

Kentucky Woodlands

Volume 3 Issue 3
December 2008

Magazine

Selective Harvesting: Part Two
Basics of Pine Management
Managing Pine for Wildlife in Kentucky

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Volume 3 Issue 3 Magazine

Promoting stewardship and sustainable management of Kentucky's non-industrial private forests.

In this Issue...

Selective Harvesting: Part Two	1
Log Trends	4
Southern Pine Beetle	4
Managing Pine for Wildlife in Kentucky	6
Basics of Pine Management	8
Comparing Wood and Fossil Fuels for Energy Production	16

Departments:

KWOA	5
Forest Health	13
Forestry 101	18
Kentucky Big Tree Program	20
Test Your Knowledge	21
Non-Timber Forest Products	22
Kentucky Woodland News To Use	24

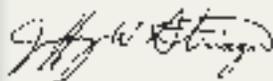
From the Editors of the Kentucky Woodlands Magazine:

While a sizable portion of Kentucky is covered with hardwoods there are also several pine species that are important to woodland owners and this edition provides you with information on basic pine management and how to improve their benefit to wildlife.

The new farm bill will be launched in 2009 and it provides significantly more support for woodlands than in the past. This will undoubtedly result in more opportunities for agroforestry practices and our continued series on this topic can be of benefit to all landowners and particularly farm owners that are considering incorporating forestry practices into their operations. There will also be increased funds for the removal of invasive plant species. One of the invasive culprits spreading from central Kentucky to other parts of the state is bush honeysuckle. In the woodland health section, we continue our "Invasive Plant Hit List" with information on controlling this significant pest.

In cooperation with the Kentucky Division of Forestry, we have started a new section of the magazine focused on providing log-pricing trends for Kentucky. We hope to continue this in future issues. Finally, take time to look at our "News to Use" section for updates on critical issues that impact woodland owners.

We hope that you enjoy this issue of the Kentucky Woodlands Magazine and we sincerely appreciate your interest and concern for the health and sustainability of our woodlands.



Jeff Stringer,
University of Kentucky
Department of Forestry



Diana Olszowy,
Kentucky Division of Forestry

About the Cover: This photo was taken along Auxier Ridge in the Red River Gorge Area of the Daniel Boone National Forest in September. The Red River Gorge is a unique and scenic natural area within the Daniel Boone National Forest in Kentucky. Known for its abundant natural stone arches, unusual rock formations, and spectacular sandstone cliffs, the Red River Gorge has been designated a geological area by the Forest Service. For more information about the Red River Gorge visit http://www.fs.fed.us/r8/boone/districts/cumberland/redriver_gorge.shtml Photo courtesy: Aaron Stringer

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Photo courtesy: Reneé Williams



SELECTIVE HARVESTING

PART II: ELEMENTS OF A SUCCESSFUL HARVEST

by Jeff Stringer

Note: Part I of “Selective Harvesting” focused on problems associated with high-grading, an unsustainable selective harvesting technique that, when repeated, leads to long-term loss of timber value. Part II provides information on how to correctly implement a selective harvest to ensure the sustainability of timber production.

A selective harvest can be used to improve a number of non-timber attributes important to many woodland owners. While this article focuses on timber production, many of the concepts can be used to assist in developing a selective harvest for other objectives.

Good stewardship requires the use of practices that enhance the future value of the woodlands and provide for sustainability of woodland resources. Simply put, sustainability means that woodlands are cared for and managed in a way that does not degrade woodland resources and does not result in a loss of future use. Managing in a manner that provides for sustainability is critically important for woodland owners who actively manage, particularly if timber harvesting is being planned.

A selective harvest is one way to ensure that timber growth and production can be sustained and that the woods are not exploited. However, a selective harvest can just as easily ruin a woodland resource as it can help one. An unplanned selective harvest can result in the loss of both short- and long-term timber value and productivity.

DETERMINING A GOOD SELECTIVE HARVEST

While every woodland is different, there are two key issues that determine whether a selective harvest is helpful or harmful. To ensure sustainability, a majority of trees left after a selective harvest must have enough vigor to respond to the growing space provided by the harvest. Further, selective harvesting in mature woodlands often creates areas that are relatively open and stimulates natural regeneration. Selective harvests should

be planned to provide for appropriate regeneration. These concerns can be posed as questions that, when answered, will indicate whether a selective timber harvest is good or bad.

- *Are the trees left after a selective harvest, healthy, vigorous, and capable of increasing in value?*

A selective harvest, by definition, removes some trees but leaves a number of others to continue to grow. These residual trees are often smaller than the trees that were removed, but if they possess good vigor, they will be able to respond positively to the harvest. If they also are of the proper species, have straight trunks, and are not wounded during the logging, they potentially can provide good future timber value.

There is a relationship between age and vigor, and indicators of both are well known. These indicators can be used to assess the condition of residual trees left by a selective harvest. Unfortunately, many believe that smaller trees are also young. However, in mature woodlands, this is often not the case (see Figure 1). In planning a selective harvest, it is critical to properly identify which trees are truly young and



An example of a good tree (left) to leave during a selective harvest. Note the well developed balanced crown compared to the spindly unbalanced crown tree on the right. Photo courtesy: Jeff Stringer

vigorous and are of the proper species and possess good form. Then they must be protected from damage during the harvest. If a selective harvest has already been completed, assessing residual tree vigor, species, form, and damage allows one to determine whether a selective harvest was helpful or harmful to the production of timber.

