Sugarbush Management Notebook

Cornell Maple Program

USDA Agricultural Marketing Service
U.S. DEPARTMENT OF AGRICULTURE

Cornell University
College of Agriculture and Life Sciences
Department of Natural Resources

Table of Contents

Chapter 1: Introduction

Cornell University Cooperative Extension

Forest Connect

Supporting Sustainable Management of Private Woodlands

An Extension Publication of the Department of Natural Resources, New York State College of Agriculture and Life Science, a Statutory College of the State University at Cornell University, Ithaca, New York

1.1 Maintaining a Healthy Sugarbush

Peter Smallidge, NYS Extension Forester and Director, Arnot Teaching and Research Forest, Department of Natural Resources, Cornell University Cooperative Extension, Ithaca, NY 14853.

A sugarbush is a special type of woodland. Woodlands include a complex mixture of natural processes and attributes such as soil type, elevation, tree species, types of wildlife, history of use, tree age and more. Foresters can help maple producers gain an in-depth understanding of these factors to achieve a healthy and productivity sugarbush, but there are several steps a maple producer can take on their own.

Three principles should guide the way a maple producer looks at a sugarbush. These principles apply to all woodlands. First, managing the sugarbush to produce a specific product, in this case sap, is really about managing which plants receive sunlight. Sunlight feeds the leaves which make sugar, which of course is needed for high quality sap. Second, trees are biological organisms, similar in some respects to a tomato plant, a cow, or a human being. Biological organisms are born, grow and eventually senesce. They also respond to stressors in their environment, and their vigor determines how well they respond. Third, as trees get larger they require more space. Because trees can't move as they get crowded, some trees will die as the sugarbush matures.

With these principles in mind, a reasonable goal for a sugarbush is to make sure that trees of good vigor and potential longevity have adequate sunlight, stress events are minimized, and the effects of crowding are controlled by the owner who selects which trees remain. Following are a few actions that maple producers can take to help keep their sugarbush healthy and productive.

Figure 1. The crown of this sugar maple showed high levels of crown dieback. The soils were too shallow for good sugar maple growth. Dieback occurred after a heavy thinning that was followed by a late May frost and then defoliation by gypsy moth and forest tent caterpillar. Accumulated stresses are difficult for a tree to endure.

1. Monitor crown health. The leafy part of the tree, the crown, is perhaps the most important part of the tree to monitor. Be alert to evidence of unhealthy crowns. Symptoms of poor crown health may include dead branches in the upper part of the crown, poor leaf coloring during the growing season, unusually small leaves, or a transparent crown (Figure 1). There will always be a couple trees in a sugarbush with poor crown health, but if several trees show these symptoms a problem exists. A symptom tells you a problem exists, but it doesn't usually

identify the problem. Crown health may decline as a result of root problems, such as compaction from machinery. Repeated injury to the crown can also reduce health because of stress on energy resources in the roots; for example when defoliation coincides with drought. Crown problems often result in less sugar production and lower yields the following sap season. In extreme cases, minimize or avoid tapping to allow trees to recover a healthy crown. Unfortunately, the causes of unhealthy crowns often can be difficult to change. Some of the following actions also help maintain good crown health.

2. Assess competition for light among trees. Trees need light to grow. Although sugar maple is tolerant of shade, it doesn't thrive in shade. Maple producers need their trees to thrive, not just survive. The appropriate stocking, that is the number of trees of a given size per acre, is a numeric index of competition for resources, specifically light. There are also visual indications of too much competition for light. First, if the upper canopy, collectively the crowns of the tall trees, is closed and doesn't allow sunlight through there may be too much competition for light. If the canopy is closed and some trees have rounded crowns yet other crowns are flattened on two or more sides, there is likely too much competition (Figure 2). If the maple trees produce seeds, but there are no seedlings, there is either too much shade or too many deer. Before taking action, visual cues to competition should be assessed by a forester who will measure stocking. In many cases the state forestry agency can provide a public forester to do the assessment. These foresters are prepaid…your tax dollars at work. If competition is high, thinning around the best trees will ensure they have enough light to continue to thrive. Look for resources on Crop Tree Management to guide the selection of trees to cut and those to leave. Woodlot and sugarbush thinning webinars are archived at www.youtube.com/ForestConnect.

Figure 2. The tree in the center of the picture is shorter than the tree to the left, and has a smaller crown. The tree on the left is winning in the contest for light, but the shorter tree is still having a negative impact.

Figure 3. Ferns and beech are native species, but can form dense thickets that complicate production for maple producers. The canopy may be vigorous and healthy maple, but the understory portends future problems.

3. Look for interfering plants. Interfering plants are either native or non-native (AKA "invasive"), and interfere with something the owner wants to accomplish. Examples of interfering plants include multiflora rose, ferns, beech, striped maple, bush honeysuckle, and many more (Figure 3). For maple producers, interfering plants may complicate access for

tubing or buckets. Interfering plants may also impede efforts to establish young desirable maple seedlings. In some areas, deer pressure is high and they browse desired plants. This browsing gives a growth advantage to the interfering plants that deer don't browse. Strategies and techniques to control interfering plants depends on the problem plant, its abundance, how thoroughly the maple producer wants to control the plant, and if the producer will use herbicides or organic strategies. The author's website includes numerous resources to help control interfering plants.

Figure 4. Repeated accurate diameter measurement of this white pine is simplified by a nail at approximately 12 inches above ground and a 3.5 ft stick.

4. Monitor tree diameter growth. Tree diameter growth is critical to maple syrup producers. Diameter growth is an index of crown health. Diameter growth also helps heal tap holes, add new wood for future tapping, and as a reservoir for sap. A tree may produce the same amount of wood each year, but the thickness, known as the diameter increment, will decrease because the wood is spread around a bigger tree. Tapping guidelines assume tree growth is sufficient to add new wood and prevent future tapping into columns of stain from prior tapping. "Pattern tapping" helps prevent tapping into a stain column, and so does adequate diameter growth. Producers should expect annual diameter increments of 1/8th to 1/10th of an inch for trees less than 16 inches, 1/10th to 1/12th of an inch per year for trees 16 to 20 inches, and 1/12th to 1/16" of an inch for larger trees. The actual growth necessary to provide a sufficient thickness of new wood depends on depth of tapping and the offset of the tapping pattern between years. "Band tapping" high versus low bands of the tree will reduce the expectation for diameter growth (but why would you strive for slower growing trees?). Annual measurements at the same position on the stem with a tape measure will reveal tree growth. Producers can place an aluminum nail in the tree at 12" high, and use a 3.5ft stick to locate consistent height to annually measure diameter at breast height (dbh) (Figure 4). Measure a minimum of 30 to 40 trees, but at least one per acre. Just as producers should measure sugar concentration, so they need to measure tree diameter growth.

Figure 5. Plastic fence hung on a single strand of high tensile wire on a bumper block, for small patch cuts, will help reduce the impact of deer on small seedlings

5. Consider tree age and longevity. Sugar maple can be a long-lived tree, with some trees reaching 300 to 400 years of age under ideal conditions. Under normal conditions, maple will likely have reduced production between 150 and 250 years of age. Maple producers could assess if there are patches of old or otherwise unproductive maples and regenerate a couple small patches every few years. Cutting within patches needs to be sufficiently intense to allow sunlight to the forest floor.

Patches could be 0.25 to 0.75 acres, and vigorous trees within the patch could be retained. Young seedlings should be protected from deer by fencing (Figure 5) or dense continuous piles of brush around the perimeter. A forester can help assign vigor-ratings to trees, and producers can monitor sap production for individual trees. The location and timing of patch cuts should synchronize with planned changes of tubing and mainline.

Figure 6. Small ruminants and poultry may be better suited to sugarbush silvopasture than cows and cattle. Each species has unique attributes that need consideration.

6. Livestock. Historically many farm woodlots and sugarbushes allowed cattle and other livestock to free range. In these cases, grazing involved a perimeter fence and then free choice by the livestock. This continuous or set-stock grazing proved detrimental to the animals, the concept as for trees, see #2) was too high. Sustainable grazing is possible, but requires considerable work. Silvopasture is a deliberate process of integrating livestock into woodlands while also managing for nutritious forage plants. Management-intensive rotational grazing in small paddocks, with herd/flock movement daily ensures ample rest periods for the land and intensive, and restorative grazing of the forages (Figure 6). With careful planning, silvopasture practices can solve some interfering plant problems. Any plans for deliberate grazing should assure that root damage is avoided; pigs in particular can cause root damage through their tendency to "root." The author's website has several references and resources for silvopasture.

Figure 7. Ruts more than a couple inches deep will shear root, limit water and nutrient uptake, and expose the tree roots to infection. Some roads are necessary, but limit the extent of roads. In wet areas, invest some low value stems to make corduroy that will float equipment.

7. Avoid soil ruts and compaction. While tree crowns are perhaps the most important part of the tree for producers, tree roots tie for first place or a very close second place. The roots anchor the tree to the ground, pull water from the ground into the stem for sap, and feed the foliage. Damage to roots by tractors, skidders, or livestock can cause sugarbush, but they should limit the number of trails. In chronically damp or soggy areas, install corduroy with a continuous mat of small logs and poles to float the tractor. Use as small a machine as possible that is safe and effective, and add high floatation tires if practical. Other types of woods work should allow equipment only during seasons when the ground is firm, usually summer, dry falls, and during cold winters. Repairing ruts with fill or corduroy may help avoid the need for a new trail and new damage in a new area, but this will not repair the damage to the roots.

8. Mixtures of species. Your sugarbush will generally be healthier and more resistant to stresses such as insect defoliation if there is a mixture of species. When thinning a sugarbush to provide more light to desired trees, avoid the temptation or outcome of a monoculture. Providing adequate sunlight to keep a thrifty maple healthy may be best accomplished by cutting…another maple…there, I said it, it is okay to cut a maple. Seriously though, most producers can look at a maple with a small crown, weak fork, or old scars from maple borers or tractors and know that tree is not productive or is otherwise risky (Figure 8). Bucket producers have the advantage of truly knowing a tree's productive capacity. Paint or mark a tree of low productivity during the season, and cut that tree later in the year when time permits. When cutting firewood or thinning, set a target for the main canopy to be about 75% sugar maple or red maple and 25% other species. These aren't hard numbers, but use them as a guideline.

Figure 8. Disease and damage can cause weak stems that are prone to failure. Trees like the one pictured should be removed to avoid complications during the season and free growing space for nearby maple trees.

Time is of course the biggest obstacle to maple producers working in their sugarbush. Start with the easy tasks, and keep a list of priorities. Use this list to guide a discussion with a forester from your state forestry agency or your consulting forester. Let them know your goal is a productive and healthy sugarbush. A forester can help you develop a plan and a schedule to optimize the use of your time. Finally, be safe in the woods; there are too many stories of maple producers hit by trees and crushed by tractors.

Acknowledgements – Joe Orefice and Steve Childs provided helpful reviews of this article. This article was adapted from an article by the author that was published in the Maple Syrup Digest October 2016.

For additional information on woodland management go to:

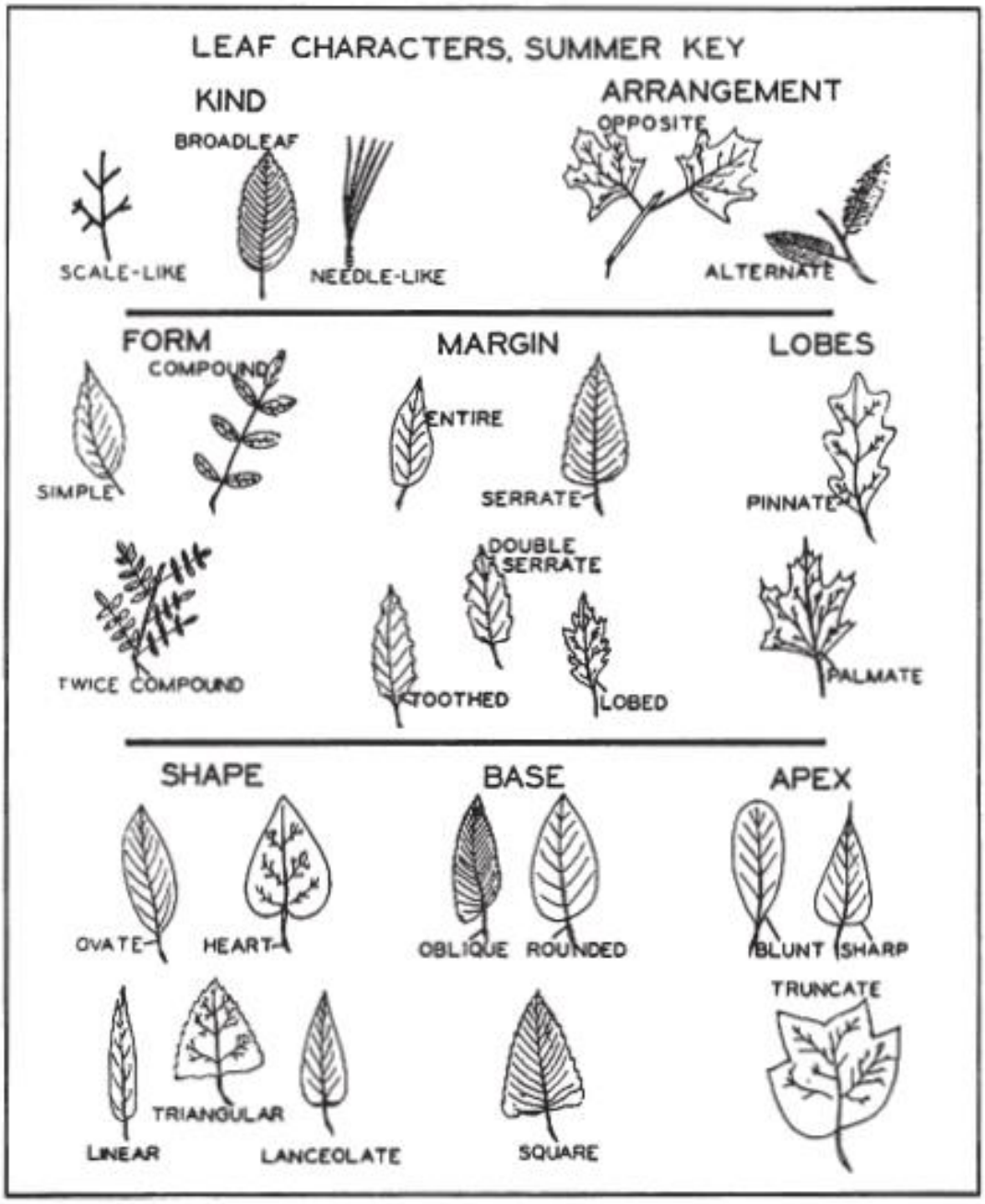
www.ForestConnect.com

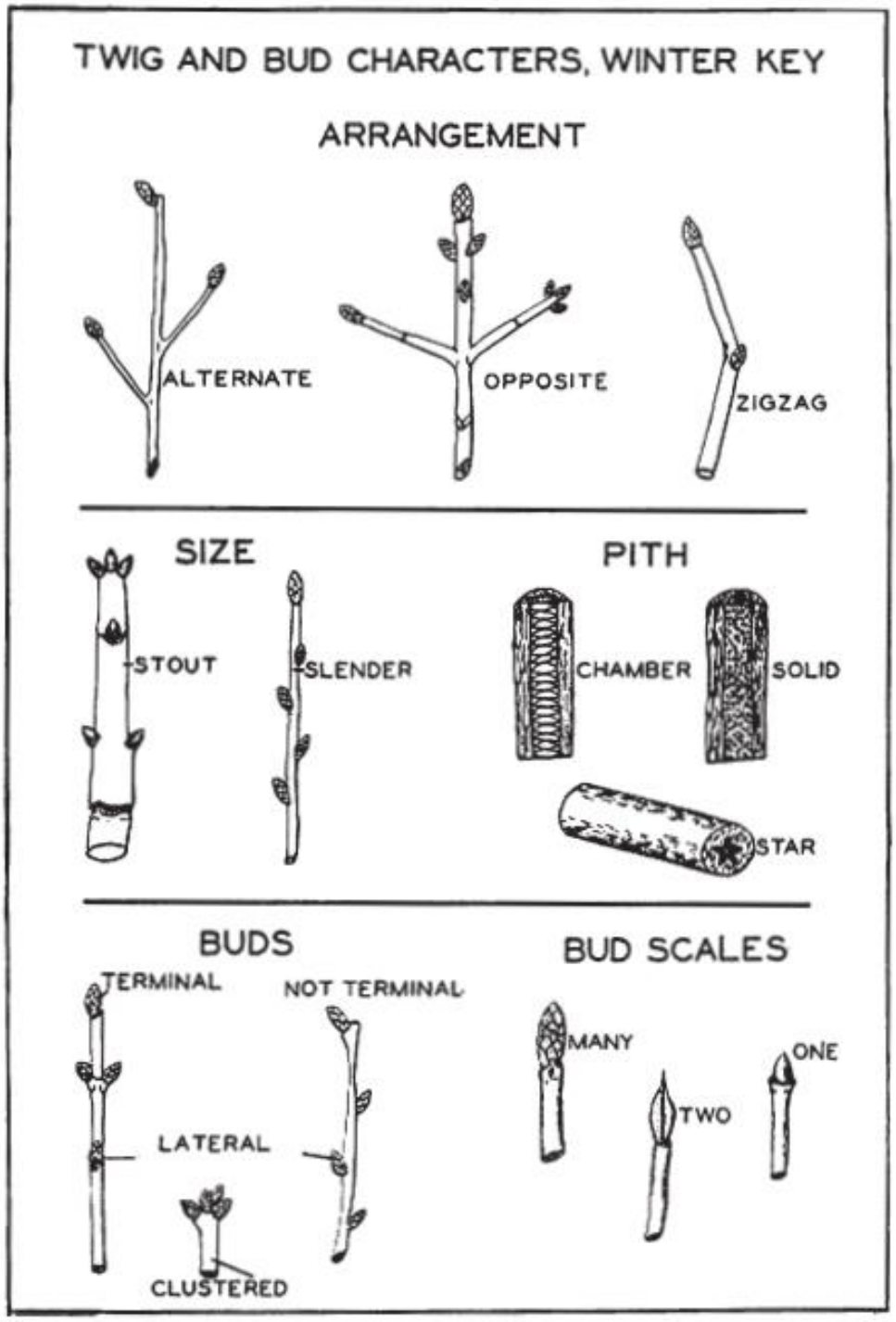
www.CornellForestConnect.ning.com

Layout and editorial assistance provided by Diana Bryant.
Support for ForestConnect is provided by the Cornell University College of Agriculture and Life Sciences, Cornell Cooperative Extension, and USDA National Institute of Food and Agriculture.

1.2 Identifying Maples and Associated Species

The following information is largely reproduced from a bulletin titled Know Your Trees, initially developed for Cornell University by J.A. Cope and Fred E. Winch, Jr. Below are illustrations of some of the unique terms botanists use to describe tree anatomy. Learning these terms will make it easier for you to describe tree species you haven't identified yet. It should also help you to know what to look for when attempting to identify an unfamiliar tree.




TWIG AND BUD CHARACTERS, WINTER KEY
ARRANGEMENT
ALTERNATE
OPPOSITE
ZIGZAG
SIZE
STOUT
SLENDER
PITH
CHAMBER
SOLID
STAR
BUDS
TERMINAL
NOT TERMINAL
LATERAL
CLUSTERED
BUD SCALES
MANY
TWO
ONE

Identifying trees by trunk bark alone can be difficult, even for fairly experienced maple producers. Bark tends to vary with how fast the tree is growing and in different regions and soils. Having some good pictures can be helpful. Trees also tend to have some bark color variations that are helpful to know on a sunny, dry day, but that are not as readily visible on cloudy days when the bark is wet.

All maples have buds that are opposite where many of the other forest species, or non-maples, have alternating buds. Ash is the other tree species with opposite buds, but ash can be easily identified by its much thicker twigs and diamond-shaped bark. Trees with bark that is often confused with maple include red oak, poplar or aspen, and basswood. These trees, however, all have alternate buds.

THE MAPLES

Maples (*Acer spp*.) are an important group of forest trees in New York State. Sugar maple is the state tree, and maples provide syrup, valuable hardwood timber, wildlife foods, beautiful fall colors, lawn trees, and watershed protection. Of the 16 or more maples east of the Rocky Mountains, 8 are found with moderate to high frequency in some parts of the state. These include sugar maple, red maple, silver maple, striped maple, Norway maple, box-elder, mountain maple, and black maple.

Maples as a group are readily distinguishable from other trees by their opposite arrangement of buds, leaves, and twigs, together with the characteristically shaped simple maple leaf (box-elder is the only exception, having compound leaves). The fruit of the maple group is also distinctive. Without exception, the fruit are winged seeds, borne in pairs and clusters of pairs, and commonly called samaras.

Pretty much any maple tree will yield sap that can be converted into maple syrup with fairly consistent maple flavor. However, not all maples are of equal value for making maple syrup. The three maple species used primarily for syrup production in New York are the Sugar Maple, Red Maple, and Black Maple. These trees tend to give both higher levels of sugar in the sap and stay dormant longer into the spring. Other maples can be used but have some drawbacks.

Tapping-Size Maples


SUGAR MAPLE

Sugar Maple (hard maple, *Acer saccharum*)

Sugar maple, the official state tree of New York, is a magnificent forest tree abundant everywhere in the state outside of Long Island. It provides beautiful borders to many miles of highway. It yields a wood of high grade. It is hard, strong, close-grained, and tough, with a fine, satiny surface, and is in great demand for flooring, veneer, interior finish, furniture, shoe lasts, rollers, and as a fuelwood of the best quality.

Bark: on young trees dark gray in color, close, smooth, and firm, becoming furrowed into long, irregular plates lifting along one edge.

Twigs: slender, shining, color of maple sugar.

Winter buds: very narrow, sharp-pointed, brown in color, terminal buds much larger than laterals.

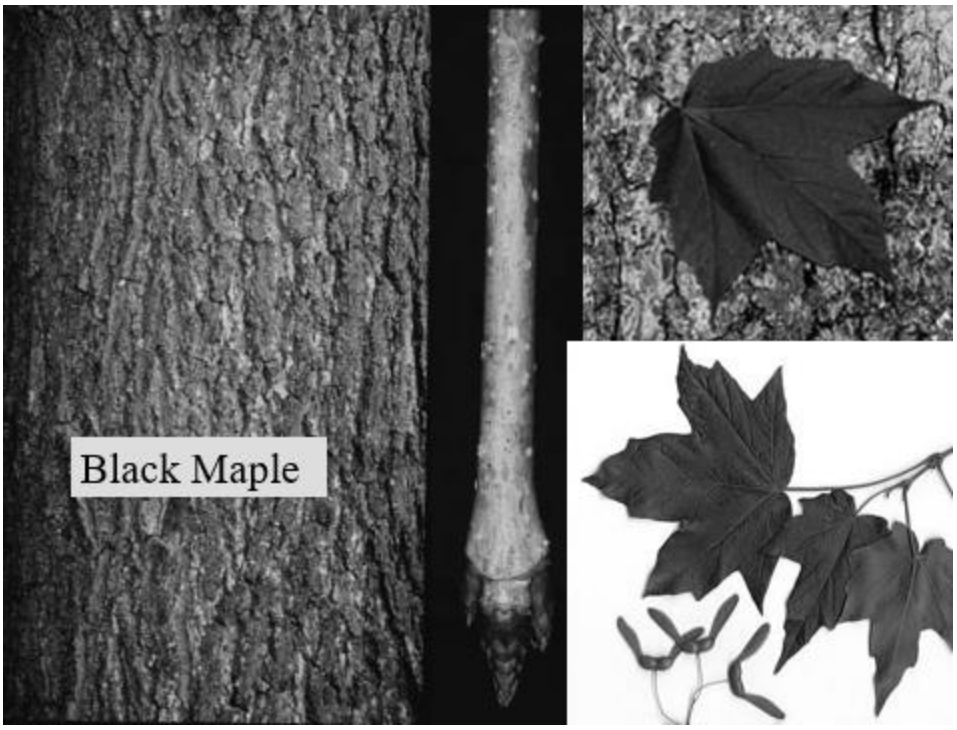
Leaves: simple, opposite, 3 to 5 inches long and fully as wide, 3 to 5 shallow lobes with wide-spaced coarse teeth, dark green in color above, paler below; clefts rounded at base. “U” shaped notches between leaf lobes, known as “sinuses”.

Fruit: samaras, in short clusters, ripening in September.

Seeds: join each other in straight line.

Wings: turn down almost at right angles.

Distinguishing features: rounded cleft between lobes of leaves; leaf lobes lacking small teeth; sharp-pointed, brown buds; brown twig.



Black Maple (*Acer nigrum*)

Black maple can be very difficult to distinguish from sugar maple. It has pointed buds and similar bark. Secondary leaves often appear to be three lobed rather than five lobed as on sugar maple. However, there is no real need to distinguish black maple from sugar maple because their performance in producing maple syrup is identical.

Further distinguishing features include: drooping leaf edges and tips, hairy lower surface of the leaves, and orange-brown dull twigs. Black maple's fall color is typically yellow compared to the brilliant orange to amber of sugar maple.

Red Maple (soft maple, swamp maple, *Acer rubrum*)

Red maple derives its name from its brilliant autumn foliage. Though it is common in swamps all over the state, it is also abundant on moist slopes and increasingly common in partially cut woodlots. It is an extremely rapid-growing tree, furnishing a fairly strong, close-grained wood that is extensively used for cheap furniture, baskets and crates, mine props, railroad ties, and fuelwood.


RED MAPLE

Bark: on young trunks smooth, light gray in color, often resembling beech; with age becoming darker and roughened into long ridges, often shaggy or scaly on surface; bark character extremely variable on different trees in same stand. Tends to have smaller checks or squares in the bark pattern, sometimes forming on younger trees or younger limbs in a bull's-eye or target-like pattern.

Twigs: rather slender, bright or dark red in color, without odor when cut or broken.

Winter buds: broad, rounded, clustered, short stalk, red in color; terminal bud slightly larger than lateral buds; numerous large, plump flower buds along twig.

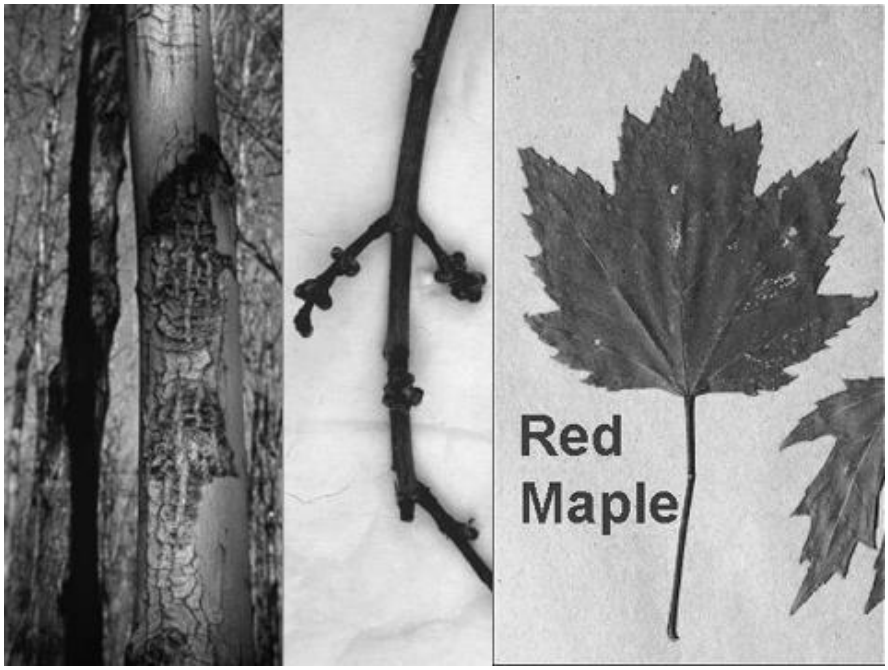
Leaves: simple, opposite, from 3 to 4 inches long, fully as wide, usually 3-lobed; clefts between lobes shallow and sharp angled (“V” shaped) as contrasted with deep clefts of silver maple; leaf edges are serrated or saw-toothed; at maturity leaves light green in color above, pale greenish-white below.

Fruit: samaras, in clusters on long stalks, ripening in May or early June.

Seeds: joined more or less end on end.

Wings: diverge at wide angles.

Distinguishing features: red buds and twigs, sharp angle between leaf lobes; leaf margin with teeth.



Red maples are commonly used in making maple syrup, but tend to have somewhat lower sugar content. Lower sugar content can be a problem for sugar makers because of the extra boiling that is required. For instance, sap at 4% sugar (a level a sugar maple standing in the open with a large full crown can attain) requires about 22 gallons of sap to make one gallon of syrup. Sap at 2% sugar (common to red maple in the open or from sugar maple in a dense woods) requires about 43 gallons of sap. Sap at 1% sugar (a level seen in silver maple, crowded red maple, or Norway maple) would require 86 gallons of sap to attain one gallon of syrup.

Many older guides to maple syrup production will include a second problem with red maples. This is that is comes out of dormancy, buds swelling, earlier in the spring than sugar maple does. The conventional wisdom is that this early bud swelling results in an off-flavor in the syrup called “buddy” flavor. However, these days, red maples are tapped right along with sugar maple with no effect on flavor. While it is true that their buds swell earlier than other maple species, it has yet to be proven that this is the cause of any off-flavor. Tapping your red maples can significantly increase your syrup yields if you have a lot of them on your property.

Here is an example of two different types of Red Maple bark. The Red Maples are flanking an example of Sugar Maple bark. Both trees have highly variable bark patterns, so it takes practice to distinguish them without leaves!

Silver Maple (white maple, *Acer saccharinum*)

SILVER MAPLE

Silver maple is generally distributed throughout the state but is not nearly as common as red maple. It prefers the same general moist soil conditions, and the wood is used for the same purposes as the red maple with which it is included under the term “soft maple” by lumbermen. Silver maple is frequently planted as a shade tree owing to its rapid growth, but because of its weak wood it shouldn’t be planted near homes or cars. Silver maple tends to be even lower in sugar content than red maple. These are usually yard trees in New York, not common in woodlots or forests except very near villages or cities. The leaves have very deep cuts or grooves on each side of the center lobe, buds are rounded and the bark is much smoother than sugar, black or red maple.

Bark: on young trunks smooth, gray in color with reddish tinge; with age becoming reddish brown in color, more or less furrowed, surface separating in long, thin flakes that become free at ends and flake off.

Twigs: similar to red maple but has distinctly rank odor when broken or crushed.

Winter buds: similar to red maple but larger, usually very dense clusters of lateral buds.

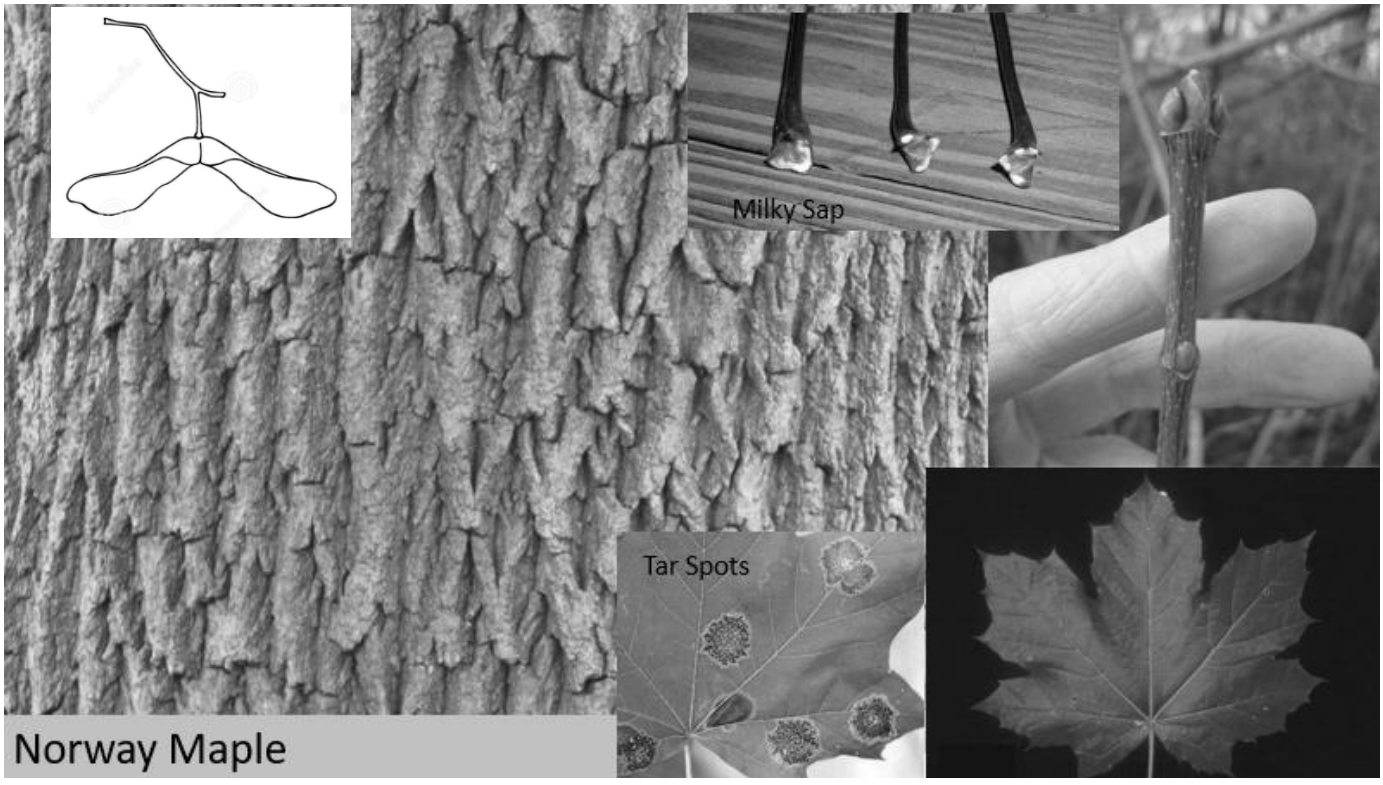
Leaves: simple, opposite, 3 to 5 inches long, fully as wide, 5-lobed; margins of lobes coarsely serrate; clefts between lobes, particularly middle two, very deep; at maturity leaves pale green in color above and silvery white below, hence the name “silver maple”

Fruit: samaras, much larger than in red maple though maturing at about same time in spring.

Wings: more widely divergent than those of red maple. Sometimes only one side of samara develops.

Distinguishing features: silvery bark on upper limbs; deeply cut clefts between coarse-toothed lobes; rank odor from crushed twig; large-winged samaras.

Norway Maple (*Acer platanoides*)



Norway maple has been widely planted in residential areas, now overplanted, and is considered an invasive weed in some of the many areas of the state where it has naturalized. It is a common backyard tree, and it can also be used to make maple syrup. Again, it tends to have lower sugar content than sugar maple, but sugar content in these trees seems to vary significantly from tree to tree. A large, healthy, sun-grown backyard tree can have equal sugar to sugar maple. The **bark** has very fine checking and **leaves**

that look much like the sugar maple only much larger. It has large, blunt terminal **buds**, and a broad leaf on a long stalk. The leaf stalk has a white, milky sap when broken. The species was removed from some sections of New York City and Long Island during an infestation of the Asian long-horned beetle, an exotic insect that feeds on and reproduces in Norway maple, other maples, and a variety of other hardwoods.

Box-Elder (Ash-Leaf Maple, *Acer negundo*)

Finally, another common backyard tree is box-elder. Although its most common name is deceptive, it, too, is a maple. In some parts of the state, it is an incredibly common weed tree. It is easy to identify because it is so different from the other maples. Box-elder is a medium-sized tree found in moist locations at lower elevations, occasionally common, and its greatest value is stream bank stabilization and shading of streams. It has a compound **leaf**, hence the name “ash-leaf maple,” but its clusters of samaras give it away as a maple. The leaflets are distinctly shaped and coarsely toothed. The tree has very weak wood and the trunk is rarely straight. The gray **bark** is ridged and furrowed, more and more so with age. The **twigs** are smooth and green even in the winter. Most box-elder have low sugar content, but again, a big one in a yard can be sweet.

Understory Maples

Striped Maple (*Acer pensylvanicum*) is an increasingly abundant species in the maturing and shady forests of the state. It thrives in shade and is restricted to the subcanopy. Striped maple reproduces easily and sometimes forms a dense understory that inhibits the reproduction of other species. This species is distinguished by bright green bark with white, or sometimes dark stripes, large goose foot–shaped leaves, and its samaras with wide-reaching wings. It rarely reaches a suitable size for tapping.

Mountain Maple (*Acer spicatum*) is another shrubby maple that does not grow past the understory. You are only likely to find it at high elevations, in moist ravines and on steep slopes. Again, it rarely reaches a size sufficient for tapping. It can be recognized by its coarsely toothed leaves, down hairs on current-year twigs and bud, and in the summertime, a spike of flowers that blooms after the leaves are fully developed.

Associated Species

BIGTOOTH ASPEN (*Populus grandidentata)*

Bigtooth aspen is a medium-sized, rapid-growing, short-lived tree that develops best on deep moist soils but is more common on dry, upland, sandy, or stony sites, where it rapidly covers slashes and burns. Here it provides habitat for wildlife that use early successional cover. The wood is similar to that of the quaking aspen and is used for excelsior, pulp, woodenware, crates, and boxes.

BIGTOOTH ASPEN
Leaf, one-half natural size; twig, one-half natural size; fruit, one-half natural size

Bark: resembles that of quaking aspen, though small branches are of a more pronounced yellow color. Lower trunk generally more deeply furrowed than that of quaking aspen.

Twigs: stout, round, reddish or yellowish brown in color in early winter, often pale and downy as contrasted with those of quaking aspen, which are shiny.

Winter buds: usually larger than those of quaking aspen, terminal bud present; lateral buds generally bending away from twig, dull, dustylooking, light chestnut brown in color.

Leaves: alternate, simple, 3 to 6 inches long, roughly triangular with square base, blunt apex, coarsely toothed margin in direct contrast to finely serrate margin of quaking aspen.

Fruit: very similar to that of quaking aspen (p. 20). Seeds: spread by wind.

Distinguishing features: coarse teeth on leaf with square base; twigs downy.

WHITE ASH (*Fraxinus americana*)

White ash is a valuable and rapid-growing tree in the woodlots of New York State. It is common throughout New York and is found up to an altitude of 2,000 feet in the Adirondacks. It prefers to grow in rich, moist woods and is common on abandoned agricultural lands. The wood is heavy, hard, strong, close-grained, and tough. Large quantities of white ash are used for agricultural implements, tool handles, oars, furniture, and sporting goods. In some locations, especially open edges and roadsides, branch dieback and tree mortality are common.

Bark: dark grayish brown in color, deeply furrowed with narrow, flat-topped, firm ridges that are somewhat scaly on older trunks; ridges in some instances tend to run together, enclosing diamond-shaped fissures.

Twigs: very stout, smooth, shining, grayish brown in color, brittle, flattened at leaf bases (nodes); leaf scar notched.

Winter buds: plump, blunt- pointed, dark brown or nearly black in color; terminal bud 1/5 inch long, larger than lateral buds; last pair of lateral buds almost on level with terminal bud.

Leaves: opposite, compound, 8 to 15 inches long, with 5 to 9 leaflets; leaflets sharp-pointed, 3 to 5 inches long, with slightly and sparsely serrate margins; borne on short stems; by this characteristic may be distinguished from black ash leaflets, which are stemless.

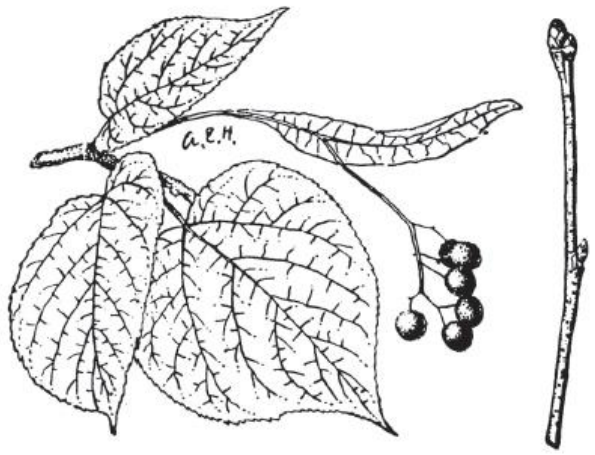
Fruit: winged seed, 1 to 2 inches long, broadly paddle-shaped with wing occupying position of blade; borne in long, open, drooping clusters, ripening in September, often not dropping off until early winter.

Distinguishing features: thick twigs; compound leaves with stemmed leaflets; brown buds; ashy-gray, older bark.

WHITE ASH
Leaf and fruit, one-third natural size; twig, one-half natural size

Unfortunately, White Ash are experiencing an epidemic due to the Emerald Ash Borer, an invasive pest that kills the tree (learn more in **Section 4.2**: Pest Insects). An infested ash tree will look unhealthy, with signs of woodpecker damage to the bark. This damage called "blonding" happens as woodpeckers fleck the outer bark off the tree to get to the larvae underneath, exposing the paler wood. Ash makes good firewood, and thanks to the emerald ash borer, is a good choice of tree for removal to thin your woodlot.

BASSWOOD (Linden, *Tilia americana)*



BASSWOOD
Leaf and fruit, one-third natural size; twig, one half natural size

Basswood is a moderately common forest tree in New York State. It grows rapidly, and its lumber has a wide range of uses. It does best in the deep, moist soils of the woodlot sections but is generally distributed except in the high Adirondacks and Catskills. The wood is soft, even-grained, light, and fairly strong and is used for boxes, crates, inexpensive furniture, woodenware, and paper pulp. It is often used as a substitute for white pine.

Bark: on young stems smooth, dark gray in color; on older trunks firm but easily cut, becoming furrowed into rather narrow, flat-topped ridges; on still older trunks furrows deeper, ridges more rounding and broader, surface scaly.

Twigs: rather slender, smooth, bright red or greenish in color or covered by gray skin, zigzag, slightly mucilaginous when chewed; fibers of bark on twigs very tough, may be used as rope.

Winter buds: terminal bud absent; lateral buds large, smooth, sometimes lopsided or humped, bending away from twigs, dark red or sometimes green in color.

Leaves: simple, alternate, heart-shaped, 5 to 10 inches long, sharp-pointed, coarsely serrate along margin; leaf base asymmetrical.

Fruit: round, woody nut, roughly pea-sized, borne singly or in clusters, with common stalk, attached midway to leafy bract, ripening in late fall but sometimes remaining on tree into winter. Bract acts as sail to scatter seed.

Distinguishing features: often found in clumps; usually large, heart-shaped leaf; humpbacked bud on zigzag twig; fruit a pea-like nut attached to a slender “parachute.”

Basswood is a maple look-alike. Without the give-away leaves, it can be hard to distinguish between the bark of basswood and maple in the winter. This is because both basswood and maple have highly variable bark. If you are not sure, there are two tricks to aid identification. 1. Even in winter, look up. You will be able to tell in the twig branching pattern whether your tree’s leaves are alternate or opposite. All Maples opposite, and one of the few trees in the region that are. Basswood is alternate. There is an illustrated example of opposite and alternate twigs on **page 9**. Basswood may also have value as a sap tree. The viability of processing its sap into syrup is being explored. Furthermore, its flowers are used to make a distinguished honey.

AMERICAN BEECH (*Fagus grandifolia)*

American beech has perhaps the widest distribution of any forest tree in the state and for that reason is one of the best known. In the Adirondacks and Catskills, it forms an important part of the hardwood forest but is almost equally common throughout the rest

of the state. Although the tree is of large and stately size, its wood is less valuable than that of many of its associates in the woodlot section of the state, with the result that it has been left standing. Because of its heavy shade, American beech has also excluded more valuable trees. Beech bark disease, which is a fungus that grows on injuries caused by a scale insect, infects and kills large numbers of beech trees in the Northeast. The wood is heavy, hard, strong, tough, and close-grained and is excellent as fuelwood. It also is used largely in the acid-wood industry, for baskets and crates, and to some extent for furniture.

Bark: smooth, close, steel gray in color, easily recognized by this character.

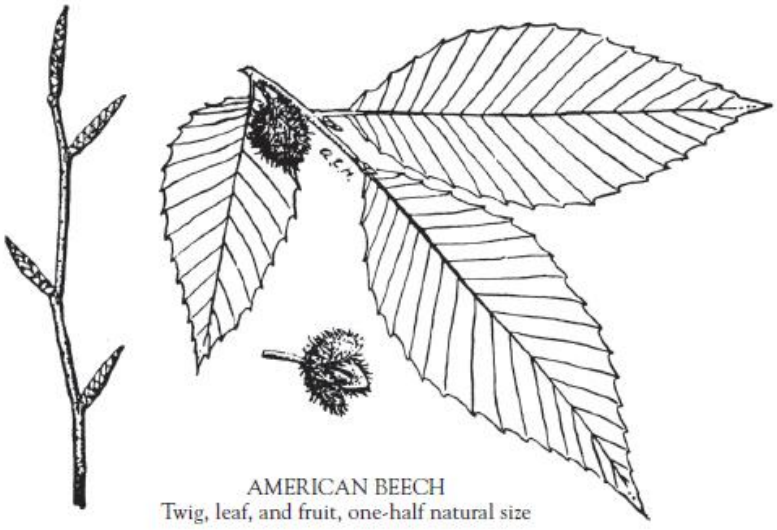
Twigs: slender, zigzag, smooth, shining reddish brown in color, becoming gray on older twigs.

Winter buds: terminal bud present, slender, 3/4 inch long, sharp-pointed, covered with light brown scales; lateral buds not much smaller than terminal bud.

Leaves: simple, alternate, 3 to 4 inches long, ovate, coarsely toothed on margin, bristle tipped; at maturity very thin, dull green in color above, pale green beneath.

Fruit: stalked burr, covered with soft, curving prickles, containing a nut. Burrs: usually in pairs, open up to let nuts fall in early autumn, remain on tree into winter. Nut: triangular, pale brown in color, shining, with sweet, edible kernel.

Distinguishing features: smooth, gray bark; coarse, sharp teeth on leaf margin; cigar-shaped buds.



AMERICAN BEECH
Twig, leaf, and fruit, one-half natural size

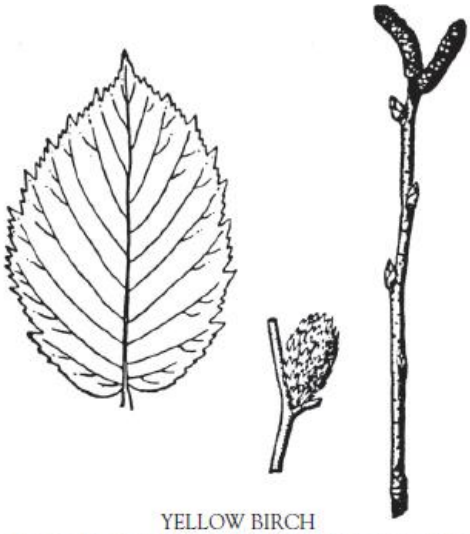
Because of Beech Bark Disease (BBD), this once valuable tree is causing problems for sugarbush managers. The tree is shade tolerant and its seedlings and saplings are tough competition for young maple. It is able to easily sprout from its roots and form dense clonal colonies of these “root suckers”. This mode of reproduction has been enhanced by the spread of BBD – a tree in decline will produce root sprouts at a higher rate. These dense colonies of understory beech shade out maple seedlings, and so their control has been a high priority. Learn more about how to control American Beech in **Section 5.1** of the chapter on regeneration.

YELLOW BIRCH (*Betula alleghaniensis)*

Yellow birch is an important and prominent timber tree in New York State. It is common throughout the state, except on Long Island, on rich, moist uplands in company with beech and sugar maple, but also is found with red spruce in the swamps and along

waterways. The heavy, very strong, hard, close-grained, light brown wood is largely used for furniture, woodenware, flooring, interior finish, airplanes, and agricultural implements. Its value for fuelwood entitles it to a place in farmers' woodlots. Its seeds often sprout and grow from the tops of rotten stumps and logs.

Bark: on young branches close, bright, silvery, yellowish gray in color; with age peeling into thin papery layers that roll back and extend up trunk in long lines of ragged fringe, making excellent tinder for starting fires in rain; on very old trunks becoming rough and furrowed, reddish brown in color.



YELLOW BIRCH
Leaf and twig, one-half natural size; fruit, one-fourth natural size; male flower buds at upper right

Twigs: slender, smooth, yellowish brown in color, and often hairy, slightly wintergreen-flavored; with abundant, spur-like laterals as in black birch.

Winter buds: terminal bud present on spur-like lateral branches only, about 1/4 inch long, conical, sharp-pointed.

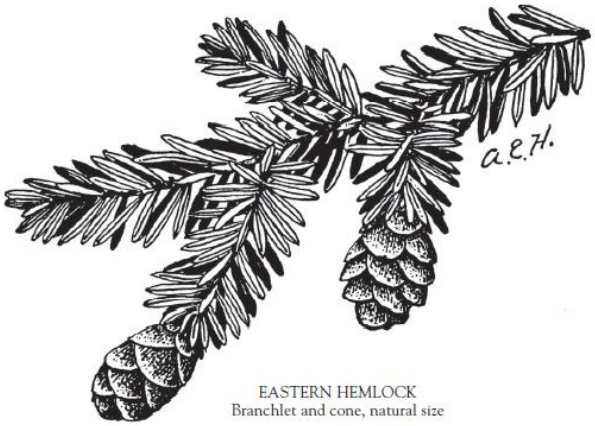
Leaves: alternate, simple, ovate, 2 to 5 inches long, sharp-pointed, with fine doubly serrate-margin, found usually in pairs, not opposite on lateral spurs, undersurface somewhat hairy, particularly along veins.

Fruit: an erect, cylindrical, cone-like structure as in other birches, though usually wider in proportion to its length, 1-1/2 to 2 inches long, falling in late autumn and throughout winter. Bracts: 3-lobed, distinctly hairy, whereas in black birch they are smooth.

Distinguishing features: silvery gray to yellowish bark, peeling in thin sheets; slight wintergreen flavor in bark and twigs; undersurface of leaves hairy along veins.

EASTERN HEMLOCK (*Tsuga canadensis*)

Eastern hemlock is a valuable forest tree that is very widely distributed throughout the state. It is particularly common on northern exposures, shaded gorges, steep mountain slopes, and borders of deep swamps. The wood is light, not strong, coarse-grained, brittle, not durable, splinters easily, and is light brown in color. It is largely manufactured into construction lumber and is also in demand for mechanical pulp.



EASTERN HEMLOCK
Branchlet and cone, natural size

Bark: reddish to grayish brown in color, with shallow, broad connecting ridges; inner bark bright cinnamon red in color. High tannin content of bark of commercial value in tanning leather.

Twigs: slender, yellowish to grayish brown in color, rough when needles are shed.

Winter buds: very small, reddish brown in color, not resinous-coated.

Leaves: borne singly, twisting to appear 2-ranked with third row pointing forward on top of twig; with distinct short stalk, flat, 1/2 inch long, rounded or notched at apex, dark green in color above, paler below with 2 white lines, persisting 2 to 3 years.

Fruit: a cone, stalked, pendant, 3/4 inch long, ripening in one year, grayish brown in color when mature, falling during winter following maturity. Cone scales: with rounded entire margins. Seeds: in pairs, winged, light brown in color, 1/16 inch long, ripening in September.

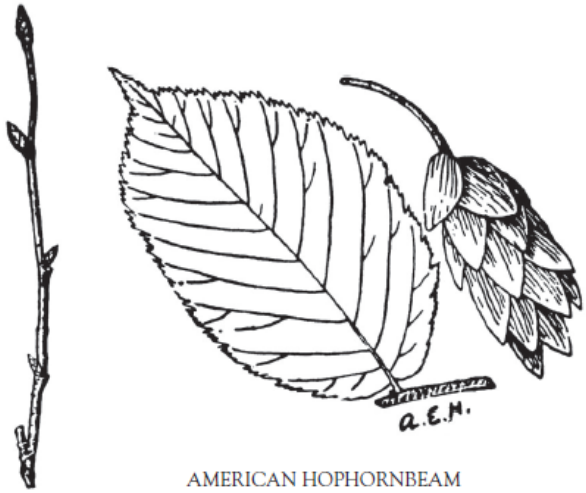
Distinguishing features: needles with tiny stalks; small cones.

Hemlock has special significance to a sugarbush. It can be a really negative species to have around maple tubing – it shades and freezes sap in the lines, and creates great habitat for squirrels and other rodents that chew through tubing. For this reason, many producers avoid running tubing through hemlock groves. Additionally, hemlock is an important species for ecosystem health as it shades and cools streams to adequate temperatures for fish and invertebrate reproduction.

The hornbeams below can be very useful in the sugarbush. They are generally small understory trees, but with massive strength – great for holding high tensile wire that supports the tubing system.

HOP HORNBEAM (ironwood, *Ostrya virginiana*)

Hop hornbeam is closely related to the American hornbeam and is rather generally distributed throughout New York State on dry, gravelly, and stony soils of slopes and ridges, sometimes taking possession of woodlots in central New York to the exclusion of other species. The tree is slow-growing and is rarely found larger than 10 inches in diameter. The wood is very heavy, hard, and strong, hence the name “ironwood.” It is used for tool and implement handles and for levers and makes excellent fuelwood when seasoned.



AMERICAN HOPHORNBEAM
Twig,leaf, and fruit, one-half natural size

Bark: thin, very markedly flaky; light grayish brown in color, broken into narrow, flattish pieces, loose at ends.

