750. For public information, contact the State and Private Forestry Program, USDA Forest Service, 5 Radnor Corporate Center, 100 Matsonford Rd., Suite 200, Radnor, PA, 19087, 610-975-4103.

USDA Natural Resources Conservation Service

Contact: Steven L. Machovec, Resource Planning Staff Leader, USDA-NRCS, 441 S. Salina St., Suite 354, Syracuse, NY 13202-2450, 315-477-6527, or your county NRCS office listed under "U.S. Government" in the white pages of the telephone directory.

Appendix 14. (continued)

Addresses of Private Organizations*

American Forest Foundation

Contact: Robert Simpson, Vice President, American Forest Foundation; Director, American Tree Farm System, 1111 19th Street, Washington, DC 20036, 202-463-2458.

American Tree Farm System

Contact: Carolyn Willard, Education Coordinator, NY Tree Farm Committee, Empire State Forest Products Assoc., 123 State St., Albany, NY 12207, 518-463-1297.

Catskill Forest Association

Contact: Dinnie Sloman, Exec. Director, Catskill Forest Association, P.O. Box 336, Arkville, NY 12406, 914-586-3054.

Empire State Forest Products Association

Contact: Kevin S. King, Exec. Vice President, Empire State Forest Products Assoc., 123 State St., Albany, NY 12207, 518-463-1297.

F.I.R.S.T.

Contact: David Potter, Chairperson, F.I.R.S.T., Cooperative Extension Center, Parkside Drive, Ellicottville, NY 14731, 716-373-1260.

NY Christmas Tree Growers' Association

Contact: Robert Norris, Exec. Secretary, 646 Fintches Corners Rd., Red Creek, NY 13143, 716-621-9469.

NY Forest Owners' Association

Contact: Deborah Gill, Exec. Secretary, NY Forest Owners' Assoc., PO Box 180, Fairport, NY 14450, 716-377-6060.

NY Institute of Consulting Foresters

Contact: Peter Zubal, President, NY Institute of Consulting Foresters, c/o A-Z Forestry, RR 3, Box 229A, Bear Swamp Rd., Moravia, NY 13118, 315-495-2815. Roger Djeinleski 518-793-2544 Ext. 353.

NY Society of American Foresters

Contact: Valerie A. Luzadis, Chairperson, NY Society of American Foresters, c/o Division of Education and Communications, Empire State Forest Products Association, 123 State St., Albany, NY 12207, 518-793-2541.

NYS Forest Practice Board

Contact: R. Dean Frost, Chairperson, NYS Forest Practice Board, R.R. #1, Box 80, Whitney Point, NY 13862, 607-692-3066.

NYS Maple Producers' Association

Contact: Arthur Merle, Secretary, NYS Maple Producers' Assoc., 1884 Rt. 98, Attica, NY 14011, 716-535-7136.

NYS Timber Producers' Association

Contact: Linda Luchsinger, Exec. Secretary, NYS Timber Producers' Assoc., P.O. Box 300, Boonville, NY 13309, 315-942-5503.

NYS Woodsmen's Field Days

Contact: (Mrs.) Phyllis White, Exec. Coordinator, NYS Woodsmen's Field Days, P.O. Box 123, 120 Main St., Boonville, NY 13309, 315-942-4593.

Northeastern Loggers' Association

Contact: George Mitchell, Exec. Director, NE Loggers' Assoc., P.O. Box 69, Old Forge, NY 13420, 315-369-3078.

T.H.R.I.F.T.

Contact: Michael Virga, Editor of *Hilltalk*, T.H.R.I.F.T., c/o Lyons Falls Pulp & Paper Co., P.O. Box 338, Lyons Falls, NY 13368, 315-348-2208.

*Officers are subject to change; thus, it may be necessary to obtain updated addresses from one of the public organizations previously listed.

Suggested References

American Pulpwood Association Inc. 1983. Safe Manual Felling. 83-A-13. Wash., D.C. 23p.