• *Are the woods regenerating properly?*

Ultimately, in most woodlands dominated by hardwood species, adequate natural regeneration is required to ensure long-term timber production. It is possible to evaluate the regeneration potential of a woodland before or directly after a selective harvest. If the regenerative potential is found to be poor before a harvest, the harvest should be delayed or designed in a manner to help regeneration. If this is not done and the selective harvest is conducted, regeneration could be negatively affected, and timber production could be harmed for a significantly long time.

USING A SUSTAINABILITY INDEX TO ASSESS WOODLANDS

Answering yes to the first question means that at least in the short term (10 to 20 years), the woods will produce timber resulting in short-term sustainability. If the answer is no, then there will be little or no timber production possible in the next 10 to 20 years and possibly for much longer. If the second question is answered yes, then the stage is set for the production of valuable timber over the long haul (+ 40 years). If the answer is no, then long-term timber production is in jeopardy. Table 1 provides a simple explanation of how these two questions can be used to gauge the success of a selective harvest.

Table 1. Short- and Long-Term Sustainability Index				
Healthy Residual Trees	Proper Regeneration	Viable Timber Production		Sustainability Index
		Short-Term	Long-Term	
Yes	Yes	Yes	Yes	Good
Yes	No	Yes	No	Short-term
No	Yes	No	Yes	Long-term
No	No	No	No	Poor

CHARACTERISTICS OF HEALTHY AND POTENTIALLY VALUABLE RESIDUAL TREES

Tree diameter is often mistakenly equated with tree age. It is thought that small trees are young, and large trees are old. While this is intuitive, in many woods, it is also incorrect. Many of our woodlands were established due to agricultural abandonment or intensive harvesting that caused large numbers of trees to become established at the same time. These woods are considered even-aged, meaning that the majority of the trees, especially overstory trees, are close to the same age. These woods may contain trees of the same species that range significantly in diameter. Many of the large overstory trees are large because they were the first to sprout, or they were faster growing at the very start of their development. Because of this head start, they were able to gain a competitive advantage over other trees and outgrew them. In these cases, small diameter trees are so because of the



Figure 1. Stump of a 5 inch diameter white oak that is 82 years old. Photo courtesy: Jeff Stringer

competition from the faster-growing trees of the same age. Many sawtimber-sized overstory hardwood trees are between 70 and 100 years old and average between 18 and 24 inches in diameter. In the same woods, there will be 6- to 16-inch trees that will be in the same age range or slightly younger.

Figure 1 shows the stump of a 5-inch white oak tree that is 82 years old. This white oak tree was growing among 20-inch overstory trees that were 90 years old. Most individuals would look at a 5-inch diameter oak and guess that the tree would be 15 to 25 years old. Based on this assumption, many believe that leaving small-diameter trees during a selective harvest equates to leaving young trees with a lifetime of growth ahead of them. This is unfortunately incorrect and shows the importance of proper aging of trees in developing a good selective harvest.

Oftentimes, these older, smaller trees possess little vigor. Generally, healthy vigorous trees can be identified by their crowns. Healthy trees, especially those that are young, will have crowns that still have a main leader, are well balanced (crowns that are protruding from the main stem on three or four sides) and have at least 35 to 40 percent of their total height in crown. For example, look at small diameter oak trees in a mature woodland, and you will notice that many of their crowns are flat topped and sparse. This is an indicator of low vigor and often of old age. When released through a harvest,

these trees can remain for many years without growing. In some cases, they will die back.

Residual trees should be of a commercial species, have straight trunks, and have not been wounded during logging. A small branch knocked off is not a problem, but if there are wounds on the base of the tree from skidding or if the top is knocked out, there may be severe damage to future value. Figure 2 shows a residual tree wounded during a selective harvest that was conducted 15 years ago. At that time, the tree was relatively small with a significant potential to grow into a veneer tree. However, skidding was not planned, and many of the smaller residual trees, including the one shown, had the bark knocked off near the ground by contact from logs being dragged behind the skidder. The wounding was significant, and the damage to the butts of the residual trees caused open wounds that have not healed, resulting in significant loss in value.

MAINTAINING ADEQUATE REGENERATION

To maintain long-term sustainability, analysis of the regenerative potential is necessary, and selective harvests in mature woodlands should be designed to provide for proper regeneration.

At some point, a woodland must regenerate new trees of the appropriate species if long-term timber value is to be maintained. Further regenerating a diverse species mix is also preferable and can help hardwood forests maintain value over the long term. A woodland should be analyzed to determine its regenerative potential, and plans should be undertaken to ensure that a variety of commercial species can regenerate. For example, oaks can maintain good regeneration on poor-quality sites (dry uplands), but on medium- and high-quality sites, oaks cannot develop adequate amounts of small seedlings and saplings in the understory due to the deep shade that persists on these sites. Without the presence of these before a harvest, oaks will not regenerate. It also takes considerable planning to select and protect small diameter maples and other species that can grow successfully in the shade of the understory. While these species may regenerate easily under a mature overstory, keeping the sapling and pole-sized trees intact during a selective harvest can be a challenge. Other species such as yellow-poplar and black walnut need full sunlight, and open areas must be established for these species to regenerate. If the selective harvest does not take into consideration the regeneration needs of the overstory species present, regeneration could be less than adequate and, in some instances, non-existent.

Also, a management plan must take into account invasive species and make sure that the harvest is designed to avoid problems with the establishment of these species and minimize or eliminate their presence.