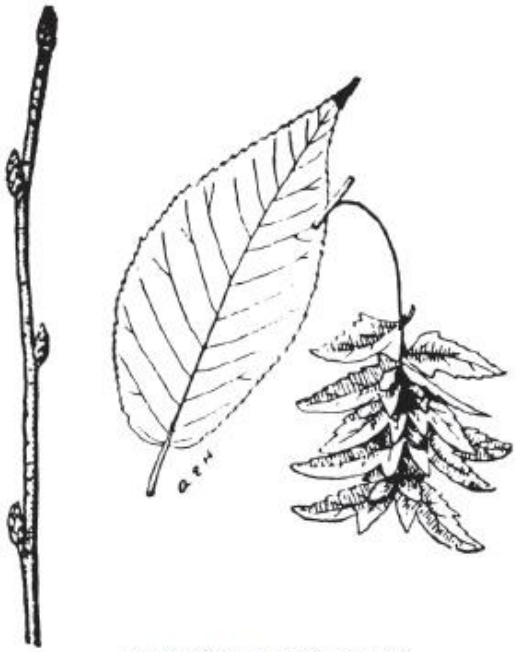
Twigs: fine, reddish brown in color, smooth, and shiny; very easy winter character for identification of tree, particularly of young saplings.

Winter buds: terminal bud absent as in birches and elms; lateral buds small, light reddish brown in color, bending away from twig.

Leaves: alternate, simple ovate, 3 to 5 inches long, doubly and finely serrate on margin.

Fruit: small, seed-like nutlet, enclosed in inflated, sac-like bract. Bracts: in clusters 1 to 2 inches long, resembling hops, hence the name “hop hornbeam.” Fruit usually falls before winter.

Distinguishing features: shreddy bark; shiny, reddish-brown twigs; papery fruit like a hop.



AMERICAN HORNBEAM
Twig, leaf, and fruit, one-half natural size

AMERICAN HORNBEAM (musclewood, blue-beech, *Carpinus caroliniana*)

American hornbeam is a small-sized, bushy tree, found frequently along watercourses and the edges of swamps generally throughout the state. It is rarely more than 6 inches in diameter. The wood is very heavy, hard, strong, close-grained and is occasionally used for mallets on account of its hardness.

Bark: smooth, thin, dark bluish gray in color, close-fitting, with smooth, rounded, lengthwise ridges that resemble tensed muscles.

Twigs: very slender, dark red in color, shining.

Winter buds: terminal bud absent; lateral buds small, often angled in cross-section, narrowly ovate, pointed, covered with many reddish-brown scales.

Leaves: simple, alternate, ovate, 2 to 4 inches long, finely and doubly serrate on margin.

Fruit: a small prominently ribbed nutlet, 1/3 inch long, enclosed in 3-lobed leaf-like bract. Bracts with their enclosed nutlets are in long, drooping clusters that ripen and fall before winter.

Distinguishing features: “muscles” in bark; fruit a nutlet enclosed in 3-part “dress.”

THE OAKS

Of the 300 oaks known in the world, 55 are native to North America, and most of these are in the eastern United States. The oaks make up the largest group of forest trees native to New York. Sixteen species of oaks are native to this state. They grow under a wide range of conditions and show wide variations in form and other distinguishing characteristics. The oaks of New York do not thrive in the high forests of the mountains; therefore, representatives of the family found in the Adirondack section are in the sheltered valleys of the foothills. South and westward in the drainages of the Susquehanna, Genesee, and Alleghany Rivers, they become plentiful in variety and number.

The best way to become acquainted with New York oaks is to divide them into two major groups, the one comprising the white oaks and the other the black oaks. It is easy to place the oaks of New York in these two groups by remembering the following characteristics of each:

The white oaks: The leaves have rounded lobes (not bristle-tipped), and the kernels of the acorns are usually sweet. All the oaks of this group mature their acorns in a single season;

for this reason they are sometimes called “annual oaks.” The most important members of the group in New York are **white oak, swamp white oak, bur oak, post oak,** and **chestnut oak.**

The black oaks: The leaves are bristle-tipped (not round-lobed), and the kernels of the acorns are usually bitter. All the oaks in this group require two seasons to mature their acorns; for this reason they are sometimes called “biennial oaks,” which means two-year oaks in contrast with the one-year white oaks. The immature acorns are very helpful in recognizing the members of the black-oak group, especially during the winter months when the trees are without leaves. The most important members of this group in New York are **black oak, red oak, scarlet oak,** and **pin oak.**

NORTHERN RED OAK

WHITE OAK

This guidance only covers a few of the most common species found in a typical sugarbush in New York. For more complete descriptions, color photos, and additional species relevant to your property, look for a quality regional ID book.

Chapter 2: Sugarbush Assessment

2.1 Assessing Potential for a Commercial Sugarbush

Assessing the Commercial Potential of a Site for Maple Sap Collection

Steve Childs, Peter Smallidge and Mike Farrell, Cornell University Cooperative Extension, Department of Natural Resources. Ithaca, NY www.CornellMaple.com (March 12, 2020)

These 9 variables are intended to help a potential commercial maple producer evaluate the relative merits of one or more selected woods for profitable maple production. A poor or medium rating does not mean that the woods should not be tapped but that production costs in money or labor will likely be higher or greater investments will be necessary to allow the sap collection to be established relative to other sites. Some problems may be avoided if the potential producer is a creative problem solver. Small-scale producers and hobby producers have less emphasis on financial return, so these variables are relevant but perhaps not weighted as heavily.

1. Tapping Density (Number of Taps Per Acre)

Mark a center point in the sugarbush for a circular plot with a radius of 26.4'. This is a 1/20th acre plot. Measure out the circle and count 1 tap for each tree 10" diameter or more, and count each tree you will double tap (usually 18 to 20" diameter) as 2. Total this count for each plot and divide by 20. The same process could be used on a 1/10th acre plot (radius = 37.2') and multiple by 10.

Alternative

Use the third page of this guide to "point sample" trees with an angle gauge or prism. This process is faster and gives equally valid results. Video link https://www.youtube.com/watch?v=ovaHN7spfdQ

Input these estimates of tap density per acre into the cost spreadsheet to obtain a cost per tap evaluation. It can be found at www.Cornellmaple.com. The goal is to have at least 50 taps per acre.

Good 40+ taps per acre
Medium 20 to 40 taps per acre
Poor 1-20 taps per acre
Remediation – N.A., or thin sugarbush to increase growth and diameter of smaller maples (**Section 3.4**)

2. Soil types: Use your area soil maps

(http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm)
Good – well drained, moderately well drained,
Medium – excessively well drained, somewhat poorly drained
Poor – poorly drained
Remediation – N.A.

3. Health and Quality of available trees (see indicators below)

Good – healthy trees, rapid taphole closure, canopy not closed,
Medium – tree health mixed, canopy closed, few indicators of poor health
Poor – crown dieback, thin crowns, numerous trees with indications of poor health
Remediation – Thin to reduce abundance of medium and poor quality trees, favor maple on better soils

Indicators of unhealthy trees:

- Stem defects: insect scars, fungus, weak forks,
- Crown: upper crown dieback, thin crowns, live crown ratio less than 30%, recent defoliations
- Butt/root: exposed roots due to erosion, skidder damage, stem scars

4. Access:

Distance between collection site and sugarbush:

Good - sugar house or open road (normally kept open all winter) downhill and within 1000'.

Medium - sugar house or open road (normally kept open all winter) downhill and within 2000'. Seasonal road (may be seasonally maintained by the maple producer) is downhill and within 2000' of the collection site. Open road, sugar house or seasonal road level with the production woods.

Poor – No obvious access so road must be constructed by the producer. Production woods downhill from open road, sugar house or seasonal road. Greater than 3000' downhill to collection site.

Remediation – N.A., install new road, move sugar house, or lease site for collection tank

5. Access to and within the sugarbush:

Good – access roads throughout for maintaining tubing, thinning and woods to the woods and within the woods
Medium – access roads to the woods
Poor – no current access roads to the site; limited or low quality interior trails
Remediation – install roads or trails, commercial harvest with emphasis on quality well-located roads

6. Availability of electricity – important with vacuum not for buckets or gravity

Good – Electric readily available. Access to collection site is readily available if maintaining a generator

Medium – Electric within 500'. Access to collection site requires maintenance if using a generator

Poor – Access to the collection site is very limited if maintaining a generator
Remediation – Use buckets, install road for easier access to generator, or extend main line for easier generator location

7. Steepness of site – for tubing

Good – gradual downhill to the collection site B slopes (3 to 8% slope)
Medium – steep enough to be difficult in some places OR too flat for good tubing drop A slopes (0 to 3% slope) and C slopes (8 to 15% slope)
Poor – Access difficult due to steepness D and E slopes (>15% slope)
Remediation – N.A., or install roads on contour for easier access. Steep slopes may favor 3/16" tubing designs.

8. Needed Management:

Good - No canopy thinning or understory vegetation management needed
Medium - Light to medium thinning of canopy trees or understory vegetation management needed
Poor - Significant thinning or understory vegetation management needed
Remediation – thin woods by crop tree release or basal area reduction, or manage undesirable vegetation

9. Associated vegetation:

Good - Few evergreen trees, little or no interfering understory species, mostly deciduous, ~25% of basal other than sugar maple
Medium - Some evergreen trees, some interfering understory, 10% to 25% basal area other than sugar maple
Poor - Significant evergreen trees present, less than 10% basal area other than sugar maple, significant interfering understory: multiflora rose, honey suckle, other thorn trees, briers, beech, poison ivy
Remediation – Thin woods to enhance species composition, or control interfering species

2.2 Point Sampling for Number of Taps per Acre

Use the angle gauge or prism to count the number of trees, by diameter class, at several points. Record all your tree counts on one form. Record how many sample point you visit. Multiple the "tree count" for each diameter by the "multiplier" and record the product in the "#taps/diameter" column. You can double the "multiplier" for trees $\geq$ 18" if you plan to use two taps. Total the final column and divide the sum by the number of points you visited. This is an estimate of the number of sugar maple trees per acre available for tapping.

Number of Sample Points Visited = _____

Tree Diameter Mid-point (DBH, inches)	Tree Count	Multiplier	# Taps/Diameter
10 (9 to 11)		18.3	
12		12.7	
14		9.4	
16		7.2	
18		5.7 (x 2)	
20		4.6 (x 2)	
22		3.8 (x 2)	
24		3.2 (x 2)	
26		2.7 (x 2)	
28		2.3 (x 2)	
30		2.0 (x 2)	
		TOTAL =	

Approximate number of trees at each point

Total # taps / Total # sample points =_____/ _____

=_____estimated number of taps per acre

Sugarbush Assessment Tally Sheet - ***Composition and Structure***

DATE

Stand Location Information	

Sample Point Summary
(number of sample points)

	DBH	6"	8"	10"	12"	14"	16"	18"	20"	22"	24"+	Basal Area/ac or TPA	Basal Area or TPA (%)
Species	*TPA multplier ->*	*50.9*	*28.6*	*18.3*	*12.7*	*9.4*	*7.2*	*5.7*	*4.6*	*3.8*	*3*		
sugar maple	#stems (acceptable)												
	# stems >50% wknd crcmfnc												
	# stems >25% crown dieback												
	TPA												
	# stem												
	TPA												
	# stem												
	TPA												
	# stem												
	TPA												
	# stem												
	TPA												
	# stem												
	TPA												
	# stem												
	TPA												
	# stem												
	TPA												

Basal area per acre = (# stems x 10) / number of sample points • *TPA [trees per acre]* = # stems in a DBH class x TPA multiplier/ # sample points. Quadratic mean diameter = SQRT [(average maple basal area per acre/average number maple per acre) / .005454)]

2.3 Estimating Taps

Estimating Taps Per Acre

Maple producers will need to estimate the potential number of taps per acre to assess the productive capacity of an area, and to aid in estimating the costs for installing tubing systems or buckets. Two methods allow producers to collect data that estimates the number of taps. One method uses a tape measure to establish a 1/20th acre plot. The other method uses an angle gauge to select trees from a sample point. Both methods are valid and useful, but use different mathematical principles. The data will be most easily reported using a dot-dash tally system. Use approximately one plot or point per acre.

Once you know the number of taps per acre, you can compare sites (see site comparison handout), and estimate costs using the tapping and tubing cost estimator available at www.CornellMaple.com (look at "publications" and then "tools")

Method 1. Fixed Radius Plot

Use a tape measure or rope to create a circular plot with a radius of 26.4'. Count all 10" dbh (diameter breast height, 4.5' above ground) and larger sugar or red maples within the plot. Stems larger than 26" could be counted twice. You do not need to record the dbh of the stem. Multiple the number of counted trees by 20 to obtain an estimate of taps per acre.

Plot #	1	2	3	4	5	6	7	8	9	10
# taps per plot										
Plot multiplier	20	20	20	20	20	20	20	20	20	20
# taps per acre										

Average number of taps per acre = _____

Method 2. Variable Radius Plot

Use an angle gauge at each point to count all red or sugar maple trees greater than 10" dbh and record them as TPP or "taps per point." Assign each tree to the appropriate dbh class. Trees should "fill the window" when inspected at 4.5' above ground. For each point, multiple the number of taps per point (TPP) in each DBH category by the "tree per acre" multiplier (*TPA) determined for the mid-point of each diameter class. *TPP *TPA equals taps per acre for that DBH category*. Sum a row of TPA= to estimate taps/acre. Average for all points. One point/ac.

		DBH Category											
		10-11.9	12-13.9	14-15.9	16-17.9	18-19.9	20-21.9	22-23.9	24-25.9	26-27.9	28-29.9	30+	Σ
POINT	**TPA >*	*15.2*	*10.8*	*8.1*	*6.3*	*5.1*	*4.2*	*3.5*	*2.9*	*2.5*2*	*2.2*2*	*1.8*2*	
1	TPP												
	TPA =												
2	TPP												
	TPA =												
3	TPP												
	TPA =												
4	TPP												
	TPA =												
5	TPP												
	TPA =												
6	TPP												
	TPA =												
7	TPP												
	TPA =												
8	TPP												
	TPA =												
Average	TPA												

Chapter 3: Sugarbush Improvement Activities

3.1 Sugarbush Management Basics

Cornell University Cooperative Extension

Small-Scale Sugarbush & Woodlot Management
Tree Description and Selection Summary Table

(Peter Smallidge, NYS Extension Forester, June 2012. www.ForestConnect.info)

Thinning a woodlot can improve the growth of the residual trees by increasing their access to sunlight. During a thinning harvest, crop trees are retained for enhanced growth. Eventually, crop trees are removed as part of a regeneration harvest.

Prioritize your work in areas with the best soils and with the least amount of sky that is visible through the closed leafy canopy. Large trees may have value and you should consult a forester. Select cut vs. leave trees after understanding the impacts on the overall woodlot's growth and development. Always work safely.

1. RELEASE AND RETAIN TREES that are of a species that matches the owner's objectives, have a healthy crown located in the upper canopy, *and* are generally free of structural defects (especially root or butt damage).
2. CUT TREES if: not a species suited to the owner's objectives, have poorly formed crown and in the lower canopy, *or* have defects that may limit the longevity of the tree.

Complete this table and discuss answers with the workshop instructor.

Tree Number	Species	Approx. DBH	Upper or Lower Canopy Position	Crown, stem or root characteristics that are noteworthy for tree health or quality.	Crop Tree?	Based on adjacent trees, would you cut?
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Cornell University
Cooperative Extension

Chainsaw Safety Best Management Practices

Peter J. Smallidge, NYS Extension Forester and Director, Arnot Teaching and Research Forest. Cornell University Cooperative Extension. Ithaca, NY 14850. January 2008.

Many forest owners will use a chainsaw at some point to clear trails, collect firewood, or thin their woods for improvement and growth of the residual trees. Chainsaws are important tools, but can be especially dangerous if improperly used. Chainsaw operators should be in good physical condition, have properly functioning equipment, appropriate personal protective equipment and know which cutting techniques to use for a given situation. Following are some BMPs (Best Management Practices) to help ensure you are safe and productive with your saw.

1. **Be where you are**. Accidents with chainsaws happen in a split second, but those accidents often result from existing circumstances. Be alert to your existing circumstances of person, place and equipment. Through complete attention to your activity, that being the safe operation of the chainsaw, you can greatly reduce your potential for injury or death. Think only about what you are doing, how you are doing it, your personal ability, and the current conditions. If you mind starts to wander, stop running the saw.
2. **Participate in an approved safety and productivity course before using your saw.** Good courses will last several hours. Some courses with advanced instruction will require several days, but are worth the investment. Some chainsaw dealers provide limited instruction. Nationally, a course known as Game of Logging for Landowners provides comprehensive technical training for landowners on felling and saw maintenance. In NY, these courses are sponsored through Cornell University's ForestConnect and NYFOA.
3. **Always wear appropriate personal protective equipment**. Minimally, equipment includes: a hardhat, eye protection, hearing protection, cut-resistant chaps or pants, and sturdy boots.
4. **Identify hazards in and near the tree you plan to cut.** Look for dead branches, hanging branches, standing snags, saplings in the path of the falling tree, and other structures that might impede the falling tree. Remove hazards if possible. If hazards cannot be managed, pick a different tree to cut. Evaluate snags within one tree height of your location and cut those you deem of high risk.
5. **Determine the back or side lean of the tree relative to the direction the tree will fall.** Look into the crown of the tree you will cut and determine where the majority of weight is located. Consider branches that extend to the side which add weight. Special techniques, available in training courses, are necessary to fell a tree against the natural lean. Avoid using ropes, chains and tractors to pull a tree against the lean.
6. **Identify and clear an escape path.** When the tree starts to fall, you need to be at least 15 feet away from the stump and at a 45 degree angle from the direction of the fall. Take time before felling to clear any obstacle that might block your path. Do not stand near the stump of a falling tree. After the tree falls, look for falling branches and trees before moving to the next tree.

7. **Determine the length and thickness of the hinge.** A correctly felled tree depends on the hinge wood to determine the direction of travel. Based on what you learned in an approved felling course, measure the tree to determine the length and thickness of the hinge. Be careful not to cut your hinge.
8. **Determine the final cuts.** Know where you will stand and how you will execute your final cut. If using wedges, how many will you need and where will you place them. Make a final check on safety and others before releasing the tree to fall.
9. **Maintain your equipment.** Assess the operability of your saw and safety equipment at the beginning and end of each day. Keep your chain teeth sharp, the chain appropriately tight, and the engine running smoothly. Make adjustments to equipment as necessary during the day. Replace broken safety equipment. Improperly function equipment can cause increased fatigue and greater chances for injury.
10. **Stop before you get tired.** Know the limitations of your physical endurance. If you stop before you get tired, you will be around tomorrow to cut the tree that will be where you left it.

Cornell University
Cooperative Extension

If a tree falls in the forest when you cut it, do you know which direction it will fall?

Peter J. Smallidge, NYS Extension Forester and Director Arnot Teaching and Research Forest, Cornell University, Ithaca, NY. March 2007.

Has this happened to you?…attired with appropriate chainsaw safety equipment you walk to a tree destined for the firewood pile. You notice an opening in the forest canopy into which you could fell the tree, but alas the tree is leaning in another direction. You hope against hope the tree might fall towards the opening, but reality strikes and you pinch your saw and hang the tree. Unfortunately, this scenario and worse happens repeatedly each year. Take heart, your luck is about to change especially if you complete a Game of Logging training. You will then know how to evaluate your ability and the lean of the tree to know if you can move the crown of the tree against gravity and into a forest canopy opening. You will learn how to work through your felling plan and execute a perfect tree fall knowing how to avoid hanging the tree and the associated headaches, risks and hazards.

Unfortunately, most forest owners and other chainsaw users have never had a safety course, much less a course in directional felling that provides safety plus productivity training. What more could you ask for in a course? Here's what…include some training on chainsaw chain and engine maintenance for the full benefit of safe and productive woods work. Add to that small classes sizes and the fact that every participant gets hands-on instruction. Through educational programs such as exist at the Cornell University's Arnot Forest the opportunity for this type of training exists. The program, Game of Logging for Landowners, teaches forest owners the skills they need to go from beginner to accomplished tree feller. Sessions are limited in class size to allow individual attention from the certified instructor. At the Arnot Forest, members of the NY Forest Owners Association and NYS Maple Producers Association receive a substantial price discount.

I know that a thorough working knowledge of directional felling is essential for safe and productive work in the woods. I have participated in three levels of the Game of Logging training. I use the skills in management and research throughout the state. My wife and I use the skills in our woodlot. The training is mandatory for people who work at the Arnot Forest. The skills you learn in saw sharpening and maintenance more than pay for the cost of the course. But don't take my word, listen to some testimonials from people who have taken and now use the skills that come with directional felling.

Testimonial 1 (Ron Pedersen)

The Game of Logging should be required at a young age, like driver training or hunter safety for a big game license. My chaps and helmet probably used to feel out of it, but now they are in use whenever there is action. I'm fortunate I am in one piece and was able to take GOL 60 years later than I should have. Directional felling is now a fun challenge, no longer a complete mystery, and when I miss, the stump usually shows me why. Safety and know how – that is sustainable. I can't imagine anyone thinking that GOL isn't a great value!

Testimonial 2 (Chuck Winship)

We, at Sugarbush Hollow, a maple syrup operation, will not let anyone use a chainsaw in our woods without first taking the Game of Logging course. We do extensive timber stand improvement even among our tubing systems. The course, with its various levels, provides each of us with the right safety procedures which enables us to have the necessary confidence and skills in handling the most dangerous tool invented by mankind. We have the ability to make the felling of trees efficient from a time and effort point of view. The trees fall where we want them without hanging up or damaging the residual trees as well as avoiding the tubing systems. The course is fun and taught by a person who can hold your interest all day. Those of us new to a chainsaw, men and women, can safely and effectively compete against those who have chainsaw for years without this training.

Testimonial 3 (Tim Levatich)

Game of Logging 1 and 2 have radically improved my felling work. I now have a quick step-by-step system and the proper techniques to get any tree down to the ground. I feel much safer and I work more efficiently, so I can get more done with my limited time. The courses I've already taken are well worth the fees paid - it's hands-on training with individual attention and real skills learned. I'm planning to take GOL 3!

Testimonial 4 (Mike Farrell)

Although I was trained as a forester, my chainsaw skills were very limited before taking GOL. Whereas I used to just mark the trees to be cut and let someone else do the felling, I now have the confidence and skills to do the actual cutting when implementing thinning operations.

These forest owners have described how they have benefited from Game of Logging for landowners course. Levels I, II, and III are offered each year through Cornell's ForestConnect program and in some offices of Cornell Cooperative Extension. Each level is required before attending the next level. For more information or to register visit the "workshop" link at www.ForestConnect.info or call 607 255 2115. Class size is limited and spaces fill quickly.

Section 3.2 Working with Foresters

By Peter Smallidge

Some good advice for a landowner who plans to conduct any management activity in their forest is to seek advice and counsel from a forester. This section discusses the process a landowner should use to select a forester and what factors to consider when deciding how to pay a forester for services. The logical basis for the recommendation to seek assistance is consistent with advice to the homeowner who seeks counsel from a plumber, electrician, attorney, or a tax preparer for assistance and guidance. In all these situations, we need technical information and perhaps assistance with complex decision-making. Typically, our efficiency and the results improve when we get advice from a professional. We almost always pay for these services.

The exception to the "pay for services" rule is when a DEC public service forester visits a woodlot. In those cases, the DEC forester arrives pre-paid through your state and federal tax dollars and provides services free of any additional charges. Public-sector foresters will provide many important services, such as a developing a stewardship management plan based on your objectives and thus giving you a benchmark against which you can assess future management decisions. Because of time constraints and work-load demands, DEC foresters must limit the variety of services they provide. Thus, at some point, you may need to locate a private-sector forester.

Types of Foresters

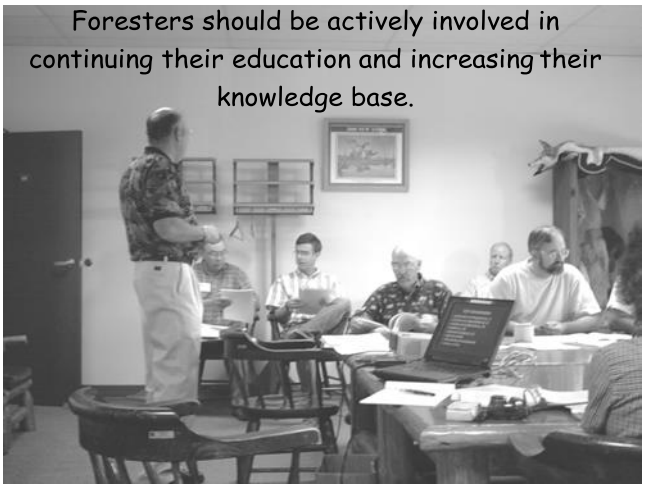
Even though there is no legal definition of a forester in New York, the profession recognizes a forester as a person who has completed college-level training that has a forestry focus. This education most often includes a 4-year degree, in a science-based curriculum that emphasizes courses that often include tree identification, forest ecology, forest management, soils, forest measurements, silviculture, wildlife management, hydrology, harvesting, recreation, and more. Other foresters have a 2-year degree, with more limited course work. All foresters should expand on their original education with continuing education through universities and professional societies. Foresters work in either the public sector, as described above, or the private sector. Foresters in the private sector include consultants whose primary business is providing services to landowners or industrial foresters who work for the forest industry and provide services to landowners as part of the process of supplying wood to the mill. All foresters are important to forestry in New York. The landowner pays the consultant a fee and

the industrial forester is paid by the mill. Landowners should consider both consultant and industrial foresters when looking to develop a relationship with a private sector forester. The extent to which any forester can service the specific needs of the landowner depends on many factors, such as technical ability, conflicts of interest, business philosophy, personal ethics, landowner resources to invest, and the landowner's ability to communicate their ownership objectives to the forester. New York is fortunate to have exceptional foresters available from public and private sectors, but landowners will need to find the forester who is best suited to their needs.

A deceptive group of people will try to present themselves as a forester wanting to help the landowner. These people are actually timber brokers, loggers, or perhaps trained foresters who de-emphasize their forestry skills to work as brokers. This group of people seeks only to maximize their own profits with disregard for the landowner's objectives. In some cases they will purchase trees from a landowner and re-sell the trees, even without cutting them, to another person or company. This leaves the landowner disconnected from the person who ultimately cuts the trees and perhaps with little control over how and when the timber is harvested. In other cases these individuals will offer "forestry services" to the landowner, then sell the timber to themselves or a subsidiary company at below market prices and charge the landowner a fee to supervise the harvest. Thus, the landowner most importantly may not achieve their true ownership objective, likely won't have their forest treated sustainably, and seldom comes close to realizing the actual market value for their timber. When hiring a forester you are buying a service and buyer: beware.

Loggers are critical to many forestry processes, and unfortunately they are often maligned. Loggers are trained to harvest trees in a safe and effective manner. They can often construct skid trails and haul roads, which your forester should locate, that you can subsequently use for hiking or skiing. However, loggers are not trained to give technical advice on how to sustainably manage your forest to meet the full range of your ownership objectives. Your forester, and many educational web sites, can help you think about the process of selecting a logger.

Finding a Forester for You


Foresters should be actively involved in continuing their education and increasing their knowledge base.

Your forest is valuable to you for its monetary, recreational, and aesthetic qualities. Just as you wouldn't hire someone for your company or business without asking for a resume and references nor should you hire the first forester you meet. By considering several foresters, you improve the odds of finding one that will best suite your needs. What factors should you use to evaluate foresters and which foresters do you evaluate? Select a forester based on a combination of factors. These factors include:

- educational background,
- involvement in continuing education,
- participation in their professional forestry society,
- work experience,
- references,
- visits to their previous jobs,
- a demonstrated commitment to sustainable practices,
- certification through a professional society or independent organization, and
- their personal interactions with you.

Price for services is an issue, but use this as a secondary consideration after you are

Good professional foresters provide competent technical assistance. Photo courtesy of S. Wolf.

satisfied with the other factors. It isn't possible to emphasize one criterion over others on the list. Review your candidates thoroughly and proceed with diligence. It's helpful to call several recent landowner clients, but the landowner may not be able to effectively judge all aspects of sustainable forestry. The best way to accumulate the information needed to evaluate several foresters is to write down what you want the forester to do based on the stewardship plan prepared by the DEC forester and then ask several foresters to submit a letter of intent or brief proposal outlining the services they would provide and for what price. Foresters who are eager to serve landowners will be happy to comply with such a request.

With hundreds of foresters in New York, who should you ask for proposals? Finding potential foresters in your region is a straightforward but daunting task. Here are five strategies that if used together, will help you build a list of potential private sector foresters. Websites for each are listed in the "Additional Information" or "Resources and Recommended Publications" section of this booklet or your local Cornell Cooperative Extension office can help you contact these sources.

1. Start with a copy of the DEC Cooperating Forester Directory from your local DE C office or their website. Those listed meet minimum eligibility requirements but the directory isn't a complete list of foresters in the state.

2. Go the Society of American Foresters webpage and look for Certified Foresters in your area. Foresters are certified by SAF based on education, work experience, statement of work ethic, and a written exam that evaluates competency. Additionally, many NY consulting foresters are members of the NY Institute of Consulting Foresters or the Association of Consulting Foresters.

3. Talk with other forest owners and look for advertisements in forest owner magazines. Potentially good sources of information are members of the statewide forests landowner association the New York Forest Owners Association (NYFOA) or regional groups such as the Catskill Forest Association (CFA) and Tug Hill Resource Investment for the For Tomorrow (THRIFT).

4. Ask for a free visit and consultation with volunteers in Cornell's Master Forest Owner program. These landowner-volunteers are trained by Cornell Cooperative Extension to provide non-technical assistance. They have typically experienced, and overcome, the same problems you're currently dealing with.

5. Attend landowner workshops and woods-walks to meet with the foresters who are investing time in supporting the landowner educational needs.

As you can see the process to collect names isn't trivial, but it is a critical step before you request proposals.

Hiring a Forester

Once you've selected your forester, how do you negotiate and foster a relationship? Foresters will encourage you to have a contract with a logger, and similarly they should be receptive to a contract with you. There are several issues to consider within a contract but that discussion is beyond the scope of this article. Fundamentally, the contract should identify the parties involved and the property, the terms of payment, constraints or requirements on the parties, and the services to be provided. Be sure to review any contract with your attorney.

In the forestry profession there is considerable discussion and debate about service fees. There are two categories of service – one is timber sale design and administration and the other is broadly grouped as forest management activities. One of the most contentious issues among foresters is payment for assistance with timber sales. I won't address pay scale or amount, but rather payment method.

Some, but not all, industrial foresters won't charge youdirectly for services because they may expect the timber to be sold to their mill, and under some circumstances this is a desirable working relationship. Many mills have been established for decades and seek long-term sustainable relationships with forest owners. Some mills have well-qualified and credentialed foresters who can provide a variety of services.

Among consultants the most common payment method is as a percentage of sale or "on commission." Payment on commission means some percentage of the timber sale value goes to the forester; the more high-value timber that is cut, the more money the forester makes. If you decide to hire a forester using commission, know that you can negotiate the rate of commission and that you need not be bound by the "usual" rate. Most consultant foresters will be able to describe what they see as advantages to payment on commission.

An increasingly common payment method and one that has several advantages for landowners is to pay on a flat rate, such as per hour or per acre, rather than pay a commission for timber sale assistance. The advantages of flat rate include the following:

1. Avoiding the potential for a conflict of interest. The potential exists because the forester makes more money if they administer a sale where they designate a greater number of high value trees and a lesser number of low value trees for harvest. Foresters won't inherently favor high-value trees, but a flat rate avoids the perception for a conflict of interest.

2. With flat rate, a forester receives fair compensation at a known rate for any and all services. A forester deserves fair compensation because they can provide important and valuable technical assistance. Because timber sales involve similar skills (e.g., inventory, planning, tree selection) regardless of the quality of the timber, a flat rate ensures fair compensation for the forester and a stable price for the landowner.

Note that the sale of low value timber to improve the forest may require more time for marking and marketing and thus perhaps higher costs than high value sales.

3. A flat rate allows a forester to provide services to a landowner without a timber sale or with a sale involving low value trees. Some foresters won't work with landowners who want to cut cull trees or other low value trees. Payment on commission of sale isn't possible if the only desired service is to update a management plan, mark boundaries, designate trails, girdle habitat trees, or plant open land.

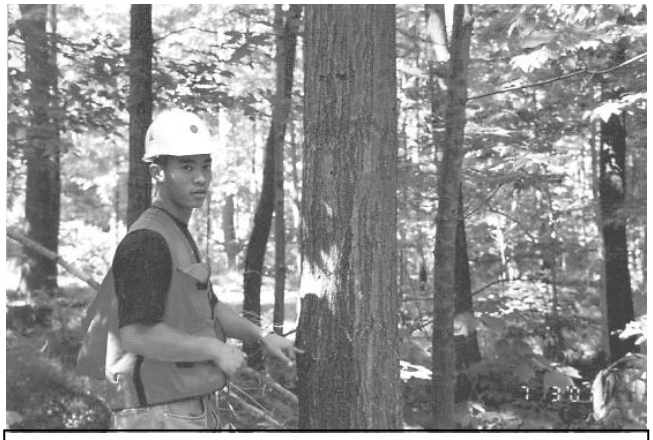
Good forestry, or bad forestry, can happen with any type of forester or payment method. The landowner needs to emphasize their desire for the use of sustainable practices that meet the goals for the property. Through a combination of the process to find a forester, a contract with a forester, and clear communication of your goals, find a strategy that ensures the sustainability of your forest resource.

Summary Points

When working with a forester, start with a free visit by a DEC forester. You might actually be well served to talk with a MFO volunteer before a DEC forester visits so you learn about some educational resources and focus your questions to make efficient use of the DEC forester's time. In addition to the DEC public sector foresters, private sector foresters include consultants who seek landowners as clients and industrial foresters who ensure their mill has a sufficient supply of wood.

If you decide to hire a forester from the private sector it is in your best interest to solicit proposals from a number of foresters who describe what they will do to further your stewardship plan and what credentials for employment they would bring to you.

When you discuss method of payment, know that most private consultants and some industrial foresters will suggest that the usual way to pay foresters is as a commission or percentage of a timber sale. There are other options than payment on commission, so landowners can consider working with an industrial forester or hiring a consulting forester using a flat scale based on time or services. An increasing number of foresters and forest owners are deciding not to establish a relationship based on a commission.



Finding the right forester will help you ensure the health, productivity, and sustainability of your forest.

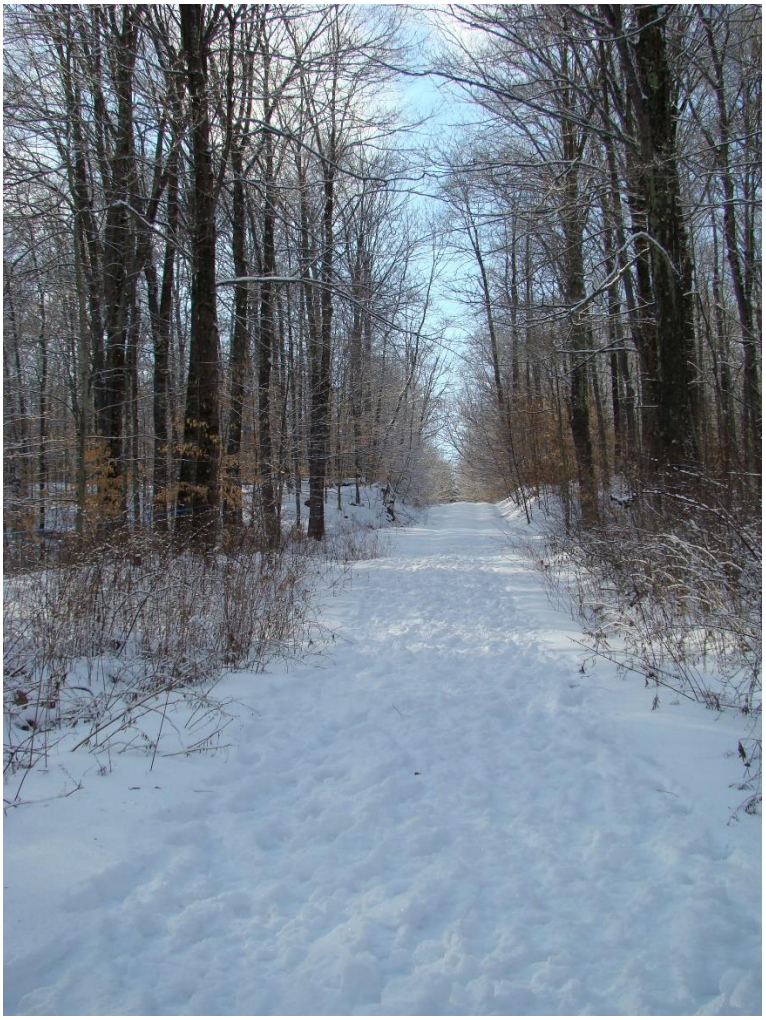


Figure 1. A snowy winter road illustrates any number of ownership objectives that might include hiking, hunting, collecting of maple sap, or firewood collecting. Most ownership objectives are compatible, but they need to be written down.

3.3 Forest Stand Improvement

Strategies to Improve Your Woodland

Many landowners, especially those new to the process of managing their woodlands, want to know if and how to make improvements. This is a common question that illustrates an interest and commitment by the owner to be more fully invested in their property. It is worth noting that I don't think I know a woodland owner who believes their woods have achieved full improvement. This is a never ending, but endlessly enjoyable quest. The question is broad because "improvement" will mean different things to different people. However, there are several practices you can use to cover a broad range of interests.

The first and absolutely essential step as an owner, and to improve your land, is to identify your ownership objectives. Some people might call them goals. Whatever the label, the important questions to ask yourself and your co-owners include: "Why do you own the land?", "Why do you keep paying taxes on the land?", "What does the land give you (tangible or intangible) now or in the future, that you want and need?". Your ownership objectives usually won't change much in the short-term, but might change some over many years or decades. It is important that your spouse, mature children, and others who have a stake in the property go through the same process (Figure 1). By knowing your objectives, you will be able to assess the importance or suitability for any action that might occur on your property. Your objectives will help gauge your reaction to a boundary line that isn't surveyed, an eroding trail, or the request by a neighbor to harvest firewood.

No one starts the journey of woodland ownership knowing all they need to know. It is helpful to have someone that has been in your shoes talk about your options. Cornell University Cooperative Extension offers the Master Forest Owner volunteer program. The MFO volunteers are woodland owners who have been trained to use their varied talents, knowledge and experience (Figure 2) to help other woodland owners learn about their

property. The volunteers don't provide technical assistance, but can share educational resources and networks about groups like the New York Forest Owners Association. Most people look for advice from those who have shared the same questions and trials, so the MFO volunteers provide themselves as a peer who will make a free visit and get you started on improving your property for your objectives. Request a free visit from an MFO volunteer here www.CornellMFO.info

Figure 2. Master Forest Owner volunteers are trained in key principles of tree identification and tree measurement. They offer non-technical advice that can help other woodland owners get started with improving their woodlands.

You may know, or the MFO volunteer may tell you, that your interests will benefit from the technical assistance of a forester. There are many types of foresters. A good starting point is with the NYSDEC foresters who will visit your property and provide free technical assistance. These public service forester arrive "pre-paid" by your tax dollars, but more importantly don't carry any bias of what they recommend. They can provide a plan, and guide you to the outcome you desire. In my experience the DEC foresters are all capable, sincere, and a treasure to have walk in the woods with you. You can find your DEC public service forester here http://www.dec.ny.gov/lands/97398.html

Once you reach the point that you want to improve your woodlands, you are also likely eager to learn about your woodlands, the habitats, and the features you see. There is an enormous amount of information and resources to help with this. As part of its Land Grant mission, Cornell University offers assistance through offices of Cornell Cooperative Extension in each county, and through the statewide program ForestConnect. ForestConnect helps connect people to their woods through applied research and the development of educational materials. This information is systematic and strategic to address concerns of woodland owners through a variety of delivery systems that help woodland owners find the answers they need. ForestConnect is found at www.ForestConnect.info and includes hundreds of pages of free publications, and links to scores of webinars at www.youtube.com/ForestConnect. You can also network with other woodland owners at http://CornellForestConnect.ning.com

Figure 3. One of NYFOA's ten chapters is visiting a private woodland and learning about strategies to manage invasive plants from one of Cornell's Regional Extension Foresters, and sharing their own experiences.

Another important educational resource for woodland owners is the NY Forest Owners Association (www.NYFOA.org). NYFOA is an association of woodland owners for woodland owners. In addition to the bi-monthly magazine, a powerful resource is to connect with your local chapter. Chapters host regular events and newsletters that provide opportunities for woodland owners to further learn from each other (Figure 3). Joining NYFOA is an important step in improving your woods.

The size of your property will influence the types of action you can take, and should take, to improve your woods. Smaller properties are more easily managed, but lack some of the options available on larger parcels. There is no threshold for small and large (see www.nyfoa.org issue 2017 January/February), but rather it depends on the desired activity. The important truth is that every property can be improved.

Many owner interests that relate to improvement depend upon the types and sizes of trees. The first step is to be able to identify the trees and plants on your property. Many of the MFO volunteers know the common trees and plants. You can also watch the tree identification webinars for hardwoods and conifers on www.youtube.com/ForestConnect. You can also use a good book such as Cornell's "Know Your Trees" or "Trees of New York: Native and Naturalized" by Professor Donald J. Leopold.

The trees and plants that grow on your land depend in part on the soils. We can't really change the soils in the woods, but we can make sure that we favor those species that are adapted to the soil we have. Two resources to help you learn about your soils are Google Earth Pro and Web Soil Survey. These are free, online tools that will open your eyes to a new way to look at your property. I have a blog about how to use these, plus tutorials http://cornellforestconnect.ning.com/profiles/blogs/google-earth-and-web-soil-survey

Figure 4. The impacts of deer on NY woodlands can have profound and long-lasting effects. You usually don't see the full number of deer on your property. The first step is to assess deer impacts with a vegetation assessment protocol such as http://AVIDdeer.com

Finally, any discussion about improving your woods should include a discussion about those factors that have a primary role in degrading our woods. The primary factors include deer browsing, interfering plants and exploitive harvesting. At the 50th Anniversary of NYFOA, they recognized these three factors and started an initiative called "Restore New York Woodlands" to call attention to the problem and work with partners to create solutions.

Deer are perhaps the single biggest detriment to the sustained vitality of our New York woodlands. In most areas of the state, the number of deer exceed the carrying capacity of the land. It isn't so important to know the number of deer per square mile, but rather the impact of deer on the vegetation (Figure 4).

Deer preferentially browse desirable trees and herbs, but don't browse most undesirable plants. The other two degrading factors are aggravated and compounded by deer browsing. You can learn more about deer, and a simple method to assess the impacts of deer at a Cornell website http://AVIDdeer.com

Interfering plants are those plants that interfere with one of your ownership objectives. Interfering plants are either native or introduced. These plants might reduce biodiversity, tree regeneration, recreational access, habitat for wildlife, or aesthetic quality. Importantly, many interfering plant problems originated because of an overabundance of deer. If the deer problem exists, and hasn't truly been resolved (a difficult task), efforts to manage interfering plants will likely fail. Information about problem plants can be found in the ForestConnect webinars, on the ForestConnect website, and in several previous issues of the NY Forest Owner magazine on the NYFOA web page.

The third, but equally important, factor that degrades our woodlands is exploitive harvesting. Unfortunately, this may be the most common of harvesting practices that occurs in NY. It goes by many names such as selective cutting, diameter-limit cutting, and high-grading. The arguments in support of this practice might include: "the little trees are younger and we'll give them more light" (Figure 5), "there are diseases and insects and we should cut the big ones", or "diameter growth has slowed on the bigger trees". Incidentally, the last statement is true, but invalid because the larger trees may have less diameter growth, but still have greater volume growth. Many woodland owners inherit or purchase an exploited woodlot. The process for remediation is involved, and will require dedication and commitment by the owner. These degraded woodlands desperately need improvement. Learn more at the ForestConnect webpage and youtube channel.

Figure 5. Seldom do the big trees represent old trees and the smaller trees represent young trees. This picture is of a tree cookie of a 4.5 inch diameter northern red oak that is approximately 80 years old. It was beneath a 32 inch diameter northern red oak of the same age. The smaller tree is, for whatever reason, not suited to growing on that site. Giving it more sunlight won't really help. Photo credit: Lew Ward, NYFOA Southern Tier Chapter.

The time you spend on woodland improvement won't end, but that's part of the joy we experience as woodland owners. Always work safely in the woods, don't take chances, breathe the fresh air, and try to learn something new each time you're among your trees.

Integrated Vegetation Management:
Controlling undesirable woody plants in the forest

By, Peter Smallidge, Ph.D., NYS Extension Forester and Director, Arnot Teaching and Research Forest, Department of Natural Resources, Cornell University Cooperative Extension, Ithaca, NY 14853. www.ForestConnect.info

Support for ForestConnect is provided by the Cornell University College of Agriculture and Life Sciences and USDA NIFA.

American beech and many other native and non-native woody plants can dominate a woodland, exclude or limit the regeneration of desired plant species, and limit the biodiversity of the site. In high abundance, these species can complicate access for maple producers. Often these interfering species gain dominance because of selective deer browsing of desired plant species, and prolonged deer pressure can create a legacy effect that persists even if deer impacts are controlled.

In all forest vegetation management situations, not exclusive to beech, you should start with a plan that details the interfering species, the desired plant species, the costs, how the interfering vegetation will be treated, and how the site will be re-vegetated. Webinar archives detailing the vegetation management planning process are available at www.youtube.com/ForestConnect. The word "treatment" is used here to describe the manner in which the vegetation is manipulated, often with the goal of killing the stems causing the interference. The treatment has two attributes – the method and the mode. Method is typically mechanical or chemical and mode is either broadcast or selective. Biocontrol methods are not described here. Each treatment can be described by a method and a mode. First we will review some principles, then consider some examples.

Which Method and Which Mode?

Both mechanical and chemical methods have useful applications (Figure 1). Often the choice depends on the attitude of the owner, the time of year, the terrain, or the equipment. For some circumstances, a mechanical method is followed by a chemical method. Mechanical methods might include hand-pulling, brush saws and chain saws, timber ax and Fecon mowers, or livestock. Chemical treatments are herbicides, a type of pesticide that targets plants.

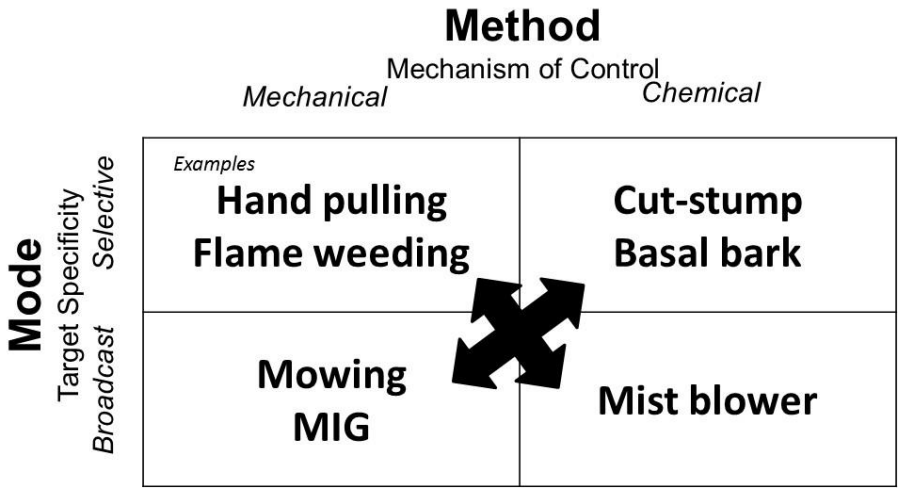


Figure 1. A matrix of mode and method for vegetative treatments, with examples for each combination.

The decision about whether to use chemical methods may be decided by the owner's attitudes and comfort with the use of herbicides. Some owners, such as maple produces who are certified organic, are restricted from using most conventional herbicides. Herbicides are regulated by the EPA through authority given to the state-level regulatory agencies. The regulatory process helps inform users about the known ways that the active ingredients will behave in the environment. If an owner uses an herbicide, they should carefully follow the label. Of particular consideration is whether the herbicide has soil activity. Soil activity may result in injury or death of adjacent non-target stems. Home recipes of chemical concoctions should never be used.

Mode is selected depending on the desired specificity of the treatment to individual or groups of stems. A selective treatment affects individual stems and a broadcast treatment affects all stems in an area. If an interfering species is mixed with a high percentage of a desired species, a selective treatment may be used to reduce injury to the desired species. Selectivity is possible through physically isolating one stem from others, by using a treatment that only affects a certain species, or by applying a treatment at a time of year when desirable species are not susceptible. If the interfering species predominates, or financial or logistical constraints preclude a selective treatment, then a broadcast treatment would be applied.

The abundance of undesired stems is often a good place to start when considering whether to use a selective or broadcast mode. The principle to consider here is the fixed cost to visit each stem in a selective treatment. If there are too many stems per acre, that means (1) the cost per acre will become prohibitive and (2) because there are a fixed number of stems per acre the interfering stems have likely displaced the desirable stems and a broadcast treatment would have limited relative collateral damage. Although not widely studied, the threshold between selective and broadcast is about 400 stems per acre. Each owner's situation is a bit different, so this threshold should only be used as a guide.

Selective Manual

- Types of treatments would include pulling, girdling or cutting.
- Pulling treatments are best applied in circumstances of small plants, where the interfering plant has only recently been established and there is little potential for subsequent seed input from that plant. Pulling has the potential negative consequence that the soil is disturbed and the exposed mineral soil may provide a suitable seedbed for some other undesirable species.

Figure 2. Girdling, such as the flame treatment being used on this buckthorn, kills the phloem and vascular cambium and starves the roots. Girdling at the base of the tree may result in suckers emerging at ground level.

- Girdling severs the phloem and vascular cambium just inside the bark. Girdling can be accomplished with an ax, saw, or flame torch; chemical girdling is called basal bark and described below. (Figure 2) Girdling has the advantage of more quickly treating the stems as

compared to cutting and not needing to immediately address the downed stem. Stem size matters because a large dead tree may become a hazard in the future. This treatment can be combined with a frill herbicide application (see "hack-n-squirt" below) as an integrated strategy.

- Cutting uses a saw to sever the stem and fully disconnect the foliage from the roots. Traditional timber stand improvement with firewood as a product is an example of this treatment. Special safety concern is warranted for those who use a chainsaw. Also, in most hardwoods and shrubs, cutting will stimulate stump sprouting, and also root sucker sprouts from beech and tree-of-heaven. Shade intolerant species such as black locust and aspen may develop root sucker thickets after cutting if enough light is available. This treatment can be combined with an herbicide application to the cut surface (see "cut-stump" below) as an integrated strategy to prevent sprouting.

Selective Chemical

- Types of treatments include foliar, hack-n-squirt (AKA injection), cut-stump, and basal bark. Selective chemical may also be integrated with selective manual (Figure 3).
- Treatments can be quick, cost-effective and reduce or typically eliminate the potential for post-treatment sprouting from stumps or roots.
- Treatments require the use of a chemical, but the chemical is used on individual stems to reduce the potential for collateral damage.
- Information about all herbicides that are legal for use in NY is available at www.pims.psur.cornell.edu. Other states have a similar database through their state's Cooperative Extension or regulatory agency.

Figure 3. Brush saws can be used as a selective mechanical treatment, or combined with an herbicide to the freshly cut stump to limit sprouting. Personal protective safety equipment is essential.

- Foliar treatments are applied to individual plants (Figure 4). Applications of foliar sprays on tall or broad plants may result in overspray and a heightened potential for drift onto adjacent plants. Foliar treatments are commonly a low concentration of glyphosate (e.g., Roundup) or triclopyr (e.g., Garlon 4 ultra) perhaps mixed with imazapyr (e.g., Arsenal, Polaris AC) or sulfometuron methyl (e.g., Oust). The herbicide labels will describe mixing ratios. Foliar treatments can be applied following a mechanical cutting, after stems sprout new foliage, thus allowing for the use of less chemical and greater control.
- Hack-n-squirt treatments use a hatchet or similar tool to expose the phloem, vascular cambium and outer most xylem tissues, the wood, to a fairly concentrated (25% to 50% active ingredient) application of glyphosate. Imazapyr might also be used to control some species. The role of the hatchet is to expose the inner wood; other tools might include a portable drill or divots made by a chainsaw. The objective is to make multiple relatively small wounds that receive an application of the herbicide.

Figure 4. Foliar spray treatment of large plants has the potential for overspray onto nearby plants. Be alert to the proximity of desired plants. The treatment pictured is of glyphosate; the personal protective equipment (PPE) exceeds label recommendations, but can use additional PPE. Picture by L. Merle.

- Cut-stump treatments are appropriate when the stem is severed, but stump or root sprouts will occur without additional treatment (Figure 5). Herbicides might include glyphosate or triclopyr. Glyphosate is mobile in the root system and will be translocated from the stump to root sprouts that are controlled. Triclopyr is less mobile than glyphosate. Follow label details, but herbicides are typically applied to the outer 2 inches of the freshly cut stump surface or to the entire surface and sides of the stump. Recent research on glyphosate (J. Kochenderfer, USFS) found that glyphosate could be applied up to 72 hours after the beech tree was cut with minimal reduction in control of root sprouting.
- Basal bark treatments use an herbicide, typically triclopyr, in an oil-based carrier to chemically girdle a stem (Figure 6). As with mechanical girdling, the full circumference must be treated. Treated stems seldom if ever sprout. Details are provided in the link below, but lower doses and broader seasonal opportunities exist than were previously considered.