Ashley, B.S. 1991. Simplified Point-Sample Cruising. NA-UP-01-91. USDA For. Svc. Northeastern Area State and Private Forestry, Morgantown, Pa.

Burns, R.M., tech. comp. 1983. Silvicultural Systems for the Major Forest Types of the United States. Agric. Handb. 445. USDA For. Svc., Wash. D.C. 191p.

Burns, R.M., B.H. Honkala. 1990. Silvics of North America: Vol. 1. Conifers. Agr. Handb. 654; U.S. GPO: 1990-555-099. USDA For. Svc., Wash. D.C. 675p.

Burns, R.M., B.H. Honkala. 1990. Silvics of North America: Vol 2. Hardwoods. Agr. Handb. 654; U.S. GPO: 1991-555-469. USDA For. Svc., Wash. D.C. 877p. Currently out of print.

Carmean, W.H., J.T. Hahn, and R.D. Jacobs. 1989. Site Index Curves for Forest Tree Species in the Eastern United States. Gen. Tech. Rep. NC-128. USDA For. Svc. North Central Forest Exp. Sta., St. Paul, Minn. 142p.

Chambers, R.E., Ph.D. 1992. Managing Your Forest for Timber and Wildlife! Wildlife Bureau, N.Y. State Dept. of Environ. Cons., Albany. 6p.

Cope, J.A., F.E. Winch. 1989. Know Your Trees. 147J85. N.Y.S. Coll. of Agr. and Life Sci., Cornell Univ., Ithaca. 71p.

Decker, D.J., J.W. Kelley, T.W. Seamans, and R.R. Roth. 1983. Wildlife and Timber from Private Lands: A Landowner's Guide to Planning. Inf. Bull. 147IB193. N.Y.S Coll. of Agr. and Life Sci., Cornell Univ., Ithaca. 56p.

Decker, D.J., J.W. Kelley. 1986. Enhancement of Wildlife Habitat on Private Lands. Inf. Bull. 147IB181. N.Y.S. Coll. of Agr. and Life Sci., Cornell Univ., Ithaca. 40p.

Drooz, A.T., ed., coordinator. 1985. Insects of Eastern Forests. Misc. Publ. 1426. USDA For. Svc. Wash., D.C. 608p. Currently out of print.

Goff, G.R. 1993. Computerized Forestry for Private, Nonindustrial Forest Owners. Res. and Ext. Ser. 147RE34. Dept. Nat. Resour., N.Y.S. Coll. Agr. and Life Sci., Cornell Univ., Ithaca. 20p.

Goff, G.R., C. Doolittle. 1992. Directory of Forestry, Fish, and Wildlife Publications. Cons. Circ. 147V18#6 and V20#4. Dept. Nat. Resour., N.Y.S. Coll. of Agr. and Life Sci., Cornell Univ., Ithaca. 9p.

Goff, G.R., J.P. Lassoie, J.A. Blumenberg. 1993. Assistance for New York Forest Owners. Cons. Circ. 147v.18#3. Dept. Nat. Resour., N.Y.S. Coll. of Agr. and Life Sci., Cornell Univ., Ithaca. 14p.

Gutierrez, R.J., D.J. Decker, R.A. Howard, Jr., and J.P. Lassoie. 1979. Managing Small Woodlands for Wildlife. Inf. Bull. 147IB157. N. Y.S. Coll. of Agr. and Life Sci., Cornell Univ., Ithaca. 32p.

Haussman, R.F., E.W. Pruett. 1978. Permanent Logging Roads. NA-FR-18. USDA For. Svc. Northeastern Area State and Private Forestry, Radnor, Pa. 43p.

Hornbeck, J.W., W.B. Leak. 1992. Ecology and Management of Northern Hardwood Forests in New England. Gen. Tech. Rep. NE-159. USDA For. Svc. Northeastern Forest Exp. Sta., Radnor, Pa. 44p.