HOW TO ENSURE SUSTAINABILITY

Understanding the basic principles of how woodlands regenerate and what characteristics constitute vigorous, high-quality trees is the key to assessing whether a selective harvest will improve a woodland or degrade it. Foresters can identify young, potentially high-value trees and develop an improvement harvest to protect them and encourage their growth while removing larger valuable timber as well as low-quality trees that are hindering their development.

Contracts should require a logger to protect residual trees from harm. Research has shown that damage to residual trees can be held below 10 percent and further damage reduced by avoiding harvesting in March and April, the time of year when bark is easily stripped from trees. Foresters may also recommend the use of designated skidding areas to avoid unwanted damage to residual trees or regeneration.

Foresters can also mark a selective harvest to encourage regeneration. In some cases, group openings can be made to promote species that require sunlight. In other instances, larger open areas could be prescribed to remove degraded overstory trees. Partial shade can be left in some areas to encourage oaks if there are some oak seedlings and saplings present. Foresters might recommend postponing harvesting in some portions of the woodlands to avoid a problem with exotic invasives or give that area time to develop its regeneration capacity.

Significant planning is required to develop a successful selective harvest. A landowner should consider consulting a professional forester to design a successful improvement harvest that provides for adequate regeneration of our many hardwood species. Often, their experience and expertise can make the difference between a sustainable or unsustainable harvest.

About the Author:

Jeff Stringer, Ph.D. is a hardwood extension specialist at the University of Kentucky and is responsible for continuing education and research in hardwood silviculture and forest operations. He is also an editor of the *Kentucky Woodlands Magazine*.

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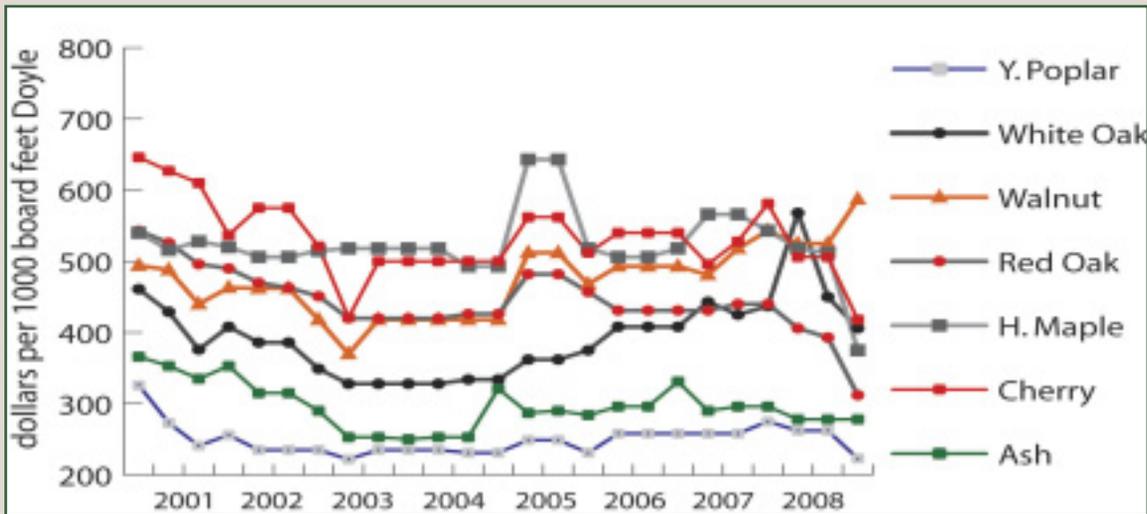
Figure 2. Internal rot created by skidding damage that occurred during a selective harvest 15 years ago.

Photo courtesy: Steve Gray

Kentucky Delivered Log Prices

Statewide Average - US Forest Service Grade Two

Prices reported are averages for medium quality (grade 2) logs delivered to sawmills across Kentucky through the third quarter of 2008*. Values are dollars per thousand board feet (Doyle scale). Stumpage value (the value of logs in the tree) are typically one-half to one-third of log values.



*Data collected by Chris Nevins, Kentucky Division of Forestry Timber Harvest Compliance and Forest Resource Utilization Section. Analyzed by Jeff Stringer, University of Kentucky, Department of Forestry Extension. In depth log price reporting can be found in "Growing Gold" by the Kentucky Division of Forestry at www.forestry.ky.gov

Southern Pine Beetle in Kentucky

The southern pine beetle (SPB) is the most highly destructive bark beetle found in the southeastern United States. The beetle attacks and kills all species of yellow pine. In Kentucky, the preferred host trees are mature and overmature shortleaf, loblolly and Virginia pines. In cases of intense outbreaks, the beetle is also known to attack eastern white pine.

Populations of SPB occur naturally in forests but usually in low numbers. However, when adverse environmental conditions such as drought or storms create stress in trees, beetle populations can explode. Beetle attacks are cyclical and usually short in duration, lasting two to three years. However, major outbreaks seem to occur every 10 years. Most recently, beetle attacks intensified in 1999, 2000 and 2001 with epidemic conditions existing throughout south central, southeastern, eastern and northeastern Kentucky.