Figure 5. Cut stump treatments are used to control stump or root sprouting that occurs on some species. Personal protective equipment for both chainsaw use and herbicide use need to be utilized.

Broadcast Manual

- In woodland settings, there are few options for broadcast manual treatments. These include rotary brush heads on small tracked machines and management intensive grazing.
- Small tracked machines (e.g., Fecon, Timber Ax) can maneuver in many wooded settings and clear vegetation in the lower strata (Figure 7). Depending on the operator, these machines

Figure 6. Basal bark treatments use a chemical, often triclopyr, that girdles the stem.

Figure 7. Fecon mower heads can be used for broadcast mechanical, and to some extent selective mechanical treatments of large stems or areas otherwise difficult to access.

have the potential to selectively avoid desired stems. As with selective manual, this treatment may stimulate root and stump sprouting.

- Management intensive grazing is grazing strategy often used in silvopasture systems (Figure 8). It requires a high level of grazier awareness and understanding. Management intensive grazing might be preceded by a rotary mower as described above.

Broadcast Chemical

- Broadcast chemical treatments are only used when interfering stems fully and almost exclusively dominate the site, and the foliage is at a height where it is accessible to spray equipment.
- Because broadcast chemical treatments opens the entire understory, care must be taken to monitor the species that re-occupy the site to assure other interfering species don't assume dominance.
- A few isolated desired species can often be protected by clipping them at ground level just before spraying. The lack of foliage protects the clipped stems and most will resprout.
- Broadcast chemical treatments are essentially foliar treatments, but done with equipment that sprays broad areas rather than selective targets. In some situations, this treatment is the most efficient and provides the best control of interfering species. Both backpack and tractor/skidder mounted sprayers are available.

Figure 8. Management intensive grazing (MIG) or mob grazing, if done carefully, can reduce the height and density of the understory. MIG treatments that eliminate the understory would likely damage the overstory trees.

Resources:
Online support to further understand and visualize treatments include the following:

- A good internet source to understand forest vegetation management is provided by Penn State Cooperative Extension at www.extension.psu.edu/fvm.
- Penn State's Forest Herbicide Manual is at http://extension.psu.edu/publications/uh174
- Chemical selective treatments www.youtube.com/ForestConnect
- Manual herbicide application methods http://www.nrs.fs.fed.us/pubs/gtr/gtr_nrs96.pdf
- Silvopasture (i.e., sustainable woodland grazing) http://www2.dnr.cornell.edu/ext/info/pubs/MapleAgrofor/Silvopasturing3-3-2011.pdf

Find more information for mixing and using herbicides in **Section 4.5 Forest Herbicide Quick Reference** (p. 120).

Layout and editorial assistance provided by Diana Bryant and Dorian Hyland. Support for ForestConnect is provided by USDA NIFA and the Cornell University College of Agriculture and Life Sciences.

3.4 Thinning for Syrup Production

Improving Maple Sap Quality and Quantity Through Forestry: Should You Thin Your Sugarbush?

Peter J. Smallidge, NYS Extension Forester
(607) 592 – 3640; pjs23@cornell.edu
www.ForestConnect.info

Key Points:

1. Start thinning in young sugarbushes.
   - Best outcomes happen when thinning begins in stands having an average tree diameter of approximately 5 to 7 inches. Delaying thinning until average diameters are greater than 12 inches complicates decision making.

2. Most NY sugarbushes are "over-stocked"…too many trees even for minimal growth.
   - In natural forests, tree density decreases from more than 10,000 trees per acre in young brushy forests to fewer than 150 trees per acre in mature forests. The optimal density of trees depends on the maturity of the sugarbush. The sequence of thinning steps and chart, below, give guidelines to help determine the intensity of cut. Growth should be ¼" for trees up to 14" diameter and 1/8" for trees 18" diameter and larger.

3. Focus the initial cutting on off-species and high-risk trees. Improve spacing among trees.
   - You're making an investment of sunlight into the remaining trees, so leave the best trees behind. Remove trees that don't contribute to sap production or that hinder well-formed maple trees. Cut unthrifty or risky maple trees. Avoid cutting more than 30% to 40% of the basal area in one entry.

4. Measure tree diameter before tapping (10" minimum).
   - Sap volume depends on the amount of wood and sap sugar depends on crown leaf volume. Small trees don't produce enough to justify the damage to their stem caused by tapping.

5. Clues to know when to thin.
   - Closed canopy; absence of understory; dead lower branches; growth less than desired (see #2 above); high basal area; unexplained tree mortality.

6. Learn and use directional felling.
   - Correct chainsaw technique allows the feller to select the direction the tree falls, reduces the likelihood of personal injury, increases productivity, and reduces damage to neighboring trees. A hands-on course, like Game of Logging for landowners, is worth the cost of registration.

Sequence of Steps to Thin:

1. Determine the residual desired stocking as number of trees per acre or basal area per acre. Measure the current stocking at a point. (use chart below)
2. Without dropping below the target residual stocking, mark to cut the off-species and poor vigor trees. Reassess stocking before marking additional trees for cutting.
3. Mark for cutting trees of low vigor and of high risk that might die before the next harvest entry (usually at least 10 to 15 years). Return to step one and re-assess stocking. If adequate go to next step.
4. Mark for cutting all trees made of multiple stems, especially those with acute forks and included bark.
5. Mark for cutting trees with poor crown development.
6. Mark for cutting those trees with lowest sap sugar concentration.

Sugarbush No No's

1. Too many roads
2. Access roads damage roots
3. Over stocking
4. Over tapping
5. Slow tap hole closure
6. Random tapping
7. Sustained livestock

Residual stocking guidelines for sugarbush and timber management. Adapted from Lancaster et al. 1974. Res. Pap. NE-286. Select column 1, 2, or 3 and current average diameter (DBH) to identify approximate residual (after cutting) stocking of canopy trees.

	1. Sugarbush Management Starting when trees are approx 6" ("S" line)		2. Sugarbush Management Starting when trees are approx. 10-16" ("C" line)		3. Timber Management ("B" line)	
Average Stand DBH	**Residual Trees per Acre**	**Residual Basal Area (Sq. ft. per acre)**	**Residual Trees per Acre**	**Residual Basal Area (Sq. ft. per acre)**	**Residual Trees per Acre**	**Residual Basal Area (Sq. ft. per acre)**
6	125	25	185	35	280	55
8	100	30	135	45	185	65
10	75	40	100	55	130	73
12	60	50	80	65	100	80
14	50	52	60	75	75	88
16	45	58	55	75	70	92
18	30	60	50	80	55	95

2020 Summary of Results

Sugarbush Thinning Experiments

Sugarbush Thinning:

Tree Growth, Health, Sugar, Sap, Syrup

Peter J. Smallidge, M. Farrell, S. Childs, and B. Chabot
Cornell Maple Program
(607) 592 – 3640; pjs23@cornell.edu

www.CornellMaple.info
http://CornellForestConnect.ning.com

Benefits of Thinning

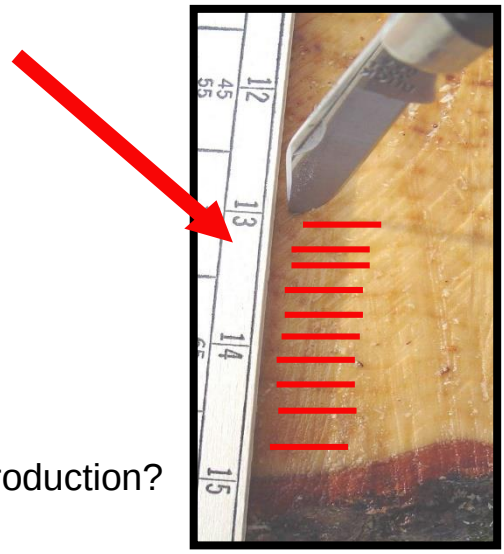
- Reduce insect and disease affected trees
- Improve tree production
- Remove poor quality stems
- Remove poor producing stems
- Maintain or improve crown size and live crown ratio
- Obtain firewood, saw timber

Does Thinning Help Maple Producers?

Vigorous Sugar Maple Growth Means…

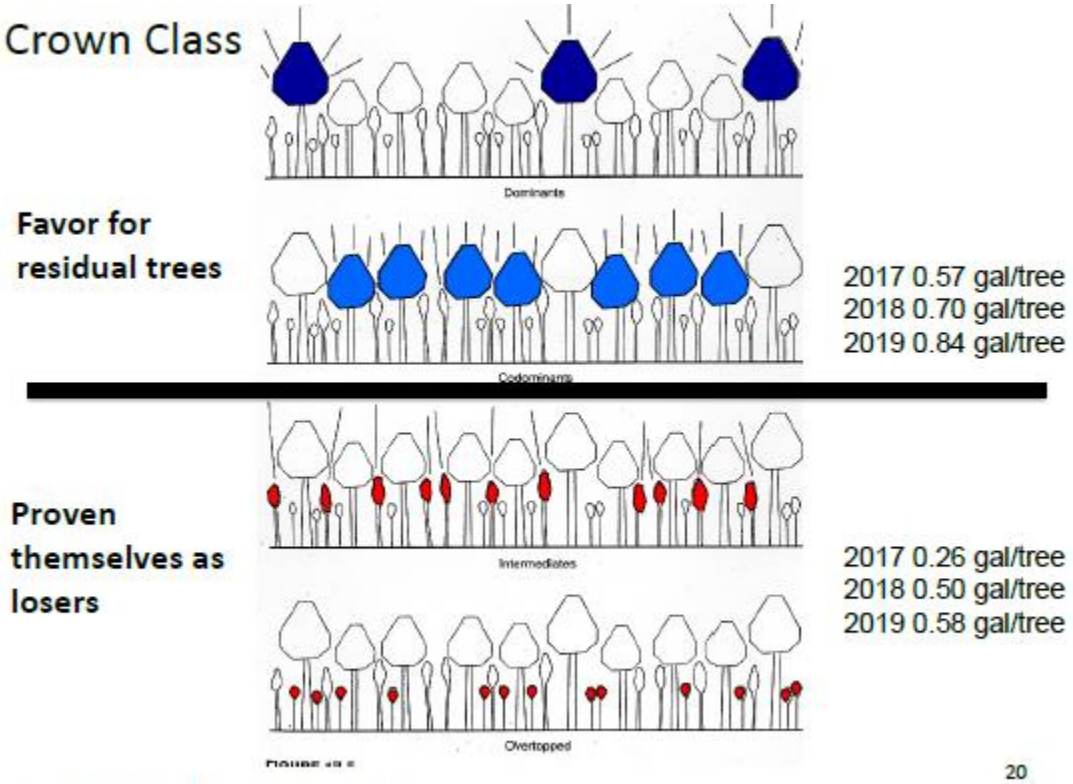
- More foliage
- Maintain live crown ratio
- More volume of sap producing wood
- Trees reach tapping size sooner
- More wood for future tapping
- Larger xylem vessels
  - –Sucrose storage
  - –Differential pressure
  - –Release of sugars

But what are the effects on sap sugar and syrup production?



Which Trees to Retain During Thinning

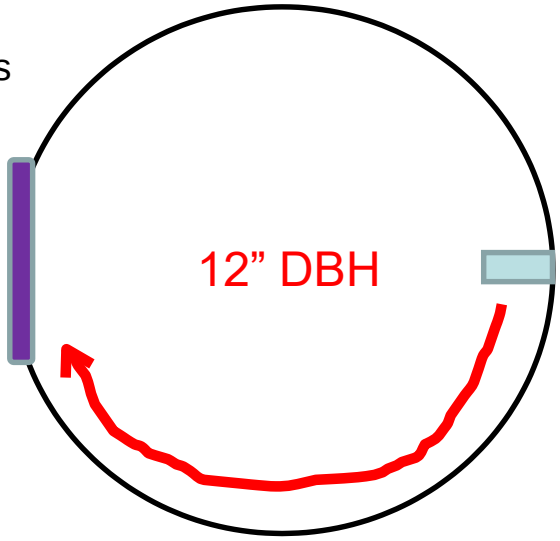
1. 75% Sugar Maple & 25% other desired hardwoods
2. High vigor and low risk trees
3. Single stem trees
4. Deep & wide crowns
5. Typically, favor upper canopy
6. High sap-sugar concentration (secondary)



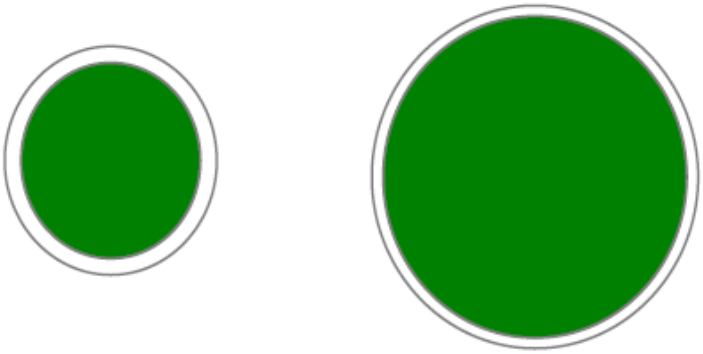
From Nyland, 1996. p. 355

Why Worry About Diameter Growth?

- 12” diameter = 37 columns = 37 years or less before returning to location of first tap
- 1.5” tap depth requires 3 inches diameter growth in 37 years
- Tapping in bands (upper vs. lower)
- Minimum of 0.09 inches diameter growth per year (varies with tapping depth and tree diameter)
- For each diameter class, we can forecast the minimum necessary diameter growth



Basal Area Increment

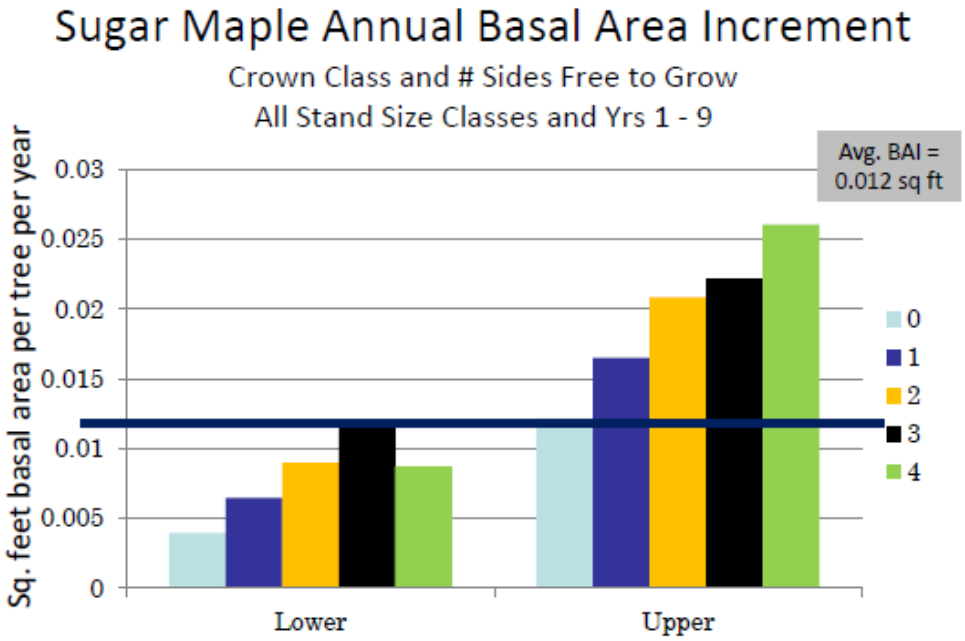


10” to 10.4”
DBH Δ = 0.4
BA1 = .55 sq ft.
BA2 = .59 sq ft.
BAI = 0.04

16” to 16.4”
DBH Δ = 0.4
BA1 = 1.4 sq ft.
BA2 = 1.47 sq ft.
BAI = 0.07

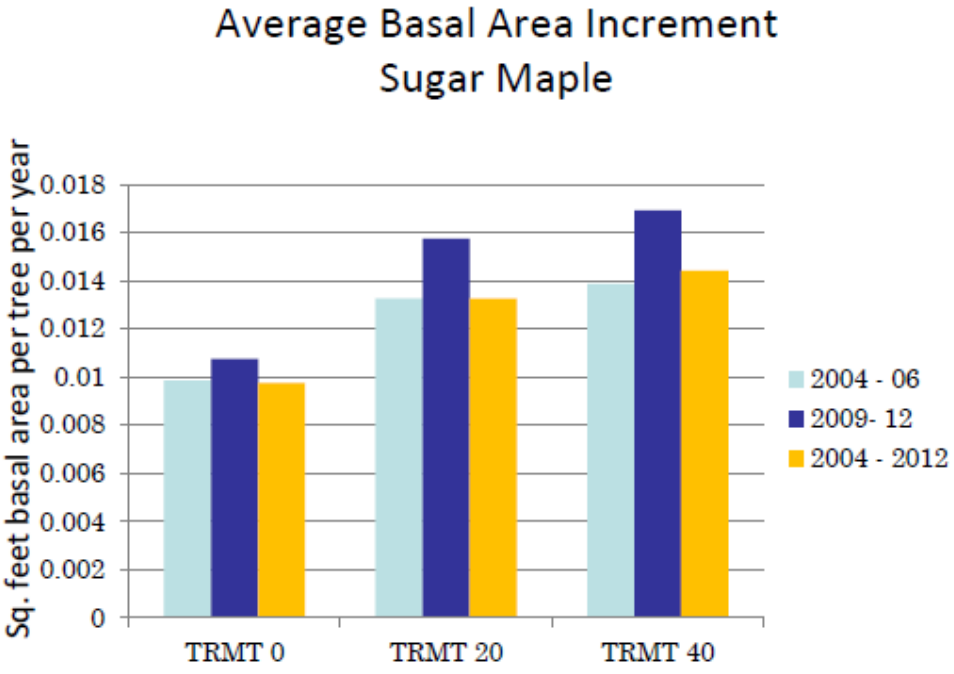
Results from Thinning Experiments on the following pages

For this graph, the key indicates number of sides of the tree that were released during the thinning treatment. The light blue indicates trees that were not released, with 0 sides free to grow. The green indicates a tree that was released with all 4 sides free to grow.

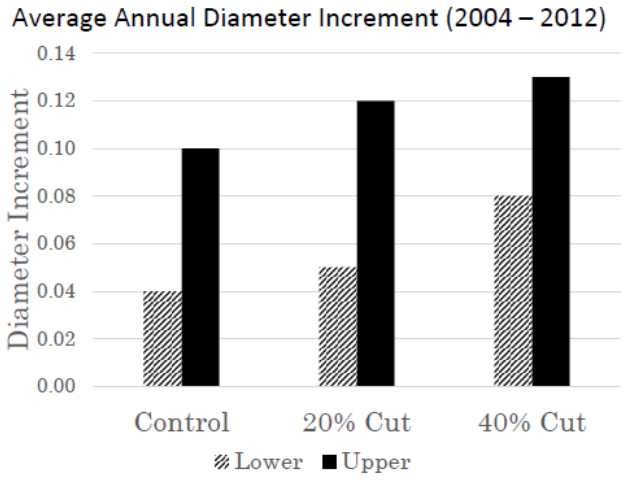


Under the *x*-axis, the designations Lower and Upper refer to the trees' canopy positions. These results indicate that trees in the upper canopy had a greater growth response to the thinning than trees in the lower canopy. The general trend shows increased growth rates with more sides released.

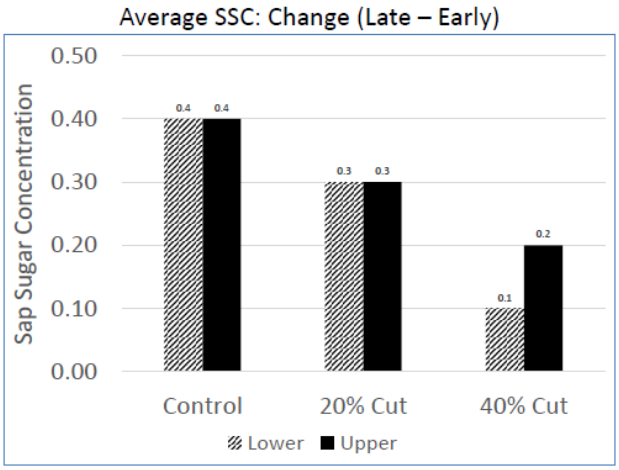
The three groups on this graph display results from 3 different treatments. TRMT 0 is the control. TRMT 20 indicates 20% basal area removal, and TRMT 40 indicates 40%.



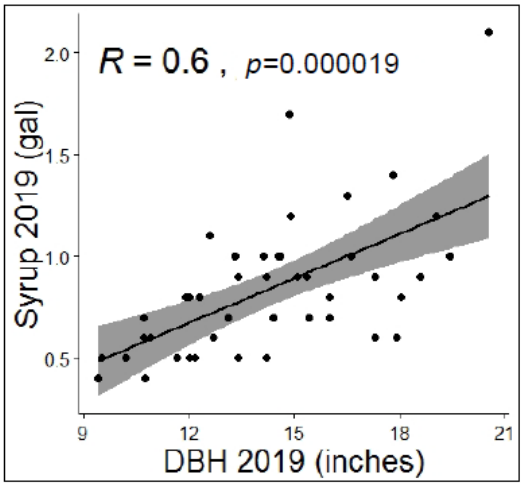
How does Thinning Affect Sap Sugar?



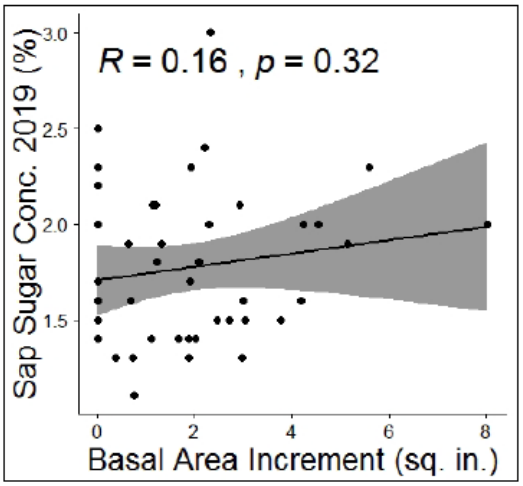
Tree Growth and Syrup Production



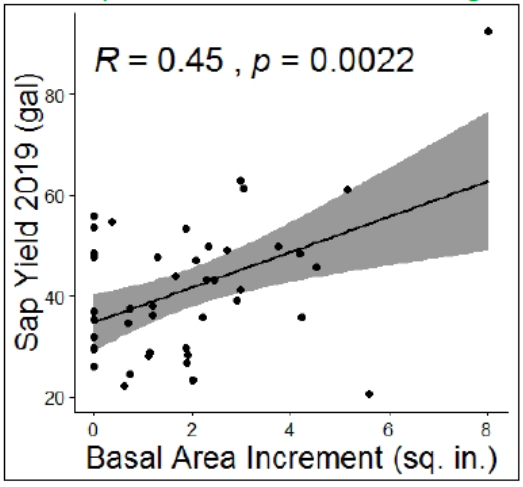
Big Trees Produce More Syrup



SSC Unrelated to Tree Growth

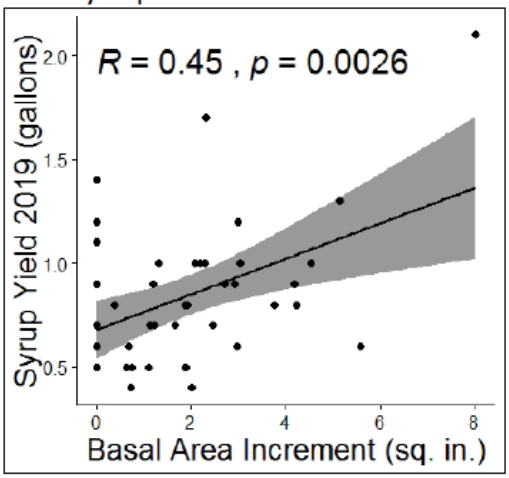


Better Sap Yield From Faster Growing Trees



Syrup Yield Increases with Tree Growth

2019 Syrup and Wood Increment



Conclusions for Tree Response to Thinning

- Sap Sugar Content (SSC) is either independent of, or inversely related, to tree growth
- Tree crown size more important than tree size for SSC
- Thinning increased growth for at least 9 years
- Trees on thinned plots achieved the minimum necessary diameter growth
- Faster growing trees produced more syrup
- Thinning makes trees grow faster

Summary: Although in the near term SSC may remain the same or even decrease with faster tree growth following a thinning, the faster growing trees will produce more sap and ultimately more syrup. Long-term, the crowns of the trees will become fuller, increasing SSC and health of the tree.

Sugarbush Management Project: Recommendations

- Start thinning in young sugarbushes, but large trees also respond.
- Match cutting intensity (light vs. heavy) with other operations.
- Thinning should remove 20-35% of the basal area with an emphasis on lower crown class trees and trees of poor form.
- Thin and replace tubing on the same interval (10 –15 years?).
- Retain high quality stems.
- Retain ~25% in other species.
- Measure tree diameter before tapping (10” minimum).
- Learn and use directional felling. Keep safety a priority.

Acknowledgements
Cornell University:
•Cooperative Extension
•Agricultural Experiment Station
Cornell Maple Team – CCE Educators
Maple producers throughout NY
Gavin Mackellar, Mark Baran, Mou Jian Lee
Renewable Resources Extension Program (USDA NIFA)
Western NY Maple Producers

3.5 Logging

Small Woodlot Management:
Low Impact Harvesting

Peter Smallidge. NYS Extension Forester. Cornell Cooperative Extension. Ithaca, NY
pjs23@cornell.edu 607 / 592 – 3640 www.ForestConnect.info

Low impact logging is one part of the small-scale woodlot management approach. Woodland owners are able to utilize trees that specifically meet their objectives. They are not obligated to harvest a minimum volume, value, or area to satisfy the necessary operational thresholds associated with conventional forest harvesting. Owners benefit from a more thorough knowledge of how their woodland functions. Small-scale systems allow for a more thorough utilization of trees than is possible through conventional harvesting.

Low-impact logging, with ATV or other small sized equipment, is desired by owners for many reasons. Low impact logging has a smaller impact on the woodland, often resulting in less soil disturbance and a reduced likelihood of damage to root systems and the trees left behind to grow. Do-it-yourself, or small-scale management provides options for woodland owners not available through conventional, commercial systems. Both small and conventional systems have appropriate roles.

Low impact logging is also low productivity logging. These systems are not intended to produce as much wood in a day as the equipment used in larger sized systems. Low impact equipment is less expensive, with ATV costs between $5,000 and $10,000 and a logging arch for less than $2,000. Some owner have a small 4 wheel drive tractor, and a log skidding attachment is about the cost of the arch, or a winching system for about $3,500. Low impact systems can provide a woodland owner with their wood needs for firewood or to cut into boards. Small-scale systems may produce about 0.25 to 0.75 full cords per hour, or 100 to 300 board feet per hour, assuming easy and short skids.

Low impact systems can mesh with owner objectives to utilize small quantities of wood. Owners can take classes through Cornell University Cooperative Extension to learn about selecting which trees to cut and which trees to leave. Directional felling is a safe way to cut trees. Owners operating chainsaws should use a chainsaw safety helmet that protects head, eyes, and ears. They should also wear cut resistant chaps or pants. Steel toe and cut resistant boots will protect their feet. A hands-on directional felling course is taught through the Game of Logging. These courses are offered through ForestConnect, county offices of Cornell Cooperative Extension, and the NY Forest Owners Association.

Videos of an example low impact system in operation are available on YouTube. Either go to www.YouTube.com/user/petersmallidge or go to YouTube and search for “petersmallidge” or “low impact logging”.

Low Impact Logging Safety Considerations

1. Be where you are! Avoid distractions that take your mind away from the task at hand. If you find yourself thinking about something other than your low impact logging activity, stop and either quit for the day or take a break.
2. Keep yourself in good physical condition. Discuss your intended activities with your physician. Exercise regularly, eat healthy food, and drink plenty of water. Do not use any equipment if you are taking any drugs, medications, or alcohol.
3. Be familiar with your equipment and know its limitations. Obtain training as needed.
4. Felling trees is the most dangerous activity in low impact logging. Participate in a certified course that allows participants to practice directional felling. Game of Logging is a nationally recognized program and has a training curriculum designed for woodland owners. An article about Game of Logging for Landowners is available at www.ForestConnect.info
5. Inspect your equipment before each use and correct any damage or wear and tear before operation.
6. Many injuries happen when there is more than one person working. If you work with a partner, use extra caution.
7. Most low impact logging equipment, ATVs and tractors, are not intended to driven on a side- slope. Avoid side-slopes and the potential to tip and crush the operator.
8. Do not exceed the safe load capacity of your equipment. You may be able to move the log, but turning and stopping may be compromised.
9. Go slowly in the woods. This reduces wear and tear on your equipment, allows you to look for hazards, and increases your ability function safely.
10. Use equipment that, minimally, lifts the front end of the log to prevent the log end from catching on a stump or rock. Examples of this equipment includes an arch, skid cone, or roller bar. Full suspension with an arch eliminates dirt that dulls chain and band saws.

Operational Strategies & Best Practices

1. Obtain and follow a management plan.
2. Apply silvicultural principles at a smaller scale
3. Focus on one area of a few acres per year.
4. Match equipment with the desired annual volume and products.
5. Anticipate merchandising, multiple objectives and improved utilization using your equipment.
6. Keep the work area clear. Invest time to create a trail that matches the limitations of your equipment.
7. Use physics to your advantage.
8. Anticipate and visualize each step of the process, from felling to unloading, before you start.

Logs to Lumber – Wise Use of a Renewable Resources

By, Peter Smallidge, Ph.D., NYS Extension Forester and Director, Arnot Teaching and Research Forest, Department of Natural Resources, Cornell University Cooperative Extension, Ithaca, NY 14853. www.ForestConnect.info

Support for ForestConnect is provided by the Cornell University College of Agriculture and Life Sciences and USDA NIFA.

A common feature of managed woods, and an aspect that has made them popular among farmers, woodlot owners and maple producers is the potential to harvest logs and produce boards. Managing your woods for lumber involves consideration of the logs for lumber, but also cultivating the woods to ensure future productivity and healthy trees. If the woods are mined rather than tended, future options and opportunities may be eliminated.

An Internet search for "lumber from local woodlots" will yield access to a free publication on the ForestConnect publications page that addresses types of trees and wood properties, measuring trees, harvesting plans, and matching lumber supply with building needs. In this article I will share information on manipulating the woods, harvesting, and utilization. Additional resources are listed at the end of the article.

Manipulating the woodlot – what you take and what you leave

The starting point for harvesting trees is to have a clear and full understanding of your ownership objectives. Obtaining lumber is one objectives, but you may also be interested in maple sap and syrup, aesthetics, trails, wildlife habitat and more. A written management plan will help you obtain these varied objectives.

If a harvest removes trees that are large enough to provide lumber, the owner will benefit from involving a forester. The forester can write a plan for the owner, and can also mark trees that will be removed in the harvest. The forester can identify trails the owner can use for skidding the logs, or the forester can administer a commercial sale if the logs are sold. If the harvest is commercial, it is in the owner's interest to sell the standing trees in a lump sum sale. It is rarely advantageous for an owner to harvest trees and then sell the logs roadside. The owner might also designate specific trees to retain as logs for personal use, or buy back some logs from the logger. Discuss these options before signing a timber harvest contract.

The strategy for harvesting will fall into one of two broad categories. One category, called "intermediate treatments" is intended to improve and enhance the existing woods, or residual trees left behind. Intermediate treatments are analogous to weeding your garden. The other strategy is a "regeneration treatment" and is intended to grow the next forest. Based on the condition of your woods and the specifics of your objectives, your forester can develop a harvesting plan to suit your needs.

A harvest is a good opportunity to adjust the composition, the mixture of species, in your woods. For owners with a high percentage of white or green ash, harvesting will allow you to utilize some ash and concentrate growth on other desirable species. Harvesting should not attempt to eliminate ash, but the harvest may diminish its abundance. Ideally this process happens before

the emerald ash borer (EAB) is close, and you can avoid crisis management as part of forest management. The ForestConnect site (see resources below) has a fact sheet on silviculture for invasive insects. Owners and their forester might plan for several sequential but small-scale harvests the owner conducts every few years to provide lumber at the timing and quantity you can manage while avoiding an abrupt change in the forest.

Except in special circumstances such as created by the emerald ash borer or hemlock woolly adelgid, harvesting should generally maintain the mixture of species that have naturally established on the site. Of course there will be changes as forest succession proceeds, but the species naturally established are likely (but not always) matched to the soils and will perform well.

Figure 1. Thinning, an intermediate treatment, should remove stems that allow the best trees to grow until the final harvest. In this picture, two oak stems are marked for harvest and concentrate growth on the better quality stems. Both marked trees could produce lumber.

A temptation when harvesting trees for use as lumber is to cut the biggest and straightest trees and leave the rest. This harvesting strategy is effectively a diameter-limit cut and also known as a high-grade. The removal of only the biggest trees and those most easily turned into boards can result in a degraded woodlot with predominately trees of low value, poor form, undesired species, and slow growth. Owners who heat with wood, or sell firewood, have distinct advantages in being able to utilize the cull trees. The smaller trees are most often similarly aged “runts”, and are not younger trees that need to be released. A forester can help you select trees (Figure 1) that ensure you obtain the logs you need for lumber, cull the woods, and leave a residual forest (the trees that remain after harvesting) that will be healthy and productive.

Harvesting and processing

Either the owner or someone contracted by the owner can harvest trees for use as logs. Harvesting trees, regardless of size is potentially dangerous to the owner and can damage the residual trees.

The person felling the trees should have completed Game of Logging (GOL) training levels I and II, and hopefully level III. Game of Logging is an educational program that originated for loggers to increase productivity and safety. It has been adapted for and found great favor with woodlot owners. The GOL teaches owners how to use PPE (personal protective equipment) and also PPB (personal protective behavior). For someone with adequate training, felling a tree can be

Figure 2. Although this tree would produce lumber, cutting the tree would include the double hazard of the stem under tension and the likely re-settling of the root ball. Some trees are better left uncut.

straightforward. However, trees under tension (AKA spring poles), root balls of windthrown trees (Figure 2) that may tip back into their hole, and hung trees are relatively common and warrant special consideration to avoid personal injury or death.

The equipment used to move logs is an important consideration. Professional loggers use skidders and forwarders to move logs; this equipment is designed specifically to work in forest settings. Most owners will use a tractor or an ATV to move logs. These machines can move logs, but they need special attachments and special attention. Logs moved by tractor or ATV need to ensure that the front end of the log is elevated off the ground. Without elevation, the log may catch on stumps or rocks with the potential for damage to the machine and injury to the operator. Further, the center of gravity on a tractor or ATV is usually higher than for skidders, so special care must be used to avoid operating on side-slopes where the machine might roll sideways. (Figure 3). A variety of 3-point hitch skidding winches are available for tractors and arches are available for ATVs. Look for a training course and use considerable caution; every year there are tragic accidents that involve woodlot owners, maple producers and farmers.

Figure 3. Special attachments for ATV and tractors, shown here with a winch, increase safety and productivity. Care is needed if these types of machines are used for small scale logging.

A common source of damage to residual trees is when an owner or someone they contract uses equipment that isn't quite adequate to do the job. The wrong tool for the job seldom works well, and often results in increased risk of damage or injury.

The time of year trees are harvested can influence the need for additional actions. For ash, summer harvesting can result in significant lengthwise splitting of logs to the point they cannot be sawn into boards. The splitting of ash logs can be reduced or eliminated by cool weather logging from late fall through early spring (before the ground thaws). The added advantage of winter logging is that dragging logs on frozen and snow-covered ground will reduce dirt and rock in the bark that dulls chain

saws and band saw blades. In the spring, roughly late March through mid to late June, the bark of trees is "loose" and more likely to peel away in large sections if bumped by a tractor or skidder. Also, soft and wet ground in the spring can result in significant rutting.

The grade of logs, an assessment of quality, may change depending on the duration and conditions of their storage before milling. Hardwood logs of light color (e.g., maple) cut during the summer will quickly start to lose grade because microorganisms will spread in the wood and change its color. In this case, the change in grade is based on wood color and not wood structure. For some owners the change in color is desirable and adds aesthetic complexity to an otherwise ordinary board. The volume of each log may decline as they lose moisture and shrink. Logs may also check, split on the ends, which can reduce the usable length of the logs. Control of these concerns is accomplished by processing hardwood logs quickly, usually within a month, keeping the logs under a sprinkler system as done in many industrial log yards, or by coating the ends of the logs with an end-grain sealant.

Figure 4. Advance planning will allow arranging logs in a manner to more easily load the sawmill. Creating a cut bank or using a gentle slope makes easy work of loading logs if the sawmill lack hydraulics logging.

Felled trees should be bucked into log lengths that optimize straightness and reduce taper. Skidding shorter logs typically causes less damage to residual trees than skidding long logs. Regarding taper, there might be a straight 16 foot log, but the log's diameter may change by 2 to 4 inches or more and cause a significant loss of lumber in slab wood. By convention, logs are usually cut 4 to 6 inches longer than the final product to allow for end trimming after the boards have dried. Logs can be sawn immediately. There is usually no advantage to wait, although some logs may sit for several weeks or months before being sawn. Logs should be stacked on a pair of sacrificial logs to allow for air circulation, reduce dirt in the logs and increase the ease of movement of the logs.

Adequate space for storage of logs after harvest is necessary. A commercial sale will require a landing that can be accessed by a log truck. If logs will be milled on-site, plan for the location of the portable sawmill, moving logs onto the mill, access with trucks or wagons to move lumber, and how slab wood and sawdust will be disposed.

Storing and using lumber

Select a custom sawyer who has experience. An experienced sawyer can help you fully prepare for the sawing and storage of lumber. Use your local personal networks, or resources listed below to find a sawyer. Consult with the sawyer before harvesting to make sure any special needs are known, how the logs should be arranged, (Figure 4) and to ensure the sawyer is available.

Sawn lumber needs to be stickered as soon as it is cut. (Figure 5). Drying the lumber in a stable rack will reduce twist, cupping, and splitting of the boards. Stickering is the process of stacking the lumber in a pile with several small wooden strips, usually about 1 x 1 inch, between each layer of boards. Spacing between stickers is usually 18 to 24 inches. Stickers are an inexpensive investment in a potentially high quality product. Piles of stickered lumber should be elevated on a sturdy foundation of block about 12" to 16" above ground. Usually, boards of different thickness and length will be stacked in different piles. Position those stickers near the ends of the boards, as close to the end as possible, to reduce end checking. Cover the piles of lumber with old metal roofing or plywood. Plastic coverings tend to collect water and may not allow adequate air flow.

Figure 5. Lumber should be stickered immediately after sawing, ideally as the boards come off the mill. In door storage, as illustrated, is ideal if space is available.

The utility of a species will depend on the project. In many utilitarian projects, the lumber that is available is the lumber that is used. One consideration is the strength of the wood especially for structural or load bearing uses. Internet resources are available to guide the type, quantity and dimension of lumber used for rafters and joists. Your local building code officer may also have resources. A second consideration is durability. If wood is kept dry, the board will resist decay. Other than rot resistant wood such as black locust, white cedar, white oak or larch, wood exposed to the elements will benefit from a preservative. Several preservative treatments are commercially available and owners should consult online reviews and with local vendors and builders for suggestions on brands.

Other resources

1. Numerous publications are available via www.ForestConnect.com A social network is also accessible for owners at www.CornellForestConnect.ning.com and includes an events page, blogs, questions and answers, and a place to post pictures of what you are doing in your woods.
2. Some of the manufacturers of portable bandsaw mills maintain lists of sawyers. Look on the Internet for sawyers in your area from company webpages for Woodmizer, Baker, Timberking, or Norwood.
3. The discussion boards at www.forestryforum.com have numerous topics related to small scale harvesting, sawmill operation, lumber handling and timber framing.

FARMI TREE HARVESTING METHOD

1) ONE MAN OPERATION

Farmi tree harvesting is a system designed to give high output in production with low investment in machinery. It allows existing tractors with PTO and three-point hitch to be used by farmers, woodlot owners and contractors. One person can operate very efficiently.

2) TREE LENGTH SKIDDING

Farmi tree harvesting is based on tree length skidding, whereby the trees are felled and delimbed in the woods and then skidded to the landing, where they are bucked and stacked.

3) WHAT IT COSTS

For an investment of $2000-4500 a farm tractor can be put to use in the fall and winter, when it would otherwise generally be standing idle. This is the lowest possible investment for a productive operation.

4) EQUIPMENT

17hp to 150hp farm tractors, with PTO and 3-point hitch, are used with matched Farmi winch, complete with grapple, snatchblock, and chain chokers. ROP's cab, front end loader or weights are necessary. Chain saw, hard hat, safety gloves and boots complete the requirements.

FARMI WINCH	TRACTOR SIZE	OPTIONAL EQUIPMENT
JL 290	17-30 HP	1)Belly pan
JL 351 & JL 351 P	20-40 HP	2)Radiator Shield
JL 501	40-60 HP	3)Valve stem protector
JL 601	60-150 HP	4)Tractor tire chains
JL 60T	100-200 HP	

5) PRODUCTION

a) USDA Forest's Forestry Sciences Laboratory reports 246 board feet per trip as an average of a 23-day study. The equipment used was a JL 30 (now replaced by JL 351) winch on a used international 340 tractor (33 HP).

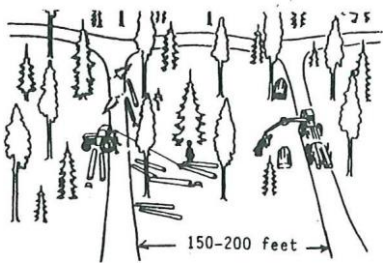
b) Forest Engineering Institute of Canada reports an average load volume of 0.33 ct (0.9m^3) in a five day study. The equipment used was a JL 30 winch on a IH 444 (38 HP).

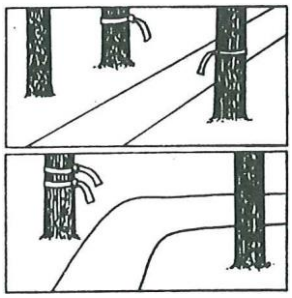
6) DAMAGE TO RESIDUAL STAND

The Farmi method is very useful in thinning operations where damage to the remaining trees must be avoided. A 1979 study (J. Peusu) of two thinning operations found that damage on the remaining trees was slight. Of the remaining trees in one woodlot, only 1.5% were damaged and 0.5% in the other. The equipment used was Farmi JL 306 winches on Leyland 282 and Valmet 702 tractors.

7) . PLANNING STAGE

The Farmi tree harvesting method is designed to minimize damage to the remaining trees in selective cuttings. The machinery never leaves the planned skid trails. The trees are winched to the trails and then skidded out to the landing. Alternatively, one can winch the trees to the skid road and then transport the trees out with a forwarder. An inexpensive and compact forwarder can be made for firewood and pulp production by pulling a trailer behind a farm tractor which is equipped with Farmi knuckleboom loader.





SKID ROUTES

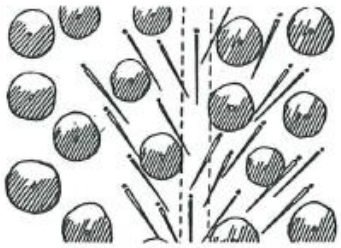
The stand terrain and the equipment which is available to transport the trees determine how close the skid trails are to each other. Two hundred feet is one popular distance.

The skid trails are planned and marked before marking the trees to be cut. The object is to find the most advantageous routes for the machinery. Plan the routes as straight as possible because they will serve you through the thinning to the final felling. When planning your routes, avoid side leaning and rather, skid slightly uphill or downhill.

8) DIRECTIONAL FELLING IN SELECTIVE CUTTING

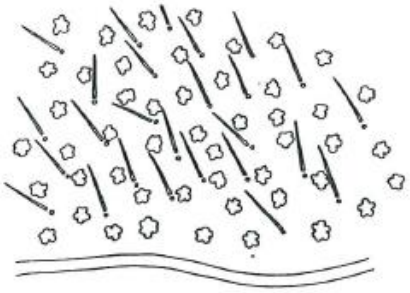
Directional felling saves labor and reduces damages on the residual stand. The small logging slash is left on the skid road where it reduces soil compaction and protects the tractor's tires.

SKID ROUTE

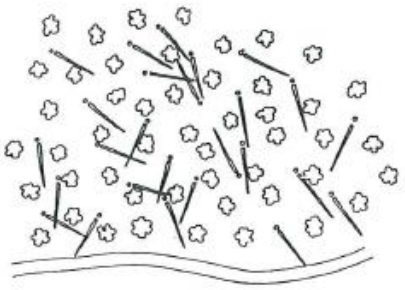


Felling pattern to open up skid route.

BUTT END FIRST

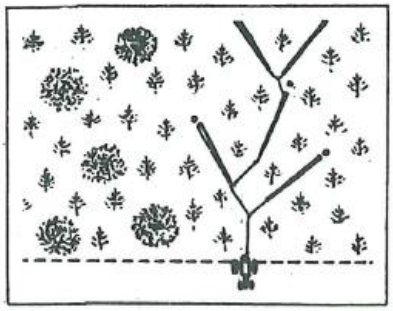


TOP END FIRST

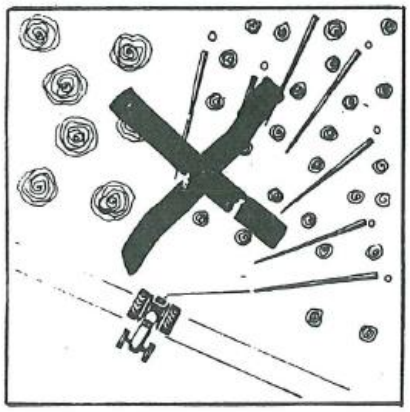


Note that the same trees have been felled in both cases. It is more difficult to winch out the trees butt end first because every tree is behind its stump. As the butt end is heavy, it will dig into the ground and might get hooked behind roots and stumps. The trees felled top end first can be winched out in four hitches. The risk of damage on the residual stand is also smaller.

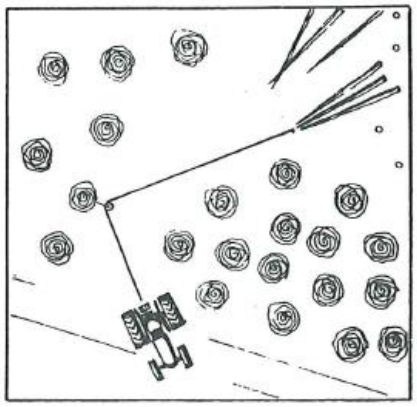
9) POSITIONING OF THE TRACTOR



Always position the tractor on flat ground in line with the direction of the pull.

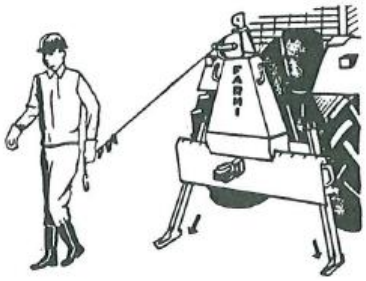


Do not winch from angles exceeding 30° sideways.

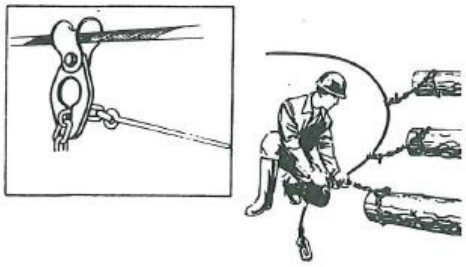


Use a snatchblock to avoid winching sideways. Also use a snatchblock when obstacles prevent direct winching.

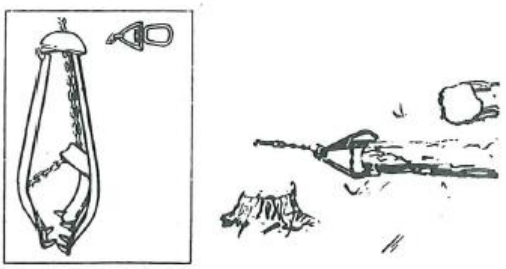
10) PREPARATION FOR WINCHING



Lock brakes of the tractor before winching. Lower the 3-pt. hitch so that the stabilizer legs or dozer blade are anchoring the winch to ground.



Several logs can be hooked up and winched in at one time by means of keyhole sliders on the cable. The skidding chain should have a pin on the end which makes it easier to pass the chain underneath the tree.



Large hardwoods are easiest skidded by hooking a streamline 3-pronged grapple around the butt end. The grapple shields the log from getting hooked behind obstacles. The grapple is also used when the log is lying in snow or mud and skidding chains cannot be attached.

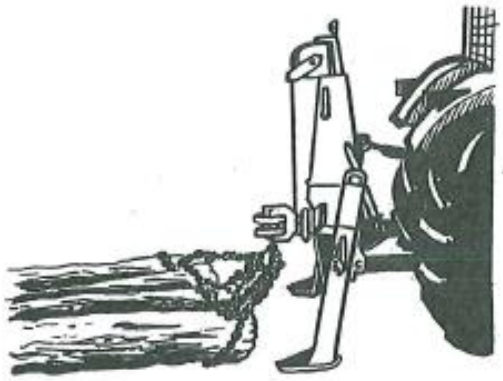
11) WINCHING

Start the power takeoff. Operate the Farmi clutch with the control rope, standing a safe distance of at least six feet from the winch. Some operators prefer to operate the clutch from the tractor seat, provided they have a protective guard screen on their canopy or on the winch. Engage the clutch gradually; the harder you pull on the rope, the more power is supplied to the winch drum. The winch clutch immediately disengages when you quit pulling on the rope.

The clutch will slip when the selected pull is not enough to move the logs, preventing damage and increasing cable life, particularly if the load becomes hooked behind an obstacle.

The winch cable runs over the upper sheave (pulley); the high pulling point causes the load to force the legs or dozerblade into the ground, anchoring the unit. Adjust the legs out more if the tractor slides backwards when winching.

Pulling from a high point also reduces the tendency of logs to dig into the ground.



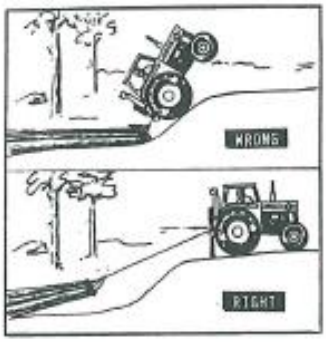
Stop winching when the logs get within 5-10 ft. from the tractor. Turn off the PTO. Turn the lower snatchblock to the right and run the cable under it. (The lower snatchblock is built so that the cable cannot come out when the logs are pulled forward.)

Engage PTO, pull the clutch control rope and winch the logs to the pulley. Keep tension on the cable and pull the thinner rope that operates the brake ratchet. Stop pulling on the clutch rope first. The load is now locked in place.

12) SKIDDING

Turn off the PTO, raise the 3-point hitch so the logs raise off the ground, select a gear on the tractor and drive down the skid road.

IN ROUGH TERRAIN



Release the load before driving on bad terrain. Drive trough it, then winch the load to you.

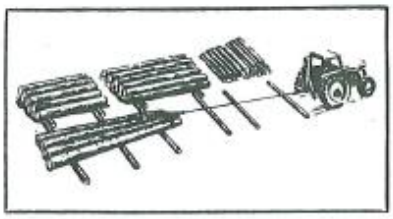
IF TRACTOR GETS STUCK

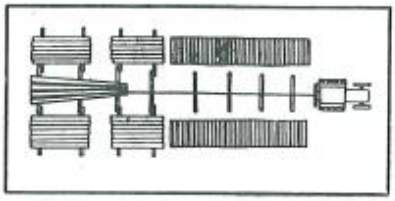
Drop the load; drive to firm ground, then winch in the load. If the tractor won't budge, winch yourself out, remembering to always run the winch cable through the lower snatchblock.

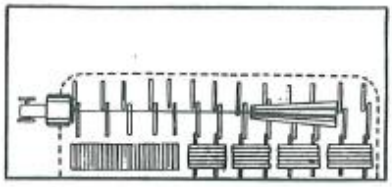
DROPPING THE LOAD

Lower the 3-point hitch. Engage the PTO. Pull the winch clutch rope momentarily until the brake ratchet releases, dropping the logs to the ground. Disengage the PTO. Turn the lower snatchblock to the right and remove the cable. Unhook choker chains from the logs and stow in Farmi frame brackets.

13) LANDING LAYOUT AND PROCEDURES







The location and layout of the landing areas are important factors to consider when planning the operation, particularly if products must be sorted. This section outlines a recommended landing layout that can be used when products must be sorted (for example, sawlogs and pulpwood). If only one product is produced, the landing layout will be simpler. The tree lengths are dropped at the first log pile and the tractor is driven past the last pile with the cable free-wheeling. The sawlogs are bucked off and the tops are winched to the pulpwood pile.

Push the logs together with the stabilizer legs of the winch. An optional dozerblade is available for most Farmi winch models.

Your logging machinery is a valuable asset which is available for use on demand. Access to forestry machinery enables you to promptly harvest damaged trees after a storm, before the trees are damaged by insects or rot. You can also take advantage of good prices for certain species or specific items.

ALTERNATIVE METHOD

(The alternative forwarder method was reffered to in paragraph 7). The stems are winched to the skid road and bucked to the desired length. The logs are then loaded on to the trailer with a knuckleboom loader. The Farmi loader can be mounted on the tractor's 3-point hitch or the tongue of the trailer. Hook up to the trailer makes transport easier as the grapple is placed on top of the load. The loader is not affected by turning actions. Disconnecting the trailer also disconnects the loader from the tractor.
The trailer should have bogie wheels.
Adjustable bunks makes it possible to transport products of varying lengths.