Hunter, M.L. Jr. 1990. Wildlife, Forests and Forestry: Principles of Managing Forests for Biological Diversity. Prentice Hall, Englewood Cliffs, N.J. 370p.

Jones, G.T. 1993. A Guide to Logging Aesthetics. Northeast Forest Resources Extension Council Series NRAES-60. Northeastern Reg. Agr. Engr. Svc., Coop. Ext., Soc. for Protection of New Hampshire Forests. Ithaca, N.Y. 28p.

Jones, S.B. 1989. Timber Taxation — A General Guide for Woodlot Owners. Ext. Circ. 367. Coll. of Agr., Pennsylvania State Univ., University Park. 9p.

Marquis, D.A., R.A. Ernst, and S.L. Stout. 1992. Prescribing Silvicultural Treatments in Hardwood Stands of the Alleghenies (revised). Gen. Tech. Rep. NE-96. USDA For. Svc. Northeastern Forest Exp. Sta., Radnor, Pa. 101p.

Martin, W.C., C.T. Smith, and L.M. Tritton, eds., 1989. New Perspectives on Silvicultural Management of Northern Hardwoods: Proceedings of the 1988 Symposium on the Conflicting Consequences of Practicing Hardwood Silviculture; 1988 June 9-10. USDA For. Svc. Gen. Tech. Rep. NE-124 and SAF 8904. Northeastern Forest Exp. Sta., Radnor, Pa. 107p.

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Perkey, A.W., B.L. Wilkins, and H.C. Smith. 1993. Crop Tree Management in Eastern Hardwoods. NA-TP-19-93. USDA For. Svc. Northeastern Area State and Private Forestry, Morgantown, W.V. 57p.

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Skelly, J.M., D.D. Davis, et. al., eds. 1987. Diagnosing Injury to Eastern Forest Trees. AGRF-08. USDA For. Svc. Coll. of Agr., Pennsylvania State Univ., University Park. 122p.

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Wenger, K.F., ed. 1984. Forestry Handbook. John Wiley & Sons, New York. 1335p.

Wood, H.P., R.W. Kulis. 1980. Woodland Boundries. L-206. Coop. Ext. Svc., Univ. of Massachusetts, Amherst. 4p.

Suggested References (continued)

Addresses:
Many of these publications are also available at county Cooperative Extension offices, county FSA/NRCS offices, forestry school libraries, and regional U.S. Forest Service offices.

American Pulpwood Association Inc.
1619 Massachusetts Avenue, NW
Washington, DC 20036

USDA Forest Service
Northeastern Area, State and Private Forestry
5 Radnor Corporate Center
P.O. Box 6775
100 Matsonford Rd., Suite 200
Radnor, PA 19087-8775
215-975-4101

USDA Forest Service
P.O. Box 96090
Washington, DC 20090-6090
202-205-0957

USDA Forest Service
Forest Resources Management
180 Canfield St.
Morgantown, WV 26505
304-285-1536

USDA Forest Service
North Central Forest Experiment Station
1992 Folwell Ave.
St. Paul, MN 55108
612-649-5249

USDA Forest Service
Northeastern Forest Experiment Station
Publications
359 Main Rd.
Delaware, OH 43015
614-368-0127

NY State Department of Environmental Conservation (NYSDEC)
Forest Resource Management Bureau
Room 406
50 Wolf Rd.
Albany, NY 12233-4253
518-457-7370

Cornell University Resource Center
7 Business and Technology Park
Ithaca, NY 14850
607-255-2080

Northeast Regional Agricultural Engineering Service (NRAES)
Cooperative Extension
152 Riley-Robb Hall
Ithaca, NY 14853-5701
607-255-7654

Prentice Hall
Englewood Cliffs, NJ 07632

University of New Hampshire
Cooperative Extension Publications Center
12B Forest Park
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Glossary

The definitions given in this glossary refer specifically to the management of small woodlands for timber.

aspect - the compass direction toward which a slope faces.