Trees that have been attacked by SPB can be easily identified. Infested trees demonstrate faded foliage, with yellow or

red needles. Other symptoms of beetle attack can be found by examining the bark closely. Adult beetles bore directly



The southern pine beetle (small inset image) is a serious pest of pine trees. The pine tree above shows the exit holes and associated pitch tubes that are evidence of a southern pine beetle infestation. The larger photo shows some of the scope of the most recent infestation. Photos courtesy - U.S. Forest Service, Southern Region.

through the outer bark into the living cambium. At this point of attack, the tree exudes resin through the bore hole, forming a pitch tube. These pitch tubes are initially white and resemble kernels of popped corn. Older pitch tubes are reddish-brown in color. Adult beetles also carry a fungus known as blue stain which streaks the sapwood. This fungus clogs the conductive tissues of the tree, causing further damage and eventually death.

When beetle populations are at normal levels, natural enemies, such as weather extremes, disease and insect predators,

prevent outbreaks from occurring. Also the implementation of sound forest management practices, primarily thinning mature pine stands, keeps beetle populations in check. Three methods are highly effective in controlling SPB: salvage cutting, cut and leave, and chemical control.

If you notice any of the symptoms occurring in your pines, please contact your local Division of Forestry office.

-- Diana Olszowy, Kentucky Division of Forestry

KWOA Addresses Legislative Task Force on Woodlands Economy and Management

KWOA and partners conducted a two-hour presentation and discussion on the economic potential of Kentucky's woodlands with a select group of attentive and thoughtful Kentucky legislators. Representative Rick Nelson chaired the November 20th meeting at the Capitol. KWOA President Jim Corum led the presentation that included remarks by more than a dozen KWOA members, partners and invited experts. Corum proposed to the task force that Kentucky's \$8.7 billion forest industry has the potential to generate a \$34 billion economic impact with proper management of its timber. KWOA presented five major issues that threaten the health and productivity of Kentucky's woodlands with accompanying recommendations to solve each problem. The issues and recommendations are briefly provided as follows:

Issue 1: Forest Health

Recommendation:

Legislatively establish the forest health task force (chaired by the state entomologist) attached to the Kentucky Division of Forestry with funding if possible.

Issue 2: Timber Theft

Recommendation:

- Strengthen criminal prosecution of timber theft
- If legislation is enacted include all stakeholders (e.g. KWOA, KFIA, Loggers)
- Strengthen fine collection and enforcement of repeat Bad Actors
- Establish a law enforcement unit of the Kentucky Division of Forestry to increase criminal prosecution of Timber Theft and Arson

Issue 3: Competitive Disadvantage

Recommendation:

Establish incentive program for woodland owners to enhance the production of CERTIFIED WOOD using Indiana's Classified Forest System as a model

Issue 4: Wildfire

Recommendation:

- Establish a law enforcement unit of the Kentucky Division of Forestry to increase criminal prosecution of Timber Theft and Arson
- Provide funding for the development of fire lanes on private woodlands
- Provide reward for information leading to the conviction of a wildland arsonist
- Adopt recommendations of the Governor's Task Force on Wildland and Arson (2006)

Issue 5: Limited Markets for Abundant Low Grade Trees

Recommendation: Request Legislative Research Commission investigate the potential to develop incentives package for the utilization of low quality trees. Provide stimulus to encourage co-generation using woody biomass.

Final Recommendation: KWOA and its partners recognize that while some issues such as forest health and timber theft can be addressed in the upcoming session; however, many issues will take more time to develop. To deal with these significant issues KWOA requests that both the House and the Senate convene a joint task force in 2009 to further discuss legislative initiatives.

WE NEED YOU & YOU NEED US!!

KWOA members can look with pride on the accomplishments of the organization during 2008. 2009 finds us poised, ready to serve you and your interest in cost efficient, environmentally friendly sustainable forestry, as well as to deepen our advocacy of the following: Issues of Forest Health, Property Tax Fairness, Apparent Lack of Good Insurance Products for Woodland Owners, Certification Procedures, Seeking Additional Markets and Current Log Prices. These are only a few of the issues begging for our attention.

By renewing/joining, you will receive the following benefits and services:

- Periodic newsletters
- With the Membership Plus option, you will receive the newsletters of the National Woodland Owners Association
- Access to our annual two-day membership information rich conference at General Butler State Resort Park, March 20-21, 2009.
- Open invitation to attend the quarterly business meetings of the Board of Directors of the KWOA
- Representation of your interests at the Kentucky Best Management Practices (BMP) Board and at hearings on legislation affecting woodland owners.
- Frequent interactions of directors representing woodland owner interests at the Kentucky Division of Forestry and the University of Kentucky Department of Forestry
- Invitation to our cosponsored field days with the Kentucky Division of Forestry and the UK Dept. of Forestry and UK Extension Service
- Representation on the Kentucky Tree Farm Committee
- Representation on the Kentucky Forest Health Task Force
- Representation on the Kentucky Conservation Committee
- Representation on the Kentucky Legislative Research Commission Task Force on Land Stewardship and Conservation.

Come join with other woodland owners just like you, in learning, socializing, and in sponsoring the activities that will make your woodlands healthier, more hospitable to wildlife, aesthetically more engaging and more valuable.

To join KWOA or for more information about KWOA activities please visit www.kentuckywoodlandownersassociation.com or contact Betty Williamson at willdan@bellsouth.net or 270.821.8657.