Chapter 4: Common Diseases and Pests

Section 4.1 Noting Signs of Tree Stress

Tree and Forest Health

Forest Connect Fact Sheet Series

Cornell University Cooperative Extension and New York State Department of Environmental Conservation www.ForestConnect.info

Trees are tough - they can handle 40 mile per hour winds, insects feeding on their leaves, and even losing a limb or two. So, how do we know when we need to step in and give our trees a helping hand? Well, it depends on the situation and your objectives.

For instance, ornamental trees or individual trees that are important to a landscape often require much more attention than forest trees. Whether for aesthetics or shade, having trees in your yard can add value to your property, and having even one unhealthy tree can be a risk to your investment.

Trees generally require much less attention when it comes to forest health. If you lose one or two, there are many more. And, a few trees will die every year as part of the natural forest cycle. In order for all the remaining trees in a forest to grow an average of one inch larger in diameter, one in five of the existing trees must die. When looking at the health of forests, monitor for problems on a "stand" level. One defoliated tree is not a problem, but 10 trees could be.

Our primary forest health issues are the result of insects, diseases, and abiotic (non-living) factors. Most of these "pests" will not be able to kill a tree on their own, but the damage they cause adds stress to the tree. When a tree is stressed, it taps into the food (carbohydrates) stored in its roots or trunk to continue to survive. Stressed trees need to recharge just like humans do. If the stress is mild, the tree usually recovers. If the tree is hit with an additional stressor, it may not be able to recover as well and will begin to decline. Decline is when the growth rate slows down - leaves are small and discolored, annual twig growth is short, and little diameter growth is added to the trunk. Once a tree has started to go into decline, and if stress continues, it likely will die in three to five years. We can group the serious stressors into three categories - predisposing factors, primary invaders, and secondary invaders.

Predisposing factors such as ice damage can weaken trees, making them more susceptible to insects and disease.

Predisposing factors are usually abiotic (caused by non- living organisms). Abiotic factors are often things we have no control over, and therefore can do little to prevent. If serious enough these predisposing factors, such as drought, flood, ice damage, hail, and soil compaction, can kill trees on their own. One predisposing factor we can control is

competition among trees for light. By thinning the forest, we can provide adequate light for the trees that remain.

Primary invaders are insects and diseases that will attack healthy trees. These include insects that feed on foliage, root-feeding insects, fungal rusts and foliar leaf spots. Minor amounts of damage caused by primary invaders can be tolerated by trees or easily controlled for, but serious damage can cause tree mortality.

Secondary invaders are insects and diseases that attack trees that are already stressed (from predisposing factors or primary invaders). Most woodboring insects, bark beetles, and some trunk and butt rots are attracted to stressed trees. These pests often stay with the tree after it dies and help in the decomposition process. There is generally little that can be done to stop secondary invaders.

Decline Scenario Example

2001 - Winter; forest hit with severe ice storm- many broken tops (open wounds).
2003 - Spring; Forest Tent caterpillar outbreak- hundreds of trees defoliated
2004 - Spring; Forest Tent caterpillar outbreak continues, weakened trees start to die.
2005 - Spring; Forest Tent caterpillar outbreak continues;
Summer; drought and Lecanium scale outbreak, many trees start to die.

In this situation the first stressor is abiotic (ice storm), followed by three years of defoliation by an insect, compounded by drought (abiotic) and the stress of an additional insect.

How do you know when to start worrying about your trees? Review the following basic list of signs[1] and symptoms[2] of problems, severity of the damage and actions you can take. Ornamental trees generally warrant more pest management due to their high visibility, but some forest pests are worth controlling. Cultural controls (altering the environment) are usually the best approach in more forested situations, but some pesticides can be used in certain circumstances. Evaluate all costs and benefits before using a pesticide. Some pesticides only can be applied by a licensed pesticide applicator. Contact your local Cooperative Extension office for guidance.

[1]Sign- the actual stressor- egg masses, pupal cases, fungal spots on leaves, mushroom conks.

[2]Symptom- the outward expression of the presence of a stressor- slow growth rate, early leaf drop, cankers

Signs and Symptoms of Tree Stress

Insect Damage

Leaf Chewing

Agents - Forest and Eastern Tent Caterpillar, Gypsy Moth, Viburnum Leaf Beetle, Japanese Beetle, Sawflies

Symptoms - Chewed foliage, removes chunks or entire leaves, sometimes leaves the veins.

Control - If only a few leaves are eaten or there is only a little damage, then no control is warranted. If most leaves are affected and are completely eaten, consider treating landscape trees, and promoting predators in forested situations. Healthy deciduous trees can only handle being defoliated three to four years in row; conifers even fewer. In epidemic situations consider spraying.

Prognosis - Minor feeding- prognosis is good; repeated defoliation - expect tree death.

Forest tent caterpillar larvae feed on foliage, leaving only the major veins and leaf petioles behind.[a]

Leaf and Twig Sap – Feeding

Agents - Scales, Aphids, Adelgids. Only a few species of concern- Hemlock Woolly Adelgid, Balsam Twig Aphid, Beech Scale, European Fruit Lecanium.

Symptoms - Leaf distortion and decline, insects suck fluid from leaves and twigs.

Control - Encourage predators, prune heavily infected areas, sprays available- time appropriately.

Prognosis - Depends on specific insect- range from good to eventual death.

Twig Mining

Agents - White Pine Weevil, Pine Tip Moths, Pine Shoot Beetle

Symptoms - “Wilting” of tips in many conifer species, distorts growth.

Control - Damage can spread quickly through a stand. If only one or two trees affected, identify the pest, prune out damage, and use available sprays. If a whole stand is affected, consider sanitation cut (removal of infected individuals).

Prognosis - Good if controlled early on.

Bark Beetles/Cambium Feeders

Agents - Bronze Birch Borer, Engraver Beetle, Elm Bark Beetle, Black Turpentine Beetle. These agents are generally attracted to stressed/ declining trees but some species in this group will attack healthy trees. Some introduce diseases.

Signs - Small holes in the bark or raised ridges resembling tunnels under the bark. Larvae tunnel through and feed on the vascular tissue between the bark and the wood, girdling the tree.

Control - Remove infested trees if concerned about spread to other declining trees.

Prognosis - Poor, eventual death of most trees.

Borers

Agents - Locust Borer, Pine Sawyer, Wood Wasp, Asian Long-horned Beetle, Sugar Maple Borer, Emerald Ash Borer. Many species will attack healthy trees.

Symptoms - Holes/tunnels into wood- can girdle or make tree susceptible to breaking and decay.

Control - Reduce other stresses. Generally there is little that can be done. Trees can be removed when invasives such as the Asian Long-horned or the Emerald Ash Borers are involved. Some pesticides may be available.

Prognosis - Poor, decline or eventual tree death.

Diseases

Leaf Spots

Agents - Maple Tar Spot, Cedar-Apple Rust, Anthracnose, Rhizosphaera, Dothistroma, Powdery Mildew. Generally not a concern for forest trees.

Signs - Surface spots or dead areas on leaves.

Control - Sanitation- rake up fallen leaves in autumn. Late season spots on deciduous trees are little concern. Sprays are available.

Prognosis - Some leaf spot fungus can cause death, some have little effect; most contribute to decline.

Stem and Branch Cankers

Agents - Cytospora, Stem Rusts, Black Knot

Symptoms - Swellings or sunken areas on twig, branches and trunk, often discolored, cracked open with age.

Control - Prune out affected area 6 inches below canker during winter. Remove cankers from the vicinity.

Prognosis - Eventual death, often slow.

Vascular Wilts

Agents - Dutch Elm Disease, Verticillium Wilt, Ash Yellows

Symptoms - Individual branches turning yellow (flagging), death of major sections of the crown, wilting leaves.

Signs - Bluish streaking on the underside of the bark or surface of the wood; peel back bark on a ½" diameter branch to find coloring.

Control - In a landscaping situation, prune out the affected limb if possible, or remove the whole tree. Some fungicides are available for Dutch Elm Disease. In a forest you should remove the affected trees when thinning- schedule of thinning is important.

Prognosis - Usually tree mortality.

Trunk Rots

Agents - Large Conks (mushrooms) growing out of the side of the tree.

Symptoms - Fungus has colonized the tree and generally there is a large column of decay associated with the conk. Removing the conk will have no effect on the fungus. Generally only found on trees in decline, wounded trees, and standing dead trees.

Control - If infected tree is in a high traffic area or near something of value, consider removing. In forested areas, let stand or remove when thinning. These trees can be hazardous but they can also have high value to wildlife.

Prognosis - Generally tree mortality, can be slow.

Disposal of infected trees can be tricky. Many of the insects and diseases that can cause a tree to die often die with the tree, or are natural parts of the environment and no special precautions need to be taken. When dealing with trees killed by a non-native pest such as Dutch Elm Disease or the Asian Long-horned Beetle, trees should be either burned, buried, or chipped before the next cycle of the pest begins. Also, do not transport firewood out of infested areas, even if you don't expect it to be infested- this is a popular way for insect larvae and eggs to spread quickly as was seen with the gypsy moth and is a potential for the Asian long-horned beetle.

Thinning your forest encourages healthy tree crowns.[b]

General tips for keeping your trees healthy:

- Keep them free of stress
  - Water ornamental trees during drought.
  - Do not plant in flood prone areas.
  - Thin forests to encourage healthy tree crowns.
  - Do not drive or re-grade over the root system. A good network of roads will help keep soil compaction to a minimum in your forest.
- Monitor for pests – most pests are adapted to certain trees, so learn about potential pests ahead of time.
  - Every few weeks spend some time in your forest or landscape and look for signs of problems.
  - Carefully and specifically identify the pest before taking action.
  - Get current cultural and chemical recommendations from your local Cornell Cooperative Extension Office.
  - Act quickly- if you feel you might have a real problem on your hands, catch it early.
- Plant the right tree in the right spot.
  - Select the proper trees for your soils, climate, and weather.
  - Look for insect and disease resistant varieties.
  - Plant trees correctly.
- Consider your whole "landscape" and know what you're dealing with.
  - Is your pest actually a pest?
  - Is this an isolated incident, or can it spread?
  - Is it a natural pest? Or introduced?
  - How many trees have been affected?

Black knot leads to cankers on tree branches, like this black cherry, and can eventually lead to death of the infected tree.[c]

Additional References:

Houston, David R., Douglas C. Allen, and Denis Lachance. 1990.Sugarbush Management: a Guide to Maintaining Tree Health. Gen. Tech. Rep. NE-129. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 55 pp.

Johnson, Warren T. and Howard H. Lyon. 1994. Insects that Feed on Trees and Shrubs. Ithaca, NY. Comstock Pub. Associates/Cornell University Press. 560 pp.

Sinclair, Wayne A., Howard H. Lyon, and Warren

T. Johnson. 2005. Diseases of Trees and Shrubs. Ithaca, N.Y. : Comstock Pub. Associates/Cornell University Press. 660 pp.

Web Pages of Interest:

Cornell Entomology Insect Diagnostics fact sheets http://www.entomology.cornell.edu/ Extension/DiagnosticLab/IDLFS

USDA Forest Service Forest Health Protection http://www.fs.fed.us/foresthealth/

USDA Forest Service- Northeastern Area Forest Health Protection http://www.na.fs.fed.us/fhp/ index.shtm

Prepared by Bob Beyfuss, Rebecca Hargrave, and Steve Vandermark with support of Cornell Cooperative Extension of Greene, Chenango, and St. Lawrence counties. Edited and compiled by Kristi L. Sullivan, Peter J. Smallidge and Gary R. Goff, Department of Natural Resources, Ithaca, NY. 2006.

Photos from: www.forestryimages.org - [a]Minnesota Department of Natural Resources Archives, Minnesota Department of Natural Resources, [b]Steven Katovich, USDA Forest Service, [c]Tim Tigner, Virginia Department of Forestry.

Printed on Finch Paper, made in New York State and certified as meeting the standards of the Sustainable Forestry Initiative® Program.

With support from the New York Forest Owners Association.

Silviculture and Invasive Insects

Cornell University Cooperative Extension, Department of Natural Resources, Ithaca, NY www.ForestConnect.info

Forest Connect Fact Sheet Series

Introduction

Forest or woodlot management has historically tried to address a variety of owner objectives. These have included strategies for preventing, reducing, and recovering from impacts of invasive or exotic insects, as well as native ones. The recent spread of hemlock woolly adelgid, emerald ash borer, and Asian long- horned beetle has heightened concerns about appropriate practices for proactively and reactively responding to their potential effects on our forests. This fact sheet suggests ways that woodland owners and managers can use silviculture to maintain healthy and productive trees, and ways to respond if and when these insects arrive.

Owners and their managers should prepare by learning about the threats and keeping watch for an approach of these and other exotic insects. They should develop a plan of action, and act promptly when any of the three appear nearby. For the present, management in forests having hemlock, ashes, and maples should capitalize on a variety of methods. These include using silvicutlure to keep the trees vigorous. Landowners should also regenerate the older trees before any become weakened with age. That may require control of interfering vegetation to assure native species diversity. Where susceptible species occur only as a component of the forest, landowners can reduce their abundance to reduce the risk to their woodland.

The hemlock woolly adelgid initially attacks new foliage, but will spread to older foliage. The insect develops through 6 stages and is mobile in the "crawler" stage. Photo by Connecticut Agricultural Experiment Station Archive, Connecticut Agricultural Experiment Station, Bugwood.org.

Expectations from invasion of woodlands by hemlock woolly adelgid, emerald ash borer, and Asian long- horned beetle.

All of these invasive insects exist in New York[1]. Trees die when infested by any of them. If occurring at a large scale, that mortality could have profound ecologic, economic, and social consequences.

The hemlock woolly adelgid occurs in parts of eastern and southeastern New York, and in recently discovered populations of the Finger Lakes region. It attacks eastern hemlock that occurs as a primary species in nine forest community types, and as a component of eighteen others. Hemlock also grows in pure stands along some draws and ravines, and on lower slopes. Its loss would importantly compromise some ecologic conditions, visual qualities, and habitat values in those woodlands. This insect

[1] Other materials describe the patterns and probability of invasion. See www.ForestConnect.info for related websites.

Cornell University Cooperative Extension

Development and distribution was supported by USDA Forest Service Northeastern Area State and Private Forestry and NYS Department of Environmental Conservation.

Tree mortality in southern states associated with hemlock woolly adelgid occurs within a few years. In the north, tree mortality has been slower, but typically occurring within a several years. Photo by William M. Ciesla, Forest Health Management International, Bugwood.org.

could also have a major impact on riparian areas dominated by hemlock trees. Landowners could favor or even introduce another conifer at many sites and still have viable forests. Still, the character of mixedwood and many natural conifer stands would change appreciably.

The emerald ash borer was recently found in New York, and has affected forests near the state's western and northern borders. It attacks white and green ash. These grow mostly in mixture with other species. The former occurs in twenty-six different forest cover types, and the latter in eighteen. Green ash may form pure stands at bottomland sites (US For. Serv. 1990). The vast second-growth forests that regenerated on former farmlands may have appreciable amounts of both species. Loss of these trees would still leave many viable hardwood woodlands, but it could have important eco- logic and economic impacts. Except where these species occur in pure stands, landowners could favor other trees during thinning and

The emerald ash borer is small and does not fly long distances. It has a metallic green color, a small body size, and blunt head. Long distance dispersal is commonly associated with movement of firewood. Photo by Howard Russell, Michigan State University, Bugwood.org

other tending operations. Emerald ash borer also attacks black ash. That species grows mostly in swampy woodlands, and other frequently flooded areas (US For. Serv. 1990). Loss of black ash would change the character of poorly-drained sites where it occurs, and re- duce the supply of splints for basket making.

The Asian long-horned beetle has been found within the state only in the New York City area. Yet it has recently killed trees in rural forest areas of Massachusetts, and could potentially affect maple-dominated woodlands of rural New York as well. Sugar maple dominates those northern hardwood forests, growing on 31 million acres in Northeastern United

Tree decline associated with the emerald ash borer looks similar to that associated with ash yellows. Photo by Michael Bohne, Bugwood.org

States (US For. Serv. 1990). Red maple also occurs widely throughout the region, and may dominate bottomland and poorly drained sites. To have these species killed off would prove catastrophic. It would drastically change the character of northern hardwood woodlands and have profound economic, ecologic and social impacts. Substituting other tree species for the maples seems impractical.

The Asian long-horned beetle is large and typically covered with white or yellowish spots. Adults tend not to move far and may repeatedly infest the same tree. Photo by Joseph O'Brien, USDA Forest Service, Bugwood.org

Hemlock woolly adelgid, emerald ash borer, and Asian long-horned beetle kill trees within just a few years after infesting a site, allowing landowners only limited time to react. Hem- lock woolly adelgid generally causes mortal- ity within 4 to 10 years, but even within 3 to 6 years at southern latitudes (US Forest service 2005, Pa. Dept. Conserv. Nat. Resourc. 2008).

Until the recent infestation of Asian long-horned beetle in Massachusetts, insect damage and control efforts have been confined to urban areas.
Infestations in rural woodlands and forests create new challenges for forest health specialists. Photo by Michael T. Smith, USDA Agricultural Research Service , Bugwood.org

Secondary agents may shorten the time until tree death (US Forest service 2005). Emerald ash borer kills trees within 3 to 5 years (Ohio Dept Agric 2008), and even in 2 to 3 years (Wikipedia 2008). Asian long-horned beetle causes mortality within 10 years (Hayes and Haugen 2002), but the rate varies with tree size and vigor. Tunneling by the insect damages the wood, and degrades a tree.

The role for silviculture when managing threats of exotic insects

Usually, Integrated Health Management re- lies on silviculture to reduce potential impacts of natural injurious agents, but may also include direct control of pests and other problems. Current research continues to evaluate biocontrol insects and fungi for use against these three exotic pests, but no candidates have shown immediate promise. For the present, use of insecticides or biologic controls for hemlock woolly adelgid, emerald ash borer, and Asian long-horned beetle seems impractical and un- likely at the stand and forest levels.

For most harmful insects, silviculture attempts to:

1. Keep trees vigorous and remove age classes before they become weakened by maturity. That usually helps to slow or reduce losses to some degree.

2. Change the species composition to reduce the abundance of susceptible ones. That can happen by proper species selection during thinning and related cutting, and through an appropriate reproduction method and seed source.

These measures usually make woodlands more resistant to infestation and more resilient in their response afterward. Thinning can shift the species composition by removing susceptible trees. It also favors vigorous trees and those not yet weakened by old age. These better withstand stress. Vigorous trees may also take longer to die after an infestation by many insects, allowing more time to implement a reaction and recovery plan. Yet tree vigor does not reduce the certainty of mortality or lessen the effects of hemlock woolly adelgid, emerald ash borer, and Asian long-horned beetle. Once they infest a tree, it will die.

Step 1. Be prepared for these three exotic insect pests.

Long before hemlock woolly adelgid, emerald ash borer, or Asian long-horned beetle in- fest a forest, owners should develop a strategy for minimizing likely losses and adjusting to the change in forest conditions. Exact actions will depend on the management objectives, the species composition of a forest, and how the loss of any one species might compromise an owner's interests. These may include timber and real estate values, as well as non-market benefits derived through recreation, wildlife, and other ecosystem services. In some cases,

Woodland owners should review their ownership objectives with their forester to refine priorities that might influence forest health and how they are able to enjoy their property. Photo by Peter Smallidge.

changes resulting from an infestation might even enhance the values of interest.

But woodland owners should not rush ahead carelessly. Instead they can:

1. Start now to consider the purposes of ownership, and review the management objectives.

•Write down the values of interest, and their relative importance.

•Determine what species and forest conditions provide the desired benefits.

•Study the management plan to evaluate how loss of a susceptible species might alter the desired outcomes and change the management options.

2. Identify specific areas (also called stands) having high numbers of threatened tree species.

•Make an inventory if none available.

•Identify susceptible stands for future action, looking for the most susceptible ones to treat and the most valuable trees to salvage.

3. Develop plans for prompt action.

•Assign specific actions and priorities to the stands.

•Prepare a treatment list to sequence the containment and salvage cuttings.

•Identify contractors and mills to do the work and take any usable logs.

4. Watch the situation on and near the forest

•Keep apprised of regional assessments.

•Begin on-forest monitoring to detect arrivals.

•Look for signs of the insects on branches and boles of trees felled for firewood or other uses.

•Notify authorities immediately as these insects appear nearby.

5. Act promptly when an outbreak approaches.

•Verify the action plan and treat the most threatened stands first.

•Engage a contractor without delay if salvage cutting possible.

• Move ahead promptly and boldly.

A state-mandated quarantine will prevent movement of firewood, logs, and lumber from trees attacked by emerald ash borer and Asian long-horned beetle. So waiting until these insects enter a forest compromises the opportunity for salvage cutting. Instead, owners should anticipate their arrival by removing maple and ash trees as soon as monitoring detects these insects nearby.

Step 2. Act promptly when the insects arrive.

No one knows where and how rapidly these insects will spread. Some areas may escape an infestation altogether. Yet with such fast acting and certain killers, owners must respond promptly. That requires vigilance, particularly as any of these insects appear even in the vicinity of a forest. Woodland owners must remain particularly watchful in regions where all three might occur together. Immediate action should include:

1. Notifying state forest health specialists so they know about the infestation.
2. Cooperating with authorities to contain an emerald ash borer or Asian long- horned beetle infestation by cutting and chipping all affected trees right where they grew.
3. Salvaging the timber from trees affected by hemlock woolly adelgid.
4. Adjusting management plans to restore the values of interest.

Once hemlock woolly adelgid, emerald ash borer, or Asian long-horned beetle infest a forest, landowners can only attempt to contain an infestation. Local and state forest health specialists will help landowners to identify appropriate actions for their woodland. Movement of wood from infested trees may spread the emerald ash borer and Asian long-horned beetle to new sites. So, quarantines usually prohibit transportation of wood products from any tree affected by these insects, and even from seemingly healthy trees within a quarantine area. As a consequence, wood from infested ash and maple trees should remain in the forest.

Landowners can salvage or transport logs from hemlock trees after loss to hemlock woolly adelgid, especially in regions where the insect has become common. However, to con- trol inadvertent spread of the hemlock woolly adelgid, logging contractors should power wash equipment before moving to a new site.

Step 3. After the infestation, manage to rehabilitate the woodlot

Rehabilitation treatments should follow an infestation to reestablish the values of interest, though emphasizing species less susceptible to these exotic pests. Where an infestation does not compromise the objectives, owners may only want to monitor the forest conditions to watch for unexpected changes that deserve attention at some later time.

Where impacts require a post-infestation intervention, the recovery plan might include:

1. Manipulating the spacing and density of desirable trees and species in partly affected stands that had moderate losses, perhaps leaving a lower stocking and reduced species diversity.
2. Regenerating other desirable species as replacements in understocked stands, doing this with some urgency where needed.
3. Reducing hazards by felling dead trees along trails and roads, near buildings, and within frequently visited areas.

Both the mortality of large trees and overstory cutting should trigger an understory response. That may include development of

Beech root suckers may develop following canopy opening associated with harvest or decline of overstory trees. Beech thickets create dense shade the together with deer can inhibit the regeneration of other desirable hardwood species. Photo by Peter Smallidge.

both tree seedlings and of some interfering plants that cause regeneration failures. Problem species like ferns, grasses, American beech root suckers, striped maple, witchhobble, pin cherry, and black birch often increase and grow rapidly following a heavy to moderate overstory disturbance due to natural causes or cutting. Woodland owners need to control interfering understory plants if they occur on 30% or more of the stand area. Approved herbicides usually prove most effective for all but small areas. Landowners must insist on appropriate and safe application by skilled people.

Reestablishing susceptible tree species in the aftermath only perpetuates a problem. So landowners should treat them as interfering plants, and limit their regeneration following an outbreak. Lack of an alternate seed source in devastated stands may require tree planting to restock a forest, even introducing new species that may importantly transform the ecosystem.

Additional Assistance

Hemlock woolly adelgid, emerald ash borer, and Asian long-horned beetle will require continued vigilance. Everyone should learn to identify these insects, understand their habits and effects, and how to deal with them. Educational materials are available through Cornell University Cooperative Extension, SUNY College of Environmental Science and Forestry, and articles in publications by the New York Forest Owners Association or the Catskill Forest Association. Woodland owners should communicate with the NYS Department of Environmental Conservation about changes in the presence of these insects on and near their forests. Foresters and other natural resource managers should periodically contact that agency for updates about the status of these insects in or near their area, and participate in educational events through the Society of American Foresters and other organizations.

Literature Cited

Hayes, E., and D. Haugen. 2002. Asian long-horned beetle: A potential invader of Minnesota. Minn. Dept. Nat. Resourc. www.dnr.state.mn.us

Ohio Dept. Agric. 2008. Emerald ash borer. Div. Plant Indus., Ohio Dept. Agric. www.ohioagriculture.gov/EAG/

Pa. Dept. Conserv. And Nat. Resourc. 2008. What is hemlock woolly adelgid? Pa. Dept. Conserv. and Nat. Resoruc. www.dcnr.state.pa.us/forestry/woollyadelgid

US For. Serv. 1990. Silvics of North America. US For. Serv. Agric. Handbk. 654.

US For. Serv. 2005. Hemlock woolly adelgid. Pest Alert. North. Area State and Priv. For. NA-PR-09-05.

Wikipedia. 2008. Emerald ash borer. Wikimedia Found., Inc. www.wikipedia.org/wiki/Emerald_ash_borer

---

Authored by Dr. Ralph Nyland, SUNY College of Environmental Science and Forestry, Syracuse, NY.
Peer reviews were provided by Drs. Doug Allen and Rene' Germain of SUNY-ESF.
Layout and design by Diana Bryant.
Suggested citation: Nyland, R. D. 2009. Silviculture and invasive insects. Cornell University Cooperative Extension ForestConnect Fact Sheet. P. Smallidge, ed. 6 pgs.

Gypsy Moth

Lymantria dispar (Linnaeus); Family: Lymantriidae

Injury

The gypsy moth is one of the most important forest pests in the Northeast. The caterpillars feed on leaves of forest, shade, ornamental and fruit trees, and shrubs. A single defoliation can kill some evergreens, but usually two or more defoliations are needed to kill hardwoods.

Description

Larvae (caterpillars).
Photo from www.forestryimages.org
USDA APHIS, Oxford, North Carolina Archives.

Small larvae are dark brown to black and very hairy. As they reach maturity they become slate colored and have 2 rows of blue spots (5 pairs) followed by 6 pairs of red spots on the back. Fully-grown larvae are 2 to 2 1/4 inches (50-56 mm) in length.

Pupae.

Adult moths.

Photos from www.forestryimages.org
Terry McGovern, USDA APHIS PPQ.

Pupae are brown and teardrop shaped. A few threads of brown silk hold the pupae in place on the tree trunk.

Male moths are brownish with black markings and have a wingspan of 1 to 1 1/4 inches. Females have white wings with dark markings and a tan to buff colored body. Females are heavy bodied and do not fly.

Egg mass and hatching larvae.
Photo from www.forestryimages.org
William M. Ciesla, Forest Health Management International.

The egg masses are 1 1/2 inch long by 3/4 inch wide (38 x 19 mm), covered with a dense mat of buff colored hairs. They are often found on trunks of trees or underside of larger branches. Current year egg masses have a good buff tan color and are hard and velvety to the touch; older ones are faded, and soft to the touch as the eggs have hatched.

Life History

There are four distinct stages to the development of the Gypsy moth -- egg, larva, pupa and adult (moth). The eggs are round, black to brown in color, and deposited in masses of 100 to 600 eggs in July and August. The tiny caterpillar overwinters inside the eggshell, but does not hatch until the following April or May. When the eggs hatch, the 1/4 inch (6-8 mm) long caterpillars remain on the egg mass for a few days before climbing to the tree to feed.

The young caterpillars also spin silken threads and hang down from the tree branches. Wind often breaks the threads and carries the caterpillars to nearby trees and shrubs. This is called "ballooning." Long range dispersal is aided by man -- egg masses or pupae may be inadvertently carried on vehicles, outdoor furniture, plants and the like.

The female passes through 6 caterpillar growth stages; the male, 5 stages. Each time the larva grows it sheds its skin and a new larger skin forms. The larval stage lasts for about 7 weeks.

In June and early July, full-grown larvae may leave the host plant and seek out protected places to form the pupa or resting stage. At this time, the large caterpillars may be seen crawling across walkways or roads, or up the side of a house. The pupal stage lasts about two weeks.

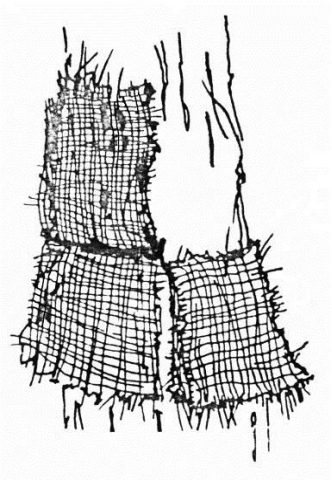
Moths emerge from the pupae -- the males usually emerge first. Males are strong fliers and may be seen flying in a zigzag pattern during the daytime. The female does not fly, but remains near the pupation site and releases a sex attractant (pheromone) which attracts males. After mating she deposits her eggs in a single mass and then dies. There is one generation per year.

Management

Before mid-April, look for overwintering egg masses on tree trunks, rock outcroppings, fences, sides of buildings and woodpiles. Scrape off the fuzzy buff colored egg masses into a container, and destroy them.

Young caterpillars may be controlled by spraying. The homeowner can spray small trees and shrubs, but larger trees should be done by a professional arborist. READ and FOLLOW the manufacturer's instructions when using any pesticides. If needed, spray foliage in May after larvae hatch (90–448 GDD; growing degree days). If using Bt (*Bacillus thuringiensis* ssp. *kurstaki*), apply before larvae reach 1 inch in length.

Pupae may be crushed when found on the trees or in other protected places. It is not practical to try and control the adults. The females might be collected by hand and destroyed, but trapping the males or trying to catch them in flight is not effective for control in areas of high populations.



Burlap folded over a string wrapped around a tree trunk. Left side of the burlap fabric is lifted up to show where to look for and remove any caterpillars.

Older caterpillars can be controlled to a degree by banding the trees. The older larvae move up the trees in the evening to feed and back down at dawn to seek shelter during the day.

A burlap strip 12 to 18 inches wide can be cut and tied around the trunk with twine. Fold the top half of the band down and over the lower half to provide a sheltered area for the caterpillars to hide under during the day. Lift up the burlap and look between the layers, to collect and destroy caterpillars daily.

Alternatively, a 6 to12 inch band of nonporous material can also be wrapped around the trunk and smeared with a sticky substance such as Tanglefoot (available at many garden supply centers.) The caterpillars will stick to the Tanglefoot as they try to move over it. Remove caterpillars by raking the band with a comb whenever they become numerous, and destroy them.

NOTE: the hairs on the caterpillars can be irritating, causing itchy bumps on the skin. Use gloves or tools rather than bare hands, when picking up, brushing off, or crushing gypsy moth caterpillars.

Prepared 1981 by Carolyn Klass, Senior Extension Associate, Dept. of Entomology, Cornell University
Updated 2012

http://idl.entomology.cornell.edu

Saturday,
July 29, 2006

Controlling Forest Tent Caterpillars in Limited- Acreage Maple-Producing Woodlots

Intern: Anna Barensfeld *Project Leaders: Steve Childs, Pete Smallidge, Paul Weston, Brian Chabot*

Previous New York State Outbreaks:

1887
1896-1901
1923-1924
1935-1940
1951-1955
1980-1982
1991-1993

The Hard Facts on Forest Tent Caterpillar

The Forest Tent Caterpillar (*Malacosoma disstria)* is an indigenous species in North America. Its population fluctuates between extremes on a somewhat regular schedule, periodically reaching outbreak proportions about every six to sixteen years. Outbreaks usually subside after two to four years of heavy defoliation, but have persisted for up to six years.

Tree dieback is generally minimal during an outbreak, but severe and repeated defoliation can cause significant mortality and/or reduced growth. Of note to maple producers, quantity and quality of sugar maple sap is greatly reduced as a result of defoliation.

"Forest Tent" is somewhat of a misnomer, as the larvae do not actually spin tents, but spin silk mats on trunks and branches. They congregate in large bunches on these mats to molt or rest after feeding.

The Nature of the Beast: Biology

There is one generation of Forest Tent Caterpillar (FTC) each year. Young larvae appear when leaves are beginning to unfold. Newly hatched larvae are **uniformly black**, are **less than 1/8 of an inch (3mm) long**, and bear **conspicuous hairs**. Colonies stay together and move about in single file, following silk trails laid down by leaders. With each successive molt, markings of **pale blue lines** along the sides of a **brownish body** and a row of **keyhole-shaped, white spots on a black background** become more evident. When full grown, caterpillars are about **2-2.5 inches (50- 64mm) long**.

Larvae usually go through five "instars," or developmental stages between molts. When there is a high population and heavy defoliation, the fourth and fifth instars move around a great deal in search of food and for suitable sites to spin their cocoons.

Five to six weeks after hatching, the larvae spin cocoons of yellow, powdery silk between folded leaves, bark crevices, and any other sheltered places that can be located. Moths emerge ten to fourteen days later,

(continued on page 2)

The Nature of the Beast…Continued

(continued from page 1)

and live for only a few days; during this time they mate and females lay the eggs. They do not eat. They are **stout bodied**, **buff colored**, and have a **wing span of 1 to 1.5 inches (25-38mm)**. The **forewings** have **two darker oblique lines near the middle**. Great numbers are attracted to lights at night. Strong winds can carry the moths for miles, spreading the FTC outbreak next year.

http://mothphotographersgroup.msstate.edu/Files/Live/JH/J

Moths lay their eggs on upper crown branches, masses of 100-350 encircling small twigs in bands of up to one inch. Each cylindrical mass is cemented together and coated with a hard, glossy substance called spumaline. Within three weeks the embryos develop into larvae that overwinter in the eggs and hatch in the spring.

Predator and Prey: Natural Controls

Furia crustosa *has attacked these caterpillars. The near FTC at left is in the beginning stages of infection, while at far right, the mycelium has completely engulfed the FTC body.*

These Forest Tent Caterpillars have recently succumbed to Nuclear Polyhedral Virus (NPV). Note the inverted V shape of the lower left hand FTC and the emaciated look of the others.

At the three observation sites monitored this summer, several natural predators contributed to population decline. These included:

Nuclear Polyhedral Virus, **or** *NPV***.**
Larvae infected with NPV are completely taken over by the pathogen. The body turns into a liquid mass of viruses that spill from the cadaver when the cuticle eventually ruptures. Caterpillars killed by NPV are typically found hanging in place by their midsection, appearing like an inverted V. Infected larvae appear sluggish, emaciated, and upon dying, turn darker in color and wilt.

*Furia crustosa***, a fungus**.
Caterpillars come into contact with infectious *furia* spores when they disperse over the ground. The mycelium eventually grows to fill the body cavity, and after the caterpillar dies (typically within 4-5 days after first contacting the spores), the hyphae emerge and the mycelium grows over the outside of the body, completely covering it with a brown, crusty covering. The disease can spread from caterpillar to caterpillar, and the predator fly *S. aldrichi* may contribute to the spread.

*Calosoma sycophanta***, a beetle.**
This beetle is a colorful metallic green, 23-30mm. They grasp their caterpillar prey at the middle and cut it in half with sharp mandibles. They actually injure more caterpillars than they eat. They also tear open cocoons and attack they pupae.

(continued on page 3)

Predator and Prey: Natural Controls…Cont.

(continued from page 2)

Sarcophoga aldrichi, **or "Friendly flies."**
This fly emerges in late May, and is at once a great pest and a great boon to humans. They are one of the most effective predators of FTCs. By late June, the female adults larviposit eggs on the cocoon of the caterpillar, and after working its way through the silk the maggots burrow into the pupa, feeding on the pupa and leaving only a dark mush behind. The maggot remains in the cocoon an average of 10-12 days. They are called Friendly flies because of their large numbers and tendency to swarm humans, but they do not bite.

Possibly, Spiders
Numerous spiders were noted in the presence of FTCs on the boles of trees, but none were observed to prey on the caterpillars. Literature states that spiders are known caterpillar predators.

Additional FTC predators include ants, birds, frogs, mice, skunks, 75 species of Hymenoptera (bees and wasps), 52 species of Diptera (gnats, mosquitoes, and flies), 9 species of Coleoptera (beetles), and 1 species of Dermaptera (earwig).

Other natural controls include unseasonably low temperatures in the winter and spring (such as a late or hard freeze following larval emergence), extremely high temperatures in the late spring (reducing mating success and viability of offspring), and outbreak collapse due to exhaustion of food supplies.

The EXPERIMENTS

FTCs are currently a serious defoliator in many places in New York State. Even though the pest is usually a major problem for just 2-4 years in a given woodlot, maple producers must limit defoliation in order to continue tapping trees, due to the reduced quantity and quality of sap during an outbreak.

Commonly, it is recommended not to tap trees that have been severely defoliated the previous summer. But not tapping for just one year can jeopardize a producer's market in future years, harming a small farm's income and livelihood.

Many maple producers operate woodlots of less than the 15 acre size normally required to treat FTC with aerial pesticide spraying. At that size and smaller, spraying is not economical. Producers need proven alternative techniques to limit defoliation due to FTCs to avoid losing syrup production and markets.

This summer we trialed several methods of reducing defoliation in woods where serious defoliation was expected. Our goal was to keep defoliation at 50% or less, or to encourage re-foliation through fertilization following damage.

1. <u>Tanglefoot Traps</u>

Literature suggests that use of "sticky traps" and "tree aprons" may provide some control of caterpillar defoliation, but these methods had not been tested on individual trees in a small woodlot setting.

We chose Tanglefoot, a sticky anti-pest paste of castor oil, resin, and wax, as the sticky trap and burlap for the apron.

(continued on page 4)

FTC Host Trees at the Arnot:

Sugar maple

Beech
Ash
Elm
Birch
White Oak
Pink Oak
Aspen
Basswood
Red Maple
Hemlock
(even Goldenrod)

Conifers, Red Maple, and Sycamore are not typically considered FTC host trees.

Other NY State host trees include cherry. Apple, and alder.

Above, FTCs mass below a Tanglefoot band. Below, a double band application with burlap apron, at the St. Lawrence County Learning Farm site.

- **Tanglefoot Traps…continued**

Applications were made at 3 locations: the Arnot Research Forest, at a participating woodlot near Skaneateles Lake, and at CCE of St. Lawrence County Learning Farm.

What did we find?

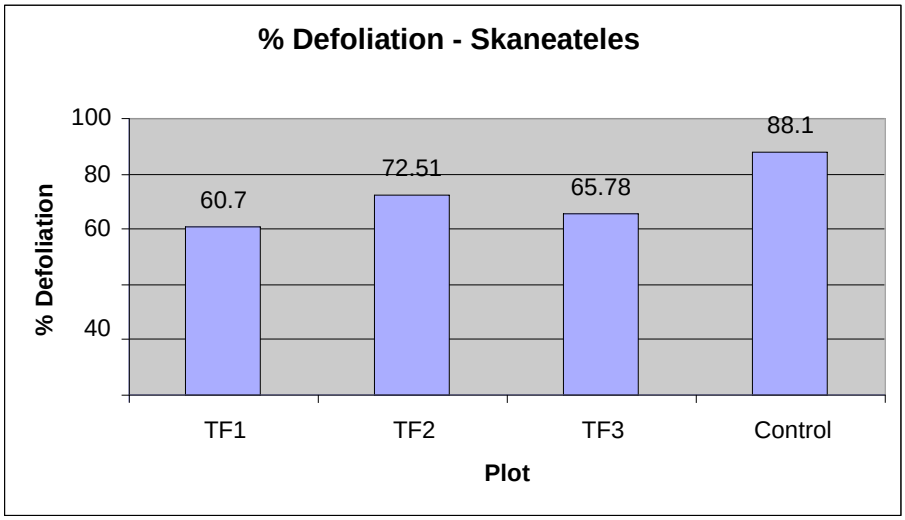
Tanglefoot seems to do a good job of disrupting FTC movement. FTCs are gregarious foragers that move about looking for feeding sites, following pheromone lines laid down by the most active among them. The sticky bands seem to restrict their free movement up and down the boles of the trees. While we expected the caterpillars to actually get stuck in the Tanglefoot, they prefer to avoid touching the substance if possible. When they do get stuck in it, they become mired in it and die.

Only one of the three sites provided reliable data. Despite their high initial population, FTCs at the St. Lawrence County site died off at an early instar for an unknown reason, before they were able to do any significant defoliation. The small sample size here at the Arnot left fluctuations in the data set. At the site on Skaneateles Lake, however, the results were notable. Here, three plots of between 8-10 trees were treated with Tanglefoot, and one control plot received no treatment.

The percentage difference in defoliation between the control plot and the Tanglefoot application plots average was 21.8%. While clearly not the 50% reduction we were aiming for, this is a real reduction and worth noting. If only the Tanglefoot plots where burlap aprons were used, TF1 and TF3, are considered, the percentage difference between control and experimental plots improves to 24.9%.

It is possible that defoliation remained significant on the treated trees, though lower than on control trees, because while movement of FTCs was restricted, the Tanglefoot bands effectively kept FTCs locked into eating the leaves on the experimental trees. There was no flow of FTCs in or out of treated trees.

Plots TF1 and TF3 were also applied with burlap aprons between two bands of Tanglefoot. The percentage difference in defoliation between the control plot and the Tanglefoot plots average was 21.8%



- **Pheromone Lines**

Recently much work has been done to develop synthetic FTC pheromones (chemicals produced by animals and insects to attract one another).

We wanted to investigate whether FTCs actually followed these synthetic pheromones. We used the pheromones in two different applications at the Arnot Research Forest.

In one application, lines were treated with different synthetic pheromone concentrations and strung from one tree to another in order to draw caterpillars away from desirable "source" maples to "sink" trees. In some cases, the sink trees were banded with Tanglefoot.

In another application, trails of synthetic pheromones were sprayed down the trunks of maples extending from the upper reaches of a tree down to chest height.

What did we find?

In observations, FTCs did not respond to the pheromone treatments. While they sometimes appeared on the pheromone lines, they seem to be irresponsive to pheromone concentration; for the handful of times they followed the 20 parts per million line, they equally followed the 0 parts per million line.

- **Light Nitrogen Applications**

Defoliation causes trees to lose out on prime sugar storage time at the height of the summer. They will generally set a terminal bud and push out a second set of leaves later in the summer, but this is past peak sap-sugar production.

Since the timing of terminal bud set and cessation of caterpillar feeding are almost synchronous, fertilizing woodlots in May with low levels of nitrogen (25 and 50 lbs. per acre plots) may allow for immediate re-foliation from continued growth of the terminals.

Our hope was to encourage trees to re-foliate earlier, staving off the setting of terminal buds, and avoiding or reducing tree stress. In this way, leaves are pushed out right from the same shoots as the previous set of leaves.

Applications are at CCE of St. Lawrence County Learning Farm and the participating woodlot near Skaneateles Lake.

What did we find?

At the site near Skaneateles Lake, there is significant releafing; the continuation of the end shoot, from which the leaves 'pop' out. In the 50lb. nitrogen plot, there are more leaves, but no bigger than in the 25lb. nitrogen plot. In a control area, some trees have no releafing, but others seem to be releafing with the same vigor as the fertilized trees. Later in the summer a few trees in the woodlot will be cut and growth in their crowns will be measured so that specific conclusions can be made.

Bright new leaves can be seen springing out from the shoot above old, defoliated leaves.

Arnot Teaching and Research Forest

Department of Natural Resources
New York State College of Agriculture and Life Sciences

Cornell University

611 County Route
13 Van Etten, NY
14889

(607)589-6095

www.dnr.cornell.edu/arnot
arnot@cornell.edu

- **Adult Moth Traps**

Pheromones are also used in traps for adult forest tent moths. We wanted to determine if these traps are successful at trapping moths in a small woodlot setting.

This application would not reduce defoliation until the following year, 2007.

What did we find?

The moth traps are only drawing marginal numbers of Forest Tent individuals, not enough to reduce the moth population.

However, these traps will be useful for correlating the number of trapped moths with an egg mass count in the winter. Perhaps a sugar maple producer will be able to put out these traps in their sugarbush, and from the number of moths they catch, expect a certain level of defoliation in the spring. They will thus be freed from the time-consuming job of conducting egg-mass counts to predict caterpillar populations.

The pheromone traps are hung at 11 various elevations and locations throughout the Arnot Forest and at 3 locations at the Skaneateles woodlot. There is also 1 trap at the St. Lawrence County Learning Farm.

Citations

Meeker, James R. "Common Name: Forest Tent Caterpillar." *Featured Creatures* Jan. 2001 <http://creatures.ifas.ufl.edu/trees/forest_tent_caterpillar.htm>

Batzer, Harold O. and Robert C. Morris "Forest Tent Caterpillar." *Forest Insect & Disease Leaflet 9.* U.S. Department of Agriculture and Forest Service. <http://ww.na.fs.fed.us/spfo/pubs/fidls/ftc/ tentcat.htm>

Fitzgerald, Terrence D. The Tent Caterpillars. Ithaca: Cornell University Press, 1995.

Previous New York State outbreak data:

Kraus, Naja. "All you ever wanted to know about Forest Tent Caterpillars and much more…" *NYSDEC Division of Lands & Forests.* <http://www.dec.state.ny.us/website/dlf/privland/forprot/health/caterpillar/ftc02.pdf>

All photographs: Anna Barensfeld unless otherwise noted.

Woodlot Management and the Emerald Ashborer

Written by Mark Whitmore and Pete Smallidge

Excerpt from *Woodland Health: A column focusing on topics that might limit the health, vigor, and productivity of our private or public woodlands*. Coordinated by Mark Whitmore.

Woodlot owners in New York will at some time be dealing with the Emerald Ash Borer (EAB), *Agrilus planipennis*. In the last issue of the New York Forest Owner we provided an update on the EAB situation in New York; please refer to this article for background information. In this article we will focus specifically on what you can be doing as a woodlot owner to prepare for the EAB.

One of the most important things to remember is that EAB is not currently widespread in New York so most woodlot owners have time to plan ahead and benefit from additional ash volume growth. Indeed, if the state's efforts to "Slow the Spread" are successful we will have even more time to develop and implement management strategies. One thing to consider is that every year your woodlot is EAB free the ash volume is increasing and in some stands this can be significant. Right now we really have no good guesses about how fast EAB will be moving through the state. However, if people stop moving infested firewood, many of the states' wood- lot owners will have perhaps several more years before the EAB arrives in their neighborhood. So cool your heels if you've been thinking about liquidating your "ashets" and start planning ahead to minimize EAB impacts.

The specific course of action a landowner selects will depend on their objectives, abundance and maturity of ash in their woodland, the abundance and quality of other species in the woodland, owner's geographic proximity to EAB infestation, the avail- ability of markets, and owner's ability to complete or coordinate work tasks in the woods.

In young stands with mixed species, consider cutting some ash that shade desired species to promote species diversity and reduce ash abundance.

The attitudes and resources of the private forest owner will influence management decisions in response to EAB. Forest owners who seek productive forests may want to be proactive to capture value while markets are

favorable but should be mindful of lost volume if EAB is not near. Forest owners who will be able to personally utilize ash or sell in nearby markets may want to wait for the insect to arrive and harvest at that time. Owners who desire minimal manipulation of their woods similarly may wait and then respond to man- age effects that may cascade from ash mortality, such as invasive plants, less desirable regeneration, loss of diversity or reduced forest stocking. Each owner needs to personally assess their objectives, and consult with forestry professionals attuned to the owner's objectives, to guide their strategy and timing for a response to EAB.

Effective management of forests in anticipation of EAB requires knowledge of forest characteristics such as the variety of other desired tree species, presence of invasive plants, forest density, tree age and average tree diameter. Most forest owners should work with a forester to acquire this information. Information on how to select a forester is available through Cornell University Cooperative Extension and at www.ForestConnect.info. The NYS Department of Environmental Conservation (DEC) provides free Stewardship management planning advice to forest owners upon their request. Contact the local DEC forestry office to obtain assistance from a DEC Forester. DEC also maintains a list of Cooperating Foresters, foresters in the private sector who provide services to forest owners.

Because the arrival of EAB is imminent, and there are no known methods of control on an area-wide basis, forest owners should assess their interest in managing impacts and, if appropriate, capturing the value that exists in ash on their property. Young, fully forested areas but with low abundance of ash stems will experience minimal ecological impact from EAB. Forests that are increasingly mature or having greater abundance of ash will be more dramatically affected when the insect arrives. Owners should strive for a mixture of species and forests that are adequately stocked for optimum growth. Stocking refers to the number and size of trees per acre; full or over- stocked woodlots have reduced growth of trees and an increased potential of natural mortality. The natural mortality isn't controlled, and in some cases the ash may survive and future desired tree species may not.

In young forests and forests having low densities of ash, owners may benefit from non- or pre-commercial thinning to reduce the density of ash in favor of alternative desired species. This will shift growth to other desirable species and ensure they are thrifty if and when ash mortality occurs. In areas being planned for planting, species other than ash that are suited to soil conditions should be used. In forests that are heavily stocked with ash a non- or pre- commercial thinning could be used in one or two steps to open the stand gradually and encourage regeneration of desirable species without opening the stand up too much and thereby encouraging invasives.

In maturing forests, where the average tree is 12 inches diameter or larger, owners should evaluate their desire to capture any value that exists in ash. However, owners should strongly avoid the temptation for unnecessarily harvesting other high value trees that may serve as an important seed source to restock the forest following the death or removal of ash. Management in mature stands with abundant ash may seek to establish

regeneration of other species in anticipation of EAB's arrival. In woodlands with abundant ash, this management strategy will result in a dramatic visual change. Owners should carefully consider their ownership goals and all management options. Complete liquidation of ash from a woodland is not recommended. If there are no ash left in the woods we will not have the chance to find that one rare individual that may be resistant to EAB.

Markets for ash in New York have remained remarkably resilient despite the implementation of quarantine regulation over large parts of the state and the flood of ash into the marketplace resulting from panic selling. This is largely because the regulating agencies, NYS Department of Agriculture and Markets and USDA APHIS, have been proactive with education and implementation of regulations that work with industry to enable commerce in a responsible manner.

When forests are disturbed through natural processes or management activities, they experience some type of change. Forests typically display predictable patterns of response, depending on local condition, existing interfering vegetation, current deer populations, and the type of disturbance. Specific conditions or actions that might inhibit the development of healthy and ecologically functional forests following EAB include: the spread of invasive plants that compete with desirable plants, deer browsing that reduces desirable species, logging disturbance without attention to water quality best management practices, high-grade (diameter limit) harvests that remove all or most of the valuable trees prior to effective forest regeneration, damage to the root systems or stems of residual trees during logging, or removal of desired trees needed for seed production.

Lastly, now is the time to begin planning for the worst case scenario where the vast majority of our ash is killed. If we do nothing our genetic resources for possibly reintroducing ash into our future forests will be minimal. We should be collecting seed and preserving it now, before the EAB takes this resource away. There is a National Ash Tree Seed Collection Initiative by the USDA to conserve ash seed and information can be found at: *http://www.nsl.fs.fed.us/geneticco- nservation_ash.html*

Cornell University Cooperative Extension recommends these steps for private forest owners:

1. Work with professionals to evaluate your need and desire to manage the impact and extent of mortality associated with EAB relative to your ownership objectives. Your ownership objectives influence the following recommendations. Be calm and deliberate in your decision making.
2. Determine the current status of EAB in New York by checking the DEC website and identify any revisions to management recommendations. EAB status may change more than once each year. Consider geographic location and the need for timely actions.
3. Assess the abundance and age of ash in your forest. Consult with a forester to learn how ash abundance in your woodlands, relative to other species, will be affected by

the potential complete loss of ash.

4. In young forests or those that have low ash density, you could harvest or kill the ash that compete (shade) with other desired trees. This will retain some ash that are not competing and will ensure that a mixture of species is thriving when the EAB arrives and affects your forest.
5. In mature forests and those with high densities of ash, identify potential markets and harvest ash trees to capture the best value. Avoid the temptation to include other species in the harvest to make the harvest viable. Retain vigorous and dominant stems of other species to form the remaining and future forest. The arrival of EAB into NY has resulted in quarantines but markets have remained robust and agencies are working hard to minimize any disruption of commerce.
6. Call Before Your Cut: Consult with a forester, DEC or Cooperating Forester, prior to making decisions to cut or not to cut.

Peter J. Smallidge is the NYS Extension Forester and Director of Cornell University Arnot Teaching and Research Forest. He can be reached at email:pjs23@cornell.edu or visit his website at www.ForestConnect.info

Mark Whitmore is a forest entomologist in the Cornell University Department of Natural Resources and the chair of the NY Forest Health Advisory Council.

Early Detection of the Hemlock Woolly Adelgid (*Adelges tsugae*) in Small Northeastern Hemlock (*Tsuga canadensis*) Woodlots

Forest Connect Fact Sheet Series

Cornell University Cooperative Extension, Department of Natural Resources, Ithaca, NY www.ForestConnect.info

The hemlock woolly adelgid (*Adelges tsugae* Annand) is a serious non-native pest of hemlocks (*Tsuga canadensis* and *T. caroliniana*) in the Eastern United States. Originally from Japan and China, the hemlock woolly adelgid (HWA) was first detected in the East in the early 1950's in Richmond, VA. It has since spread on eastern hemlocks throughout the Eastern U. S. from the southern Appalachian Mountains to New York and New England. (Figure 1).