basal area - the cross-sectional area of a tree (in square feet) 4½ feet from the ground. Also, the sum of the cross-sectional areas of all trees within a stand per unit of area.

blowdown - an uprooted tree that has been blown over by wind (see **windthrow**).

board foot - a quantity of wood equal to 144 cubic inches (1 inch by 12 inches by 12 inches); commonly used to express the volume of wood in a tree, sawlog, veneer log, or piece of lumber.

bolt - a short log (usually less than 4½ feet in length), or a square timber cut from a log.

browsers - wildlife that feed on small bushes, sprouts, herbaceous plants, and small trees.

buck - to saw felled trees into shorter lengths.

butt sawlog - the first log cut from the base of a tree; usually of much higher value than the other logs.

canopy - the crowns of all the trees in a forest.

clear-cutting - to remove all trees, regardless of size, from an area; clear-cutting produces an even-aged stand but may also result in erosion.

commercial - viewed with regard to profit.

compartment - distinct management unit of a woodland or stand.

competition - the struggle for survival that occurs when organisms make similar demands on environmental resources.

conifer - a tree belonging to the order *Coniferales,* such as pine, spruce, fir, or cedar, that is usually evergreen and cone-bearing and that has needles or awl-shaped or scale-like leaves; often referred to as "softwood" (does not necessarily refer to the hardness of the wood).

cord - (see **face cord** and **standard cord**)

cost sharing - a policy whereby one party or agency agrees to pay a percentage (usually up to a maximum dollar value) of the specific expenses incurred by a second party.

crop tree - a tree that has been selected for future timber harvest, usually on the basis of its location with respect to other trees and its relative timber value.

crown - collectively, the limbs, branches, and leaves of a tree.

cruise - (see **timber cruise**)

cull - a tree or log of no timber value. Cull trees are removed as necessary during thinning to lessen competition with crop trees.

cutting cycle - the schedule for harvesting or felling operations in a forest stand.

DBH (diameter at breast height) - the diameter of a tree at roughly breast height or 4½ feet from the ground.

defects - imperfections in the tree that lessen its sawtimber value. Examples include rot, taper, sweep.

duff - (see **leaf litter).**

ecosystem - an interacting system of living organisms (plants and animals), soil, and climatic factors.

even-aged forest - a forest in which all of the trees are essentially the same age (within 10 to 20 years).

face cord - a stack of wood 4 feet high and 8 feet long, composed of logs of varying length.

felling - the act of cutting down a standing tree.

financial maturity - the age at which a tree is no longer increasing in value at a profitable rate.

fire lane - a vegetation-free strip of land strategically placed to help stop fires from spreading.

fixed costs - expenses that are regularly occurring, must be paid when due, and generally are not influenced by owner activities.

flowchart - a diagram depicting the stepwise process by which an application program analyzes data.

forest inventory - a survey to assess the characteristics and future timber productivity of a stand.

form - the shape of a log or tree; usually used in connection with timber quality.

frilling - a method of killing unwanted trees by cutting a narrow (1-2 inches) band through the living tissues around the bole. It is usually necessary to inject a herbicide to ensure death of the tree.

girdling - a method of killing unwanted trees by cutting a band 3-5 inches wide through the living tissues around the bole; can be used instead of felling to prevent damage to nearby trees.

growing stock - the sum of all the trees in a forest, including both their number and volume.

growth simulation models - computer programs that predict future forest growth, characteristics, and yield.

habitat - a place where a plant or animal naturally lives and grows.

high-grading - a practice whereby all trees of reasonable commercial value are removed, leaving a stand of poor quality with depleted future timber productivity.

increment borer - a tool used to extract a core of wood from a tree to determine its age without felling it.

input - information fed into a computer or any part of a computer.

kerf - (see **saw kerf**)

Glossary (continued)

knot - that portion of a branch that has become incorporated into the body of a tree.

landing (or) **yard** - a place where logs are brought and assembled for loading and transporting to a mill.

leaf litter (or) **duff** - the layer of dead organic debris (leaves, twigs, animals), sometimes partly decomposed, on top of soil.

log grade - a figure expressing the quality and value of a log.

log rule - a device, usually in tabular form, used to calculate the volume of a log based on its diameter (inside the bark at the small end) and length.

log scaling - measuring logs to determine volume in board feet, cubic feet, or cords.