Photo courtesy: Diana Olszowy

Managing Pine for Wildlife in Kentucky

by Tom Barnes

Wildlife biologists often refer to dense pine thickets as biologic deserts, meaning they provide little in the way of wildlife habitat. Is this an accurate description? Yes, no, maybe? The real answer is a bit of yes, no and maybe. Yes, pine forests can provide habitat for some game and non-game species if managed correctly. For instance, during periods of severe winter weather in states north of us, pine siskins, crossbills, red-breasted nuthatches and other pine-dependent species can be attracted to mature pine forests. That is why these birds typically pass through Kentucky and end up in the Piedmont area in those years. Maybe pine forests can be managed for quail, deer and turkey if they are taken care of and thinned judiciously, followed up by hardwood brush control and prescribed fire. Pine forests are of little wildlife value if they are not intensively managed in this state and taken care of.

There is little in the way of true pine forests in Kentucky, and most of the pine in the state is in the form of planta-

tions in the western and southern parts of the state. With little doubt, if left unmanaged, these plantation forests can quickly become biologic deserts as the canopy closes, blocking sunlight from reaching the forest floor that allows for the growth of food plants for quail, turkey or deer. However, if managed appropriately for lumber (not pulp) a mature pine stand can be quite good habitat for quail, turkey, deer, and some songbirds. The key to pine management for wildlife is selecting the appropriate pine species, which means our native pitch or shortleaf (sometimes called yellow pine) and obtaining an optimum basal area (basal area refers to the cross-sectional area of a tree at 4.5 feet above the ground) that can provide wildlife habitat and trees that can be harvested for lumber.

Why use our native species for pine plantations in Kentucky? There are several reasons, with the first being that these are adapted to our growing conditions and do not have the potential to escape and cause problems in natural areas. For example, white pine would not be a good choice, even though it is native, because it reproduces and spreads rapidly and is causing problems in many hardwood forests in eastern Kentucky. Many years ago the U.S. Forest Service put in plantations of white pine on ridgetops, and now, two to three decades later, it is looking at using fire to keep these trees from literally “taking over” the hardwood forests surrounding them. In a similar vein, one could suggest planting loblolly, a native species to the South, but in Kentucky these trees may not overwinter and reach maturity. Of course you could plant the “improved” cold-tolerant loblolly or the hybrid pines promoted by some timber companies, but they would not provide the same quality of habitat as our native species.

What is the optimal basal area for wildlife in pine plantations?

At the first thinning you should try to get to 60 sq ft/acre of basal area if wildlife is one of your goals. This level of thinning opens up the canopy sufficiently to allow for the growth of plants that will provide food for quail, turkey, deer and songbirds. If wildlife is more of a consideration than timber production, going down to as low as 30 sq ft/acre in later thinning operations will provide enough cover for deer, roosting and feeding sites for turkeys and decent grassland habitat for quail. The first thinning should probably not go down as low as 30 sq ft/acre, as many trees might be damaged by ice or windstorms. Once the canopy has been cut back, you will end up with issues related to hardwood brush control, because pine plantations are not a true “natural” com-

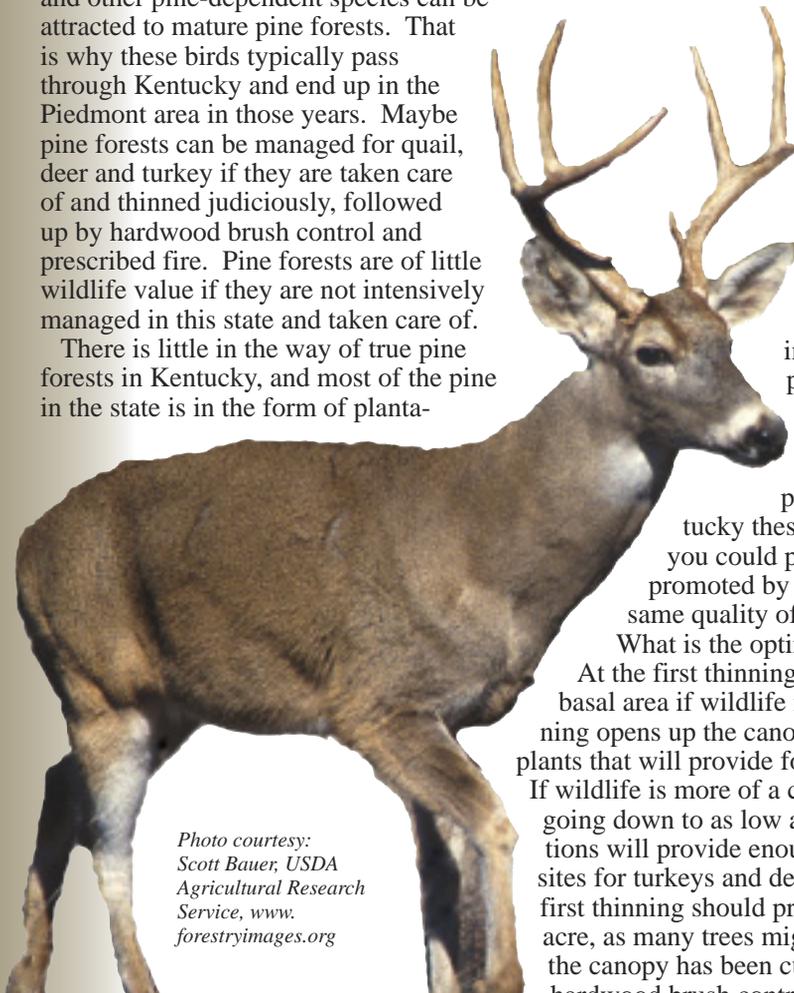


Photo courtesy:
Scott Bauer, USDA
Agricultural Research
Service, [www.
forestryimages.org](http://www.forestryimages.org)





Mature white pines growing on a rich hardwood site. Photo courtesy: Steven Katovich, USDA Forest Service, www.forestryimages.org

munity type in Kentucky. It is the very nature of the hardwood trees to invade and take over the site. To manage this issue you will need to either burn the forest every few years or use herbicides like Arsenal™ to control the hardwood sprouts.