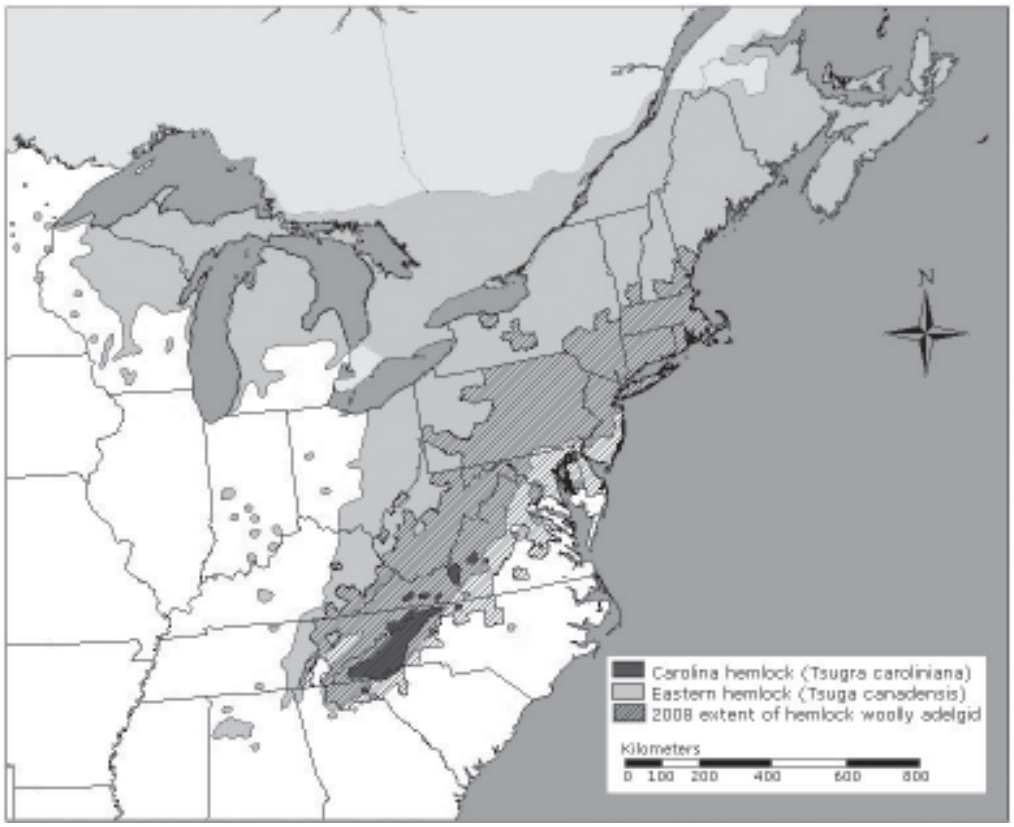


Figure 1. *Hemlock Woolly Adelgid distribution in the eastern United States as of 2008. Map courtesy of the USFS Northern Research Station.*

The HWA's impact is quite dramatic in the southern forests where hemlocks exhibit little resistance and die a few years after becoming infested. In the north, the situation is quite different where some infested trees survive for ten years or more. Mortality in the Northeast has occurred primarily in the more southerly regions of New York's Hudson River Valley, Connecticut, and Rhode Island. It's still too early to tell if mortality will be severe in the upstate regions of New York and in northern New England.

The HWA currently occurs over nearly half the native range of eastern hemlocks in the U.S. and spreads about 10 miles per year. HWA has nearly reached the southern-most distribution of hemlocks, but its range continues expanding to the west and north.

Detecting new HWA infestations at the leading edge of its range is important so land managers and woodlot owners can slow its spread and take steps to manage it. Early detection and notification of forest health specialist is an important first step to control this and other invasive pests. Many hemlock patches are small, may be confined to gullies or gorges along waterways, or occur mixed with hardwoods. These areas can be quickly surveyed by a few people. Once HWA is found, or when patches (known as stands) are larger than 10 acres, the infesta- tion can best be monitored using the method developed by Costa and Onken (2006).

Cornell University Cooperative Extension

Development and distribution was supported by USDA Forest Service Northeastern Area State and Private Forestry and NYS Department of Environmental Conservation

Biology

The HWA is a small aphid-like insect. The adults are tiny, only about 1/32 of an inch, and covered with dry, white, waxy wool that makes them look like the tip of a small cotton swab (Figure 2). In North America, only females that reproduce asexually exist and each one lays 50 to 300 eggs beneath the woolly mass (Figure 3). There are two generations per year and each generation has six stages of development: an egg, four nymphal instars, and an adult. The adults of the overwintering generation produce eggs in April and May. These eggs hatch into the first in-star nymph, or crawler, the only life stage that successfully disperses in North America. The crawlers settle on hemlock twigs near the base of a needle and insert its long sucking mouthparts, or stylets, into the twig. Once the crawler settles, it turns a dark color and will not move for the rest of its life (Figure 4). The spring generation develops into adults that begin producing eggs in June. The crawlers that hatch in early summer from these eggs settle and enter a non-feeding resting stage that lasts through the summer. The HWA are difficult to detect during this resting stage b e c a u s e they are small and have not produced much of the characteristic waxy wool. Feeding resumes in October and this generation continues to develop through the winter months with the adults producing eggs the following spring. For a more thorough review of the HWA and its biology please refer to McClure, et al. (2001).

Figure 2. *Heavy infestation of the HWA. Mark Whitmore*

Figure 3. *Adult HWA with eggs. Michael Montgomery, USDA Forest Service,*

Figure 4. *Newly settled first instar HWA nymphs (indicated by arrow). PA Dept. of Conservation and Natural Resources - Forestry Archives, Bugwood.org*

Dispersal

The tiny first instar crawler disperses from tree to tree primarily by wind, on the feet of birds, or in the fur of small mammals (McClure 1990). A widely held view by researchers is that casual human contact with the HWA during surveys is not responsible for dispersal. The crawlers can become established anywhere within a tree crown but after a few generations will invariably be found on the lower branches as the crawlers fall downwards through the canopy.

Signs and Symptoms

The HWA can be difficult to detect at low population levels. The first signs of the HWA are the presence of a few white woolly masses (ovisacs) on the underside of twigs, most often on the most recent growth (Figure 5). As popu- lations build the HWA will also occur on older twigs (Figure 2). With time the needles will lose color, drop from the twigs, and terminal buds will die causing shoot growth to cease (Figure 6) .

Figure 5. *Light infestation of the HWA. Mark Whitmore.*

Figure 6. *Needle loss due to HWA infestation. Chris Evans, River to River CWMA, Bugwood.org*

Detecting the Hemlock Wooly Adelgid Time of Year

The HWA is most visible from January through June when the white, waxy wool is new and abundant. The summer months are not good for detection because the small HWA resting stage is difficult to see with the naked eye, although there may be some residual wax on the twigs from earlier generations. Winter is also optimal because it is easier to locate hemlock trees in a stand when there are no leaves on the deciduous trees. This can be particularly important in areas where the hemlocks have a patchy distribution.

HWA Look-Alikes

To the untrained observer and from a distance there are a number of potential HWA look-alikes. The most common are small spider sacs and spittlebugs. Spider sacs are made of much stronger fiber than the wool of the HWA and are usually not closely appressed to the twigs. Spittle- bugs are found on twigs but make watery, white foam and are not found in winter (Figure 7). Scale insects are also common but are found on the needles, not on the twigs (Figure 8). Other common potential look-alikes are bird droppings and pine pitch.

Figure 7*. HWA (left) and a spittlebug (right) on hemlock. Mark Whitmore*

Figure 8. *Elongate hemlock scale on needles. Eric R. Day, Virginia Polytechnic Institute and State University, Bugwood.org*

Tree Examination

Light infestations of the HWA will be patchy within the tree's crown so examine as many branches and trees as time allows. The first step is to examine the underside of the lowest branches, paying close attention to the most re- cent year's growth. If the lowest branches can- not be reached, examine the lowest branches with close-focus binoculars. Close-focus binoculars can also be used to look at trees in inaccessible locations like gorges, but be careful about the lighting. The arrangement of hemlock needles on the twigs will reflect light in a manner that mimics HWA ovisacs from a distance. Try to look upwards at the underside of the branches rather than from the side or top.

Surveying the Stand

It's important to know where the hemlocks and waterways are in a stand. Aerial imagery works best for providing a landscape view of a property. Develop a plan of movement within a stand to maximize the trees/branches examined. If more than one person is surveying, move together in a systematic way and communicate regularly. When surveying small stands, examine as many trees as possible because infestations can begin on just one or a few trees. Even when several trees are infested, the distribution of the HWA can be patchy.

The best place to look in a stand is along streams or other waterways. Birds are important vectors of HWA and their behavior within a stand brings them to water. Often the HWA can be found on branches closest to water and absent on the other side of a tree. With limited time in a stand, walk along the streams and examine the trees closest to the water.

Once the HWA has been detected in a stand, examine adjacent trees moving outwards in concentric circles to determine the number of infested trees and where the most heavily infested trees are. Accurate mapping of infested trees and stands will help when monitoring future spread and evaluating management options.

Management options

There are currently two ways to manage HWA insects and the impacts they cause: 1) chemical insecticides; or 2) the use of natural enemies as biological control agents. Infested hemlock trees can be protected individually with chemical insecticides. Systemic insecticides applied as soil drenches or injections into the organic layer can provide multiple years of protection from a single treatment.

Biological control agents from Asia and the Pacific Northwest have been evaluated for over a decade and some promising candidates have been identified. However, we still cannot say with certainty that these agents will be effective.

Cultural practices are available, with options depending on the character of the woodland, the objectives of the owner, and the extent of infestation. These management options are described by Orwig and Kittredge (2005) and by Ward et al. (2004).

References

Costa, S.D.; B. Onken. 2006. Standardizing sampling for detection and monitoring of hemlock woolly adelgid in eastern hemlock forests. FHTET-2006-16. Morgantown, WV: U.S. Department of Agriculture, Forest Service, Forest Health Technology Enterprise Team; 11 p. Available at: http://www.fs.fed.us/foresthealth/technology/pdfs/HWASampling.pdf

McClure, M.S. 1990. Role of wind, birds, deer, and humans in the dispersal of hemlock woolly adelgid (Homoptera: Adelgidae). *Environmental Entomology*, 19(1) 36-43.

McClure, M.S.; Salom, S.M.; Shields, K.S. 2001. Hemlock woolly adelgid. FHTET-2001-03. Morgantown, WV: U.S. Department of Agriculture, Forest Service, Forest Health Technology Enterprise Team; 14 p. Available at: http://www.fs.fed.us/foresthealth/technology/pdfs/fhtet-2001-03.pdf

Orwig, D. A. and D. Kittredge. 2005. Silvicultural options for managing hemlock forests threatened by hemlock woolly adelgid. Harvard Forest Fact Sheet. Available at: http://harvardforest.fas.harvard.edu/publications/pdfs/Orwig_HWA_fact_sheet_2005.pdf

Ward, J. M. Montgomery, C. Cheah, B. Onken, and R. Cowles. 2004. Eastern hemlock forests: guidelines to minimize impacts of hemlock woolly adelgid. USDA Forest Service Northeastern Area State and Private Forestry NA-TP-03-04. Available at: http://na.fs.fed.us/pubs/tps/eastern_hemlock/eastern_hemlock.pdf

Authored by Mark C. Whitmore, Department of Natural Resources, Cornell University, Ithaca, NY. Comments and advice were provided by Dennis Souto, US Forest Service, and Jerry Carlson, NYS Department of Environmental Conservation. Layout and design by Diana Bryant.

Suggested citation: Whitmore, M.C. 2009. Early detection of the hemlock woolly adelgid (*Adelges tsugae*) in small northeastern hemlock (*Tsuga canadensis*) woodlots. Cornell University Cooperative Extension ForestConnect Fact Sheet. P. Smallidge, ed. 4 pgs.

4.3 Fungal Diseases

Fungi in many forms are abundant throughout the soil in every forest and backyard. Fungal Diseases are common and will rarely kill a tree, but they can often reduce tappable wood surface in maple and contribute to decline long term. As **Section 4.1** explains, fungal infections are usually a **primary invader**, opening up the tree to worse infection, and even death, by a secondary invader.

A tree may become infected with a fungus and show few or minor symptoms, and then go on to live a long, productive life. Weak, lower canopy trees with small crowns or which are growing in poor soils are more susceptible to fungal diseases. Managing for healthy, vigorous trees increases resistance of the sugarbush. Though an infection does not necessarily mean a death sentence on its own, when a tree becomes stressed for other reasons, the combination of the fungal disease and additional stressors makes it more susceptible to decline and death. This makes obviously diseased trees a good choice for removal during an improvement thinning.

Root Rot (*Armillaria* sp.)

Armillaria sp. is one of those fungi that are prolific in forest soils. An infected tree will have black mycelial cords that look like “shoe strings” growing between the bark and the sapwood. However, this cannot be seen until the tree is already dead, and the bark is easy to peel away (see images below).

Root rot disease caused by *Armillaria* sp. usually only infects pre-stressed trees, leading to their decline. This can be fairly common in stands that experience repeated droughts, insect defoliation, or that are growing on depleted soils. The first signs of disease are crown dieback and reduced productivity during the sap season.

On the left, you can see the black mycelium of *Armillaria* beneath bark that has been stripped away. On the bottom right is a closer view of "shoe string" appearance of the fungus. The tree pictured here is a birch that has been dead for a while. Many trees are affected by this fungus.

Tar Spot Disease (*Rhytisma acerinum, R. americanum)*

This disease causes the black tar spots that appear commonly on Norway Maple (*Acer platanoides*), and sometimes other maples. While forest maples are minimally affected by the fungus, it can cause widespread early leaf drop and reduced productivity in Norways, and therefore is more significant to lawn and urban sugaring operations. The life cycle of the fungus that causes the infection allows dried leaves that sit under the tree in the fall to infect new leaves. Quick removal of these leaves can help mitigate the problem.

Verticillium Wilt

This disease is only common in backyard trees. Forest maples should not have this problem. The disease may observed when leaves unexpectedly turn brown in midsummer, often on one side of the tree. The links below have useful information and photographs for identification and management:

https://utahpests.usu.edu/ipm/notes_orn/list-treeshrubs/verticillium-wilt

https://www.extension.iastate.edu/news/2005/jun/071602.htm

Cankers (*Nectria* sp., *Eutypella* sp.)

Cankers are caused by fungal infections. They can girdle whole trees, kill branches, and open the tree up to secondary infections by insects, bacteria, or other fungi. This secondary infection can kill the tree. More likely, however, is an eyesore that reduces the tapping surface of the tree. The tree pictured above is tapped annually, but only on the opposite side of the bole. These are good trees to target for removal during thinning.

Fusarium

Fusarium is a fungus genera that can affect many tree species. In maples, it can appear as a black spot that "bleeds" into the bark. A small infection of this kind is pictured above. As with other types of fungal infections, *Fusarium* will stress a tree, and can contribute to its decline in combination with other stressors.

For more details and more diseases, view the Sugarbush Management page of the Cornell Maple Program website (http://blogs.cornell.edu/cornellmaple/sugarbush-management/) which includes a tool for accessing external resources that compliment this notebook.

4.4 Invasive Plants & Competitive Vegetation Management

Shade-Tolerant Interfering Forest Vegetation Management Matrix for the Northeast

Developed in 2019 by: Brett Chedzoy; Cornell Cooperative Extension of Schuyler County (bjc226@cornell.edu) and Peter Smallidge; NYS Extension Forest, Cornell University (pjs23@cornell.edu)

Elements of the Matrix are explained below the chart

	Chemical		Mechanical			Biological
Veg Types	Broadcast	Basal/Inject	Mow/Cut	Girdle	Excavate	Silvopasture
Short-lived herbaceous	2	3	2	3	3	2
Low perennial herbaceous	2	3	2	3	3	2
Tall herbaceous perennial	2	3	2	3	3	2
Annual vines	2	3	2	3	3	2
Perennial vines	2	3	2	3	3	2
Canes	2	3	1	3	2	2
Shrubs	2	2	1	2	1	2
trees	2	1	1	1	1	2

*1 = good results; 2 = mixed results; 3 = impractical to implement or insufficient results. See "**supplemental information**" below*

Common Examples of Vegetation

Herbaceous, short-lived:	stiltgrass, garlic mustard
Low herbaceous perennial	ferns
Tall herbaceous perennial	knotweed, swallow wort
Annual vines	mile a minute
Perennial vines	grape, bittersweet, poison ivy
Canes	Rubus, multiflora rose
Shrubs (<10')	barberry, autumn olive, honeysuckle, privet, Euonymus, buckthorn
Trees (>10')	beech, Carpinus, Ostrya, striped maple

Comments

Chemical - assumes proper application methods, conditions and label requirements are met

Mechanical - assumes treatments are repeated with adequate frequency to obtain desired result

Biological - assumes proper management and implementation, and other initial treatments to control plant height

Supplemental Information for the "Shade-tolerant Interfering Forest Vegetation Management Matrix"

Explanations for predicted outcomes:

Row B – Chemical/broadcast: Selective, non-selective and pre-emergent herbicides for labelled use can be at least partially effective when properly applied under the right conditions. Factors limiting effectiveness in forest applications include: access; coverage; plant conditions like growth phase and drought stress; resistance features, both genetic and morphological; meteorological conditions; and skilled application. Broadcast herbicide treatments are usually more effective for short-term control - such as to temporarily reduce understory interference to establish or release regeneration - and are most effective when coupled with other control strategies.

Row C – Chemical/basal or injection: basal spray and injection are impractical treatment methods for most types of interfering vegetation, with the exception of larger woody stems that are readily accessible. Basal treatment formulations will be most effective on thin-barked species like beech. Systemic herbicides labeled for injection will yield the best results when wood is not frozen and the proper dosage is used.

Row D – Mechanical/mow or cut: Severing stems by cutting either with simple tools or specialized machines provides instant gratification, but usually short-lived results. Most of the example plants are capable of vigorously resprouting. Intensive and continued mowing would be necessary to exhaust root reserves to the point of mortality for most species. Nonetheless, judicious mowing can increase the viability of more durable methods from the chemical and biological categories.

Row E – Mechanical/girdle: Impractical except for larger-diameter woody stems that are unlikely to sucker or coppice. The cambium tissue beneath the bark must be fully severed, and some species can take up to several years to die after girdling.

Row F – Mechanical/excavate: Plants and most roots are removed using heavy equipment. Effective for species that will not propagate from root fragments. However, the significant soil disturbance normally associated with excavation will often stimulate the soil seed bank and potentially give rise to other noxious plant problems.

Row G – Biological/silvopasturing: Managed livestock impacts such as defoliation, girdling, browsing and trampling are skillfully used to limit the growth of undesirable plant species, while fostering the growth of desirable ones. Silvopasture establishment usually requires some combination of initial treatments from the other columns to reduce vegetation height and density before livestock can be effective. Targeted livestock impacts through intensive rotational grazing will gradually shift understory vegetation to a more stable complex that is resistant to invading plants.

Other biological controls: The only plant from the list of examples that is known to be somewhat controlled from a biological agent (other than livestock) is the mile a minute vine. Solarization (prolonged, dense shading) is another method that could be practical when used on small patches of emerging or resprouting plants.

Additional Resources:

www.nyis.info	New York State invasive species clearinghouse
www.forestconnect.info	Cornell Forestry Extension

Developed in 2019 by: Brett Chedzoy; Cornell Cooperative Extension of Schuyler County (bjc226@cornell.edu) and Peter Smallidge; NYS Extension Forest, Cornell University (pjs23@cornell.edu)

Buckthorn - Control of an Invasive Shrub

Glossy buckthorn (*Frangula alnus*) and common/European buckthorn (*Rhamnus cathartica*) are common in many parts of NY, and can aggravate many ownership objectives. A variety of chemical and mechanical (i.e., organic) methods are available to control these species.

***Figure 1**. Glossy buckthorn (pictured) typically is found on moist soils. It lacks the thorn and toothed leaf margin of common buckthorn. The bud, foliage and habitat are similar to true alder and care should be used to avoid confusing these species. Both invasives have dark-colored fruit. However, alder-leaved buckthorn, a native non-invasive, has only 5 – 6 pairs of veins, reddish fruit, fine teeth on the leaf edge, and less than 3 ft tall.*

The buckthorns originated in Europe, northern Africa and western Asia. Their history of introduction into the US is poorly recorded, but many other examples of species that have become interfering were introduced in the middle 1800's (Figure 1). Glossy buckthorn was formerly known as *Rhamnus frangula* and is different but looks similar to the native alder-leaved buckthorn (*Rhamnus alnifolia*). Glossy buckthorn is a small shrub that is most common on moist soils, often near wetlands. As with other interfering species, the interfering buckthorn species can dominate a site resulting in complicated access, reduced success with forest regeneration, and a reduction in plant species diversity. Recommendations for the treatment of glossy buckthorn will usually apply to common buckthorn (*Rhamnus cathartica*; Figure 2). Care should be taken to avoid mis-identification with the native non-invasive alder-leaf buckthorn (*Rhamnus alnifolia*). More information about these species can be found by a search for "buckthorn" at https://gobotany.newenglandwild.org/

Many interfering plant species become problematic because of a current of historic over-abundance of deer. Further, once an interfering plant is controlled, consideration for the plants that may occupy the site is warranted especially with high deer impact. If deer impacts are currently high, removing the interfering plant won't necessarily result in the desired outcome for the owner. A simple field measurement protocol is available to assess the extent of deer impact; a description is available at www.AVIDdeer.com

Control of interfering forest plants is guided by principles of Forest Vegetation Management (FVM). FVM includes (1) certain identification of the interfering plant species and understanding its biology, (2) inspection for the abundance of co-occurring desirable species that should be retained, (3) consideration of any current or planned management activities, deer impacts and site conditions that might enhance or complicate treatment, (4) an evaluation of the costs and logistics for all feasible treatment methods and modes (described below), and (5) a

determination and strategy for those plants desired on the site after treatment. Webinars about FVM are archived at www.youtube.com/ForestConnect

Figure 2. *Common (AKA European) buckthorn leaves are hairless and have toothed edges. Glossy buckthorn leaves have a smooth edge, unlike common and alder-leaved buckthorn, and may have fine hairs on the lower side.*

Methods of treatment are either mechanical (i.e., organic) or chemical. Both methods have advantages and disadvantages depending on the circumstances. Modes of treatment are either selective or broadcast. Selective treatments will isolate and treat a single stem of the interfering species. Broadcast treatment are applied to an area and all stems of all species present are affected. All treatments can be described by a method and mode, or an integration of methods and mode. For example, hand pulling is selective mechanical, and cut-stump is integrated because it involves cutting (mechanical) followed by an herbicide (chemical) treatment to the freshly cut stump (Figure 3).

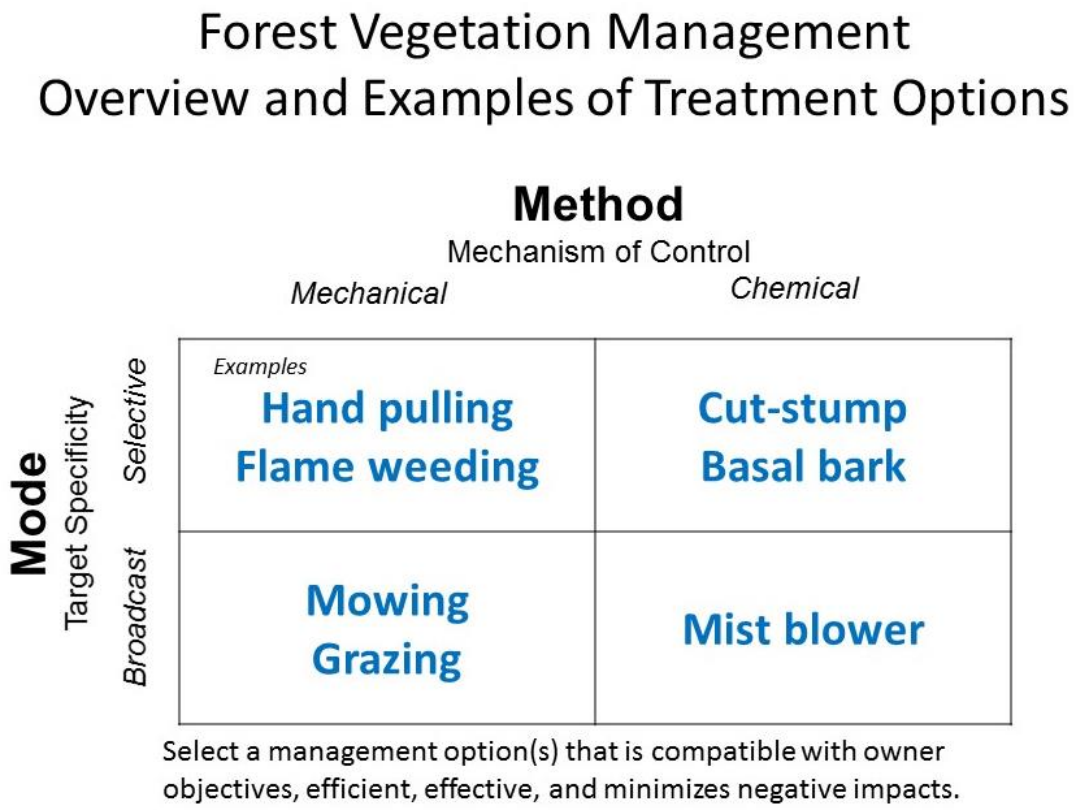


Figure 3. *All treatments can be described by a method and a mode. Each combination of method and mode has advantages and disadvantages depending on the circumstances. Combinations of methods and modes result in an integrated treatment, often providing greater efficiency and effectiveness.*

The selection of a broadcast versus selective treatment for buckthorn or other woody interfering species depends on the number of stems per acre and the abundance of desirable species. If a relatively low number of desirable species are intermixed with the interfering species, or if the total number of stems to be treated requires too much labor, a broadcast treatment may be more appropriate. Many of the treatments described below will include specific product information, none of which should be considered to imply an endorsement.

Herbicides can be an efficient and effective tool, but involve additional considerations. The use of herbicides in New York requires that the name of the target species be included on the product label. Chemical treatments are complicated by the fact that invasive species have only relatively recently been recognized in New York, and only a few herbicides list these species on the label. Fortunately, many labels are being adjusted to address invasive plants. Also, home remedies and off-label applications of an herbicide are illegal. Herbicide treatments in general require extra care because it involves the use of a chemical, and specifically for glossy buckthorn to ensure there is not movement of the herbicide into nearby classified wetlands. Research data is scant, but movement to wetlands would typically result from a saturating rain within 12 to 24 hours of the herbicide application.

Figure 4. *Stump sprouts from common buckthorn following cutting. Failure to treat the sprouts either mechanically or chemically will negate management efforts within a few years.*

Labels for the herbicides listed below can be obtained at http://www.dec.ny.gov/nyspad/products All herbicide products described in this article are unrestricted in New York, and thus can be purchased without a pesticide applicators license. NYFOA members have a "member benefit" that allows for the less expensive contractor pricing on herbicides through www.Arborchem.com; some of the products listed below are available from this vendor. Herbicides labeled for treatment of buckthorn are listed in Table 1. Some of these products require the person making the application to also possess a supplemental label called a "2ee." 2ee labels, in addition to the product label, can be obtained from the URL previously listed. Other products may also be available.

A small area with scattered buckthorn may be appropriately managed with a selective treatment. Buckthorns typically sprout from the stump following cutting (Figure 4), so some post-cutting treatment is required. One mechanical treatment is a new strategy that uses black plastic baggies on cut stumps. This is a new product that appears to have good potential, but there is no apparent research to document its effectiveness. More information is available at www.buckthornbaggie.com Another selective mechanical option with small plants is to pull

them. A potential disadvantage to pulling is that soil disturbance may stimulate the germination of seeds of the buckthorn or other undesirable species.

Because many non-native woody plants expand leaves before native species, a selective chemical foliar treatment in early spring can target the buckthorn with limited potential for collateral damage (Figure 5). The early emergence of buckthorn leaves may provide a window of opportunity of a couple weeks for a selective chemical foliar treatment. There are only few herbicides labeled in New York for foliar treatment of buckthorn (Table 1). An Internet search will provide vendors of these products. If there are no or few desirable species intermixed with the buckthorn, or overspray would result in limited collateral damage, then the foliar treatment could be extended into the growing season. If all circumstances allow, a foliar treatment may be the most efficient way to control a small area of small buckthorn. Because Gordon's Brushkiller (Table 1) also acts by penetration through bark, care should be made to avoid overspray onto nearby desired woody stems, even though their foliage may not have emerged.

Figure 5. *Many non-native invasive species will expand their foliage early than other species. This picture illustrates multiflora rose in early spring that has leafed out beneath black locust.*

A second selective mechanical/chemical treatment is "cut-stump." This treatment involves cutting each stem and applying an appropriate herbicide to the freshly cut surface (Table 1). On large stumps, a chemical-grade spray bottle may be most effective. On smaller stumps a sponge-type paint brush may be more efficient. With care, there will be little or no collateral damage. The cut-stump treatment is likely more labor intensive than a foliar treatment because it involves cutting the stem, handling the stem, and applying the herbicide. The advantage is the potential for treatment from June through October, and little to no collateral damage, or movement from the treated stem.

A third selective chemical treatment, more appropriate if there are few and larger diameter stems, is a basal bark treatment (Table 1). Penn State University Cooperative Extension has a fact sheet on the general use of basal bark treatment, not specifically about control of buckthorn (shortened URL https://goo.gl/yZvnR6). For areas with small buckthorn, a basal bark treatment is not likely to be the best treatment option because of the effort and overspray when applying to small diameter stems.

Regardless of the treatment option selected, there are likely buckthorn seeds in the soil that will germinate (Figure 6). Scout the area to ensure that any mature, fruiting buckthorn are controlled. Newly germinated seedlings should be controlled regularly, but certainly before they mature and produce fruit. Annually, inspect the treatment area for seedlings. Hand pulling may control these small plants if they are not too numerous or as time permits. Patches of seedlings might also be controlled with a foliar spray or brush saw, essentially a broadcast treatment but in a localized area. Each subsequent year should produce fewer new seedlings and less effort.

***Figure 6**. Following treatment, the increase of sunlight on the soil and the potential of soil disturbance may stimulate the germination of buckthorn seeds. Pictured are new germinants of common buckthorn following cutting of the overstory.*

Table 1. A partial list of products registered in NY for control of buckthorn. Obtain and read label. Note that label specifications may change. Annually refer to details at http://www.dec.ny.gov/nyspad/products

Product	EPA Number	Species	Methods
Gordon's Pasture Pro "Hard to Kill Brush"	2217-952	• glossy buckthorn • common (European) buckthorn	foliar basal bark cut stump
Pathfinder II	62719-176 (plus 2ee)	• glossy buckthorn • common (European) buckthorn	basal bark cut stump
Accord XRT II	62719-556 (plus 2ee)	• glossy buckthorn • common (European) buckthorn	foliar (only for common buckthorn) cut stump (both species)
Bayer Advanced Brushkiller Plus (concentrate)	72155-19	• glossy buckthorn • common (European) buckthorn	cut stump

Cornell University Cooperative Extension

Forest Connect

Supporting Sustainable Management of Private Woodlands

An Extension Publication of the Department of Natural Resources, New York State College of Agriculture and Life Science, a Statutory College of the State University at Cornell University, Ithaca, New York

Treatment of autumn olive and other interfering shrubs

Peter Smallidge, NYS Extension Forester and Director, Arnot Teaching and Research Forest,
Department of Natural Resources, Cornell University Cooperative Extension, Ithaca, NY 14853.
Contact Peter at pjs23@cornell.edu, or (607) 592-3640. Visit his website www.ForestConnect.info,
and webinar archives at www.youtube.com/ForestConnect.

Autumn olive (*Elaeagnus umbellata*) is an introduced species and recognized as invasive because it can readily colonize fields, open woodlands, and may invade the interior of woodlands. It is characterized by simple, alternate, elliptical leaves with undulating margins and silver and rusty scales on the leaf and twig (Figure 1). Some twigs have a thorn. Flowers are light yellow and are borne in clusters on the stem. The fruit is a reddish berry. The lower leaf surface and the twig have silvery and rust-colored scales (Figure 2). A similar plant, Russian olive (*Elaeagnus angustifolia*) is differentiated by silvery scales on twigs and upper and lower leaf surfaces, plus a narrower leaf. Both species grow as a large shrub or multi-stemmed tree to approximately 20 to 25 feet.

Figure 1. Autumn olive foliage has undulating margins and a mixture of silvery and rust-colored scales. Flowers are pale yellow-white.

Autumn olive was propagated and released in the early 1960's for use in wildlife habitat and to reclaim droughty infertile soils. It is able to fix nitrogen through its roots. The abundant production of fruits are eaten and spread by birds and other wildlife. It grows well on droughty soils, but survives well on mesic soils. It is uncommon on poorly drained or wet soils.

Figure 2. The twigs and buds have scales, and some branches terminate in a thorn, as seen in the lower right of the image.

Strategies to control undesirable or interfering plants, such as autumn olive, can be categorized into treatments that are a combination of broadcast vs selective and mechanical vs chemical.

(Figure 3). Treatments can also be mixed, often for a more beneficial outcome, such as broadcast mowing followed by selective herbicide spraying.

The process to select the correct treatment depends on several factors. One consideration is whether the owner is willing and able to use herbicides. Another consideration is the response of the species to certain mechanical methods (e.g., cutting) and its propensity to sprout. Additional factors to consider when selecting a treatment option include the following:

- Size of plant
- Number and extent of plants
- Abundance of desired species intermixed with the interfering plant
- Ability to repeatedly treat stems that sprout
- Cost of treatments for materials and labor
- Equipment available
- Season of treatment
- Safety to the person making the treatment
- Ecological cost of a failed or delayed treatment
- Environmental cost of the treatment to soil and surrounding plants

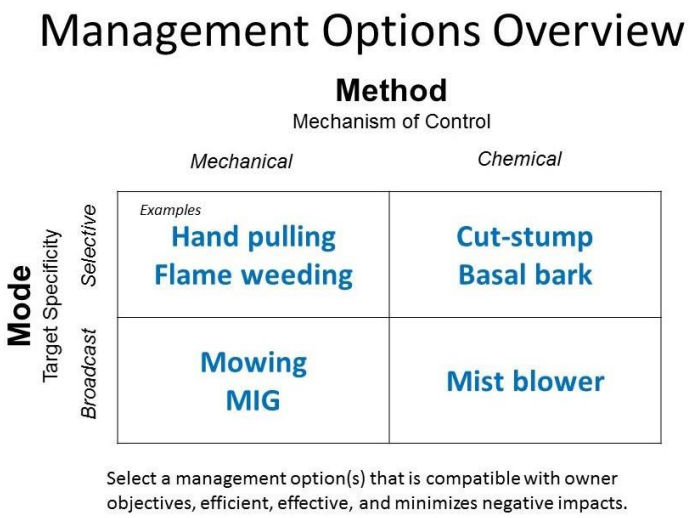


Figure 3. Mode and method examples are illustrated to suggested different ways to control a variety of undesired plants. Not all examples are appropriate in all situations. Some example illustrate the integration of multiple modes and methods (e.g., cut-stump).

Take for example two-year old autumn olive sprouts, presumably 3 to 5 feet tall that are intermixed with a desired species the recommended treatment would be a selective application of an herbicide. Cutting alone would stimulate additional sprouting. A broadcast treatment of mowing or spraying would negatively impact the desired species.

There are several good resources to help guide owners who are interested in man- aging interfering plants such as autumn olive. These resources include general publications about the characteristics of herbicides, how to apply herbicides in forests, and strategies of integrated/forest vegetation management. There are also several publications about the control of specific species that have application in New York. These are all available here: http://blogs.cornell.edu/ccednrpublications/vegetation-management/.

In addition to written publications there are several webinars about vegetation management, and a variety of other species and related topics. Webinars cover chemical and organic options and are archived at: www.youtube.com/ForestConnect

The previously mentioned publications and webinars make reference to the importance of reading and following the label on herbicides. I strongly encourage a high level of familiarity with and adherence to the label. Notably,

Figure 4. Basal bark treatments work by a chemical girdling of the stem, so the product must be applied to fully coat the entire circumference of each stem. Pathfinder II is the most common unrestricted basal bark product.

the target plant species must be listed on the label for the treatment to be compliant with NYS law. All products registered for use in NY have their label posted here: http://www.dec.ny.gov/nyspad/products?0

The selective treatment requiring the least time and effort would be to apply Path- finder II as a basal spray (Figure 4). A basal spray is an herbicide mixed in oil. Pathfinder II is a premix of Garlon 4 (triclopyr) mixed in vegetable oil. It is unrestricted so can be purchased without a pesticide applicators license. The basal spray is applied to the full circumference of all stems. As sprouts, there may be multiple stems. Spraying can happen throughout the year as long as spray can be applied from ground level to about 16 inches up the stem. The product is absorbed through the bark and chemically girdles the plant. Additional information about basal bark treatments, including a recent fact sheet from PSU Cooperative Extension is available at http://CornellForestConnect.ning.com/ and search for "basal bark treatments".

Figure 5. Brush saws are effective tools for vegetation management. The shoulder strap provides a barrier for kickback that would injure the operator. Safety equipment is still necessary.

Another treatment option would be to use a brush saw (Figure 5) to sever the autumn olive stem at ground level and then apply Pathfinder II to the freshly cut sur- face. This treatment would use less herbicide, so lower cost, but would have the added cost of labor and more equipment to cut and handle the stems. There is also a slight risk of personal injury from the saw, but properly equipped and maintained brush saws are quite safe.

Figure 6. Like autumn olive, multiflora rose (pictured) leafs out before other species. This early leaf display provides a management option for foliar treatments which avoid contact with those desired species that haven't yet broken bud.

A final option would be a selective herbicide treatment to foliage. During the growing season the de- sired species are also leafed out, and treatment is not recommended. However, many of the introduced species leaf-out before and remain in leaf longer than native species (Figure 6). This phenological pattern provides an option, though the window of treatment is often only a couple weeks. One ex- ample of an unrestricted herbicide labeled for foliar treatment of autumn olive is Stalker, which has the active ingredient imazapyr. Note that imazapyr may move in the soil to non-target plants. There are relatively few unrestricted herbicides in New York that are labeled for autumn olive, and many are formulated for control and exclusion of all vegetation.

For additional information on woodland management go to:
www.ForestConnect.com & www.CornellForestConnect.ning.com

Layout and design provided by Diana Bryant.
Support for ForestConnect is provided by the Cornell University College of Agriculture and Life Sciences, Cornell Cooperative Extension, and USDA National Institute of Food and Agriculture. 7/2018

4.5 Forest Herbicide Quick Reference Resource Guide[1]

Always read and follow the pesticide label. The applicator is typically the person responsible for ensuring a safe and effective treatment. Pesticide regulations vary by state. Check with your local office of Cooperative Extension for the relevant guidelines.

Internet resources

Cornell's Pesticide Management Education Program	http://pmep.cce.cornell.edu/
NYS Labels	http://pims.psur.cornell.edu/
NYS DEC Bureau of Pesticides	www.dec.ny.gov/about/640.html
Penn State Forestry Extension – Forest Pesticide Use Manual	http://pubs.cas.psu.edu/freepubs/pdfs/UH174.pdf (or at www.ForestConnect.info via publications)
PSU Forest Vegetation Management	http://fvm.cas.psu.edu
US Environmental Protection Agency	www.epa.gov/pesticides/index.htm
Cornell ForestConnect publications page	www.ForestConnect.info see also http://CornellForestConnect.ning.com
Herbicide suppliers	http://fvm.cas.psu.edu/providers.htm

Active Ingredients and Example Trade Names

Glyphosate	Rodeo, Round-up ProMax, Razor Pro, Accord XRT II,
Imazapyr	Arsenal, Stalker, Chopper (this active ingredient is reported to flash to non target species
Triclopyr	Garlon 3A, Garlon 4, Garlon 4 ultra, Pathfinder II, RemedyUltra
Pichloram	Tordon
2,4-D	

[1] The information provided here is intended strictly as an example of resources available to pesticide applicators. All pesticides should be used in strict compliance with the label and only by qualified personnel. Any mention of trade names and vendors is for reference purposes and does not imply an endorsement. Omission of trade names and vendors does not imply their lack of quality, performance or service.

Mixing Herbicides – Starting and ending concentrations -- 2017

Peter Smallidge, NYS Extension Forester and Director, Arnot Teaching and Research Forest,
Department of Natural Resources, Cornell University Cooperative Extension, Ithaca, NY 14853.

Support for ForestConnect is provided by the Cornell University College of Agriculture and Life Sciences and USDA NIFA.

Interfering plants can complicate the plans of woodland owners and foresters to regenerate desirable trees species, or otherwise enjoy the benefits of their investment (Figure 1). In some circumstances mechanical or organic methods can be used to control interfering plants. In other circumstances chemical control, alone or integrated with a mechanical treatment, may be the most cost effective and efficient strategy. Herbicides, a type of pesticide used to control plants, are important tools for woodland management if they are used correctly. Herbicides that are purchased in a concentrated form need to be diluted before use. While correct herbicide mixing is an essential part of safe and effective use, the process of converting a concentrated form to a correct dilution can be a daunting task.

Correct mixing is an important consideration for all modes and methods of herbicide applications, whether foliar, injection, basal bark or cut-stump. The basic process is that a concentrated product is diluted in a liquid such as water. The mixing process is the same for all carriers. The question becomes how much product and how much of the carrier are needed; the answer depends on the final volume of mixture, called the formulation and the amount of active ingredient (a.i.) in the concentrate that is recommended for the treatment. Some terms in this article may be unfamiliar to some readers; key terms are defined here, and more information about forest pesticides is available at the Penn State Forest Vegetation Management website at http://extension.psu.edu/natural-resources/forests/vegetation-management There are also good background webinars on the correct use of herbicides in the forest

Figure 1. *Ferns are native to our woodlands and can be attractive as a uniform ground cover. However, in efforts to regenerate desirable native species they can interfere because of their dense shade, thick roots, and attractive habitat for seed predators*

at www.youtube.com/ForestConnect Labels of pesticides available for use in NY can be found and downloaded from http://www.dec.ny.gov/nyspad/products

Using the correct concentration of an herbicide is an important part of Integrated Vegetation Management (IVM), also sometimes called Forest Vegetation Management. The herbicide label specifies the maximum concentration, and exceeding that concentration is illegal and a waste of the product. Similarly, a mixture that is too dilute may waste the product if the concentration is insufficient to control the target plant. Refer to the product label or fact sheets by Cooperative Extension or other reputable organizations to identify the best concentration for the season and the target. Note that in New York, it is legally permissible for herbicide treatments in woodlands, which are considered a type of agricultural treatment, to use a less dilute concentration than the amount specified on the label, but it is never legal to use a higher concentration than specified on the label.

The correct concentration of product to use is prescribed based on the label by someone who is familiar with pesticide use. The correct concentration depends on the season and the treatment technique. For example, a prescription to treat beech in the summer might specify an herbicide treatment to foliage with a formulation that uses a glyphosate-based product containing 2% of the product mixed in water plus a surfactant. Conversely, a prescription to treat beech in late fall might specify an herbicide treatment that uses a glyphosate-based product delivered via hack-n-squirt, drill-n-fill, or cut-stump, with the formulation containing 50% or 75% of the product mixed in water.

An Abbreviated Glossary of Terms

Active ingredient – Abbreviated "a.i.", refers to the amount of the chemical components in the "product" (see definition below) that act on the target organism. The product may also include a carrier (if pre-mixed) and inert ingredients.

Carrier – the herbicide is often obtained as a product in concentrated form that needs to be diluted before use. The liquid that dilutes the product and carries the active ingredient into the plant is the carrier. Acceptable carriers are specified on the product label and might include water, vegetable oil and diesel fuel.

Formulation – the formulation is the combination of the product and the carrier. This is the material that is applied to the target plant.

Label – every pesticide has a label, written documentation that describes the chemistry of the pesticide, safety equipment and protocols, target organisms that can be controlled, and how to mix and apply the pesticide. The use of a pesticide legally and contractually binds the user to the details of the label, so users should read and follow the label.

Product – the chemical as it comes from the purchased container. Some people may call this the "concentrate." In some cases the product is pre-mixed to include the carrier and is formulated as ready for use. Products that are pre-mixed are at the correct dilution and require no further manipulation before use.

Treatment – any manner of applying the herbicide to vegetation. More generally, any manipulation of vegetation.

In discussions of how to prepare a formulation, it is important to clarify if the "percentage" refers to the dilution of the product or the dilution of the active ingredient in the formulation. For example,

there are glyphosate products that can be purchased with concentrations of the active ingredient that range from less than 3% to more than 50% (Figure 2). Using products with a.i. concentrations of 3% and 50% as examples, a dilution of equal volumes of water and product (written 1:1) would be a 50% product dilution because there is 50% water and 50% product. However, this equal-volume formulation would be an a.i. dilution to 1.5% and 25%, respectively, because half of 3% is 1.5% and half of 50% is 25%. These details are important, and should be referenced as a product dilution or active ingredient dilution.

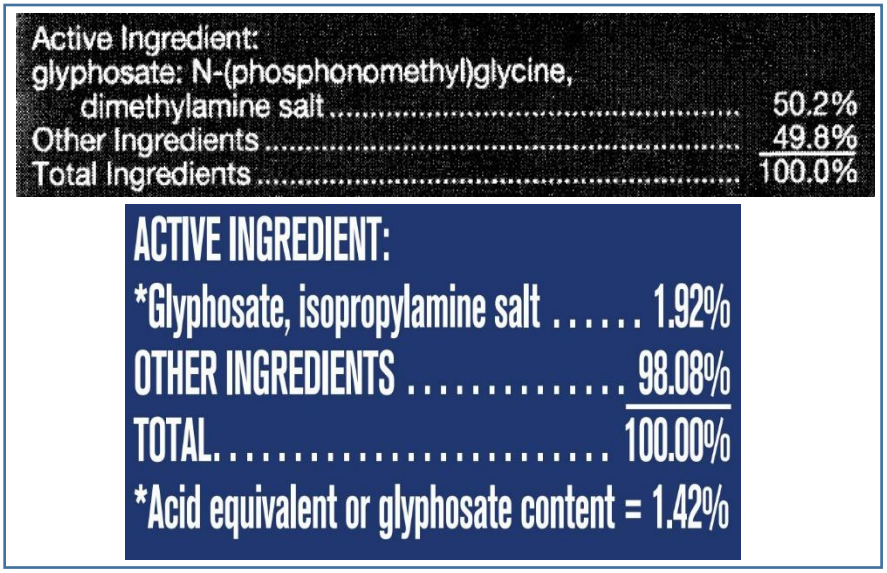


***Figure 2**. Each herbicide label will specify the concentration of active ingredient (a.i.) within the product. These two labels illustrate the range of a.i. of glyphosate in two commonly available products. The label will describe how to make several common dilutions of the product, but discussion of treatment needs to include a statement of the amount of active ingredient in the formulation.*

Unless the product is premixed, all labels include a table that specifies the quantities of the product to mix with the carrier (Figure 3). The details of this table, or any table, are specific to that particular product and are not transferrable to the next product you use. Although the mixing table usually has options for all common formulations, it is useful to know the simple math necessary to calculate the dilutions of product to formulation.

Mixing for Hand-held Sprayers

Prepare the desired volume of spray solution by mixing the amount of this product in water as shown in the following table:

Spray Solution

Spray Concentration	Amount of This Product for Desired Volume:		
(percent)	1 gal	25 gal	100 gal
0.5%	2/3 fl oz	1 pt	2 qt
0.75%	1 fl oz	24 fl oz	3 qt
1.0%	1 1/3 fl oz	1 qt	1 gal
1.5%	2 fl oz	1 1/2 qt	1 1/2 gal
2.0%	2 2/3 fl oz	2 qt	2 gal
3.75%	5 fl oz	3 3/4 qt	3 3/4 gal
5.0%	6 1/2 fl oz	5 qt	5 gal
10.0%	13 fl oz	10 qt	10 gal

2 tablespoons = 1 fluid ounce

***Figure 3**. This table is an example of a specific herbicide and the quantities of the product to mix with water to attain a desired concentration of the formulation to apply. Note the table provides the V_1 to mix in the carrier, with the quantities as either teaspoons or ounces.*

It is possible to calculate the dilutions using this formula:

Formula 1: $C_1 V_1 = C_2 V_2$

In this formula "C" is for concentration and "V" is for volume. The "1" and "2" are the starting and ending amounts. So, for example, C_1 is the initial concentration of product and C_2 is the final concentration that is applied to the target plant. The C_1, V_1 and C_2, V_2 are the four variables of the

formula. If we know three of the four variables, we can solve for the fourth variable. The concentrations will usually be a %, and the starting and final volumes will need to be in the same units. Volumes are sometimes a challenge because the final volume (V_2) will often be in gallons and the initial volume (V_1) would often be in ounces. Because we often want to know the initial volume, V_1, it is best to convert the final volume, $V2$, into the units of the measuring device you will use. I use a Pyrex mixing cup dedicated for this task (don't borrow mixing utensils from the kitchen!), and thus convert the volume of my spray tank to either ounces or milliliters.

The typical goal when calculating a dilution is to determine V_1, or the amount of the product to add with the carrier into the sprayer. C_1 is the original concentration, C_2 is the final concentration as recommended by the label or a fact sheet, and V_2 is the volume in the sprayer or container. If we're making a product dilution, we start with the product at 100% (note, the a.i. will be less than 100%), and we may want a final formulation, for example, of 2% product in a 3 gallon container. *Formula 2* illustrates the rearrangement of *Formula 1* to solve for V_1.

Formula 2: $V1 = C2\ V2 \div C1$

To obtain *Formula 2*, both sides of the equation in *Formula 1* are divided by C_1. On the left side C_1 becomes $\frac{C1}{C1}$, which equals 1, and is canceled to result in *Formula 2*. This rearrangement is an application of basic algebra that you may remember from high school or that a family member has recently learned.

It helps to practice the formula with some simple numbers that make sense intuitively. Let's assume the desired final formulation is 25% product with a volume of 1 gallon. We know that 1 gallon has 128 ounces. The initial or starting concentration of the product is 100% and the initial volume, the ounces of product we need to add to the mixture, is unknown. Intuitively if the final volume is 4 quarts with 25% product, we would expect one quart (1 of 4) or 32 ounces as the initial volume. Use *Formula 2* to check our intuition and solve for V_1 in ounces. Remember, C_2 is 25%, V_2 is 128 ounces and C_1 is 100%.

Formula 2: $V1 = C2\ V2 \div C1$

Solution 1: $V1(ounces) = 25\%\ x\ 128\ ounces \div 100\%$

(the "%" cancels, leaving ounces on both sides of the equation)

$V1\ ounces = 0.25\ x\ 128$ ounces

$V1\ ounces = 32\ ounces$

$V1 = 1\ quart$

In solution 1, remember the final volume, 128 ounces, is the total volume and needs to include both the volume of the product and the carrier. You can check how you solve the equation by ensuring that the units are the same on both sides of the equation. If the units are not the same, you've made an error in the algebra.

Now, let's solve the earlier problem with initial concentration at 100%, the final concentration at 2%, and the final volume at 3 gallons in the spray tank. For starters convert gallons of spray tank to ounces.

$128\ ounces \div 1\ gallon\ x\ 3\ gallons$ = 384 ounces (note, "gallons" cancel leaving ounces, and ounces become the common measurement)

Solve for the initial volume using *Formula 2*: $V1 = C2\ V2 \div C1$

Solution 2: $V_1(ounces) = 2\% \; x \; 384 \; ounces \; \frac{100\%}{}$

(note "%" cancels from numerator and denominator)

$$V_1 \; ounces = 0.02 \; x \; 384$$

$$V_1 \; ounces = 7.68 \; ounces$$

Solution #2 is thus 7.68 ounces mixed into a total volume of 3 gallons (not 3 gallons plus 7.68 ounces). It is acceptable to round up or down to the nearest whole number, in this case round up to 8 ounces.

For solution #2, we are working with 2% of the product. We might want to know the concentration of the active ingredient. In this case, multiply the concentration of the active ingredient by the concentration of the product dilution in the formulation. Let's assume the a.i. for the product is 41% and the formulation is a 2% product dilution. Because we want to know the amount of active ingredient in the formulation, we convert the a.i. in the product to decimal notation and multiply with the product dilution of the formulation.

Solution 3:

$$a.i. \; of \; the \; formulation = 0.41 \; x \; 2 \; \%$$

$$a.i. of \; the \; formulation = \; 0.82\%$$

Thus, the formulation has an active ingredient concentration of 0.82%.

Solution 3 illustrates why it is important to know if the treatment recommendation is for a product dilution or an a.i. dilution. A woodland owner may report success with a 2% product dilution in a backpack sprayer (Figure 4), but without knowing the amount of active ingredient, you don't know how to repeat the treatment. If owners are discussing the same product, then the discussion can be about product dilutions. However, if owners are discussing a treatment using Accord XRT II (50.8% a.i.) and an off-brand (e.g., 41.0%) then they need to discuss the a.i. concentration in the formulation.

For most people these calculations require some practice. It is best to practice with the mixing ratios provided on the herbicide label (Figure 3), and then you can apply the formula to new mixing ratios.

Figure 4. *Backpack sprayers are inexpensive and handy tools for applying foliar, basal bark, and cut-stump applications of herbicide. Several brands of sprayers are available. Knowing the correct mixing concentration will reduce waste, minimize unnecessary applications of herbicides, and improve the success of the treatment. The sprayer brand pictured holds approximately 3 gallons, the V_2 used in Formula 2.*

Chapter 5: Regeneration

5.1 Woodland Guidelines for Control of American Beech

Overview

American beech (*Fagus grandifolia* Ehrh.) is a native hardwood species common to many forest types throughout the Northeast and Central States. Beech becomes less abundant as a component of forests in areas of the Lake States where drier soils may limit its distribution[1]. American beech is tolerant of shade and able to sprout from its roots (called root suckers). Suckering is often enhanced by wounds to shallow roots after ground disturbance, or occurs following decline or death of a beech tree.