MBF - thousand board feet; one board foot is a volume of lumber equal to a board with the dimensions of 1 ft. x 1 ft. x 1 in.; used to estimate log and tree volume.

mean stand diameter - the average DBH of trees in a forest stand.

merchantable - able to be turned into a product and sold for a profit.

northern hardwoods - a forest cover commonly found in the Northeast consisting primarily of beech, birch, and maple; the important timber species associated with this forest cover are sugar maple, yellow birch, and American beech. Red maple, paper birch, white ash, eastern hemlock, balsam-fir, and red spruce may also be found in smaller amounts; white pine and oak are occasionally associated with this forest cover.

output - the processed data returned by a computer on a monitor or printer, or to storage on a disk or tape.

overstocked - stocked with too many trees for optimum growth and management.

overstory - the upper crowns, or the canopy of a forest.

pioneer successional species - species such as ash, aspen, and white pine that regenerate open areas.

plot sample cruise - a method of estimating standing timber value whereby all trees above a minimum diameter are tallied within plots with specific boundaries.

point sample cruise: a method for estimating standing timber volume without establishing sample plot boundaries or measuring diameters of sample trees.

pole - a tree with a DBH of 4 to 12 inches (10 to 25 cm).

printout - data printed on paper by a computer.

pulpwood - hardwood or softwood (conifers) used in the production of paper.

regeneration - regrowth, construction, or revitalization.

releasing - removing trees from a stand to allow optimal growth of the remaining trees.

residual trees - trees that remain in a stand after a harvest.

rotation - the period of years it takes to establish and grow timber crops to a specified point of maturity when they will be harvested.

sapling - a young tree with a DBH of less than 4 inches (7.6 cm) and from 3 to 10 feet (0.9 to 3 m) tall.

saw kerf - the portion of a sawlog that becomes sawdust as the saw blade passes through the log or board.

sawlog - a log of suitable size and quality for sawing into lumber; the minimum inside bark diameter at the small end is usually 11 inches for hardwood and 8 inches for softwood, but varies by sawmill.

sawyer -any person operating a saw in a sawmill, or person operating a chain saw.

scarification - disturbing a forest floor and topsoil to prepare for natural or direct seeding.

seedling - a tree, usually with a DBH of less than 2 inches, that has grown from a seed.

shade tolerance - ability to thrive in the shade of other trees or plants.

shake - a lengthwise separation of wood, usually between and parallel to growth layers.

silviculture - the establishment, development, care, and reproduction of stands of timber.

site - a specific location; an area evaluated with respect to its capacity to produce a particular forest, based on the combination of climatic, biological, physiographic, and soil factors present.

site index - a figure representing a forestland's capacity to grow trees (based on tree height at age 50).

skid trail - a small trail laid out in the woods over which logs are pulled from the stump to the skidway or landing.

skidding - moving trees or logs from where they are felled to the landing.

slab - the portion of a sawlog removed when a log has been squared for sawing into lumber.

slash - the branches, bark, tops, chunks, stumps, and uprooted or broken trees left on the ground after logging.

snag - a standing dead tree without leaves and with few branches, or the standing section of the stem of a broken-off tree; valuable to wildlife as perches or nesting sites.

stand - a group of trees with similar characteristics that are treated as a single unit (compartment) in a forest management plan.

standard cord - a stack of wood 4 feet high, 4 feet wide, and 8 feet long (128 cubic feet).

stocking density - number of trees per unit of area in a stand, compared with the desirable number for best growth and management (see **understocked** and **overstocked**).

stumpage - the value of a tree or group of trees standing in the woods uncut (on the stump).

succession - the natural process of change on a site from one form of vegetation to another.