You should also consider this question: If I am going to put in a pine plantation, where should it be located? The easiest answer to this question is to look at your land and observe where pines are already growing. In eastern Kentucky this is most likely to be on ridgetops and southwest-facing upper slopes. In the remainder of the state, the best place may be on land that is unsuitable for growing hardwood trees, pastures or agriculture crops. While productivity will be lower in these environments, it will still provide an opportunity to have some type of forest cover on the land.

Finally, if you do have any native grass stands or natural grassland or savannah communities, do not plant pines in these habitats, as they are rare in this state and should be kept and managed as open grasslands, not pine plantations, which has happened in the past.



Photo courtesy: John Cox

A nest of quail eggs at the base of a pine tree. Photo courtesy: James Solomon, USDA Forest Service, www.forestryimages.org

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Basics of Pine Management

Information for woodland owners that are considering pine management*

by Billy Thomas and Jeff Stringer

Kentucky is considered a hardwood state with 85 percent of the woodlands dominated by pure hardwood forest types. Fourteen percent of the woodland area is covered by either oak-pine forests (nine percent) or pure pine forests (five percent). Although pine trees, also called softwoods or conifers, occupy a relatively small percentage of land area, they are nonetheless important components of Kentucky's woodlands and can benefit from management. This article provides an overview of pine establishment and management for Kentucky woodland owners. Typically, pine can provide more frequent income opportunities than hardwoods. Also, pine can provide some benefits for wildlife, such as planted stands that provide early successional habitat and winter cover and other benefits for wildlife that cannot be satisfied entirely by hardwood forests.

The majority of pines occur on marginal sites that are better suited for pine (both ecologically and economically) than hardwoods. Generally, these sites are low in nutrients required for hardwood growth, and, although a number of hardwoods will survive on these sites, they are not as prosperous, will not grow as fast, and will not produce the quality hardwood sawtimber that brings the most income. Pine can produce a product on these marginal soils and provide other benefits in a shorter time period than hardwoods. On low-productivity upland sites, particularly those with shallow soils and south- to west-facing slopes, landowners might consider favoring pine or a pine/hardwood mix over only hardwood species.

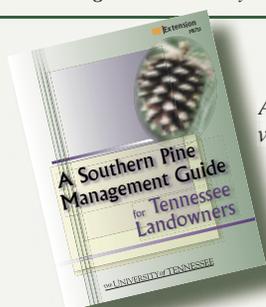
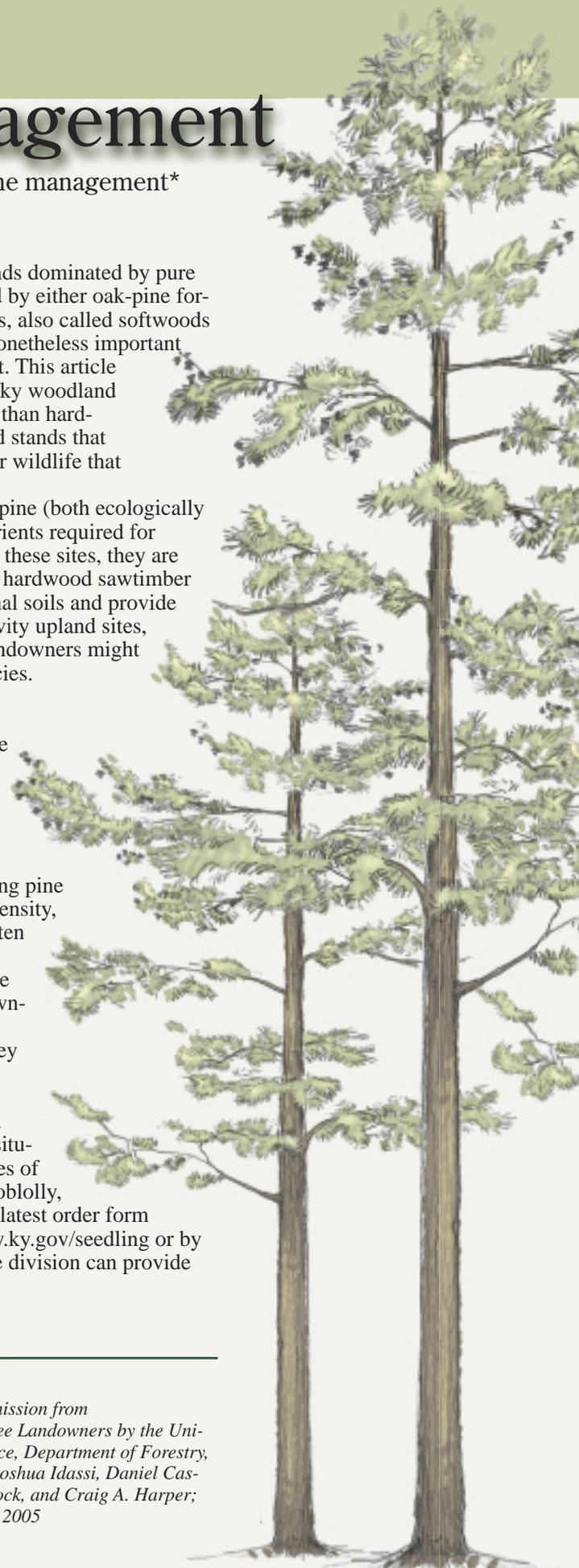
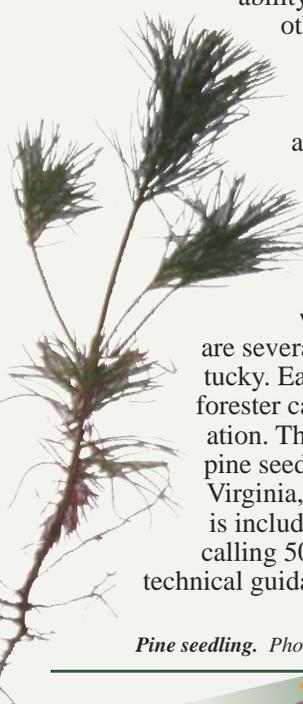
Planting Pine