A disease syndrome caused by a non-native beech scale insect and exotic beech bark fungi has spread throughout the Northeast and much of the geographic range of beech[2]. This beech bark disease kills most infected trees at least 8-10 inches in diameter, affecting the supply of beech sawtimber. Beech bark disease also reduces beechnut production on infected trees, limiting the contributions of beech as a wildlife food source. In many woodlands, although beech remains abundant, the disease syndrome has limited its contributions for timber and wildlife food source.

Beech bark disease is the result of two independent organisms, a scale insect followed by a fungus, that results in tree death and often stimulates root sucker development. Photo by Peter Smallidge.

Cornell University Cooperative Extension

With or without beech bark disease, disturbances that open the canopy will increase light on the forest floor and promote understory beech development where present. The resulting understory beech thicket creates dense shade which inhibits regeneration of other desirable hardwoods and reduces wildlife habitat values. The dense beech thickets also restrict access through the woodland. Harvesting practices in woodlands that include beech can also increase the abundance of beech through stump sprouts as well as root suckers[3].

Because beech can reproduce vegetatively via stump sprouts and root suckers, overstory harvesting has proven ineffective for controlling the amount of beech in the forest. Depending on the size structure of the beech and the amount of canopy openness, both mechanical and chemical[i] controls potentially are effective for reducing understory beech thickets (Table 1). Selecting the optimal treatment depends on owner objectives and attitudes, the extent of an area needing treatment, the size class structure of beech, and the abundance of desirable species in seedling and seed- bearing size classes[4]. Proper application of these management options will increase their effectiveness (Table 2). Where owner objectives include establishing advance seedlings of other hardwood species, the management may require a synchronized effort involving use of an appropriate silvicultural practice, control- ling the impacts of deer, and reducing the presence of understory beech and other interfering plant species[5].

Occasionally in woodlands effected by beech bark disease, an isolated mature tree will not have any symptoms. These trees may have some resistance or tolerance to the insect or fungi. Resistant and tolerant trees can be conserved to maintain tree species diversity and the potential for beech nut production to benefit local wildlife.

[i] The use of chemical trade names is not intended as an endorsement, nor is the omission of a product an indication of poor performance. Pesticide users should follow label restrictions and seek assistance from qualified professionals to ensure compliance with state and federal laws that protect applicators, the public and the environment. For educational assistance with pesticides, contact: Cornell University Cooperative Extension or your local office of Cooperative Extension.

Funding for this fact sheet was provided by the Cornell University Agricultural Experiment Station and Cornell University Cooperative Extension. Development and distribution was supported by USDA Forest Service Northeastern Area State and Private Forestry and NYS Department of Environmental Conservation.

Table 1. *Summary of beech management control options to significantly reduce the relative abundance of beech and beech root sucker development associated with harvests or beech bark disease. See associated text and citations[4] for details of control.*

	Beech Size Class		
Method	*predominately less than 2″ dbh*	*predominately between 2″ & 8″ dbh*	*predominately greater than 8″ dbh*
Mechanical	• If canopy is closed, brush saw all understory stems • Effectiveness of treatments decline with increasing canopy openings.	• Girdle stems using handsaw, ax, or flame torch • Goats girdle beech and striped maple. Small stems resprout.	• No options are effective
Chemical	• Foliar spray applications of glyphosate	• Basal bark treatment to all stems less (than 6") with triclopyr. • Cut-stump treatment of largest stems using glyphosate. Repeat as necessary.	• Cut stump treatment with glyphosate

Table 2*. Summary of treatment application techniques. The details to efficiently and safely apply these management options are beyond the scope of this fact sheet. Owners and managers should network with forest owner associations, Cooperative Extension trained volunteers, and state agency service foresters to observe the application of these techniques.*

Management Control Options	Application Techniques
Brush saw of small diameter stems	• Use all appropriate safety equipment and ensure brush saw is working properly. • Some sprouting and suckering will occur if canopy opening allows sunlight to reach forest floor.
Stem girdling	• Must completely encircle stem if done without herbicide. • Usually use a double girdle, separated by an inch or more. • Girdle must be of sufficient width to prevent "bridging".
Flame weeding of stems	• Use safety equipment and have water available to manage unanticipated ignitions.
Cut-stump treatments	• Glyphosate products have the highest level of transmission in the root system. Other chemical active ingredients have not always given desirable results. • Apply to freshly cut stumps or wood tissue. Best translocation and movement is between early July and middle October. • Apply to the outer 2 inches of the stump surface to fully wet the surface, but not to the point of run off. • Not effective on frozen wood.
Stem injection or hack and squirt	• Glyphosate will minimally translocate into the beech root system. • Most of the chemical will move up the stem into the treated plant.
Basal bark treatments	• Apply to full circumference of stems from ground level to approximately 18" in height. • Does not flash to interconnected stems
Goat browsing and girdling	• Provides temporary control, but requires considerable and sustained effort for herd management. • Browsing will impact all vegetation, except ferns, below 5′ height. Monitoring of the herd and timely movement will prevent damage to crop trees.

Woodlands where beech are predominately less than 2" in diameter

Woodlands and forests characterized by few if any large diameter beech and a preponderance of small diameter beech often have a history of harvesting or mortality of canopy beech due to beech bark disease. Some evidence suggests that root suckers develop around infected trees, and the degree of suckering in- creases as the disease progresses in a tree[6]. In some situations, the sprouts and suckers may exceed 10,000 stems per acre and represent more than 95% of stems less than 2" diameter at breast height (dbh). High stem densities of beech will inhibit the regeneration of other

Small diameter beech whips develop within a few years following the death of mature beech or often in areas having harvesting activity. Photo by Peter Smallidge.

hardwoods. Also, these small understory beech stems may grow rapidly within openings in the canopy caused by cutting or natural disturbances. They will develop into larger size trees that eventually succumb to beech bark disease, initiating new root suckering.

Mechanical treatment of small diameter beech may succeed in some situations. In a closed canopy wood- land of mature trees, brush saw clearing of all under- story beech resulted in limited stump sprouting and suckering, and the development of desirable advance hardwood seedlings beneath the overstory[7]. Brush saw treatments will likely be most feasible for limited size areas because of labor costs. However, the effectiveness should be independent of the extent of area treated. In open canopy forests, brush saw clearing of understory beech may result in resprouting of the beech stumps, and some root sucker development from roots of nearby overstory trees. Brush saw treatments provide an organic control option.

Brush saw cutting provides a mechanical and organic control method in situations where the overstory canopy is closed, beech are approximately 1" to 4" in diameter, and beech stem density is less than 500 per acre. Photo by Ralph Nyland.

For large acreages or beneath canopy openings, owners will need to use a herbicide to control small diameter beech. The crowns of beech less than 1" dbh, and often less than 2"+ dbh, are normally within reach using a ground-based foliar herbicide treatment, and particularly by mist blowing. Glyphosate concentrate diluted in water to label specifications effectively controls small diameter beech[8]. Foliar treatments are most effective in late summer and early fall. Woodland owners should follow requirements on the label for the herbicide, and insist on application by qualified and appropriately trained personnel. Worker safety and environmental protection are paramount.

For areas larger than a few acres, a backpack or skidder mounted mist blower will increase efficiency.

In smaller areas, a backpack low pressure spray tank will suffice, assuming that the spray reaches the tops of the target trees. Additional chemicals, such as Oust® (sulfometuron methyl) can be tank-mixed with the glyphosate to control fern rhizomes. Caution is warranted for foliar applications, and especially mist blower treatments. With a broadcast chemical treatment, all plants less than approximately 15 to 20' tall may be killed, including advance seedlings of desirable species. After the herbicide treatment, replacement seedlings will need to come from seed dispersed from on-site trees, seed blown or carried into the stand, or by replanting.

Untreated areas dominated by small-diameter beech will likely increase in understory beech abundance as the beech trees get larger, become infested with beech bark disease, die, and resprout from the roots. Areas with small-diameter beech that are allowed to develop into larger diameter classes must be treated with methods other than foliar sprays (see below). For some ownership objectives, delaying treatments until beech stems reach larger diameter classes may be acceptable, but that will require using one of those alternate treatments.

Woodlands where beech are predominately between 2" and 8" diameter

Areas of intermediate sized beech may have a history of previous harvests and the subsequent development of beech sapling thickets. Many of these trees will have an interconnected root system, but the degree of interconnectivity will not be known. The extent of interconnectivity will influence the efficacy of some treatments, and the choice of a method to use. Another important consideration in selecting a treatment is the density of beech to treat. Areas with more than 400 to 500 stems per acre[9] should be considered for broadcast foliar applications. Brush saw cutting and other individual stem treatments usually are most cost-efficient in areas with a lower density of understory beech.

Sapling-sized beech can dominate the mid canopy and create dense shade on the understory. Stems may be of low density and permit selective treatments such as girdling or basal bark spray. Photo by Peter Smallidge

Girdling of a stem severs and completely disrupts the cambial layer located immediately inside the bark, and kills the treated tree. The treatment can be done with small hand saws for trees <4-5 inches dbh, or using a chainsaw for larger trees. Some evidence indicates that girdling will not significantly stimulate root sucker development, particularly if the overstory canopy is closed. Crowns of some girdled trees may redevelop foliage for as many as three growing sea- sons following treatment, only to eventually die. Girdling sapling-sized beech has resulted in only limited sprouting on the stem[10]. Similarly, flame girdling of beech in this size class also resulted in stem mortality, although some crowns of larger diameter beech trees retain live foliage for up to 3 years[11]. Other work with flame treatment of beech noted the absence of root sucker development[12].

Goats can be used in woodlands to provide temporary control of beech[13]. Goats girdled beech 2" to 5" dbh and did not affect the stems of mature hardwoods or sapling sized sugar maple and red oak. Goats also girdled striped maple. Goats function as a broadcast treatment impacting most vegetation below 5 feet of height. Smaller beech stems resprouted within a year or two of removing the goats. Because goats browse preferentially, the best control occurred with goat stocking rates of 40 to 80 per acre and frequent movement to fresh paddocks.

One chemical method to control sapling-sized beech is to use a basal bark treatment of triclopyr (e.g., Garlon® 3A or 4) in water or basal oil, as per label specifications. Basal bark treatments can be applied throughout the year, but typically not before, during or immediately after a rain event. Water based treatments should not be applied in winter because the water freezes and won't penetrate frozen wood. Triclopyr does not translocate into the root system and thus will not flashback through roots of inter- connected beech stems. It also will not prevent root suckering.

Individual beech stems may also be treated using stem injection by the hack-n-squirt method. Herbicides with active ingredients such as glyphosate at 50% active ingredient or triclopyr at approximately 15% (as Garlon® 4) are squirted into the frill of a girdle or directly via a "Hypo-Hatchet®" or similar device. Other devices, such as EZJect®, can forcibly inject a capsule of herbicide into the stem. Glyphosate will move from the treated trees to other beech via an interconnected root system. Even so, these types of treatments are most effective where the majority of beech stems are injected, rather than relying on appreciable translocation through the roots as flashback[14]. Stem injection also can be used in beech stands having larger diameter beech. Some evidence indicates that after large trees injected with glyphosate die, the herbicide moves into attached root suckers and kills those small trees as well[15].

An alternative strategy for stands having beech with diameters of predominately 4" to 8" is to cut these trees and apply a concentrated solution of glyphosate to the freshly cut stumps, known as a "cut-stump treatment". Cut-stump treatments applied to all beech 5" dbh and larger using glyphosate as approximately 50% active ingredient to wet the outer 2" of stump surface resulted in 50% control of nearby beech stems greater than 1" dbh, and 65% control of those less than 1" dbh[16]. Results were similar for cut-stump treatments to all beech greater than 3" dbh, thus the greater work to cut the added smaller diameter stems doesn't seem warranted. The greatest mortality was associated with plots having the highest basal area of treated beech. The time required for cutting small beech trees (>5 inches dbh) and applying the stump treatment is greater than for basal bark applications to trees of equivalent sizes, although chemical costs may be greater for basal bark treatments and basal treatment chemicals do not provide control of root suckers through flashback. Where glyphosate was applied to stumps after brush saw cutting of all understory beech
<5 inches, no stumps sprouted and some adjacent beech trees of larger diameters also died due to flash- back via the interconnected root systems[7].

There is no evidence that glyphosate causes mortality to other species when correctly applied as a cut-stump

As beech trees increase in size, cut stump treatments of concentrated glyphosate can be applied during firewood cutting. Picture illustrates cutting and recent glyphosate treatment, before effects are apparent. Photo by Laurel Gailor.

treatment, or when injected into a standing tree. Glyphosate first kills the target tree. Then it moves through the tree's root system, causing mortality of attached beech stems. Most effects are apparent within 4 weeks of the treatment.

Woodlands where beech include stems greater than 8" diameter

A variety of management histories may result in stands having large diameter beech with or without small diameter beech. Because of the larger diameters

and ages of overstory beech, understory root suckers in these stands will likely have the greatest interconnectivity to the root systems of the larger trees. That interconnectivity provides an opportunity to control beech root suckers by stem injection or herbicidal treatment on stumps after cutting the overstory trees, thereby killing the tree's root system. For stands of this kind, simply cutting the large trees will not reduce the abundance of understory beech or control the development of root suckers.

Woodlands with large diameter beech provide opportunities for cut stump herbicide applications as part of a low-grade commercial harvest. Photo by Peter Smallidge

Cut-stump treatments and stem injection methods are particularly useful in stands with larger diameter beech that are less responsive to basal bark treatments and which offer an opportunity for utilization of cut stems. In stands where the small diameter trees are absent, simply cutting the larger diameter beech for firewood or other forest products, or for other purposes, often results in the development of root suckers near the harvested beech trees. Yet owners can control that potential post-harvest root suckering by linking cutting of the large diameter beech with cut-stump treatments applied at the time of harvest. When glyphosate is applied as 50% active ingredient to all cut beech greater than 6" dbh, the treatment resulted in greater than 90% sucker mortality in areas lacking beech bark disease[17], and 75% sucker mortality in areas affected by beech bark disease for several years[16]. Cut-stump treatments using glyphosate dilutions in water with 25% to 35% active ingredient resulted in sucker mortality of approximately 55%[16].

Injecting large diameter beech with glyphosate without cutting the tree has also resulted in mortality of understory suckers attached to the same root system[15], but the extent of mortality of root suckers may be less than with cut-stump treatments[14]. The extent of mortality will likely be enhanced with late

Concentrated glyphosate is applied to wet the surface on the outer two inches of the freshly cut stump. Herbicide applicators need to be certified in most states. Glyphosate needs to be applied at the time or the cutting or to freshly exposed active wood tissue. Photo by Mike Wine

summer injections using active ingredient concentrations of approximately 50% glyphosate.

Beech suckers not connected to a treated root sys- tem won't die as a result of either cut stump treatment or stem injection, and a second treatment may be necessary to reduce them as well. At the second entry, evaluate stem diameters and consider the appropriate treatment. Limited evidence suggests that for stumps up to 3 months old, re-surfacing the stump followed by immediate application of glyphosate will result in some control of root suckers. Basal bark treatment and brush saw cutting would also reduce these remaining beech saplings.

In woodlands where beech is abundant in all size classes, harvesting the beech trees with or without cut-stump treatments can result in significant in- creases of sunlight to the forest floor. That will pro- mote understory development. So before harvesting and treating those trees, plans should be in place to assure that desirable species occupy the openings. Prior understory removal without reducing the over- story density (e.g., by basal bark treatment, brush saw cutting, or foliar spraying) will result in development of advance seedlings in the brightened understory. Once well established, overstory cutting will stimulate these advance seedlings, filling spaces created by the harvest of larger trees.

Pesticides:

Herbicides are a subgroup of pesticides used to control plants. When applied according to label specifications they are effective tools for controlling beech. The two primary chemical active ingredients used to control beech are glyphosate and triclopyr. These active ingredients are available for general and/or restricted use in several different formulations. Formulations differ in the way they are mixed, the use of additional chemicals, and the use of water or types of oil to serve as carriers for the active ingredient. The websites below offer information on different formulations, or seek guidance through Cornell Cooperative Extension in your local county.

Penn State University Forest Herbicide Handbook: http://pubs.cas.psu.edu/freepubs/pdfs/UH174.pdf

Search for a NYS registered pesticide label by active ingredient, EPA #, or trade name: http://magritte.psur.cornell.edu/pims/current/

New York Pesticide Management Education Program: http://pmep.cce.cornell.edu

Emergency Exemptions for pests not on the label: http://pmep.cce.cornell.edu/regulation/nysdec-lib/2ee/menu99.html

---

[1] Tubbs, C.H. and D. R. Houston. American beech (Fagus grandifolia Ehrh). 1990. In *Silvics of North America* Edited by Burns, R. M. and B.H. Honkala. USDA Forest Service Agric. Handbook 654. http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm

[2] Houston, D. R. 2004. Beech bark disease 1934 to 2004: what's new since Ehrilich. Pages 133-137 in Beech Bark Disease: Beech Bark Disease Symposium June 16-18, 2004. C.A. Evans, J.A. Lucas, and M.J. Twery, eds. USDA Forest Service Gen. Tech. Rep. NE-331. www.fs.fed.us/ne/newtown_square/publications/technical_reports/pdfs/ 2005/ne_gtr331

[3] Nyland, R. D., A.L. Bashant, K.K. Bohn, and J. M. Verostek. 2004. Interference to hardwood regeneration in northeastern North America: Ecologic characteristics of American beech, striped maple, and hobblebush. North. J. Appl. For. 21(1):53-61.

[4] Nyland, R. D., A.L. Bashant, K.K. Bohn, and J.M. Verostek. 2006. Interference to hardwood regeneration in Northeastern North America: controlling effects of American beech, striped maple, and hobblebush. North. J. Appl. For. 23(2):122-132.

[5] Ward, J. T Worthley, P. Smallidge, K. Bennett. 2006. Northeastern Forest Regeneration Handbook. USDA Forest Service, State and Private Forestry. USDA Forest Service Northeastern Area State and Private Forestry NA-TP- 03-06. 66 pp. www.na.fs.fed.us/stewardship/pubs/forest_regn_hndbk06

[6] Hane, E. 2005. Effects of land use-history on beech bark disease severity. Pp. 138-141, *in* Beech Bark Disease: Proceedings of the Beech Bark Disease Symposium. Evans, C. A.; Lucas, J. A. ; Twery, M. J. (eds.). USFS Gen. Tech. Rep. NE-331. 149p.www.fs.fed.us/ne/newtown_square/publications/technical_reports/pdfs/2005/ne_gtr331

[7] R. Nyland, personal communication. January 2009. Unpublished data.

[8] Horsley, S.B. and J.C. Bjorkbom. 1983. Herbicide treatment of striped maple and beech in Allegheny hardwood stands. For. Sci. 29(1): 103-112.

[9] Sage, R.W. Jr. 1983. An evaluation of several herbicide applications used for site preparation in northern hardwood stands. MS Thesis. SUNY College of Environmental Science and Forestry. 160 p.

[10] Nyland, R.D. 2004. Simple girdle kills small American beech (*Fagus grandifolia Ehrh.*). North. J. Appl. For. 21(4): 220- 221

[11] Smallidge, P.J. 2008. Flame control of American beech sapling-sized stems. Unpublished data.

[12] Ostrofsky, W. D. 2004. Management of beech bark disease in aftermath forests. Pages 133-137 in Beech Bark Disease: Beech Bark Disease Symposium June 16-18, 2004. C.A. Evans, J.A. Lucas, and M.J. Twery, eds. USDA Forest Service Gen. Tech. Rep. NE-331.

[13] Smallidge, P.J. 2003. Woodland goat SARE Final Technical Report. Provided for USDA Northeast Sustainable Agriculture Research and Education. Available at www.dnr.cornell.edu/ext/goatsinthewoods. 15 pp.

[14] Kochenderfer, J.D., J.N. Kochenderfer, D.A. Warner, and G.W. Miller. 2004. Preharvest manual herbicide treatments for controlling American beech in central West Virginia. North. J. Appl. For. 2 (1) 40-49.

[15] Abrahamson, L.P. 1983. Control of beech root and stump sprouts by herbicide injection in parent trees. SUNY Coll. Environ. Sci. and For., Sch. For., For. Res. Notes RN-SOF-83-001. 4 p.

[16] Wine, M. 2008. Controlling American beech using the cut-stump technique with glyphosate. Cornell University Arnot Forest Intern Final Report. Department of Natural Resources.

[17] Kochenderfer, J.D., J. N. Kochenderfer, and G. W. Miller. 2006. Controlling beech root and stump sprouts using the cut-stump treatment. North. J. Appl. For. 23(3): 155-165.

Authored by Peter J. Smallidge, Department of Natural Resources, Cornell University Cooperative Extension, Ithaca, NY 14853 and Ralph D. Nyland, Department of Forestry and Natural Resources, State University of New York – College of Environmental Science and Forestry. Syracuse, NY 13210. Comments and advice were provided by Jeff Kochenderfer, Steve Horsely, Mike Greason, Jerry Michael, Bob O'Brien and Herb Boyce. Layout/design: Diana Bryant.
Suggested citation: Smallidge, P. J. and R. D. Nyland. 2009. Woodland guidelines for the control and management of American beech. Cornell University Cooperative Extension ForestConnect Fact Sheet. P. Smallidge, ed. 6pgs.

5.2 Assessing the success of hardwood regeneration

Peter Smallidge, NYS Extension Forester and Director, Arnot Teaching and Research Forest, Department of Natural Resources, Cornell University Cooperative Extension, Ithaca, NY 14853. Contact Peter at pjs23@cornell.edu, or (607) 592-3640. Visit his website www.ForestConnect.info, and webinar archives at www.youtube.com/ForestConnect.

Brett Chedzoy is the South-Central Regional Extension Forester for Cornell Cooperative Extension and Manager, Arnot Teaching and Research Forest. CCE Schuyler, Montour Falls, NY. 14891. (607) 742-3657

For four decades or more, interest in sustainable and "regenerative" forestry has been of primary interest to many people and organizations. Because all trees eventually die and society needs forests to be replaced, the question of successful regeneration is essential and central to that discussion.

At the beginning of scientific forestry in the late 1800's, research priorities focused on describing the remaining forests or establishing new forests on cutover lands or abandoned agricultural lands. As the science progressed and landscapes changed, attention began shifting to management practices that would manipulate an existing forest and ensure its replacement. By the latter half of the 20th century, considerable research was documenting regeneration failures, often associated with deer browsing impact on forest regeneration. The USFS Northern Research Station and many others immersed themselves in resolving the need to regenerate eastern forests. In 2013, the New York Forest Owners Association, in partnership with other organizations and institutions, committed itself to the Restore New York Wood- lands initiative (Figure 1) that recognizes NY's maturing forest and several barriers to regeneration.

Figure 1. The Restore New York Woodlands initiative was developed to highlight the need for attention to the barriers of forest regeneration given the maturity and aging of forests in New York.

Defining Terms

The purpose of replacing the current community of trees, "the forest", with the next forest is to ensure that the services and benefits from the forest are sustained (Figure 2). These services and bene- fits are tangible and intangible (e.g., wildlife habitat, timber, clean water, aesthetic vistas). Usually the entire forest isn't replaced at one time, but rather management units within the forest called

"stands" are incrementally replaced. A "stand" is comparable to a farmer's field with a high similarity of species, sizes and ages within a field/ stand that distinguish it from other fields/stands. The full suite of services and benefits are possible only when a stand is adequately stocked. Stocking refers to occupancy of a stand with trees such that the available sunlight is fully utilized by the canopy of the trees' crowns. The number of trees to achieve adequate or full stocking depends on tree size. Therefore, a stand is regenerated when there is adequate stocking of desirable species. The term "regenerated" should be reserved for stands that have adequate stocking of seedlings of desired or acceptable species with adequate vigor and quality that are taller than the reach of deer.

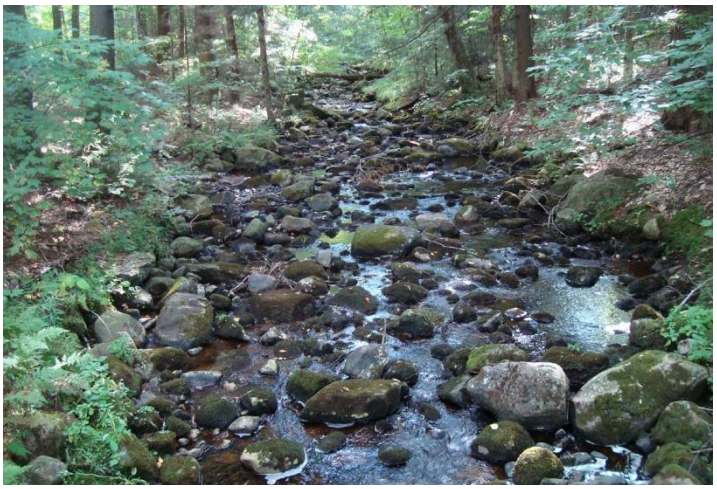


Figure 2. The full array of benefits that forests provide depend on full stocking of desirable trees and plants. For example full stocking ensures cooler stream temperatures, higher dissolved oxygen for aquatic organisms and fish, and reduced potential for erosion.

The task of regenerating a stand is not trivial. Several barriers complicate the process of regeneration including excessive browsing by deer (Figure 3), which amplify shading by interfering vegetation, and past management practices that deplete tree species diversity, productivity, seed supply and site conditions. Because owners and foresters know the goal is to replace the current stand with the next stand of similar or better quality, many people are inclined to favorably focus on the presence of a few seedlings or sapling of desirable species. In some cases, the number of desirable seedling and sapling stems per acre, the stocking, may be insufficient to create a fully stocked new stand.

On several occasions woodlot owners and foresters have pointed to isolated seedlings of desirable, or even marginally acceptable, species and used terms such as "regenerating" or "getting some seedlings." In some cases, the stems they identified were heavily browsed by deer and not likely or soon to be a functional seedling or sapling. While these seedlings are pleasant to see, they do not constitute successful regeneration. It is better to recognize a problem and seek a solution than it is to refer to a failed effort with euphemisms that obscure the need for additional action.

Figure 3. Most desirable species, including this white oak, can suffer significantly reduced growth after browsing. The impact of deer browse is pervasive in most northeastern forests. Browsing can eliminate desirable tree and herbaceous plants, and cause cascading negative impacts through encroachment of interfering and invasive species.

Stand Development

Regeneration is a process that is part of the development of a stand. A stand might be young, or have young areas if it is uneven-aged, but the young trees and the young stand change through time. Stand development is the description of how

the trees and vegetation change through time. The events and circumstances at the beginning and the end of stand development are particularly important to stand regeneration.

As a stand approaches maturity, whether financial or biological maturity, and the owner works with a forester to make plans for replacing the stand there are several conditions necessary to attain. These conditions require time and often a sequence of operations, and thus regeneration is a process. Planning for the next stand re- quires a source of new propagules, usually naturally produced seed from mature trees growing in or near the stand. As a last resort for failed natural regeneration seedlings may need to be planted. The seeds need a seedbed that is conducive to germination. The new germinates need adequate but not excessive sunlight in an environment with favorable moisture and temperature conditions. Finally, a sufficient number of seedlings need to survive mice, deer, pathogens and other mortality agents so that their continuing growth allows for the young trees to form a closed canopy and develop straight, limb-free stems.

Figure 4. Most desirable species, including this northern red oak, can suffer significantly reduced growth after browsing. The impact of deer browse is pervasive in most northeastern forests. Browsing can eliminate desirable tree and herbaceous plants, and cause cascading negative impacts through encroachment of interfering and invasive species.

In many northeastern woodlands, harvesting or other disturbances create openings in the canopy of a mature forest that allows sunlight to the forest floor. That sunlight stimulates the germination of seeds and growth of seedlings (Figure 4). If the harvest was planned and thoughtful, the trees available to produce seed are of desirable species and form. Once seedlings attain sufficient height and number (more on that later), and they are sufficiently robust to withstand the change in temperature and humidity, the overstory is removed during one or more additional harvests. An important ecological theory to consider in the regeneration process is called “initial floristic composition”, which is a well-documented explanation for how forests initiate and develop following disturbances. This theory was presented by F. Egler in 1954, and importantly states that the majority of plants that are initially present and eventually dominate are established before or shortly after the disturbance event or harvest. What this means for stand regeneration and development is that if the harvest area does not include an adequate number of desirable species within a few years, those species are not likely to establish without an additional disturbance. It is possible for a stand that was subject to a harvest or disturbance to be- come dominated by undesirable species that exclude or suppress desirable species.

Young stands need an adequate number of seedlings per acre to allow for the formation of high quality stems and to optimize growth per acre. The young forest will have many thousands of stems per acre (Figure 5). As that forest develops, the trees compete for sunlight and some die. For each increase of one inch of diameter, approximately 20% of the stems must die. This is the basis for

thinning; many trees will ultimately die and preemptive selective mortality will ensure the desired trees have sufficient sunlight to thrive.

Not every harvest needs to regenerate an adequate stocking of seedlings as the replacement of the current forest. Thinning, timber stand improvement (TSI), and similar "cultural treatments" are done to improve the quality of the current stand and not to create the next stand. To the extent the treatments increase sunlight to the forest floor, there will be some vegetative response. That response is typically the establishment of seedlings of desirable and undesirable species. However, if deer browse the desirable species, then the height growth and survival of the undesirable species are favored. As a result, the undesirable species overtop the desirable species, and the undesirable species will dominate the sapling layer. If this happens, subsequent treatments will be needed to correct the condition.

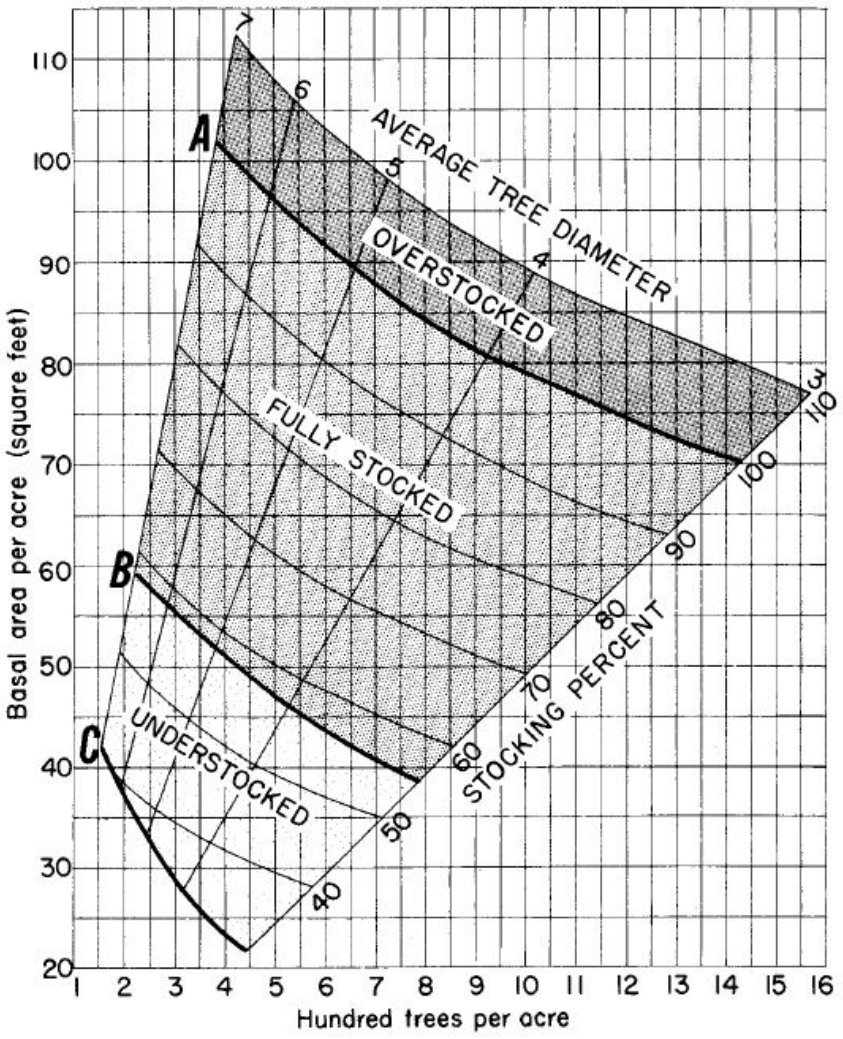


Figure 5. A stocking chart for upland oak habitats illustrates that a fully stocked stand with average stem diameter equal to 5 inches has 650 stems per acre, and 500 when it grows to an average of 6 inches. This is a 23% reduction in stem density with a one inch increase in average stem diameter. Stocking charts are also avail- able for northern hardwood forests. Figure adapted from S.F. Gingrich. 1971. USFS Research Paper NE-195. Available at https://www.nrs.fs.fed.us/pubs/8318

Regeneration Success by the Numbers

Numerical targets can help define when a stand is regenerated. Think backwards in time from a mature stand which is fully stocked when it has several hundred trees per acre to a young stand with thousands or more seedlings and saplings per acre. Because of the mortality that happens during stand development, there needs to be a large initial number of seedlings for full stocking; the actual number depends on the size and species of the seedlings. USFS research scientists have developed seedling density thresholds that are associated with successful regeneration of northern hardwood forests (i.e., maple, beech, birch, ash, basswood, etc.), Allegheny hardwoods (i.e., northern hardwood plus significant numbers of black cherry), and oak dominated forests.

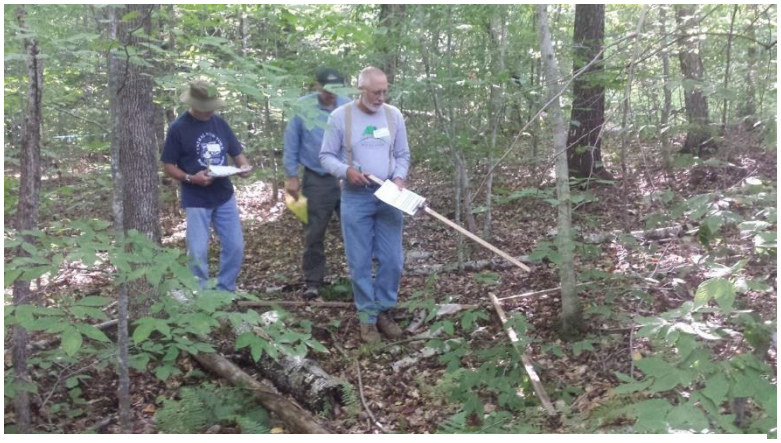


Figure 6. Basal bark treatments can be completed during the growing season to avoid the potential negative impacts of over-spray onto desired species.

Prior to harvesting, there are seedling density thresholds suggested by the USFS that guide the prescription. Assessment of these thresholds requires a deliberate inventory. The inventory data is used to assess if there is adequate stocking of advance regeneration and other stand attributes (details at https://www.nrs.fs.fed.us/tools/silvah/). Recommendations to assess seedling density relative to the threshold involves an inventory with approximately 4 plots for every 3 acres, each with a 6-foot radius (Figure 6). The stand is also assessed for deer impact and the abundance of different types of interfering vegetation. Stands with higher deer impact have higher seedling thresholds, and a consistent presence of interfering vegetation presumes treatment for its control. Taller seedlings are counted twice. A simple walk through a section of the woods is not sufficient to assess seedling abundance and whether the stand is ready for regeneration. The seedling density threshold requires 70% of the plots to be "stocked." A plot in a stand with a deer impact rating of 3 (i.e., moderate) is stocked if it has 20 or more black cherry seedlings (equal to 7,700 per acre) or 50 seedlings of other desirable hardwoods (equal to 19,257 per acre). The oak threshold density per plot is between the thresholds for cherry and other hardwoods and depends on oak seedling size. For a deer impact rating of 4 (i.e., high), the number of seedlings necessary to classify the plot as "stocked" increases by 25% to 100% depending on species. The prescription for cutting, fencing, waiting, herbicides, etc. depends on stand maturity, overstory conditions, whether 70% of the regeneration inventory plots are stocked, the frequency of plots with interfering vegetation, and other factors.

After a harvest, continued inventory is necessary to judge if the stand has success- fully regenerated. Inventory usually begins 2 years after the conclusion of the harvest. The ultimate measure of successful regeneration is if 70% of the 6-foot radius plots have at least two stems of desirable or acceptable species that are at least 5 feet tall; this amounts to an average minimum of 540 desirable stems > 5 ft tall per acre.

Forest regeneration is a process with many obstacles. Work with a good forester and invest in an appropriate inventory to measure your potential and your success. If the harvest wasn't successful, determine what needs to change and work towards success. Management prescriptions that include a reference to "hope" likely need additional thought and effort.

Literature Cited

Egler, F. 1954. Vegetation science concepts I. Initial floristic composition, a factor in old-field vegetation development. Vegetatio 4(6):412 – 417.

For additional information on woodland management go to:
www.ForestConnect.com & www.CornellForestConnect.ning.com

Support for ForestConnect is provided by the Cornell University College of Agriculture and Life Sciences, Cornell Cooperative Extension, and USDA National Institute of Food and Agriculture

Chapter 6: Wildlife, Diversity, and Ecosystem Health

Cornell Univeristy
Cooperative Extension
Agricultural Experiment Station

Arnot Forest Sugarbush Fence Establishment

September 18, 2019

(M. Ashdown, B. Chedzoy, P. Smallidge)

Summary

Total Costs Installed

Hrs	Wage	Length	Materials/ft	Labor/ft	Total / ft
397	$15	4440 ft	$ 1.67	$ 1.34	$ 3.01
397	$20	4440 ft	$ 1.67	$ 1.79	$ 3.45
397	$25	4440 ft	$ 1.67	$ 2.24	$ 3.90

- Maintenance – 0.5 to 8 hours per week ($600 - $1500+ per year)

Details

- 4440 feet of perimeter
- Insufficient low-grade volume and wrong equipment to permit a slash wall
- Low-value trees identified and marked prior to harvest
- 8 ft plastic mesh (www.deerbusters.com)
- Two strands of 12 gauge high tensile fence (5 gates strategically located)
- Top wire at ~ 7.0 ft
- Apron at bottom, weighted
- Bamboo shafts for support as necessary

Materials and Equipment ($)

Total purchase to date	$6,499
Excavator rental (2 days)	$400
Access gates (n=5)	$500
TOTAL materials/equip	$7399
per foot cost	$1.67

Labor (hours)

Actual Fence Construction	292
Scouting	9.5
Ground excavation	14
Hand excavation, gates	3.5
Shop work	13.5
Repairs	28.5
Procurement	15.5
Off-set scare wire w/ scent caps	20
TOTAL time (hours)	**396.5**

Low-Cost Fence Designs

–to Limit Deer Impacts in Woodlands and Sugarbushes

Peter Smallidge, NYS Extension Forester, Cornell University; Brett Chedzoy, Cornell Cooperative Extension Educator of Schuyler County; and Emily Staychock, Cornell Cooperative Extension Educator of Yates County

The white-tailed deer (*Odocoileus virginianus*) can significantly influence the diversity, longevity and sustainability of rural woodlands, forests and maple syrup sugarbushes. As selective browsers (Figure 1), deer will eat some plants more readily than they eat other plants. Many of the tree species deer prefer to consume are valued by owners as sources of timber, maple syrup, or as food-producing trees for wildlife, such as oak and maple. Deer also eat many native wildflower and understory plants.

Figure 1. Browse impact of deer on stump sprouts.

The effects of deer browsing on woodlands and sugar- bushes can have long-lasting effects (called "legacy" effects) that persist for decades after deer impacts are reduced. In areas with a history of deer overabundance, the failure to establish and grow new, young trees is having a detrimental effect on woodlands and the potential to keep these areas healthy and diverse.

Under high deer impact, deer eat the plants that are used to assess if there is a problem. As deer impact increases, the evidence for deer impact decreases (Figure 2). To an untrained eye, a heavily browsed woods may appear, open, park-like and picturesque rather than degraded and impoverished. In woodlands, the evidence for the over-abundance of deer include one or more of these features:

Figure 2. Small exclosures are simple and relatively inexpensive tools to assess the impacts that deer have on forest vegetation. By excluding deer, vegetation may be able to respond and illustrate the intensity of deer browsing. (Photo courtesy of Paul Curtis)

- Park-like appearance in the woods (Figure 3)
- An understory dominated by invasive shrubs
- An understory dominated by ferns (Figure 4)
- An understory dominated by non-palatable woody brush
- A browse line of the lower tree canopy
- Cropped or "Bonsai" tree seedlings (Figure 5)
- An absence or stunted wildflowers such as Trillium, Indian cucumber, or Jack-in-the- pulpit.

In most cases, recreational hunting is insufficient to control the impact that deer have on native vegetation. Depending on landscape pattern, deer population size, and food availability approximately 40% to 60% of a deer herd must die or be culled each year to stabilize the population. Reducing the

population requires even greater mortality. As the hunter demographic becomes older and less effective, and land is less accessible for hunting, the management impact of recreational hunting is increasingly limited. In some cases recreational hunting may be able to help augment other deer management strategies and reduce the impacts of deer.

Protection of isolated trees is possible with wire cages or tree tubes. Several tree tube designs are available (Figure 6). Tree tubes should be at least 5 ft tall and with ventilation ports to allow air circulation. Tree tubes need to be securely staked to the ground, and checked annually to ensure the tube is functional and the bottom in full contact with the soil (Figure 7). Tree cages made from 2" x 4" welded wire or poultry wire should be 5 ft tall and well staked. Some nut trees and conifers may do better in larger diameter cages than in tubes. Weed management around the tube or cage is necessary to improve seedling growth, and will limit habitat for rodents that might girdle the seedling.

For larger areas, fencing is a more efficient and cost-effective option than

Figure 3. An open, park-like understory in this sugarbush is a combination of too much shade and too many deer.

Figure 4. Ferns often dominate in areas with high deer pressure, and can interfere with natural regeneration of desired trees.

Figure 5. Repeated deer browsing removes the buds and forces lateral buds to expand, resulting in a bonsai-like seedling with little prospect for desirable form.

Figure 6. Examples of four tube types, both cylindrical and flat designs, the latter being assembled into a cylinder. All are 5 ft tall. Not presence of air-ventilation holes to reduce accumulation of hot air.

Figure 7. A tree tube design illustrating ventilation holes to reduce accumulation of hot air.

Figure 8. Woven wire fence 8 ft tall and suspended on installed posts is a proven method of limiting deer access to forest regeneration. (photo courtesy of Dr. Gary Alt)

Figure 9. For large areas such as this regeneration cut, a fence is most cost effective, as shown on this 4 – 5 year old regeneration cut in Pennsylvania. With high deer pressure, the effectiveness of these fences can be dramatic. (photo courtesy of Dr. Gary Alt)

tubes or cages (Figure 8). Typical fencing designs include clearing an access trail, driving posts where needed, and the use of large machinery to transport 8 ft woven wire fence spools (Figure 9). Some newer designs use 8 ft plastic mesh fence that allows for the use of small and less expensive fence posts. No fence perfectly excludes deer, and all fences require inspection and some amount of maintenance. The most expensive fences, but most effective, are made of woven wire with driven fence posts. Installation costs are typically $2.50 to almost $4 or more per running foot.

Research by Cornell Cooperative Extension and Cornell University Department of Natural Resources staff is assessing the costs and efficacy of two fencing designs to prevent or limit deer impacts. The objective is to identify low cost options that adequately exclude deer until tree seedlings grow above the reach of deer. The two methods use either plastic mesh or high tensile wire as the fencing material. These designs are being tested in 0.5 to 2 acre areas that have been managed through thinning or harvesting to increase sunlight and accelerate the establishment and growth of wood- land regeneration. In some cases, herbicides were used to control interfering understory plants (Figure 10). The fencing designs are also being tested in sugarbushes to protect young maples and pro- mote regeneration and sugarbush sustainability.

As described below, the designs are affordable for private woodland owners, and continued research is evaluating the long-term effectiveness of the de- signs at excluding deer. Fences will need to be maintained until seedlings of desirable species are at least 5 feet tall. In the early years, vegetation inside the fence will look similar to vegetation outside the fence and offer little incentive for deer to test the fence. In later years, deer may recognize that the vegetation is actually “greener on the other side of the fence” and be more likely to challenge the fence.

The fence designs shown in this fact sheet are being tested using the AVID field monitoring protocol (www.AVIDdeer.com). After one

growing season, seedlings inside the exclosures were significantly taller than seedlings outside the exclosure. If fences remain effective, then a significantly higher percentage of seedlings may grow beyond the susceptible browsing height in a shortened time frame. An appropriate number and height of seedlings is necessary to consider a woodland opening to have sufficient stocking, or seedling density. Depending on seedling height at the time of fencing, past deer pressure, soil quality, and amount of sunlight, seedlings may need 5 to 10 years of protection before they have grown beyond the typical height of deer browsing. This fact sheet will be updated as new data become available on the effectiveness of these fence designs.

The cost savings is through the use of low-value trees as living fence posts (Figure 11), and avoids the purchase and installation costs of fence posts. However, rather than attaching fencing directly to the tree, a bat- ten strip made of pressure treated wood is attached to the tree with a nail and fender washer. At most one or two nails per tree are used. On fence corners the trees should be 7" – 8" dbh (diameter at breast height), but trees as small as 3" dbh will suffice on straight runs of the fence. As the tree grows it pushes against the batten strip, which pushes against the fender washer, which floats the nail (Figure 12). The design prevents the typical situation where the tree grows around the fence material. If after 5 to 10 years the seedlings may be at a safe height, and the fence can be removed.

Plastic Mesh Fencing

Plastic mesh fencing involves higher material costs but less time invested in labor for installation. Plastic mesh fencing is available on the Internet through numerous suppliers using a search for "poly mesh deer fence." Mesh size used in this project is approximately 2" x 2", but other sizes might be equally effective. Current designs started with a 10 ft x 330 ft roll of mesh fence on a cardboard spindle, cut in half with a chainsaw. The fence height was 5 ft (Figure13). Some vendors offer 7 ft fencing which is likely to be more effective at excluding deer by al- lowing for a lower apron at ground level and taller height, but with added costs of labor to install.

Materials

- Plastic mesh fence 5' to 7' high. Ten-foot long spools can be cut in half. Prices vary from $0.48 to $0.68/foot on the full-length spool.

Figure 10. Enclosed area treated with herbicides to control interfering vegetation.

Figure 11. Flagging on paper birch identified this tree as a "fence post" tree.

Figure 12. Batten strips can be custom fit as needed to tree shapes.

Figure 13. Plastic mesh fence with single wire strand and batten strip.

Figure 14. In-line tensioners used to tighten the 12 gauge wire.

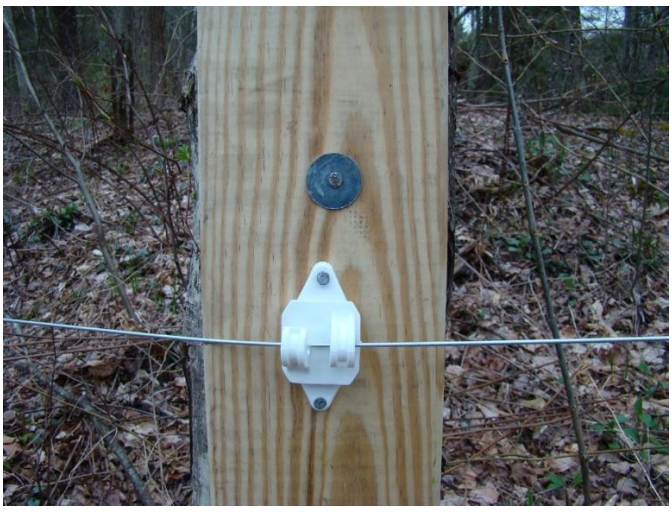


Figure 15. Pressure treated deck board (5/4 x 6) with fender washer, galvanized nail, and plastic clip for electric fence.

- 12 gauge high tensile wire, single strand
- Wire tensioner and splicing clips (Figure 14)
- Batten strips of pressure treated lumber, approximately 10-inch pieces of 2x4 or 5/4 x 6 deck boards. One per tree.
- Plastic electric fence insulators (Figure 15)
- Rust proof (e.g., galvanized) 3" to 3.5" nails
- Deck screws or galvanized joist hanger nails
- 1.25" to 1.5" fender washers
- Hog rings and hog ring pliers to secure mesh to wire
- Brightly colored synthetic baling twine

Plastic mesh fencing installation

1. Determine your perimeter and flag low-value trees to serve as living fence posts. Try to locate a tree every 40-50 feet (avoid spans greater than 60 feet). If possible, select trees to be on the "inside" of the fence. Avoid abrupt corners on the fence (Figure 16). Best results occur if trees are selected before any harvesting occurs, and those trees must be protected from damage or removal during the harvest.
2. To simplify access, clear significant brush from fence line. It may be less expensive to re-position the fence than to clear the brush.
3. Attach one plastic insulator to each 10" batten strip using deck screws or joist hanger nails. Pre-drill holes for fender washers and nails to limit splitting of the board. Attach batten strips to trees so that the insulator is approximately 54 to 58 inches above ground.
4. Thread 12 gauge wire through insulators, and tighten using wire tensioner and splicing clips.
5. Unroll and position fence to suspend from the wire.
6. Use hog rings on 18 – 24" intervals to attach the plastic mesh fence to the wire.
7. Gates are created by severing the fence vertically, and attaching an apron of fence that extends approximately 4 ft on either side of the opening.
8. If ground topography leaves gaps under fence, pile brush or slash to prevent deer from crawling under the fence. A continuous wind- row of brush or slash on the outside edge of the fence will enhance the effectiveness of the fence, and obviate the need for baling twine in the next step.
9. Install baling twine approximately 30" off- set from fence and 30" off ground. Height is important, but distance from fence can vary from 1 ft to 4 ft. Wrap twine around saplings, around wooden stakes, or use fiberglass rods with clips. (Figure 17)

The fence should be inspected two to three times per year, and after storms.

Total Cost: With labor estimated at $15/hour and materials the total project cost averages $0.59/running foot.

A modification of this mesh design that is likely to be more effective includes the use of 7 ft mesh fence and an additional strand of wire approximately 12 inches off the ground. The vertical section of the fence is approximately 6 ft to 6.5 ft, allowing for an apron plus the low wire to restrict deer moving under the fence. The cost for materials would be marginally higher, but labor costs would be as much as double because of the extra effort to install another wire, handling a 7 ft vs. 5 ft spoon, and using a ladder to hog-ring the fence to the top wire. The 7 ft and 5 ft designs have been co-located and will be compared for effectiveness through ongoing research.

Figure 16. On abrupt corners, double batten boards may be necessary to protect the tree. Abrupt corners increase resistance when pulling wire around perimeter.

Figure 17. Baling twine attached around perimeter of fence.

High Tensile Fencing

High tensile fencing involves lower material costs but almost twice as much time and thus increased labor costs. It involves the use of standard 12 gauge high-tensile galvanized wire that is secured to trees that form the perimeter of the fenced area.

High tensile fencing materials

- 12 gauge high tensile galvanized wire: Available at farm stores for approximately $100 for 4,000 feet of wire, approximately $0.03 per foot
- 8 foot long pressure treated deck boards 1 ¼ inch thick x 5 ½ inch wide, or pressure treated 2x4s (approximately $3.67/board)
- Wire tensioners and splicing clips (and appropriate tools)
- Electric fence plastic insulators
- Deck screws or galvanized joist hanger nails
- Rust proof (e.g., galvanized) 3” to 3.5” nails
- 1.25” to 1.5” fender washers

High tensile fencing installation

1. Determine your perimeter and flag low-value trees to serve as living fence posts. Try to locate a tree every 40-50 feet (avoid spans greater than 60 feet). If possible, select trees to be on the “inside” of the fence. Avoid abrupt corners on the fence. Best results occur if trees are selected before any harvesting occurs, and those trees must be protected from damage or removal during the harvest.

Figure 18. Use of a deck board as a batten strip and 8 strands of high-tensile wire

2. To simplify access, clear significant brush from fence line. It may be less expensive to re-position the fence than to clear the brush.
3. Attach plastic insulator to batten strips using deck screws or joist hanger nails. Attach insulators from bottom of batten at approximately 10”, 20”, 30”, 40”, 54”, 68”, 82”, and 96”. (Figure 18)
4. Position batten strips at selected trees. Before nailing board to tree, thread the top wire in the uppermost insulator of each board.
5. Attach batten strip with a nail and fender washer near ground line and one additional nail and washer at any location along the batten that will secure the board.
6. Thread 12 gauge wire through insulators, and tighten using wire tensioner and splicing clips. Thread and tighten one wire at a time to avoid intertwining wires. Tightening the wire helps secure the boards to the tree.
7. If ground topography leaves gaps under fence, pile brush or slash to prevent deer from crawling under the fence. A continuous windrow of brush or slash on the outside edge of the fence will enhance the effectiveness of the fence, and obviate the need for baling twine in step #9.
8. Use trees that are sufficient in diameter and firmness at angled points in the fence because they will be under significant side strain. Figure 16)
9. Install baling twine approximately 30” offset from fence and 30” off ground. Height is important, but distance from fence can vary from 1 ft to 4 ft. Wrap twine around saplings, around wooden stakes, or use fiberglass rods with clips. (Figure 17)

The fence should be inspected two to three times per year, and after storms.

Total Cost: With labor estimated at $15/hour and materials the total project cost average was $0.51/running foot.

For additional information on woodland management go to:
www.ForestConnect.com
www.CornellForestConnect.ning.com

Layout and editorial assistance provided by Diana Bryant.
This work was supported by a joint research and extension program funded by the Cornell University Agricultural Experiment Station (Hatch funds) and Cornell Cooperative Extension (Smith Lever funds) received by Cornell University College of Agriculture and Life Science from the National Institutes for Food and Agriculture (NIFA,) U.S. Department of Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture. Additional support provided by Cornell Cooperative Extension of Schuyler and Yates Counties.