sunscald - damage to a plant or tree from exposure to direct sunlight.

sweep - the degree of bend or bow in a log or tree trunk.

taper - the degree of change in diameter in a log or tree trunk.

thinning - cutting trees in an immature forest stand to reduce the stocking density and to concentrate site productivity on fewer, higher-quality trees.

timber cruise - a survey of forest land to locate timber and to estimate its quantity by species, products, size, quality, or other characteristics.

timber management - planned activity necessary for the successful production of sawlogs and veneer logs from woodlands.

timber stand improvement (TSI) - a combination of practices designed to improve growth and composition of the residual stand; includes thinning, releasing, and pruning.

topography - the features of the land, including the hills, valleys, streams, and so on.

tree scale stick - a stick used to estimate the height and diameter of standing trees; the stick commonly has gradations and scales to estimate the volume of standing trees and bucked logs; also referred to as a biltmore stick.

understocked - insufficiently stocked with trees; the wood volume is not increasing at an optimal rate.

understory - all the trees in a forest that grow below the main canopy.

uneven-aged stand - a stand containing trees of two or more viable and well-established age classes; the difference in age is at least 20 years; also referred to as an all-aged stand.

veneer - a thin sheet of wood sliced or peeled on a veneer machine and often used for plywood or surfacing furniture; veneer logs are the large (usually more than 18 inches in diameter), high-quality logs from which veneer is obtained.

windthrow - a condition where trees become uprooted due to strong winds, or a tree that has become uprooted (see **blowdown**).

wolf tree - a tree with an excessively wide crown; typically has poor sawtimber form.

yard - (see **landing**).

yield tax - a tax levied on the sale price of a commodity such as trees.

Common and Scientific Names of Trees Mentioned in this Publication

alder, speckled	*Alnus rugosa*
apple, crab	*Malus coronaria*
ash, white	*Fraxinus americana*
aspen	*Populus tremuloides* or *grandidentata*
balsam fir	*Abies balsamea*
basswood, American	*Tilia americana*
beech, American	*Fagus grandifolia*
beech, blue	*Carpinus caroliniana*
birch, gray	*Betula populifolia*
birch, white (paper)	*Betula papyrifera*
birch, yellow	*Betula alleghaniensis*
boxelder	*Acer negundo*
butternut	*Juglans cinerea*
cherry, black	*Prunus serotina*
cherry, fire	*Prunus pensylvanica*
chokecherry	*Prunus virginiana*
dogwood	*Cornus* spp.
hawthorn	*Crataegus* spp.
hemlock, eastern	*Tsuga canadensis*
hickory	*Carya* spp.
hophornbeam, eastern	*Ostrya virginiana*
larch	*Larix laricina*
locust, black	*Robinia pseudoacacia*
maple, red	*Acer rubrum*
maple, striped	*Acer pensylvanicum*
maple, sugar	*Acer saccharum*
oak, chestnut	*Quercus prinus*
oak, northern red	*Quercus rubra*
oak, pin	*Quercus palustris*
oak, swamp white	*Quercus bicolor*
oak, white	*Quercus alba*
pine, eastern white	*Pinus strobus*
pine, red	*Pinus resinosa*
sassafras	*Sassafras albidum*
shadbush	*Amelanchier* spp.
spruce	*Picea* spp.
sumac	*Rhus* spp.
tulip poplar (yellow poplar)	*Liriodendron tulipifera*
walnut, black	*Juglans nigra*
willow	*Salix* spp.
witchhazel	*Hamamelis virginiana*

This revised edition of a popular favorite, TIMBER MANAGEMENT FOR SMALL WOODLANDS, is written expressly for owners and caretakers of noncommercial forestland who want to give nature a hand in producing marketable timber and wood products. Basic silvicultural and forestry techniques are explained and illustrated; the choices are discussed; the instructions are plain talk. An essential handbook for those who already own a woodlot, and a practical guide if you're considering the purchase of rural wooded property.

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