Whether to plant or not is the question when it comes to raising pine. The answer will depend on a variety of factors including objectives, soil productivity, current tree species on the site, nearby seed sources, availability of time and resources for planting, and a host of other considerations.

Pines can readily regenerate naturally from seed if exposed to mineral soils and full sunlight. Planting pine provides more control over growing space, stand density, and arrangement than natural regeneration, which often leads to stands that are too sparse or too dense. In turn, this leads either to incomplete use of the site or added expense later to thin the stand. Landowners should discuss their situation with a professional forester so that they can get the results they want in the fastest and most economical way. There

are several pine species to choose from for planting in Kentucky. Each species has advantages and disadvantages, and a forester can help decide which species is best in a particular situation. The Kentucky Division of Forestry sells several species of pine seedlings, for \$25 to \$30 per 100, including shortleaf, loblolly, Virginia, white, and other conifers such as baldcypress. The latest order form is included in this issue and can be obtained at www.forestry.ky.gov/seedling or by calling 502.564.4496. In addition to selling the seedlings, the division can provide technical guidance and lend tree planting equipment.

Pine seedling. Photo courtesy: Charlie Saunders, Kentucky Division of Forestry



* Compiled and adapted with permission from *A Southern Pine Management Guide for Tennessee Landowners* by the University of Tennessee Cooperative Extension Service, Department of Forestry, Fisheries and Wildlife. Wayne K. Clatterback, Joshua Idassi, Daniel Cassidy, Ron Hay, David Mercker, Fitzroy D. Bullock, and Craig A. Harper; edited by Daniel Cassidy, 2005

Natural Regeneration Methods for Pine

When it comes to naturally regenerating pine, there are a few options to choose from including clearcutting, seed-tree, and shelterwood techniques. An important key to successful regeneration of pine is to control the amount of sunlight available to the developing seedlings. Mature trees are cut to make room for a new developing age class.

Clearcutting: Clearcutting is commonly used to regenerate pine in the South. Clearcutting removes all of the mature trees in the stand to provide full sunlight over the entire stand, creating an environment that will allow young pines to grow well. Artificial regeneration of pine allows the potential use of genetically improved stock and planting at precise spacings such that each seedling has the full complement of resources to grow well. Species that naturally regenerate in clearcut stands are pioneer species, like the pines. Complete or silvicultural clearcuts are those that remove all of the trees down to 1 to 2 inches in diameter. However, most clearcuts are commercial clearcuts where trees are left that are too small or poorly formed to meet local merchantability. In some cases, this could mean leaving trees less than 6 to 8 inches in diameter. These trees are usually of undesirable form and/or species, and they never constitute desirable growing stock for the next stand. If there is a significant number of these trees, they will interfere with the regenerating trees, and they are normally removed as a part of site preparation treatments. It is not recommended that hardwood stands, particularly those on medium and high quality sites, be clearcut and converted to pine. Clearcutting should be reserved for use in existing pine stands where the majority of trees are mature or of low vigor and at risk. Regardless, careful attention to timber harvesting BMP's is required during clearcutting.

Seed-Tree Regeneration: Seed-tree is an even-aged regeneration method that uses natural regeneration to establish the new age class of pines. The seed-tree regeneration method is a modified clearcut, in that some trees are left on the site to provide seed (seed trees), but essentially the site is as fully exposed as that of a clearcut. The same types of plants and animals that colonize a clearcut also find the seed-tree environment inviting. The seed-tree regeneration method is often used with pines, especially those native to the Southeast. All seed trees must be windfirm; that is, they must be able to stand for several years by themselves without the support of an adjacent canopy. The seeds should be readily dispersed by wind currents, carrying laterally for some distance. Seed trees are removed after the new pine seedlings are reestablished. However, the seed-tree regeneration method is rarely used because most landowners would prefer to recover full economic potential from their stands rather than leave large, high-value trees at risk for several years.