Cornell University Cooperative Extension

Forest Connect

Supporting Sustainable Management of Private Woodlands

An Extension Publication of the Department of Natural Resources, New York State College of Agriculture and Life Science, a Statutory College of the State University at Cornell University, Ithaca, New York

6.2 Managing Woodlands to Improve Wildlife Habitat

Peter Smallidge, NYS Extension Forester and Director, Arnot Teaching and Research Forest, Department of Natural Resources, Cornell University Cooperative Extension, Ithaca, NY 14853. Contact Peter at pjs23@cornell.edu, or (607) 592-3640. Visit his website www.ForestConnect.info, and webinar archives at www.youtube.com/ForestConnect.

Most landowners own their land for a variety of reasons, though at any point in time one objective might be of more interest than other objectives. For many woodland owners, they are interested in seeing more wildlife, whether as birds or game species, or just knowing they are providing habitat. Some owners prioritize creating habitat that they know will benefit wildlife, regardless of what they personally see. As a side note, motion-sensitive trail cameras have become reasonably priced and allow you to see more wildlife (Figure 1). The interest in wildlife for these owners may be one of many objectives including recreation, firewood or timber.

Figure 1. A trail camera, placed strategically at an intersection of varied cover, structure and water (see text for definitions) captures a reality of the interaction of predator and prey. Here, the coyote was successful, but more often they consume small mammals and have almost no impact on deer.

The objectives of wildlife, timber, firewood and recreation are common, and usually compatible on the same property. This article will address some general guidelines and strategies, but numerous resources exist to expand on the concepts presented here. There are several good publications that will help landowners who want to manage their woodlands for wildlife habitat. See the reference section at the end for a couple options.

Getting Started Managing Woodlands for Wildlife

The starting point for "what should I do?" is always "what do you want?". Knowing your objectives provides targets, and also priorities for actions. Some portions of your land may be more suitable for some objectives than others, so emphasize management actions in areas where you will receive the greatest return on your investment of time and resources. If you don't know your objectives, think about what you want, tangible and intangible, from your property. Your spouse should go through the same exercise, and perhaps your children who are interested in the property. If there are several people involved in the ownership, it might be helpful to sort objectives that are essential, and those that are of significant interest.

With wildlife as a priority, it is worth keeping in mind that wildlife need food, water, cover and space. Food and water are obvious at some level, but the details about what species need what types of food and how far

they travel for water are important. Cover are those parts of your woods, fields, and hedgerows that allow animals to rest, breed, hide, loaf and travel (Figure 2). Space allows for the freedom of a species to move within its territory without having to compete with other members of the same species for food, water and cover.

The needs of each species for food, water, cover and space are its life history traits. The life history traits for one species are covered in detail in each issue of the NY Forest Owner magazine in the column "Wild Things in the Woods." Review your back issues, and those at www.NYFOA.org for details. There are also descriptions of life history traits in the references below, or through Internet searching.

Figure 2. Downed woody material, also called slash, is one example of cover. A variety of small mammals and amphibians would benefit from the security this provides, and access to different types of foods. Owners who harvest firewood can remove less of each tree and easily create this type of cover.

(Photo by M. Ashdown)

Once you know what you want, you can begin the process of planning. The resources listed below as references offer considerable guidance on the planning process. It is also possible to contact a NYSDEC forester and ask for a (free) stewardship plan, where the plan will document the full variety of your objectives and management actions you can take. You will learn more in your interaction with the forester if you go through some of these steps first, so you understand what the forester is doing.

An essential part of planning, and a common short-coming of the otherwise best laid woodland plans, is for the owner(s) to self-assess what they can bring to the effort. One way to assess your capacity is with T.I.M.E. This acronym represents Time, Interest, Money, and Energy. You will need some of each, but a shortfall in one category can often be offset from another. Be honest and realistic. Most landowners are most in need of time. Check with other woodland owners through groups such as the NY Forest Owners Association to see if your anticipation of the time required to do certain tasks is reasonable.

The planning process includes the following steps:

1. Map the property. You can do this with online tools such as Google Earth Pro, and include soils information through the USDA Web Soil Survey. USGS topographic maps are also of great value. Review the link below for a ForestConnect fact sheet on these topics.
2. Inventory your woods. This could be as simple as taking your map or image (Figure 3) from step #1 and sketching areas of young versus older hardwoods, pine versus maple, scrub lands versus mature forest, springs, seeps, or whatever you have. Include trails, hedgerows, stone walls, streams, ponds, and the small woodland pools that only have water for brief periods of time. You could do a more detailed inventory; instructions are available online by searching for "landowner woodland inventory".
3. Once you have an inventory or at least a sketch of your woods, start to prioritize areas that you could manage to achieve multiple benefits. You will get ideas for what you

Figure 3. A satellite image from Google Earth Pro shows considerable details, such as the field, the linear corridor of a utility right of way, and the course texture of a previous harvest in the area north of the field.

might do by attending NY Forest Owner Association woodswalks in your chapter or neighboring chapter. Cornell's Master Forest Owner volunteers can't provide technical guidance, but can share what they have seen on their own land and that of other owners. Request a free visit from a volunteer at www.CornellMFO.info

4. In addition to the inventory of your woodlands, you need to know about the particular wildlife species that interest you. Unless you want any wildlife species, you need to learn more about your favorite birds, amphibians, reptiles, and mammals. As previously mentioned the NYFOA magazine has a column each issue on "Wild Things in Your Woods" that covers the details of many species. This is a great place to start. The references below also include details about what individual species need. The key is to start with 3 to 10 favorite species that are likely on your property, and build your knowledge.

Figure 4. This picture shows a type of structure found following a clearcut. The trees are young, and thus relative short and with an average diameter of a few inches. Consider the structure (tree height and diameter) of a mature forest. Both types, and others, are important for wildlife.

Figure 5. The pool shown here was created after logging and a skidder that drove through a short section of poorly drained soil. The skidder enhanced the pool with a berm of earth to hold more water a longer period of time. This 16" deep pool is almost always a certain location to find a variety of amphibians.

5. Now the fun starts, whatever that might be for your particular property. Your management actions should support your highest priority and most pressing objective(s). Your efforts will be specific to your land, but some examples of activities that accomplish multiple objectives follow.

Trails – After a landowner has permanently marked the boundaries of their property, the second most important task is to ensure there are trails that provide access to all areas. While many owners are willing to bushwhack without a trail, we usually spend more time in areas where we can easily travel. Trials can be as simple as bits of yarn or flagging on trees that guide the attentive eye through the woods, or can be as grand as you choose. The trail should be of sufficient width for humans or vehicles that will travel it. Also, a trail for walking can be more curvilinear than a trail for pulling your ATV logging arch or for x-c skiing. Trails don't directly benefit wildlife, except that when you can see areas repeatedly you will start to imagine and visualize what you might do.

Woodland Structure – Structure is what a woodland physically looks like. Structure refers to the heights of the dominant trees, the number of trees per acre, average diameter of trees, the variability in the diameter of the trees, the fullness of the crowns, and more (Figure 4). Consider how you would describe one area of your property from another…that's structure. The different types of structure often correspond to differences in the availability of food and cover, both essential to a diversity of wildlife. You can influence structure, and thus habitat diversity with simple or significant actions. These are described below as culling and "sunlighting."

Water – In most woodlands, the single activity that will result in the greatest variety of wildlife is creating access to water. Adding water to your landscape adds texture. If you have beaver in the area, you can wait and see if they decide to build some dams on your property. If you have a harvest of logs, you can likely ask the logger to expand some wet spots to encourage trapping water for periods of time (Figure 5). You can also design or build a pond, or repair a pond that exists but has become over-grown.

Culling – In the normal course of the growth of a woods or forest, there are more trees than can be supported by the sunlight that is available. As the woods grow and the average tree diameter increases by one inch, approximately 20% of the trees must die. Tree death will happen regardless of our efforts, so the option is for the owner to decide which trees will die, or let natural processes decide. Pick trees that don't support your ownership objectives and safely fell or girdle those trees. Culling can include the more traditional practices of thinning or crop tree management, with retention of considerable amount of woody slash on the ground for wildlife cover. Culling could also include creating snags, which are standing dead trees, and are important as homes for a variety of wildlife species, particularly birds (Figure 6).

Figure 6. Some trees, such as the one pictured, die from natural causes. Dead standing trees are called snags. In other cases snags can be created through chemical or mechanical girdling. Create snags in safe areas, away from trails and buildings, but a few in the woods will provide count- less food, cover and space for many species.

Sunlighting – The term "daylighting" is often used in regards to providing sunlight to forest roads so that they dry more quickly after rain and snow. I use the term "sunlighting" here to illustrate the value in making sure there is sunlight on the forest floor to stimulate the growth of herbaceous and woody plants that serve as food and cover for wildlife. Sunlight to the forest floor might be increased with a canopy opening at a cluster of culled trees, or might be something more expansive such as a one acre patch clear cut. Owners can personally open areas of a 0.25 to 3 acres as a personal project, if they have the tools and knowledge to work safely. Thus, sunlighting can occur as a continuum on your property from clusters of small gaps to larger openings. The more of the woody slash you leave behind, the greater the benefit for wildlife. It is also possible, if not advisable, to retain several live stems of nice trees in the clearing as perches and as future timber trees. Realistically, these openings will be used by deer which will preferentially browse, likely over-browse, the desired species and leave invasive shrubs in their wake (Figure 7). Be alert to these conditions and treat the problem as it develops. You might want to fence some areas to exclude deer. Unless you leave enough slash to significantly offend your aesthetic sensibilities, you likely will not exclude deer.

Figure 7. Following treatment, the increase of sunlight on the soil and the potential of soil disturbance may stimulate the germination of buckthorn seeds. Pictured are new germinants of common buckthorn following cutting of the overstory.

Planting – Many rural woodlands also have a few acres of open meadow or old pasture. These grasslands are important in and of themselves. In some cases, with an abundance of open acreage, you may want to establish some dedicated wildlife plantings on some portion of your open acreage.

Pick native species that have specific benefits as food or cover for the wildlife species on your "most wanted" list. The three key aspects of a successful planting are to: (i) select a species suited to the soil, (ii) prepare the site so that competing vegetation is controlled, and (iii) protect the plant from damage by deer and rodents.

In many ways, woodlot management is synonymous with wildlife management. Manipulations of the trees create new and varied habitats. By planning for specific and desirable changes in the vegetation, owners can influence the success and abundance of wildlife species. Plan thoroughly and work safely.

References

Gutierrez, R.J., D.J. Decker, R.A. Howard, and J.P. Lassoie. 1984. Managing small woodlands for wildlife. Cornell University Cooperative Extension, Department of Natural Resources, Ithaca, NY. 14853. Free online at http://bit.ly/Cornell-Woodland-Wildlife

DeGraaf, R.M., M. Yamasaki, W.B. Leak, and A.M. Lester. 2005. Landowner's guide to wildlife habitat: forest management for the New England region. University Press of New England, Lebanon, NH. For sale at Amazon.com

Smallidge, P.J. 2017. How to use soils information for woodland management. Cornell University Cooperative Extension, Department of Natural Resources, ForestConnect Program, Ithaca, NY. 5 pp. Free at http://bit.ly/ForestConnect-soils-woods-mgmt

www.youtube.com/ForestConnect - webinars on almost all the topics mentioned in this article

For additional information on woodland management go to:
www.ForestConnect.com & www.CornellForestConnect.ning.com

Layout and design provided by Diana Bryant.

Support for ForestConnect is provided by the Cornell University College of Agriculture and Life Sciences, Cornell Cooperative Extension, and USDA National Institute of Food and Agriculture.

Enhancing Wildlife Habitat

Catching a glimpse of a scarlet tanager darting through dense summer foliage – or a red eft scurrying along the edge of a marsh or pond…waking up to the song of a whippoorwill or northern cardinal…discovering deer tracks in freshly fallen snow…

At some point in time, nearly everyone finds enjoyment in wildlife. As a home or landowner, you have the opportunity to benefit from the aesthetic, recreational and economic rewards that come with safeguarding and managing your land in ways that allow for and respect the needs of wildlife.

Red Eft: More than two months after hatching, eastern newts transform from aquatic, gilled larvae to air-breathing terrestrials. During this land phase, they are known as efts.

Like you, wildlife requires food, water, shelter, and space to live - a place to call'home', a.k.a. habitat. Your backyard woods may have all of these things and is likely already home to a host of wildlife species. But, not all woods are created equal; in some, wildlife merely survives, in others, it thrives. No matter how large or small your backyard woods, there are choices you can make and actions you can take to increase the number and variety of wildlife species.

First, learn the lay of your land. The more you know about your land, the better able you will be to enhance its value for the wildlife you desire. Draw a map of your property that displays its prominent features, such as

- rock outcroppings and caves
- wetlands, vernal pools, spring seeps, streams or ponds
- mixed forests (deciduous and evergreen)
- openings without trees
- trees, shrubs, groundcovers and flowers that produce nuts, berries, or other fruits or natural foods
- dead or living trees containing holes, or cavities
- standing dead trees and fallen logs
- hedgerows

By mapping important features, you can assess habitat elements that already exist. Then get to know the local wildlife and the habitats that they frequent. Once you have mapped and inventoried your land and decided which wildlife species you want to attract, you are ready to identify the steps you can take to provide them with the food, water, shelter, and space they need to survive.

Basic Survival Needs of All Wildlife

FOOD

To provide food for wildlife, promote the health and growth of good wildlife food-producing trees such as oaks, hickory, beech and black cherry. Nuts, such as acorns, hickory nuts, or beechnuts provide food for chipmunks, squirrels, turkeys, bears, and others. You can

Hickory nuts provide food for many wildlife species.

Cornell University

Support provided by USDA Renewable Resources Extension Act and USDA Forest Service - NA State and Private Forestry.

promote the growth of these valuable trees by culling (cutting) less desirable trees that compete with your food-producing trees for light. Cutting in winter and leaving the tops on the ground provides browse for animals such as deer, or rabbits. Culling also creates openings or clearings. Rabbits, voles, and mice are naturally drawn to openings where they can find grasses and forbs (herbaceous plants other than grasses) to eat. Keep in mind however, that deer and rabbits may be equally attracted to your favorite vegetable garden or prized ornamentals!

If soil and light conditions are suitable in clearings, you can encourage or plant native trees or shrubs that bear fruit, nuts, or flowers. Berries, from dogwood, raspberry, blackberry, elderberry, and other plants may attract birds and bears, while flowers provide nectar and pollen to butterflies, bees and hummingbirds. The New York State Department of Environmental Conservation tree nursery in Saratoga sells a variety of shrub and tree species that produce wildlife food. For more information on ordering tree seedlings from NYS Department of Environmental Conservation, call (518)587-1120 or visit their web site at http://www.dec.stat.ny.us/website/dlf/privland/nursery/treeshrub.html

Landowners who retain a few dead standing trees (away from trails, buildings and other high-traffic places where they might present a safety hazard) will be delighted to see woodpeckers, birds, and other animals feeding on the insects and fungi attracted to the decaying wood.

Leaving dead wood on the forest floor provides habitat for amphibians, reptiles, small mammals, and invertebrates.

WATER

Water is a 'wildlife magnet'. Most living things require water for bathing, drinking, and/ or breeding. This does not mean, however, that the absence of open water in your woods will deter wildlife. Animals meet their water needs in various ways. Some get all they need from the foods they eat. Others drink dew or raindrops that cling to plants. Several make use of seeps and vernal (springtime) pools.

Some wildlife species actually create wetland habitats. Beavers are distinguished by their extraordinary ability to dam up small waterways, creating ponds that are choice habitat for other water-loving creatures as well.

In some circumstances, it may be feasible for you to create a backyard pond. It need be no larger than 3 or 4 feet in diameter. Some homeowners add small ponds to attract frogs and toads to their gardens. Frogs and toads eat a wide variety of insect pests and slugs. Assistance with planning your pond is available from local agencies including Cornell Cooperative Extension, your County Soil and Water Conservation District, and the New York State Department of Environmental Conservation.

Water sources, such as wetlands, streams, vernal pools, ponds, and spring seeps provide a critical element of wildlife habitat and can provide landowners with many wildlife viewing opportunities.

SHELTER

Shelter can provide protection from the elements, safety from predators, a secure place to raise young, or simply a place to rest. Shelter might be a hollow log, a brush pile or a hole in the ground. Even a single fallen leaf may offer shelter to some tiny creature!

Dead and dying trees (known as 'snags' and often referred to as habitat trees) – whether standing, leaning, or fallen – also play a vital role in the lives of wildlife. Fallen dead trees provide

drumming sites for grouse, as well as a place for fungi to grow. Fungi are a food source for chipmunks, deer and squirrels. Decomposing wood also provides a moist, cool habitat for amphibians and reptiles.

Trees that have been weakened by disease or injury attract insects, which subsequently attract insect-eating creatures. Through decay and the drilling of woodpeckers and other excavators, hollows eventually appear in many dead and dying trees. A variety of bees, birds and mammals build hives, nests, and dens in these cavities. Dead and dying trees can be as valuable, or more valuable to wildlife than healthy trees!

SPACE

You probably know the number of acres your property covers, but did you know that space available for attracting wildlife extends vertically as well? Trees, shrubs, and vines of varying heights provide a full range of 'suites' for animals that climb and fly. The good news is that you can encourage increased vertical structure in your woodland through management practices like thinning - which increases sunlight and in turn promotes understory growth and forest renewal.

Holes, or cavities, in trees provide refuge for many wildlife species.

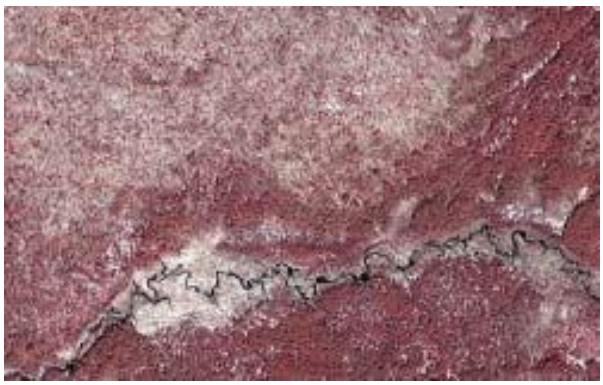
Conclusion

When properly managed, your property will offer a permanent home to some wildlife, a rearing or nesting site to others, and a welcome place to rest for those that are simply passing through. You may have to be patient, though - it could take a while for your wildlife-friendly forest to become established or for the wildlife you desire to find the habitat you have provided. But it's worth the wait!

As neighbors and friends see the rewards of your habitat improvement, they may also choose to do something positive for wildlife. By joining forces, home and landowners can enhance the quality and increase the size of the habitat provided in their neighborhoods. Several approaches and programs are available to landowners working cooperatively to manage lands that reach beyond their own backyard woods.

Once you have assessed habitat and wildlife on your land, acquire an aerial photo and topographic map of your property. The Soil Conservation District office or the Farm Services Agency (FSA) office in your county or area often has aerial photos for you to view and order. Aerial photos and topographic maps are available on-line at http://terraserver-usa.com/. Get the "big picture" perspective of our neighborhood to determine which habitat

Looking at your property as part of the "big picture" can help you determine what habitat elements are needed. On this map, large, unbroken areas of forest are rare. Maintaining or creating connections among forest patches would benefit wildlife in this area.



On this map, forest openings are uncommon. If you lived in this area you might consider creating a couple of forest openings.

components are plentiful or scarce on your land and adjacent ownerships. The home range size of different species varies dramatically so your land likely is just part of the home range of many species. Concentrate your management activities to provide habitat components that are scarce in your area; the "limiting factors".

Additional References:

Decker, Daniel J., and John W. Kelley. 1998. *Enhancement of Wildlife Habitat on Private Lands.* DNR CCE Publications, (607) 254-6556. 42 pp. Available electronically at http://dspace.library.cornell.edu/handle/1813/72

Hobson, Scott S., John S. Barclay, and Stephen H. Broderick. 1993. *Enhancing Wildlife Habitats: A Practical Guide for Forest Landowners.* Northeast Regional Agricultural Engineering Service. NRAES-64. 172 pp.

Web Pages of Interest

Arnot Conservation Education Program web site - www.arnotconservation.info

New York State Department of Environmental Conservation Bureau of Wildlife web site - http://www.dec.state.ny.us/website/dfwmr/wildlife/

Prepared by Richard Gast and Emily Selleck with support of Cornell Cooperative Extension of Franklin and Essex Counties. Edited and compiled by Kristi L. Sullivan, Peter J. Smallidge and Gary R. Goff, Department of Natural Resources, Ithaca, NY. 2006.

Printed on Finch Paper, made in New York State and certified as meeting the standards of the Sustainable Forestry Initiative® Program.

With support from the New York Forest Owners Association.

6.3 Bird Friendly Maple

The following is an excerpt from an Audubon NY publication: *Forest Management for New York Birds: A Forester's Guide*. The document is available in full on their website where they have many resources for responsible management of working lands: https://ny.audubon.org/conservation/working-lands. The full document contains many more examples of harvest scenarios and fitting silvicultural prescriptions. At the end of this section you can find the list of NY State priority birds.

Why birds?
Audubon NY has identified more than 45 priority forest bird species that would benefit from well-managed forests in New York. A significant portion of their breeding populations use forests within the Eastern Forest region and/or are experiencing population declines or significant threats.

New York's forests provide important breeding, migratory stop-over, and wintering habitat for more than a hundred species of birds. One of their most important ecological functions is to provide breeding habitat for several dozen bird species, many of which are experiencing population declines due to a number of factors, including habitat fragmentation and the loss of quality habitat. Quality forest habitat for birds and other wildlife means intact, healthy, resilient, regenerating, and diverse forested landscapes. With 63% forest cover in New York State (NYS), the way we manage forestland can significantly influence bird populations.

Habitat for Forest Birds

A Conservation Concern
Suitable habitat for wildlife provides sources of water and food, places to breed and raise young, and cover from weather and predators. Depending on the time of year, habitat needs may change, as is the case with many forest birds that migrate long distances to and from their breeding and wintering grounds. Known as Neotropical migrants, these forest birds typically leave New York in September and spend October through March in warmer climates in Central and South America. In April and May, they return north to forests in New York and beyond to breed. Once here, birds will find a mate, locate suitable nesting habitat and build a nest, produce and incubate eggs, raise nestlings until they fledge, and then continue to rear their young until the fall migration in September.

The quality of forest habitat can greatly impact breeding success of birds. In general, large, contiguous tracts of forests (i.e. landscapes) that include a diversity of tree species and forest types and both young and old forests are needed to conserve the entire forest bird community. For most of New York State, a **young forest age class is a regenerating forest that is 0–10 years in age, but can be upwards of 15–20 years**

depending on growing and site conditions. Mature forest is typically 50 years or older, and is the prominent age class found throughout the state, with much of New York's forests falling between 80–90 years of age.

Forest Habitat: Landscape-level Conditions

Forest birds thrive in landscapes dominated by forest cover (i.e. with forest cover ≥70% of the total landscape) and that have different forest types and age classes present - a condition called horizontal structural diversity or "patchiness." Some species, like Eastern Towhees and Indigo Buntings, prefer young forest habitats for nesting and raising young. Other birds, like Wood Thrushes and Scarlet Tanagers, nest primarily in the interior of large tracts of mostly mature forest. A number of species, like Downy Woodpeckers and Hooded Warblers, will use both young and mature forest if specific habitat features are present (Hartley et al. 2004, DeGraaf et al. 2006). Further, certain species will breed in forests dominated by hardwood tree species, while others prefer a mixed composition of deciduous and coniferous trees, and some species need coniferous forest stands exclusively for breeding.

For scale, a landscape can be considered to be about 2,500 acres in size (i.e. 3.9 mi^2, 1,012 hectares, 10.1 km^2), based on studies that examined forest bird habitat use in relation to landscape conditions (e.g., Rosenberg et al. 1999). Forested landscapes that are composed of approximately 5–10% young forest (0–10 years in age, on average) and predominantly of mature forest (>50 years in age), provide a suitable mix of habitat for a suite of forest birds (Rosenberg et al. 1999, King et al. 2001, Dettmers 2003, Becker et al. 2011). This would mean that given a 100–200 year rotation for even-aged stands, and with 5–10% in a young forest age class, multiple age classes would be present throughout the forest, maintaining a high degree of horizontal structural diversity. Percentages apply only to forest cover within the landscape, and do not include acreages of non-forest cover such as agricultural areas or urban, suburban, or other developed areas.

Forest Habitat in a Fragmented Landscape

In areas where forest cover is less than 70% of the landscape due to fragmentation by development or agriculture, it is important to maintain existing forest in order to sustain forest-related benefits for forest birds and other wildlife. Land use decisions should discourage converting existing forests to another cover type, and encourage restoration of non-forest areas back to forest to benefit forest birds and other wildlife. Within fragmented landscapes, forest management can improve habitat for birds by considering forest patch size and potential edge effects, as well as focusing on improving within-stand structure.

See **Stand-Level Conditions** for more information.

Photo: Kelly Colgan Azar, Flickr/CC

Wood Thrush adult and nestlings, with Brown-headed Cowbird nestling on left.

Photo: Greg W. Lasley, Vireo

Eastern Towhee

Forest Patch Size and Edge

Where the landscape is <70% forested and forest cover is fragmented by other cover types (i.e. agriculture, development), aim to keep large, contiguous tracts of mature forest intact. These core forest areas are important because many forest birds, like Scarlet Tanagers and Wood Thrushes, are area sensitive, meaning they require large habitat patches to successfully establish breeding territories, nest, and raise their young (Robinson et al. 1995, Rosenberg et al. 1999, Austen et al. 2001, Driscoll et al. 2005). In general, area sensitive forest birds need a minimum of 200 acres of contiguous forest for suitable breeding habitat (Rosenberg et al. 1999).

Forest "edge" occurs when there is an abrupt change from forest to non-forest. Edge effects, such as predation from raccoons, cats, and skunks and nest parasitism from Brown-headed Cowbirds, threaten the survival and reproductive success of forest interior breeding birds and are more pronounced in landscapes where forest fragmentation is high and where remaining forest patches are relatively small and adjacent to agricultural operations or developed areas (Robinson et al. 1995, Donovan et al. 1997, Hartley and Hunter 1998, Driscoll and Donovan 2004). Within more fragmented landscapes, edge effects have been observed more than 300 feet from the forest edge (Brittingham and Temple 1983, Rosenberg et al. 1999, Austen et al. 2001, Dunford and Freemark 2004, Driscoll et al. 2005, Nol et al. 2005, Environment Canada 2013). Which silvicultural treatments that create young forest are appropriate will greatly depend on the size of the forest patch, as even-aged management within smaller forest patches may temporarily increase edge effects and limit the amount of quality interior forest habitat. Softening or feathering "hard" forest edges to reduce an abrupt transition from forest to another cover type can also help reduce negative impacts to forest interior birds (Rosenberg et al. 1999, Rosenberg et al. 2003, DeGraaf et al. 2006). See *Young Forest Habitat* for more information.

Forest Habitat: Stand-level Conditions

The following section describes stand-level habitat components important to forest birds. All of these conditions apply to mature forest stands, and some also pertain to young forest stands. Many of the habitat features described in this section are similar to what you might find in late-successional Northern hardwood forests, but much of NYS lacks this forest age class. Depending on landowner goals, forest can be set aside from management to become late-successional forest in approximately 100–200 years, but the complex structure that is characteristic of older forests can be achieved by mimicking natural disturbances, such as wind throw and beaver flooding, through forest management. Foresters can enhance stand-level habitat features to increase forest birds' nesting success and rearing of fledglings.

Foresters and land managers can use the following descriptions of desired habitat features to compare against existing habitat conditions when performing timber cruises and forest inventories. The recommendations below (in bold face) can be integrated into silvicultural prescriptions to create or improve the key habitat features.

See Table 1 for information about forest habitat characteristics that are of particular importance to Audubon NY priority birds.

Vertical Structural Diversity

Vertical structural diversity refers to the layering of vegetation at multiple heights in a stand. Ones with high vertical structural diversity have overstory, midstory, and understory vegetation layers composed of some combination of trees, shrubs, herbaceous plants, and vines. This vertical structural diversity provides different birds with places to nest, perch, forage, seek cover, and raise young.

Structural complexity can be enhanced in mature forest by creating canopy gaps and stimulating the growth of understory vegetation (Newell and Rodewald 2011). Late successional forests (typically uneven-aged) tend to have high vertical structural diversity, exhibiting characteristics that include a tall overstory with small canopy openings (due to individual tree fall) that have allowed for several shorter canopy layers to develop, and substantial amounts of downed woody debris of larger logs and snags (DeGraaf et al. 2006, D'Amato and Catanzaro 2010). **In general, creating or maintaining vertical structural diversity within a mature forest stand is highly beneficial to many forest breeding birds.**

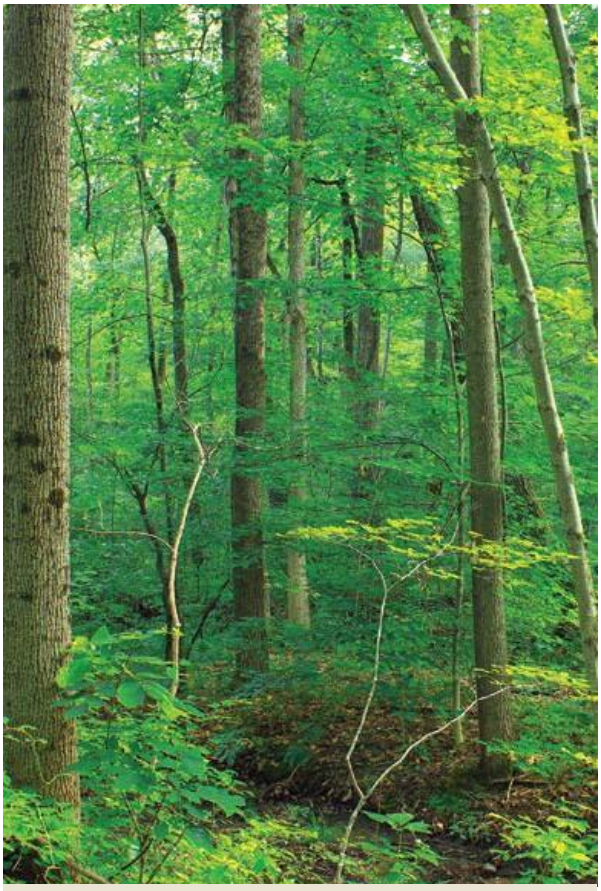


Photo: Nicholas A. Tonelli, Flickr/CC

Forest with high structural diversity

Species Diversity

Native vegetation provides the most habitat value to wildlife, and managing forests to provide a diversity of native trees, shrubs, vines, and herbaceous plants increases the suitable habitat potential for forest birds. However, some native species, such as American beech, can dominate a stand and reduce diversity. Native plants support all or part of the life cycles of our native insects, which are the primary food source for the majority of forest bird species during the breeding season. In addition, native trees and shrubs produce more nutritious mast (fruits, seeds, and nuts) when compared to non-natives.

Where interfering vegetation is prohibiting the growth of native tree and shrub species, apply control methods to the interfering vegetation to release the native species. Increase species diversity of native trees and shrubs by applying silviculture that allows varying amounts of sunlight throughout the area you are managing, thereby creating conditions that foster the growth of shade intolerant, tolerant, and intermediately tolerant species (e.g., a 5-acre patch cut in one stand and crop-tree release in another stand).

Photo: Glenn Bartley, Vireo

Blue-winged Warbler

Controlling Interfering Vegetation: Interfering vegetation includes both native and non-native invasive plants that prohibit successful forest regeneration by shading seedlings and other plants. Species such as common buckthorn, Japanese barberry, hayscented and New York ferns, and American beech, can dominate the forest understory thereby suppressing forest regeneration, reducing diversity, and decreasing overall habitat value to wildlife. Management should control interfering vegetation so that tree regeneration and native, non-invasive understory plants regenerate.

Photo: Eli Sagor, Flickr/CC

Japanese barberry in a forest understory

Managing for a diversity of native forest plants will ensure that birds have available food sources, including insects and mast, and having different species will increase the chances of having some mast production from one year to the next (DeGraaf et al. 2006).

Large Diameter Trees

Hardwood trees of at least 24 inches diameter at breast height (DBH) and softwood species of at least 20 inches DBH offer nest sites, perches, and places to forage for a number of forest birds, including Red-shouldered and Broad-winged Hawks . Large trees with cavities and large dead branches enhance the habitat for many forest birds (see *Dead Standing Trees and Cavity Trees*) . **Where possible, retain a component of large diameter trees** (DeGraaf et al . 2006, Newell and Rodewald 2011) . **If none are present, select some smaller ones to leave and become large diameter wildlife trees in the future** (DeGraaf et al. 2006).

Photo: Nicholas A. Tonelli, Flickr/CC

Large diameter trees

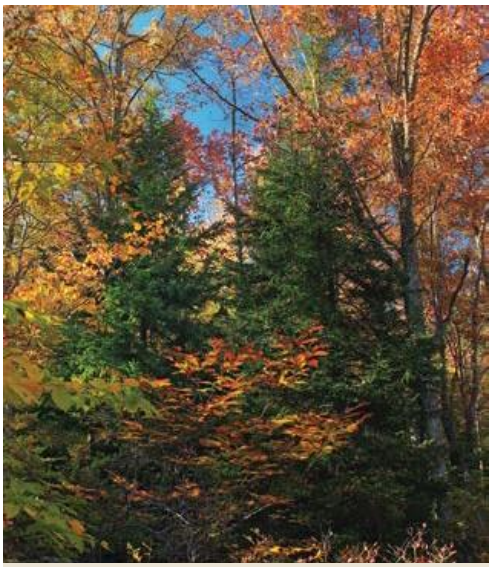


Photo: Nicholas A. Tonelli, Flickr/CC

Forest with a small group of softwoods

Softwood Inclusions

Conifer trees provide birds with cover and foraging habitat, and some species preferentially select softwoods for nesting . In particular, there are a number of forest birds that are associated with eastern hemlocks, and some species, such as Blue-headed Vireos, Northern Saw-whet Owls, Hermit Thrushes, and Black-throated Green Warblers, are strongly associated with hemlocks (Yamasaki et al. 2000). To benefit forest birds, **retain and/or promote at least some softwoods where they occur, especially within predominantly hardwood stands** (DeGraaf et al . 2006) . **Even a cluster of trees of less than an acre in size has high habitat value to forest birds** (Yamasaki et al. 2000, DeGraaf et al. 2006).

Dead Standing Trees and Cavity Trees

Dead standing trees or "snags" provide locations for nesting, roosting, and foraging for insects. Cavity trees of all sizes provide nesting and roosting sites for birds. Keeping a range of size classes of snags and cavity trees (living or dead) is desirable, but the larger the better (Tubbs 1987, Yamasaki and Leak 2006). For snags, hardwood species of sawtimber or large sawtimber size will provide the best long-term habitat value as dead standing wood, and eventually as coarse downed woody material when they fall (Yamasaki and Leak 2006). **Where you can do so safely, retain at least six snags or cavity trees per acre, with one ≥ 18 inches DBH, and three ≥ 12 inches DBH** (Tubbs et al. 1987, Hagan and Grove 1999, DeGraaf et al. 2006, Bryan 2007, Bennett 2010, Hagenbuch et al. 2011). If this minimum cannot be met, identify and retain trees that have defects that may develop into cavities over time or create snags through girdling or other methods. In clearcut or seed tree sites, keep some cavity trees and snags as reserves (Hagan and Grove 1999, Bennett 2010).

Downed Woody Material (DWM)

DWM or coarse woody debris includes logs, stumps, and large branches (Bennett 2010). DWM enhances habitat for forest birds by providing places to seek cover, perch, nest, and forage. Larger downed logs (> 18 inches diameter) provide especially important habitat structure for birds and other wildlife that forage or nest on or near the forest floor, and larger logs are used for drumming displays by Ruffed Grouse (Bennett 2010, Hagenbuch et al. 2011). In areas where deer densities are excessively high, leaving slash may deter deer browsing and benefit forest regeneration, as it provides an obstacle that prevents deer from reaching seedlings and saplings. **Protect existing DWM during harvest operations and increase DWM by leaving poor quality logs and cull material, tree tops, or other slash scattered throughout the stand rather than left in a large pile** (Hagan and Grove 1999). **Providing DWM of different size classes and stages of decay is ideal** (Hagan and Grove 1999, DeGraaf et al. 2006, Bennett 2010, Hagenbuch et al. 2011).

Photo: Matt MacGillivray, Flickr/CC

Red-bellied Woodpecker in a dead cavity tree

Photo: Suzanne Treyger

Downed woody material

Photo: Nicholas A. Tonelli, Flickr/CC

Maple seedling in deciduous leaf litter

Leaf Litter and Duff

Leaves, needles, and other decomposing vegetative materials offer foraging habitat for macroinvertebrates, such as worms and beetles. Moist leaf litter has high habitat value to Wood Thrushes, Ovenbirds, and other ground foragers and nesters. To protect the leaf litter layer, limit trails to no more than 10% of the total stand area, and confine skidding and vehicle traffic to these carefully located trails (R. Nyland personal communication). **When possible, avoid harvest operations during times with saturated soils, when rutting and soil compaction may compromise soil structure and drainage** (Leak et al. 2014).

EXAMPLE STAND 1

Stand Description

- 30–50 year old stand; even-aged, fully stocked; "mature" forest habitat from a bird perspective
- Over 50% UGS
- Mixed hardwoods with a high density of American beech in the understory
- Little to no non-beech understory/regeneration

Landscape Context 1

- 5–10% or more of the landscape surrounding this stand is already in a young forest condition

Silvicultural Prescription 1

- *Thinning with Group Selection*

Bird Habitat Objective: Because there is already enough young forest in the landscape, the "mature forest" conditions of this stand should be retained and improved, focusing on increasing vertical structural diversity by retaining short trees and establishing additional understory vegetation.

Thinning to increase vertical structural diversity and improve habitat for birds and other wildlife should retain trees of overtopped positions, thin the main canopy, and create small canopy openings that will foster establishment of understory regeneration (R. Nyland personal communication). This will keep the short trees alive, and also help to create new subcanopy layers that increase understory structure (R. Nyland personal communication). The crown thinning should maintain a relatively closed canopy (≥70%) except for creating small openings scattered throughout the stand to avoid uniform spacing and instead mimic natural disturbances (Leak et al. 2014, Nyland 2016).

According to timber management goals, identify and retain Acceptable Growing Stock (AGS), and cut the patches by removing poor quality trees adjacent to AGS – similar to a crop-tree release (Leak et al. 2014).

Understory American beech may need some control treatment to promote the regeneration of other species, helping to increase stand diversity. Care should be taken to identify and retain main canopy beech trees that may be resistant to beech bark disease so they reach reproductive maturity and produce beech nuts, an important hard mast crop for birds and other wildlife.

Photo: Suzanne Treyger

Keep in mind: Additional within-stand habitat features are detailed in *Forest Habitat: Stand-level Conditions*. Where possible, retain DWM, large diameter trees, snags and cavity trees, control invasive plants, and manage for softwood inclusions where they are lacking or limited. See Table 2 for a list of species that will benefit from the "mature forest" habitat created by this management.

Landscape Context 2

- Less than 5% of the landscape surrounding this stand is in a young forest condition

Silvicultural Prescription 2

- *Clearcut with Reserves*

Bird Habitat Objective: Because there is a need for more young forest in this landscape, even aged silviculture can be applied to the stand in support of the goal of having up to 10% young forest conditions in the forested landscape.

A clearcut with reserves (<10 ft2/acre residual basal area or 10–15% canopy closure) may be a viable option to create young forest by regenerating desirable species (including shade intolerant species) (Tubbs et al. 1987, Leak et al. 2014, Smetzer et al. 2014). It is important to control understory beech either before or after the overstory cutting. Depending on the size of the stand and the timber management goals, the cutting might create several small clearcuts across the stand, although openings should be at least 5 acres in size to accommodate breeding territories and area sensitive young forest species like Prairie Warblers (Costello et al. 2000, Alterman et al. 2005, DeGraaf et al. 2005, Chandler et al. 2009, Shake et al. 2012, Yamasaki et al. 2014).

Avoid creating hard and straight edges and aim for a more natural disturbance look, with rounded boundaries and feathered edges (Rodewald 2013, Nyland 2016). Reserve trees or patches should contain desirable seed trees, cavity trees, snags, and softwood inclusions if present (Leak et al. 2014, Nyland 2016). Reserve trees also serve as perch trees, an important habitat feature for some young forest birds. Reserve patches should be at least 0.25–0.5 acre in size for every 10 acres of a clearcut, or approximately 5% of the total area cut (Bennett 2010). Regeneration of shade- intolerant soft mast producing species, such as cherries and *Rubus* spp., will be beneficial to birds and other wildlife (Yamasaki et al. 2014).

Photo: Suzanne Treyger

Keep in mind: Additional within-stand habitat features are detailed in *Forest Habitat: Stand-level Conditions*. Where possible, retain cull or low-grade logs as DWM and control invasive plants.

Photo: Alex Galt USFWS Midwest, Flickr/CC

White-tailed Deer: Deer densities are high throughout much of New York, and subsequent overbrowsing of tree seedlings and saplings can lead to unsuccessful forest regeneration after an even-aged harvest. Monitoring regeneration response is recommended, and additional safeguards, such as installing deer fence around the harvest site, may be necessary.

Table 1. Audubon NY Priority Forest Birds that may benefit from the forest management recommendations included in this guide, their preferred nesting habitat, post-fledging habitats used, and habitat descriptions and special habitat features of significance that foresters can influence through silviculture (see *Forest Habitat: Stand-level Conditions* for detailed information). Species in red are New York State Species of Greatest Conservation Need (for more information, please visit: http://www.dec.ny.gov/animals/9406.html).

SPECIES	NESTING HABITAT	POST-FLEDGING HABITAT	HABITAT DESCRIPTION AND SPECIAL HABITAT FEATURES
Acadian Flycatcher	Multiple age classes	Young forest/ dense understory	Wet deciduous thickets
American Goldfinch	Young forest	Young forest	Open forest, thickets
American Redstart	Young forest	Young forest	Canopy gaps in deciduous forest, thickets and shrubs
American Woodcock	Young forest	Young forest	Wet thickets adjacent to clearings and intermediate aged forest
Baltimore Oriole	Multiple age classes	Young forest	Deciduous and mixed open forest, large diameter trees
Black-and-white Warbler	Multiple age classes	Young forest	Deciduous and mixed forest, downed woody material, leaf litter
Black-billed Cuckoo	Young forest		Deciduous and mixed forest, thickets
Blackburnian Warbler	Mature forest	Young forest/ dense understory	Coniferous and mixed forest, large diameter trees
Blackpoll Warbler	Multiple age classes		Coniferous, spruce-fir forest
Black-throated Blue Warbler	Mature forest	Young forest/ dense understory	Deciduous and mixed forest, dense understory
Black-throated Green Warbler	Mature forest	Young forest/ dense understory	Coniferous and mixed forest, large diameter trees
Blue-winged Warbler	Young forest	Young forest	Deciduous forest
Broad-winged Hawk	Mature forest		Deciduous and mixed forest, large diameter trees, forest openings
Brown Thrasher	Young forest	Young forest	Deciduous and mixed forest, thickets, leaf litter
Canada Warbler	Young forest	Young forest	Moist mixed forest, softwood inclusions, downed woody material, leaf litter, dense understory
Cerulean Warbler	Mature forest		Deciduous forest, large diameter trees, canopy gaps and open understory
Chestnut-sided Warbler	Young forest	Young forest	Deciduous forest, thickets
Cooper's Hawk	Mature forest		Deciduous and mixed forest, canopy gaps and other large forest openings
Downy Woodpecker	Multiple age classes	Young forest	Deciduous forest, snags/cavity trees
Eastern Towhee	Young forest	Young forest	Deciduous and mixed forest, leaf litter
Eastern Whip-poor-will	Multiple age classes		Deciduous and mixed forest, canopy gaps and other large forest openings

SPECIES	NESTING HABITAT	POST-FLEDGING HABITAT	HABITAT DESCRIPTION AND SPECIAL HABITAT FEATURES
Eastern Wood-Pewee	Mature forest	Multiple age classes	Deciduous and mixed forest, canopy gaps and other large forest openings
Evening Grosbeak	Multiple age classes		Coniferous and mixed forest, large diameter trees, softwood inclusions
Golden-winged Warbler	Young forest	Multiple age classes	Deciduous forest, clumps of shrubs and perch trees
Hooded Warbler	Multiple age classes	Young forest	Deciduous forest, large diameter trees, dense understory, leaf litter
Least Flycatcher	Mature forest	Young forest	Deciduous and mixed forest, canopy gaps and other large forest openings, large diameter trees
Louisiana Waterthrush	Multiple age classes	Young forest	Deciduous forest, fast-moving streams and brooks, downed woody material, leaf litter
Northern Flicker	Multiple age classes		Deciduous and mixed forest, open forest, cavity trees
Northern Goshawk	Mature forest		Mixed forest, canopy gaps
Northern Saw-whet Owl	Multiple age classes		Coniferous and mixed forest, snags/cavity trees
Olive-sided Flycatcher	Young forest		Coniferous forest, open forest, snags
Prairie Warbler	Young forest	Young forest	Coniferous and mixed forest, softwood inclusions
Prothonotary Warbler	Mature forest		Forested swamps or forests near ponds, lakes, or slow-moving rivers, snags/cavity trees
Purple Finch	Multiple age classes		Coniferous and mixed forest
Red Crossbill	Mature forest		Coniferous forest
Red-shouldered Hawk	Multiple age classes		Deciduous and mixed forest, large diameter trees, open understory
Rose-breasted Grosbeak	Young forest	Young forest	Deciduous or mixed forest
Ruffed Grouse	Young forest	Young forest	Deciduous and mixed forest, downed woody material
Scarlet Tanager	Mature forest	Young forest/dense understory	Deciduous and mixed forest, large diameter trees, canopy gaps, softwood inclusions, dense understory
Sharp-shinned Hawk	Mature forest		Coniferous and mixed forest, softwood inclusions
Veery	Young forest	Young forest	Moist deciduous forest, leaf litter, dense understory
Willow Flycatcher	Young forest		Deciduous thickets
Wood Thrush	Mature forest	Young forest/dense understory	Deciduous and mixed forest, large and small diameter trees, presence of midstory layer, leaf litter
Worm-eating Warbler	Mature forest	Young forest/dense understory	Deciduous forest, dense understory, downed woody material, leaf litter
Yellow-billed Cuckoo	Multiple age classes		Deciduous forest, brushy thickets
Yellow-throated Vireo	Multiple age classes	Young forest	Deciduous forest, large diameter trees

Chapter 7: Soils, Streams, and Roads

7.1 Understanding Soils

How to Use Soils information for Woodlot Management

Peter Smallidge, NYS Extension Forester and Director, Arnot Teaching and Research Forest,
Department of Natural Resources, Cornell University Cooperative Extension, Ithaca, NY 14853.

Support for ForestConnect is provided by the Cornell University College of Agriculture and Life Sciences and USDA NIFA.

An understanding of forest soils will help owners manage their woods for improved tree health and more efficient growth of trees. Forest soils should be thought of as a living layer or mantle that allows for trees to be anchored to the earth and obtain necessary minerals and water. The mantle includes layers, called horizons, with the upper most being the organic horizon often called the "duff." Below the organic horizons are the mineral horizons, and usually far below the surface is the parent material or bedrock. The science of soils is as complex as the science of forestry or the science of biology; this article will only scuff the surface of the influence of soils on trees and woodland management.

The characteristics of soils important for woodlands include their texture, organic matter, and pH. Texture is the size of the soil particles that might include some combination of fine clay, medium silt, and coarse sand. Organic matter particles in the mineral horizons help hold or bind the nutrients such as calcium and magnesium that are necessary for tree growth. Micro-organisms and invertebrates (e.g., fungi, bacteria, centipedes) are dispersed throughout the organic layers, and play important roles in decomposition. Texture and organic matter, plus other factors, influence the moisture holding capacity of the soil. The soil's pH describes soil acidity and influences the availability of nutrients. These three characteristics of soils will impact which trees occur in an area, how well they grow, the limitations imposed on certain woodland operations, and the opportunities for other types of woodland operations.

Most forest stewardship plans include a discussion of forest soils. Unfortunately, most of these discussions are of limited utility to the owner, or to anyone lacking a strong background in soil science. These discussions often mention the name of the soil series, the depth of the soil horizons or layers, and perhaps some chemical attributes of the soil. A partial example of such a soil description from a stewardship plan might read:

> "*These loams belong to the Mardin series of soil, and are most commonly found in previously glaciated areas, specifically on broad hilltops and slopes that range between 0% and 50%. They are well-drained soils with a dense*

Figure 1. *The Web Soil Survey is an online tool that provides an abundance of information about the physical and chemical properties of soils, and the impacts of soils on woodland management.*

fragipan that begins 14 to 26 inches below the soil surface."

This information can easily be found in the county's soil survey (paper copy) or the more widely available Web Soil Survey (WSS, Figure 1) produced by the Natural Resources Conservation Service (www.websoilsurvey.nrcs.usda.gov).

Specific information is also available in the WSS that would be more useful to most landowners. Information is available, for example, to address how different tree species respond to the soil, if soil conditions might limit the building of roads or landings and if the soils are prone to drought or poor drainage of moisture. If a tree species is suited to a particular soil it will have better health, better growth, and recover more quickly after a stressful event than a species that is growing "off-site." One indicator of whether a tree is suited to a particular soil is the tree's site index on that soil. Site index is the expected height of a tree species at a specific age, usually 50 years old. As an illustration, if a tree species growing on a given soil type has a site index of 65, we would expect an upper canopy tree of that species to be approximately 65 feet tall when the tree is 50 years old. To further illustrate, if sugar maple has a site index of 55 on one soil and 70 on another soil, the latter soil is better matched to the needs of sugar maple resulting in a tree that will grow better and have fewer problems with health. WSS provides the full range of information about the physical and chemical properties of soils.

Woodland owners now have access to two complementary and free resources on the Internet they can use to understand the soils on their property. One resource is WSS, as previously mentioned. WSS is a database of soils information for all lands in the US. An owner can create a map of their property and a list of all the soils (Figure 2). WSS allows the owner to generate a table of soils, and the characteristics of each soil type. A

Map Unit Legend

Tompkins County, New York (NY109)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BgC	Bath and Valois soils, 5 to 15 percent slopes	0.9	4.0%
EbB	Erie channery silt loam, 3 to 8 percent slopes	11.4	49.8%
ErA	Erie-Chippewa channery silt loams, 0 to 3 percent slopes	3.2	14.1%
LaB	Langford channery silt loam, 2 to 8 percent slopes	7.4	32.1%
Totals for Area of Interest		**22.9**	**100.0%**

Figure 2. *This figure shows an example of a soil map for a woodlot in Tompkins County, NY. The soil map legend references the map codes and the acreage in the mapped area, known as the Area of Interest (AOI).*

second resource is Google Earth Pro (www.google.com/earth). Google Earth Pro (GEP) provides recent and historic satellite images of the earth. GEP also includes tools that allow a woodland owner to draw and save property and stand boundaries, determine the area of mapped units, draw lines, measure distance, and more. Better still, WSS can be integrated into GEP with minimal effort.

A blog about using WSS and GEP is available at www.CornellForestConnect.ning.com and includes several videos on how to use and integrate these resources, and then how to use them. WSS and GEP are powerful tools, and as with all powerful tools plan to spend some time learning how to use them for optimal success.

Tables — Forest Productivity (Tree Site Index): black cherry (Defler 1937 (750)) — Summary By Map Unit

Summary by Map Unit — Tompkins County, New York (NY109)

Map unit symbol	Map unit name	Rating (feet)
BgC	Bath and Valois soils, 5 to 15 percent slopes	75
EbB	Erie channery silt loam, 3 to 8 percent slopes	65
ErA	Erie-Chippewa channery silt loams, 0 to 3 percent slopes	65
LaB	Langford channery silt loam, 2 to 8 percent slopes	75
Totals for Area of Interest		

Figure 3. *WSS allows the user to select a tree species to generate a table of site index values for species commonly found on those soils. Site index values are found in WSS under the tab for Soil Data Explorer, and then within vegetative productivity.*

A simple example of a woodlot in Tompkins County, NY will illustrate some of the ways to use soil information from WSS (Figure 2). This woodlot has four different types of soils, which WSS refers to as soil map units. The two most abundant units based on the area of interest (AOI) are Erie and Langford soils. The WSS tab for "Soil Data Explorer" allows the owner to learn the site index of specific trees (Figure 3). This example for black cherry shows that the Bath and Langford soils have a better site index than the other soils, though all are fairly good. Similarly, the soils are rated for suitability for a log landing (Figure 4) based on slope, soil strength, wetness, and potential for dust.

Tables — Suitability for Log Landings — Summary By Map Unit

Summary by Map Unit — Tompkins County, New York (NY109)

Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)
BgC	Bath and Valois soils, 5 to 15 percent slopes	Moderately suited	Bath (40%)	Slope (0.50)
				Low strength (0.50)
				Dusty (0.01)
			Valois (35%)	Slope (0.50)
				Low strength (0.50)
				Dusty (0.01)
			Langford (5%)	Slope (0.50)
				Low strength (0.50)
				Wetness (0.50)
				Dusty (0.01)
			Mardin (5%)	Low strength (0.50)
				Wetness (0.50)
				Dusty (0.01)
EbB	Erie channery silt loam, 3 to 8 percent slopes	Poorly suited	Erie (75%)	Wetness (1.00)
				Low strength (0.50)
				Slope (0.50)
				Dusty (0.02)
ErA	Erie-Chippewa channery silt loams, 0 to 3 percent slopes	Poorly suited	Erie (60%)	Wetness (1.00)
				Low strength (0.50)
				Dusty (0.01)
			Chippewa (30%)	Wetness (1.00)
				Low strength (0.50)
				Dusty (0.01)
			Chippewa, very poorly drained (5%)	Low strength (1.00)
				Ponding (1.00)

Figure 4*. One example of how management is influenced by soils are the potential for a soil to serve as a log landing. Log landings need soils that are fairly stable, not overly rocky, and relatively dry. The ratings for log landing suitability take these and other factors into consideration.*

Another example illustrates additional information available to woodland owners. After creating the area of interest (AOI), select the tab for "Soil Data Explorer" and the "Forestland" option as the manner to view soils information (Figure 5). Soil Data Explorer includes a tab for "Suitabilities and Limitations" and information on many subjects such as land classification and vegetative productivity. Information about the potential for windthrow is based on an assessment of the depth to a dense layer, depth to bedrock, and depth to a saturated layer (Figure 6). A visualization of the moderate vs. high ratings for potential windthrow allow the owner to modify cutting practices to reduce the exposure of trees on the more vulnerable soils (Figure 7).

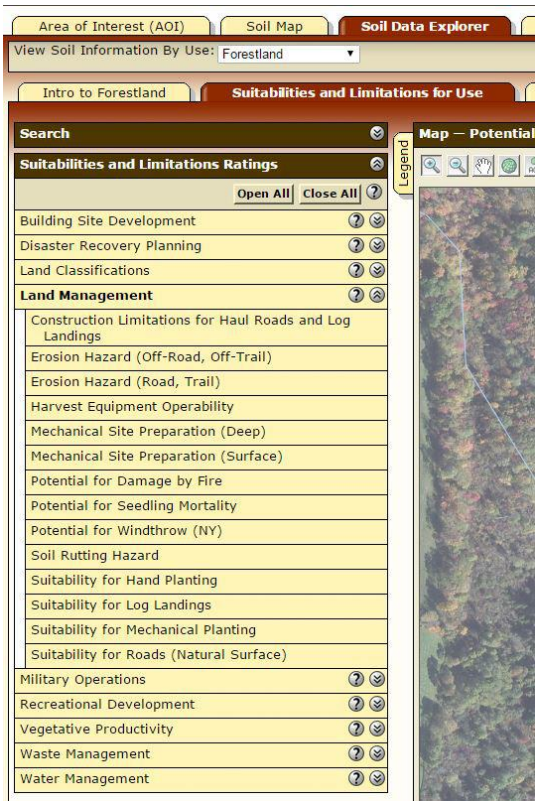


***Figure 5**. Within an area of interest, forestland soil information is provided for a variety of topics such as potential for windthrow, harvest equipment operability, and rutting hazard.*

Considering again the stewardship plan, what soil characteristics should be included? The simple answer are those that relate to the objectives of the owner. Examples of soil characteristics that might be of interest to many owners include the following:

Within "Suitabilities and Limitations"

- Soil rutting
- Potential for windthrow
- Paths and trails (look within recreational development)
- Harvest equipment operability
- Potential for seedling mortality

Within "Soil Properties and Qualities"

- pH and Cation Exchange (within soil chemical)
- Available water (within soil physical)
- Drainage class (within soil qualities and features)

Finally, the tab for "Soils Report" allows owners to inspect integrated summaries of related soil characteristics. For example, information is aggregated for tree planting and harvesting because these often involve machines.

A couple points are worth noting for the use of the WSS and GEP soils resources in your woodland management. First, the ratings are based on the general properties of a soil type and

Tables — Potential for Windthrow (NY) — Summary By Map Unit

Summary by Map Unit — Tompkins County, New York (NY109)

Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
BgC	Bath and Valois soils, 5 to 15 percent slopes	Moderate	Bath (40%)	Depth to dense layer (0.08)	1.0	4.0%
			Valois (35%)	Depth to dense layer (0.17)		
			Langford (5%)	Depth to dense layer (0.87)		
				Depth to saturated zone (0.20)		
			Mardin (5%)	Depth to dense layer (0.91)		
				Depth to saturated zone (0.20)		
			Lordstown (5%)	Depth to bedrock (0.50)		
EbB	Erie channery silt loam, 3 to 8 percent slopes	High	Erie (75%)	Depth to saturated zone (1.00)	11.0	46.0%
				Depth to dense layer (0.98)		
ErA	Erie-Chippewa channery silt loams, 0 to 3 percent slopes	High	Erie (60%)	Depth to saturated zone (1.00)	3.3	14.0%
				Depth to dense layer (0.98)		
			Chippewa (30%)	Depth to saturated zone (1.00)		
				Depth to dense layer (1.00)		
			Chippewa, very poorly drained (5%)	Depth to saturated zone (1.00)		
				Depth to dense layer (1.00)		
LaB	Langford channery silt loam, 2 to 8 percent slopes	Moderate	Langford (75%)	Depth to dense layer (0.87)	8.6	35.9%
				Depth to saturated zone (0.20)		
Totals for Area of Interest					23.8	100.0%

***Figure 6**. The details of the additional information, here windthrow, describes the attributes of the soil that predict a soil to more or less vulnerable. If a soil is vulnerable, the cause of the vulnerability may indicate if and how remediation is possible.*

projected onto a specific owner's property. Although the soil maps are usually accurate, there may be variation between the map and what the owner finds on the ground. It is prudent to spend some time in the woods to verify the maps. Second, understanding the estimates of the soil properties may require a discussion with your forester or staff at the local Soil and Water Conservation District and comparison among different parts of your property. For example, unless you know the significance of a site index of 55 versus 70, the numbers don't mean much. Finally, a soil map unit might have a low rating for some condition, but the location of that unit might be the best option available to an owner. For example an owner may be confronted with a wet rating for a potential log landing; however, there might be management strategies to mitigate this limitation such as summer logging on dry ground or winter logging on frozen ground.

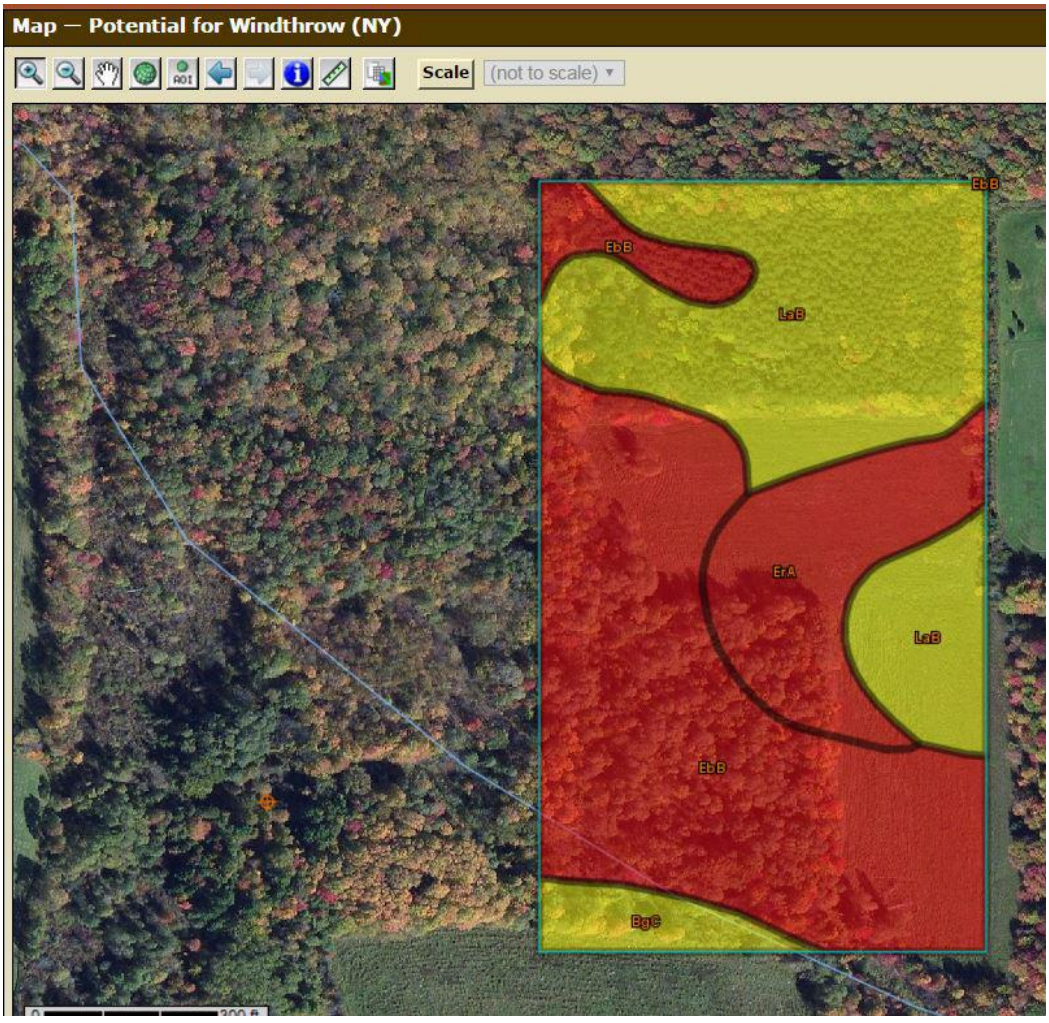


Figure 7. *The soil map units illustrate the areas of high windthrow risk such as those in the southwest portion of the Area of Interest.*

7.2 Access, Roads, and Water Management

The following is an excerpt from the New York State Forestry Voluntary Best Management Practices for Water Quality 2018. The full document has been uploaded to the Cornell Maple Program website.

Introduction

Protecting our natural resources is a critical part of a successful timber harvest. Studies have shown that timber harvesting is not a major cause of water quality problems. However, the forest truck roads, skid trails, and landings used to remove trees from the forest are vulnerable to erosion. Erosion can damage or destroy these access systems making it more expensive or impossible to use them in the future. Sedimentation—caused when the eroded soil finds its way into a stream, wetland, pond, or lake—can damage fish and other wildlife habitat as well as drinking water supplies. These problems can trigger a negative reaction from neighbors and the general public, and they may violate state or local water protection laws. They've also led to local timber harvesting ordinances. A good way to avoid controversies and restrictions on timber harvesting is to use Best Management Practices (BMPs).

BMPs are simple techniques you can use on your timber harvest to protect our natural resources. BMPs are designed to:

- Protect water quality by minimizing erosion and surface water run-off.
- Maintain hydrologic processes by limiting disturbances to water flow patterns.
- Maintain water temperature along shorelines and streambanks.
- Protect nutrient balances in the soil.

Ultimately, BMPs help keep forests healthy and maintain public support for timber harvesters and forest management.

This field guide is a practical tool for loggers, foresters, woodlot owners, and others involved in harvest operations. It provides a menu of options to give professionals the flexibility they need to make decisions in the field.

BMPs aren't just something you do at the end of a job. They're a mindset, an approach to the whole timber harvesting process that respects the land. That's why this guide is organized by time, with different BMPs to consider before, during, and after the harvest.

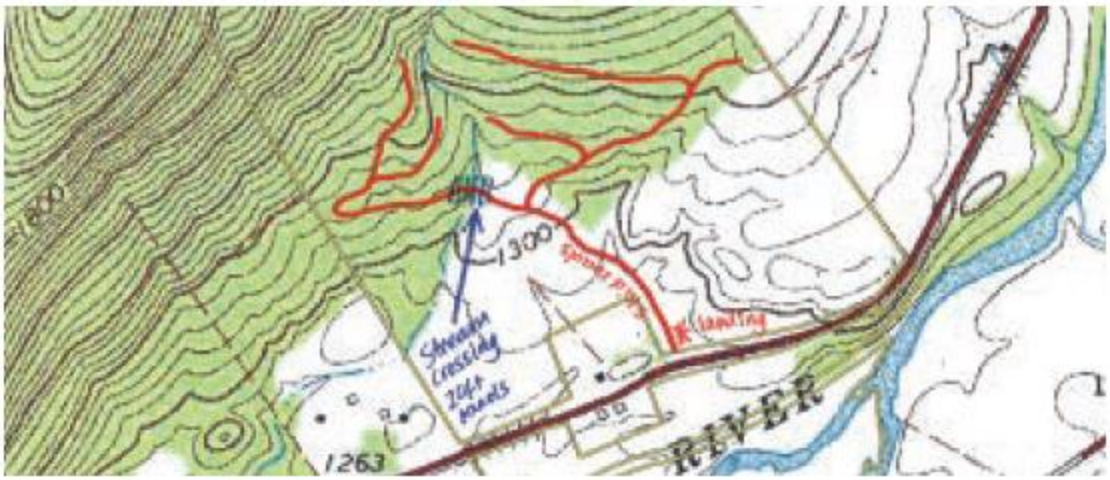
The BMPs in this guide are compliant with *Section 319 of the 1987 Amendment to the Clean Water Act* as well as the EPA-approved *New York State Nonpoint Source Pollution Management Plan*. That plan outlines a voluntary, education, and promotion-based approach to implementing BMPs.

This field guide focuses on water quality. BMP manuals from other States may include guidelines to protect other forest values such as visual quality and wildlife habitat. These values are also important, but they are not the focus of this guide.

This field guide has not been designed to provide a required standard for use in enforcement. It is not a regulatory handbook. It does not present a single prescription that can or should be applied in all cases. The ultimate objective is to have a safe, economically viable timber harvest that protects water quality.

Before the Harvest: Introduction

Planning a harvest is the most important BMP. Timber harvesting should follow a plan that protects soil and water. The thoughtful layout of skid trails, landings and truck roads will provide complete access while minimizing erosion and sedimentation. Proper layout also reduces the number of BMPs required to stabilize the site following operations, saving time and money.



The remainder of this valuable document goes through considerations to be made Before the Harvest, During the Harvest, for Stream Crossings, and After the Harvest. It includes information on how to locate and protect, roads, trails, and landings, and it goes into detail about Riparian Management Zones, wetlands, seeps, and vernal pools. It is also a great resource for choosing the best short-term erosion control techniques for your site. This document deserves a closer look whether preparing for a harvest or managing the after effects of a harvest on your roads and streams.

Chapter 8: Property

8.1 Boundary Lines – excerpted from NYFOA 50:2 March/April 2012

Ask A Professional

PETER SMALLIDGE

Peter Smallidge

Landowner questions are addressed by foresters and other natural resources professionals. Landowners should be careful when interpreting answers and applying this general advice to their property because landowner objectives and property conditions will affect specific management options. When in doubt, check with your regional DEC office or other service providers. Landowners are also encouraged to be active participants in Cornell Cooperative Extension and NYFOA programs to gain additional, often site-specific, answers to questions.

To submit a question, email to Peter Smallidge at pjs23@cornell.edu with an explicit mention of "Ask a Professional." Additional reading on various topics is available at www.forestconnect.info

Licensed professional land surveyors use a variety of tools and their extensive training to locate and map the boundaries of woodland properties.

Question

We own our property primarily as a retreat, but also for recreation and firewood. We heard about marking our property lines, but don't know if we should or how to mark the lines.

Answer

Woodland owners cherish their woodlands and forests. They often seek numerous benefits from their property, including as a retreat, a place to work the land, for collecting maple sap for syrup, timber, wildlife, privacy, and recreational opportunities. In almost all circumstances, the ability of the woodland owner to fully and continuously enjoy the benefits of their property requires that they know and mark their property boundary. Marked property boundaries define your property from your neighbors and establish a legal structure that helps protect your interests.

Two examples will illustrate the value of marked boundaries. With a marked boundary, a timber harvest on the neighbor's property is less likely to accidentally include timber from your property. A clearly marked line is appreciated by neighbors, loggers and foresters, and helps keep honest people honest. A timber thief who steals trees from an owner with a marked boundary cannot effectively use their ignorance of the property line to explain their actions. Similarly, people who are recreating or hunting on a property with marked boundaries are less likely to stray onto the neighboring property and potentially aggravate the neighbor.

Boundary marking establishes a legal structure on your property. As a legal structure, certain NY laws will apply. If you have additional questions about the practices or legal details concerning boundary marking, contact a licensed land surveyor, a DEC Environmental Conservation

A corner monument, in this case rocks that bury a 4 foot iron pipe, is marked using three blazes in vertical sequence and painted with a bright fluorescent color.

Blazes on a tree indicate the proximity of the tree to the boundary line. In this case, the tree is blazed and painted to indicate it is within one foot of the boundary line.

Officer, or Forest Ranger if your property is adjacent to NYS Forest Land or Forest Preserve.

Before marking your property boundary you need to know the location of the line. There are several advantages to having a licensed land surveyor determine the property lines and corners. Surveyors are trained to interpret property deed descriptions and have tools and experience to locate and mark property corners and boundaries. If the line is disputed in court a licensed surveyor will be most capable of defending their work. NY Licensed Land Surveyors can be found in the phone book, by recommendation from other NYFOA members or online at *www.nysapls.org*

Land surveyors can be hired to conduct a variety of tasks and simply requesting them to "survey your property" won't result in marked boundary lines. Ask the surveyor to also at least temporarily flag the boundary for you to blaze. A better request that adds minimally to the cost is to have the surveyor blaze and paint the boundary line. A blaze consists of removing a section of bark 30 to 40 square inches down to the wood. After the wood has dried, a permanent bright or fluorescent paint is used on the exposed wood and adjacent bark. Use caution when selecting a type of paint because some have the potential for fumes that can cause respiratory problems or can be an eye irritant. A blaze is a more permanent feature than a posted sign, but has a different legal implication. Posting is discussed further later in this article.

The process of blazing a property line previously established by a legal survey should begin by talking with your neighbor. Alert them to your plans, explain you will be using a legal survey on file with the county clerk, and describe how you will identify the line. Invite them to join you on the project. You can blaze a tree on your property, but talk with your neighbor about blazing trees on their property. They may allow blazing on low value trees, but to use only paint on species of higher value. Do not remove bark from a former blaze as that feature represents histor- ical evidence that establishes precedent for your legal boundary.

The position of the blaze on a tree depends on the location of the line. The convention is to place the blaze and paint facing the line. If a tree is truly a "line tree", or positioned so the boundary line runs through the tree, a blaze is positioned on opposite sides of the tree where the line would enter and exit the tree. With a line tree, the blazes may be in the center or off-center of the tree, depending on the location of the line. If the tree is on your property, the blaze and paint are on the side of the tree facing your neighbor's property. If the tree is on your neighbor's property, the blaze and paint are on the side of the tree facing your property. Typically paint and blaze are not applied to trees more then 3 to 5 feet away from the line. At the next NYFOA woods walk, talk with the owner and other participants about their experience with blazing trees on and near boundaries.

Marking the corner follows a slightly different convention. A permanent corner feature, such as a pipe or concrete monument, is demarcated by placing three blazes in a vertical sequence on one or more wit- ness trees, with the blazes facing the permanent feature. If the corner is a tree, the corner tree has blazes where the line enters and leaves the tree, and then one or more witness trees facing the corner tree. The species and size of the corner tree would likely be referenced in the written deed description.

Some Cooperative Extension publications suggest blazing into the wood and lifting a large splinter from the top of the blaze but that remains connected at the bottom of the blaze. This splinter will be evident in the blaze even as the callous tissue on the tree heals over the blaze. (see *http://extension.unh.edu/resources/representation/Resource000244_Rep263.pdf*) Other resources describe the process for locating and

continued on page 17

blazing lines (see *http://extension.umd.edu/publications/PDFs/FS619.pdf)*

The frequency of paint and blazes depends on the density of the vegetation. It is helpful to see one painted blaze from the previous blaze. Alternatively, try walking towards your property line and make sure you can see at least two blazes as you approach.

In the event of a timber theft, a journal entry describing annual maintenance of your property line will help your case. Most paint designed for boundary marking has a lifespan of 5 to 7 years. At a maximum, maintain your paint within this interval of time, but it is better to more frequently inspect your property lines to look for evidence of timber theft of other trespass. Tree marking paints are available through forestry equipment and supply dealers you can locate on the internet. On our property, our family tradition is to walk the line on July 4th and touch up the paint as needed. This helps reinforce the ownership of the property for our daughters and allows us to check on any neighbor activity that might affect our property.

In NY, a blazed and painted line does not equate to a "posted" boundary. There are valid reasons to post or not post your property. More information about how to legally post your boundary is available at *https://www.dec.ny.gov/lands/118436.html*

Although not equivalent to posting, a well maintained blazed and painted boundary indicates an owner who is attentive to their property and encourages potential visitors to ask permission before entering. If you post your property, you should also blaze and paint the lines.

Peter J. Smallidge is the NYS Extension Forester and Director Cornell University Arnot Teaching and Research Forest. He can be reached at email:pjs23@cornell.edu or visit his website at www.ForestConnect.info

Section 8.2: Leases

Cost/Benefit Analysis for Leasing Taps vs. Managing for Sawtimber Production

Michael Farrell, January 21, 2010

The following document describes the key variables in the decision of whether or not to lease a maple tree for tapping, harvest the tree immediately, or manage the tree for long- term commercial sawtimber production. A user can experiment with the spreadsheet, changing one variable at a time to see how the NPV analysis is affected. This document explains how changing the direction of any of the variables will affect the final analysis.

Tree Diameter

The smaller the initial diameter of the tree, the more likely it is that leasing for syrup production will be more profitable than managing for long-term timber production. From the forest owner's perspective, he/she should start leasing as soon as the tree is of minimum tapping size (conservative tapping guidelines state either 10 or 12" dbh whereas many producers will tap trees as small as 8" dbh). Smaller trees will not yield as much sap as larger ones, but since a landowner is paid by the tap and not the amount of sap collected, it really does not matter how much sap the tree actually produces.

Extent of Tapping Zone

The lower the height of the impact on the tree, the less impact on stumpage payments one can expect. Therefore, a landowner should request that a maple producer tap as low as possible, although in some years the snow depth necessitates high tapping.

Merchantable Height

How many possible sawlogs exist above the bottom 8 ft butt log will have an impact on the profitability of cutting immediately vs. leasing taps for many years and then cutting. If there are many sawlogs in a tree that is cut immediately, the additional stumpage value from those logs could easily tip the balance in favor of immediate timber production. However, if a pole sized tree is tall and straight with few lower branches, there are likely to be many sawlogs above the butt log once the tree reaches sawtimber size. In this case, delayed cutting will allow the tree to add significant value while allowing tapping will bring in revenues each year until the entire tree is ready to be harvested.

Growth Rates

Generally speaking, the slower a tree grows, the more likely it is that leasing taps will be more profitable than managing for commercial sawtimber production. This is due to the fact a landowner is receiving the same lease payment no matter how fast the tree is growing whereas the sawtimber value will increase rapidly if the tree is growing rapidly. For the same reason, if a landowner is considering harvesting a tree immediately vs. letting it grow for future sawtimber production, slower growth rates will also favor immediate cutting, especially when the trees are already above 16" dbh.

Stumpage Rates

The current and future stumpage rates for maple are highly volatile and largely unpredictable. The DEC publishes stumpage price reports twice a year, available at http://www.dec.ny.gov/lands/5259.html. Price fluctuations have a strong impact on the timing and level of timber harvest. Factors that would favor leasing include 1. low stumpage rates for maple logs 2. low price differentials between tapped and untapped logs

Log Scale

The three commonly used log scales in NY are Doyle, Scribner, and International ¼". I have used the formulas provided in Wiant, H. and Castandea, F. 1977. Mesavage and Girard's Volume Tables Formulated. Resource Inventory Notes No 4. March 1977. The Doyle scale is only used in the Eastern and Southern US- it underestimates board footage in small logs and overestimates in large logs. The Scribner rule is one of the oldest in existence; it assumes 1-inch boards and a 1/4-inch kerf, makes a liberal allowance for slabs, and disregards taper. The International l/4-inch scale uses a 1/8-inch kerf and is based on an analysis of the loss of wood fiber incurred in the conversion of saw logs to lumber.

Since the International ¼" estimates much higher volumes than Doyle or Scribner, using Int'l results in comparisons that favor immediate timber cutting over long term leasing. Doyle has the lowest estimates for bd ft volume whereas Scribner is much closer to the Int'l estimates. Therefore, using the Doyle scale is much more likely to result in comparisons that favor leasing taps while Scribner also has a slight advantage for leasing vs. Int'l.

Lease Payments

The higher the lease payment, the greater the likelihood that maple sugaring will be more lucrative than timber management over time. Also, the rate at which the payment increases over time will also affect the profitability

Diameter at which to start tapping and at which to add a second tap

The smaller the diameter of the tree when it is first tapped and when the second tap is added, the more profitable leasing will be for the landowner. Although overtapping could result in long-term declines in sap yield, it is very unlikely to kill the tree. Since a landowner normally receives the same price per tap no matter how much sap is produced, it is to the landowner's immediate financial advantage to start leasing trees as soon as possible.

Discount Rate

The rate used to discount future cash flows to their present values is a key variable of NPV analysis. Discounting future revenues is very important to equalize the revenue streams of leasing taps vs. managing for sawtimber production over time. Depending on the time horizon of the investment period and the year at which revenues appear, the discount rate that is applied will have a significant impact on the profitability of leasing taps vs. managing for commercial sawtimber production. Most landowners may consider using the alternative rate of return for their money as the discount rate when comparing tapping vs. timber over time. For instance, a landowner could cut a tree immediately and then put that money in an investment that will pay a certain rate of return each year (this anticipated rate of return is what should be used for the discount rate).

Generally speaking, the lower the discount rate, the more profitable leasing will be whereas high discount rates will result in immediate timber harvesting generating the highest NPV.

Agricultural Assessment

In New York State (and possibly others), landowners can receive an agricultural assessment and therefore reduced property tax payments by producing syrup themselves or leasing taps to another producer. The amount of tax savings will vary greatly depending on the assessed value of the forestland without ag assessment and the tax rate for that particular town. The greater the difference between regular taxes and ag assessment taxes, the more profitable leasing will be.

Determining the impact of this savings is best done on a per acre basis, however this analysis is being done on an individual tree basis. It is worth noting that in NY, landowners with at least 50 acres of forestland can also qualify for a tax break through the 480-A program. This program favors timber production, although it is likely that leasing for syrup production would also qualify under the program. However, very few landowners enroll in the program, as it is much more difficult to qualify, is expensive to get started, requires paying an excise tax of 6% whenever trees are harvested, and contains much stiffer penalties for withdrawing from the program and/or not following the management plan. Agricultural assessment only requires leasing 7acres of woodland, no management plan is required, and there is only a 5 year commitment with fewer penalties for withdrawing.

Time Horizon of the Investment Period

This is one of the most critical aspects of the leasing vs. timber management analysis. If one is looking for immediate revenues, cutting the timber will always be more lucrative for a landowner. However, the longer the time horizon a landowner is considering, the more likely it is that leasing taps will be more profitable. This is due to the fact that leasing taps results in annual revenues that are significantly lower than payments for timber harvesting; however, when added together these many small payments eventually add up to sums that are often times much larger than the stumpage payments.

The following pages contain three different examples of Sugarbush Lease agreements.

Sugarbush Lease Agreement

Section I. Contracting Parties, Description of Property and Term of Lease

1. This lease is made between _____, here in after called the Landowner, and _____, here in after called the Renter(s).

2. The Landowner, in consideration of the agreements with the Renter(s) here in after set forth, hereby leases to the Renter(s), maple trees to use for tapping and the production of maple sap and the right to transport such sap to a processing location herein described on the _____farm in the town of _____, New York, _____County, New York.

3. Description of lands included in this lease. (Include acreage, boundaries, perhaps as described on the current Farm Services Agency map.)
_____
_____
_____

4. This lease shall become effective on the first day of _____, 200 __, and shall continue in force until the last day of the month _____, 20____ . The renter(s) shall have the option to renew for a period of _____ year (s) after the first lease period, provided that the Landowner has not given notice of cancellation for cause, at least six months prior to the end of the current lease. The renter(s) shall advise the Landowner of intent to renew this lease not less than six months prior to the end of said lease.

Section II. Land Use

Maple trees and the leased premises shall be maintained by the Renter (s) in their present condition, or improved, and the yield of sap maintained or increased by up to date methods of tapping, installation of tubing, or tree thinning as recommended in the 2nd edition of the North American Maple Syrup Producers Manual. Any costs incurred shall be paid by the renter(s).

The following practices are mutually agreed upon:

1. The guidelines for tapping maple trees are as follows- 1 tap for trees 10-17" in diameter, 2 taps for trees $\geq$ 18" in diameter. Both the Landowner (s) and Renter (s) agree to this guideline and sign with their acceptance of this document.

2. Tap holes shall be made with tapping bits not greater than 5/16 inches in diameter for standard bucket tapping and those tap holes shall not be more than 2 inches deep. For new tubing installations or replacement tubing installations, taps shall be the so called "health spouts," or the small diameter spouts and shall not be drilled to a depth greater than two inches, including bark thickness.

3. Chemical sanitizers shall not be used, but proper practices to maintain tree health and reduce bacterial growth are encouraged.

4. Thinning of maple trees for sugarbush improvement may be carried out by the Renter(s), providing that the sugarbush has been marked for thinning by a professional forester, as described above. Such professional forester shall be mutually agreed upon by both the Landowner(s) and Renter(s) and shall be paid for by the Renter(s).

5. Sugar wood harvesting shall be allowed, provided that such trees are marked by a professional forester. Firewood cutting for sale shall not be allowed. Logging for personal use or sale shall not be allowed, except by mutual written agreement between the Landowner(s) and Renter(s).

6. Vehicles for use in tubing or bucket installation or sap gathering such as tractors, sleds or trailers shall be operated with care so to prevent damage and scaring to the bases and roots of all trees.

Section III. Time and Amount of Payment

The Renter shall pay to the Landowner the sum of _____ per tap in year one;
Year two _____; Year three _____; Year four _____; and Year five _____.
Tap count is agreed to be _____, therefore the total amount due before adjustment is $_____.

If the tap count is to be adjusted, payment for such adjustment shall be made with the second payment. The first half of such payment shall be made prior to the end of the calendar year (December 31), before the referenced sugaring season. The remaining half shall be paid upon the completion of the sugaring season, but not later than May 15 of said year. Deviations from this agreement, in reference to payment, shall be only with the mutual written agreement of both parties.

Section IV. Liability

The Renter(s) shall assume all responsibility and liability for accidents occurring to him or his employees and family members, or visitors, while engaged in the tapping of trees, gathering of sap, thinning, cutting and splitting of fire wood, and crossing of the Landowners land to get to or from the leased sugarbush. The Renter(s) shall obtain a premises liability policy covering the rented premises and shall provide a certificate of insurance, naming the Landowner as an additional insured, in an amount not less that $500,000, not later than January 1 each year of the lease. Failure to provide said certificate of insurance shall be just cause for lease cancellation at the sole option of the Landowner.

The Renter(s) shall be responsible for suppressing forest fires which may start while he is working on this property, and shall maintain all roads or fences in the same or better condition than as the initial lease.

The Renter(s) shall watch for any evidence of insect, disease, or rodent damage which might occur on the area and shall advise the Landowner of such damage.

Section V. The Landowner Agrees to:

1. Furnish the area described above and access to such area as described above, including the use of existing roads for the purposes of managing the leased area. The Landowner shall be responsible for maintaining easily identifiable boundaries.

2. Pay all taxes and assessments against the said property.

3. Keep cattle and sheep out of the area described above. Under no circumstances shall the sugarbush be pastured.

4. Include the provisions of this lease in any deed for sale of this land to another party so that it will be binding upon the new owner. The Renter(s) shall file a copy of this lease with the town clerk.

5. In the event that the Landowner(s) should decide to sell the property, he shall offer the Renter(s) an option to purchase at the appraised or asking price and give the Renter(s) a period of 45 days to provide the Landowner notice his/her intent.

Section VI. The Renter(s) Agrees to:

1. Follow approved management practices for the development of existing young maple trees into trees of the size to harvest sap from and to protect these trees from damage.

2. Furnish all labor, equipment, supplies and all operational expenses unless use of the Landowner owned equipment is specified elsewhere in this agreement.

3. To replace any firewood already cut and ready for use in the sugaring process with firewood of equal value and in the same amount not later than June 1 of the contract year.

4. Neither assign or sublet any of the land or property covered in this lease to any other person or persons without the express written permission of the Landowner.

5. The Renter(s) agrees to maintain liability insurance as set forth in the provisions of Section IV.

6. Remove all spouts from the trees in a timely manner and not later that May 15 of each year.

Section VII. Rights and Privileges:

The Landowner(s) or his designee shall have the right of entry at any time to inspect the property covered in this lease in respect to tapping, road maintenance, wood cutting or any other covered use of the property covered in this lease.

Section VIII. Enforcement of Agreements and Arbitration:

1. Failure of either party to comply with the agreements sent forth in this lease shall make him/her liable for damages caused by such non-compliance. Any claim by either party for such damages shall be presented, in writing to the other party, at lease 60 days before the termination of said lease.

2. If either or both parties of this lease die during the term of the lease, the provisions of this lease shall be binding upon the heirs, executors, and administrators.

3. Any disagreements between the Landowner and the Renter(s) shall be referred to an arbitration panel of three disinterested persons. One of whom shall be appointed by the Landowner, one by the Renter(s) and a third appointed by the two thus appointed. The decision of the arbitration panel shall be considered binding on the parties of this lease and enforceable by a court of law of competent jurisdiction. Any costs for such arbitration shall be shared equally by the Landowner and Renter(s).

Section IX. Other Agreements:

Any U.S.D.A. Farm Service Agency agreements or tax stabilization agreements with the town or state shall be respected and honored by both the parties of this lease.
Cost share payments received, during the term of this lease, from any Federal or State agency shall go to the party carrying out and paying for the work being done on the said leased property.

Section X. Signatures: This lease is binding on all parties signing, before this witness, on this day:

_____ Date _____
Landowner

_____ Date _____
Landowner

_____ Date _____
Public Notary Witness

_____ Date _____
Renter

_____ Date _____
Renter

_____ Date _____
Public Notary Witness

Originally prepared in January 2003 by
Larry Myott, UVM Extension Maple Specialist
Attorney Gregory Rainville, St. Albans, VT.
Contributing authors: George Cook, UVM Extension Maple Specialist
and George Buzzell, VT Department of Forests, Parks and Recreation

Updated September 2009 by
Michael Farrell, Director, Uihlein Forest
Cornell University Department of Natural Resources
157 Bear Cub Lane
Lake Placid, NY 12946
mlf36@cornell.edu
http://maple.dnr.cornell.edu
Office: (518) 523 9337 Cell: (518) 637 7000

SUGARBUSH LEASE AGREEMENT

Section 1. Date, Contracting Parties, Description of Property and Term of the Lease.

1. This lease is made this ___ day of _____ 20__, by and between (lessee), hereafter called the renter and (lessor) hereafter called the landowner.
2. The Landowner, in consideration of the agreements with the renter hereinafter set forth, hereby leases to the renter, to use the forest for tapping of sugar maple trees, to gather maple sap, and to transport said sap to a boiling point to produce maple syrup, the specific area herein described as (name of place) located in the Town of _____, County of _____, State of _____.
3. The description of the area included in this lease is the wooded land on which (name of place) is located as bounded on the east by the (description), to the north by the (description) and to the east (description) and to the south by the (description).
3. All sap collection activities will be confined to the wooded areas except a plastic line(s) will run from the woods to a tank(s) located at (description).
4. This lease shall become effective on the first day of (month), 20__, and shall continue in force until the first day of (month), 20__ with the renter having the option for renewal for an additional five years. The renter shall advise the Landowner by the first day of (month), 20__ of intent to renew the lease.

Section II. Land Use

1. It is the intent of both parties that the maple trees on the land covered by this lease agreement shall be maintained in their present condition or improved, and the yield of sap maintained or increased by methods of tapping and collection sap as recommended by the Cornell Maple Extension Specialist or designees.

2. The sugar maple, black maple and red maple trees shall be healthy and 10 inches diameter or greater at breast height to receive one tap hole per year. A tree 18 inches diameter at breast height or more can receive two taps and a tree greater than 24 inches at breast height can receive 3 taps. The number of tape holes per tree diameter guideline maybe reduced depending on the health of the tree.

3. Tap size shall be 5/16 diameter or less and holes drilled no greater than 2 and 1/2 inches deep.

4. Tubing system will be installed in such a way as to prevent any damage to the sugar maples as a result of the tubing installation itself. No nails, screws or other attaching devices will be fastened to the trees to attach the tubing.

5. Taps will not be “redrilled” or “reamed” after a long period between sap runs in order to expose new wood.

6. No timber harvesting or timber thinning will be conducted by either party unless agreed upon by both parties.

7. Periodic maintenance of the tubing system may be required due to limbs and trees falling to the ground from natural causes. In such cases a tree and or limb which has fallen on the tubing system may

be cut and removed to enable the initial routing of the tubing line(s).

8. Sap gathering vehicles will be limited to the hard surfaced entrances only. No motorized vehicles will be utilized within the woodlots except a small garden tractor to transport sap tubing into the woods upon initial installation of the sap tubing.

9. All equipment used for the collection of sap is furnished by and owned by the renter.

Section III Amount and Time of Payment

1. The renter shall pay the landowner the sum of $0. __ per tap hole per season. The payment shall be made on April 15 of each year the sugarbush is taped usually between February and early April.
2. It is estimated there are ____ taps covered by this agreement. The number of taps to be validated each year at time of taping by renter.

Section IV Liability

1. The renter shall assume all responsibility and liability for accidents occurring to him and his employees, or to visitors, while engaged in the tapping of trees, gathering of sap, washing tubing, repairing tubing or while crossing any other lands belonging to the landowner in the process of going to or coming from the area covered by this lease. The renter shall provide certificate of insurance in the amount of not less than $(dollar amount) no later than (month) 1, 20__.

2. The renter shall repair any damage that occurs to roads and fences resulting from the tubing installation and the sap collection process.

3. The renter shall watch for any evidence of insect, disease, or rodent damage, which may occur on the area and shall advise the landowner of such activity.

Section V The Landowner Agrees to:

1. Furnish the area described above.

2. Pay all taxes and assessments against the real-estate.

3. Allow the renter access to the area hereinbefore described as well as the use of any existing roads or trails for the purpose of installing and maintaining the tubing system.

4. Keep fenced cattle, sheep and other domestic animals out of the area described above, except as agreed by both parties. Utilization of trails for dog on leash, hiking, and recreational horseback riding is permitted

5. Include the provisions of this lease in any deed for sale of this land to another party so that it will be binding upon the new owner.

6. The landowner agrees to provide right of first refusal if the land is to be sold during the lease agreement to the renter.

Section VI. The Renter agrees to:

1. To protect the sugar maple trees from damage as may be caused by poor tubing installation techniques.

2. Neither assign this lease to any other person or persons nor sublet any part of the real-estate for any purpose without the written consent of the landowner.

3. The renter may terminate this lease at any time and is responsible for the removal from the premises of the sap collection tubing installation and equipment present in the sugarbush.

4. To provide an educational component in the sugarbush for use by _____ farm visitors to understand the use of forests in the production of maple syrup.

Section VIII. Rights and Privileges.

1. The landowner or anyone designated by him/her shall have the right of entry at any time to inspect the property and/or the taping, sap gathering, tubing installation, or other methods used.

2. The landowner or anyone designated by him/her shall have the right to use the property for use as recreational and educational activities. The tubing installation will be such as to minimize any impact on these current activities.

Section VIII Enforcement of Agreements and Arbitration.

1. Failure of either the Landowner or the Renter to comply with the agreements set forth in this lease shall make him/her liable for damage to the other party. Any claim by either party for such damages shall be presented to the other party, at least 10 days before the termination of the lease or yearly on April 15 which ever occurs sooner.

2. If either or both parties to this lease die during the term of the lease, the provisions of this lease shall be binding on their heirs, executors, administrators, and assign of the party or parties involved.

3. Any disagreements between the Landowner and the Renter shall be referred to a board of three disinterested persons, one of whom

shall be appointed by the Landowner, one by the Renter, and the third by the two thus appointed. The decision of these three shall be considered binding by the parties to this lease. Any costs for such arbitration shall be shared equally between the two parties to this lease.

Section IX. Signatures

Date_____ Landowner_____

Date_____ Renter _____

Date_____ Witness _____

Date_____ Witness _____

Written by:
Chuck Winship
64 Waterford Way
Fairport, N.Y. 14450
1-716-223-4619
October, 2000

References:

Cook, G., Myott, L., Buzzell, G.: Sugarbush Lease Agreement, January 4,1991

Goodrich, G., Goodrich, R.: 2000 Maple Tree Lease Agreement

No Author, Maple Sap Leasing Agreement, West Snowshoe, Vt. 05437

Sample Lease – Large Tract

_____ LANDS
SUGARBUSH LEASE #200x-__

AGREEMENT made this ___ **DAY OF _____, 200x** by and between

xxxxxxxxxx ("Landowner")
P.O. Box xxxx
City, State, Zip
and
XXXXXXXX ("Sugarbush Operator")
P.O. Box XXX
City, State, Zip

1. PERMISSION & UNDERTAKING: The Landowner does hereby grant to the Sugarbush Operator permission to enter upon and occupy in the manner and subject to the conditions and restrictions hereinafter stated, for a period of fifteen (15) years, between **JULY 1, 200x AND JUNE 30, 20xx,** upon the following described premises to tap sugar maple trees:

LAND OF THE GRANTOR IN xxxxxxxxx TOWNSHIP (TxRx xxxx), .

2. LEASE PAYMENTS: Sugarbush Operator will pay the Landowner a per tap lease rate (in U.S. dollars) as follows:

For tapping in 200x, lease rate of $0.xx/tap.
For tapping in 200x and 200x, lease rate of $0. xx/tap.
For tapping in 20xx and 20xx, lease rate of $0. xx/tap.
For tapping in 20xx and 20xx, lease rate of $0. xx/tap.
For tapping in 20xx and 20xx, lease rate of $0. xx/tap.
For tapping in 20xx and 20xx, lease rate of $0. xx/tap.
For tapping in 20xx and 20xx, lease rate of $0. xx/tap.
For tapping in 20xx and 20xx, lease rate of $0. xx/tap.

In subsequent leases, tap rates shall not increase more than $0.01 per tap per year.

3. TIME OF PAYMENT: The Sugarbush Operator will pay the annual tapping fee on or before June 1 of each year. Payments received after June 1 will be subject to a penalty of 1% of the amount due. Any payment received

after June 30 will result in the automatic termination of the lease. If for any reason the Sugarbush Operator uses less than 75% of the taps used the previous year, the Sugarbush Operator will pay the current lease rate based on the number of taps used the previous year.

4. RETENTION OF SECURITY INTEREST: The Sugarbush Operator hereby grants to the Landowner a security interest in all equipment on said premises by said Sugarbush Operator or by any party under said Sugarbush Operator until all obligations of the Sugarbush Operator under this permit have been performed and all other matters pertaining to this permit fully adjusted. In the event that the Sugarbush Operator shall default in any of the Sugarbush Operator's obligations hereunder, or if the Landowner should otherwise deem himself, his security interest, or his collateral unsafe, or should the Landowner in good faith believe that the prospect of performances is impaired, the Landowner may, at his option, cancel this permit and the Landowner shall have the rights of a secured party under the provisions of the Maine Uniform Commercial Code, including, but not limited to, the right to take possession of and sell, either at public or private sale, any or all equipment located on the Landowner's property under this permit, after deducting reasonable expenses and attorney's fees and all sums which may then be due or become due. The balance, if any there may be, shall be paid to the Sugarbush Operator after a reasonable time for ascertaining and liquidating all accounts due or to become due to the Landowner. The Sugarbush Operator covenants and agrees to do, make, execute and deliver, and pay the cost of recording all such additional financing statements and instruments the Landowner may reasonably require for the purpose of perfecting the Landowner's security interest hereby granted.

5. CONDITIONS & SPECIFICATIONS: This lease is specifically conditioned upon, and the Sugarbush Operator hereby agrees to comply with, the following conditions and specifications:

(a) The Sugarbush Operator shall follow these tapping guidelines

(1) The minimum size sugar maple tree that can be tapped is twelve (12) inches DBH (DBH is the diameter of a tree as measured 4.5 feet above the ground), though the Landowner may grant exceptions to tap sugar maple trees as small as ten (10) inches DBH if those smaller trees are healthy and have a good, full

crown. Tapping of trees smaller than ten (10) inches DBH is not permitted.

(2) Any healthy sugar maple tree with a good crown and a minimum of eighteen (18) inches DBH may have two taps during any one season. No more than two taps will be permitted in any tree during any season.

(b) The Landowner shall specifically designate which stands of maple trees are permitted to be tapped. The Sugarbush Operator shall not tap any other stands of maple trees. If the Sugarbush Operator does tap stands of maple trees which are not permitted to be tapped (such stands contain a high percentage of sawlog quality maple trees and are being retained to grow sawlogs), the Sugarbush Operator shall have 30 days to remove all of the taps and pipelines from these stands of maple trees, and the Sugarbush Operator shall pay a damage assessment of $5/tree for any of the trees that were tapped.

(c) The Sugarbush Operator is required to tap all tappable maple trees, as specified in 5(a)(1), in those stands (within the effective distance of the sugarhouse) that are specifically designated by the Landowner as being permitted to be tapped within three (3) years of the Landowner notifying the Sugarbush Operator that the stands are available for tapping. If the Sugarbush Operator fails to tap the maple trees in these stands within three years, beginning in the fourth year the Landowner will estimate the number of possible taps in these stands and the Sugarbush Operator will be required to pay the current tap lease rate on these estimated taps when the annual tapping lease payment is made.

(d) All taps used shall be no larger than the small taps (19/64” and 5/16”), also called the health spouts.

(e) All taps must be removed from the trees by June 1 of every year. Taps left in the trees after June 1 are subject to a $0.50/tap late fee. If more than one-half percent (0.5%) of the taps remain in the trees as of July 1, the lease will be immediately terminated. The Landowner may grant exceptions to this section due to unavoidable circumstances.

(f) If for any reason the Sugarbush Operator uses less than 75% of the authorized taps used the previous year, the Sugarbush Operator will pay the current lease rate based on the number of authorized taps used the previous year.

(g) Written permission is required from the Landowner before any chemicals of any kind can be used on or in the vicinity of the Landowner's land and trees. Should the Sugarbush Operator use any chemicals of any kind without written permission from the Landowner, the lease will be immediately terminated.

(h) The Sugarbush Operator shall keep clean any portion of said Landowner's land being utilized by the Sugarbush Operator and shall not pile up trash and other debris on said lot or surrounding area.

(i) The Landowner authorizes the Sugarbush Operator (after locations are approved by the Landowner) to clear that portion of the Landowner's land necessary to erect such structures as deemed necessary by the Sugarbush Operator as well as to construct necessary gray water pits, black water pits, sub-surface septic disposal systems, black water holding tanks, and the like. The Sugarbush Operator shall undertake said construction only after obtaining the proper permits and licenses (at Sugarbush Operator's time and expense) from the Maine Land Use Regulation Commission and other appropriate state and federal agencies.

(j) From time to time it may be necessary for the Sugarbush Operator to move some sap pipelines to allow the Landowner access to other portions of his property. In instances where the Landowner cannot reasonably access his property without going through a section of the tapped sugarbush, the Sugarbush Operator will willingly move all pipelines necessary to allow access to the Landowner. In instances where the Landowner can access his property by going around the tapped sugarbush, but such access increases the Landowner's access cost by more than twenty five percent (25%), the Sugarbush Operator can either move the sap pipelines and allow the Landowner to go through the sugarbush, or the Sugarbush Operator can pay the Landowner for all of the additional access cost to go around the tapped sugarbush.

(k) Upon termination of this lease, Sugarbush Operator may remove all improvements Sugarbush Operator has installed on the lease lot.

(l) The Sugarbush Operator agrees to protect from damage all public and private improvements in the area, including but not limited to, private roads, trails, and markers. If damage is done by the Sugarbush Operator or his operators, then the Sugarbush Operator agrees to pay for repairs for all such damage.

(m) The Landowner reserves the right to grant to other parties the privilege of cutting and hauling any growth not herein named on any or all parts of the above-named premises, but such subsequent agreements shall not interfere with the operations of the Sugarbush Operator nor damage the Sugarbush Operator's equipment.

(n) The Sugarbush Operator shall harvest timber within the sugarbush only as needed to enhance the sugarbush. Harvesting can occur only after the Sugarbush Operator receives a timber harvesting permit from the Landowner.

(o) The Sugarbush Operator shall comply and observe all Landowner's policies and laws of the State of Maine and the United States relating to cutting; removal, and disposal of debris and litter; construction of roads, trails, and buildings; protection of streams and rivers and other waters; soil erosion; and other laws, regulations, and ordinances pertaining to logging operations and their effect on the environment and zoning. Without limiting the foregoing, the Grantee shall fully comply with and adhere to Standards of the Land Use Regulation Commission as set forth in the Commission's General Notification and/or P-FW/P-4 Notification; and as further set forth in Land Use Districts and Standards, Chapter 10 of the Land Use Regulation Commission's rules and regulations. The Sugarbush Operator covenants and agrees to hold the Landowner harmless from any and all liabilities due to direct or indirect actions or omissions of the Sugarbush Operator; and to indemnify and hold harmless the Landowner for any violations of said laws, regulations, ordinances or standards and for the incurring of any liability as a result of action or inaction by the operator.

(p) The Landowner, its employees and agents, has the right to enter upon the Landowner's property at any time.

(q) The Landowner and Sugarbush Operator agree that the Sugarbush Operator is an independent contractor and is neither an agent nor employee of the Landowner for any purpose whatsoever. Sugarbush Operator shall be responsible for all payroll taxes, workers compensation insurance, social security, and any other employer and employee related costs.

(r) The Sugarbush Operator shall obtain and maintain in full force and effect throughout the term of this permit and any extensions thereof:

(1) Worker's Compensation Insurance; and

(2) General Liability Insurance with minimum coverage for bodily injury in the amount of $1,000,000 (U.S.) and property damage in the amount of $1,000,000 (U.S.) aggregate, naming the Landowner and the Agent as an additional insured as his interests may appear, which insurance shall not be cancelable without notice to the Landowner. The Sugarbush Operator shall deliver to Landowner a certificate evidencing the foregoing insurance coverage.

(s) This lease shall not be assigned, in whole or in part, without written approval of the Landowner, which approval shall not be unreasonably withheld or delayed.

(t) It shall be the privilege of the Landowner or his Agent to point out to the Sugarbush Operator, wherever he deems it proper, wherein he thinks the Sugarbush Operator fails to comply with the foregoing conditions and specifications.

(u) In the event the Sugarbush Operator fails to comply with any provision hereof, the Landowner may, in addition to all other remedies provided by laws or elsewhere herein, cancel this lease upon notice to the Sugarbush Operator if the Sugarbush Operator does not cure the condition within thirty (30) days after written notice thereof from Landowner. In the event Landowner reasonably determines that Sugarbush Operator has violated a provision hereof, whether or not

any enforcement action is pursued or is successful against Sugarbush Operator, Landowner may cancel this lease. If Sugarbush Operator shall leave improperly or create or permit damage thereof, or shall fail to remove litter, Landowner may take such corrective action as it deems necessary and Sugarbush Operator shall pay Landowner, upon demand, costs and expenses incurred by Landowner in such corrective action, including wages or personnel, costs of machinery and an additional 20 percent as an administrative cost. In the event of any default hereunder, Sugarbush Operator shall pay, on demand, the Landowner's expenses, including reasonable attorney's fees incurred in enforcing any obligation of the Sugarbush Operator under this lease or curing any default of the Sugarbush Operator under this lease.

(v) All taxes assessed on the structures, other improvements and personal property associated with the Sugarbush Operator's operation are to be paid by the Sugarbush Operator. All taxes on the land are to be paid by the Landowner.

(w) In the event that the property changes ownership (through sale, by will, etc.), this Lease will transfer to the new Landowner and will continue to remain valid throughout the duration of the Lease.

(x) Either the Landowner or Sugarbush Operator may terminate this lease at any time if the other party is in default hereunder and does not cure the default within the cure period provided for in this Section 5. In addition to any event of default under any other provision of this lease, Sugarbush Operator shall be in default under this lease if any of the following occur and Sugarbush Operator does not cure the condition within thirty (30) days after written notice thereof from Landowner:

(1) Sugarbush Operator uses the property for any use other than as a maple sap collection/processing operation. Such an operation can include a retail outlet for maple syrup products, refreshments and other gift items.

(2) Sugarbush Operator does not maintain the lease lot and any improvement installed on the premises by Sugarbush Operator in good order and clean condition, or uses the lease lot in such a manner that it is a nuisance to any adjacent or nearby properties.

(3) Sugarbush Operator stores, treats, disposes, handles or otherwise uses any hazardous or toxic substance, waste, or material or other pollutant or contaminant, upon the lease lot in a manner that is not consistent with all applicable laws or allows any spill or release thereof onto the Property.

6. CHANGES TO THE LEASE: All changes to this lease must be agreed to by both parties and must be in writing.

7. EXISTING CONDITIONS: The Landowner is responsible for all existing conditions of the lease lot prior to the arrival of the Sugarbush Operator.

IN WITNESS WHEREOF, the parties have hereunder subscribed their names on the date as indicated.

SUGARBUSH OPERATOR: **xxxxxxxxx**

By: _____ _____ Witness: _____
xxxxxxxxxxx Date

LANDOWNER: **xxxxxxxxxxxx**

By: _____ _____ Witness: _____
xxxxxxxxxxxx Date

Additional Resources

Refer to The Cornell Maple Program Website for a guide to resources that have been referred to in this Notebook: http://blogs.cornell.edu/cornellmaple/sugarbush-management/

Funding for Project or Publication was made possible by a grant/cooperative agreement from the U.S. Department of Agriculture (USDA) Agricultural Marketing Service. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the USDA.