Shelterwood Regeneration: Shelterwood is another regeneration technique useful in pines. This requires harvesting about one-half of the existing overstory and removing any unwanted understory trees. The overstory trees that are left will provide partial shade on the ground, thus sheltering the new age class from full sunlight. If they are pine, they provide for more even seed dissemination. Eventually, the overstory is removed once the newly developed seedlings are well established. This method is recommended for regenerating eastern white pine, a more shade-tolerant pine species; it can also be used with species that are somewhat tolerant of shade. The partial shade allows these species to have a growth advantage over competing species that must have full sunlight to grow quickly. For the pines that are more shade-intolerant than eastern white pine, the overstory "shelter" must be removed within three or four years. With eastern white pine, the overstory can be left on for a longer period of time (10 to 15 years). The basic premise of the shelterwood method is that regeneration is established under the protection of the upper canopy while the amount of understory exposure (most importantly, sunlight) is regulated through two partial overstory

Softwoods and Hardwoods

Tree species are often classified as either softwoods or hardwoods. The names can be somewhat misleading in that they have nothing to do with the "hardness" of the wood. Rather, the terms refer to flowering or broadleaf trees (hardwoods) and coniferous or needled trees (softwoods). Softwoods, or conifers, are usually evergreen, having leaves that are needles or scalelike. Hardwoods dominate Kentucky's land coverage and its species diversity (~120 hardwoods compared to eight softwoods).



A clearcut can be used to establish a new pine forest. The area on the left side of the image was treated with herbicides to control hardwood competition. The untreated area on the right shows hardwood sprouts that will compete with pine seedlings. Photo courtesy: Jeff Stringer

removal cuts. Gradually, the regeneration is released from the influence of the upper canopies. As it forms an overstory canopy of its own, it becomes the dominant canopy on the site.

Site Preparation Treatments

To produce conditions that are necessary to effectively and efficiently regenerate pine species, silvicultural techniques classified as site preparation are often applied in conjunction with a regeneration harvest prior to or directly after the establishment of seedlings. Foresters use site preparation treatments to control competition on the site, prepare the site for planting by removing brush and litter, and prepare the soil for seedling establishment (natural or artificial). There are three ways to implement site preparation treatments: chemical, mechanical, and burning. All three can be used effectively in any combination given the economic constraints of the landowner. Cost-share programs may also be available to help offset the costs of these early operations.

Chemical Site Preparation: Site preparation that uses the systematic application of herbicides is classified as chemical site preparation. The goal of the process is to control dense or unwanted vegetation that might interfere with the survival and development of seedlings. The application of the herbicide can also inhibit hardwood sprout competition. Many pines are shade-intolerant and flourish when direct sunlight is available. The removal of overtopping vegetation increases the survival of planted seedlings. After commercial clearcutting, if enough trees are left, it is recommended that these be deadened using herbicides. The herbicides used are based on the species present. The techniques used to apply the herbicides can vary widely. In some instances, herbicides are applied over the entire stand with a helicopter or ground equipment that is designed for this purpose. However, many times the trees are treated by hand, using techniques such as hack and squirt, cut stump, or basal bark. Foresters should be consulted to help determine the most effective herbicide and techniques.

Mechanical Site Preparation: Mechanical site preparation works toward removing unwanted vegetation or breaking down logging slash and debris. These techniques use heavy tractors and bulldozers to pile, rake, shear, chop,

or disk the woody debris and vegetation. Removing this material provides a clean planting site, reduces standing competition, and often tills or mixes the soil and the organic material to enrich the soils, increasing the likelihood for pine tree growth. Just as many herbicides can be used in chemical applications, there

are many mechanical techniques available, ranging from simply knocking over stand vegetation to pushing the debris into organized piles or windrows. Mechanical preparation is often used in conjunction with fire, burning the debris once it has been piled together.

Site Preparation by Prescribed Fire: Prescribed fire reduces the levels of slash, debris, and litter while releasing nutrients back into the soil. A properly timed fire will kill vegetation that initially invades a harvested stand and will also increase the ease of planting seedlings. Controlled fire should be used only under ideal conditions. If the site is too wet, the application will be useless. If the site is too dry or wind and weather conditions are not ideal, the fire can burn too hot and create potential short-term nutrient and erosion problems in the area to be planted.



*Prescribed fire can be a useful tool in controlling unwanted vegetation.
Photo courtesy: Terry Price, Georgia Forestry Commission, www.forestryimages.org*

Smoke management should be a priority when applying fire. Considering the liability and safety issues surrounding the application of fire, landowners should always work with a professional forester and double check to ensure that all the proper permits and regulations have been filed and followed.

Thinning Pine Stands

Thinning is a technique that is used to adjust the density of forests or plantations. Thinning is required in most pine stands to ensure that an adequate number of valuable trees are established to quickly and fully occupy the site. This is needed to ensure that competing species do not overrun the regenerating trees. As these stands age, they will become crowded, growth will start to slow dramatically, and slower growing trees will start to die. This mortality is an inescapable function of nature. As pine stands grow, individual trees compete for light, soil moisture, nutrients, and space. Many trees are crowded by faster-growing neighbors and will eventually die. Thousands of pine seedlings populate a naturally seeded acre. In a plantation, usually 500 to 800 seedlings are planted. However, at maturity only 50 to 100 large-diameter, sawtimber pine trees, greater than 20 inches, remain. More than 90 percent of the trees die. By actively managing pine stands through thinning, this mortality can be reduced by allowing selected trees to take advantage of additional space, sunlight, and nutrients.

The fundamental results from thinning are the improvement of stand health and growth and a reduction in the rotation length. Thinning is a forestry technique that mimics this natural process of mortality under the guidance of a trained professional. By applying cuts to immature stands, material that might otherwise die before rotation age can be used, and growth can be concentrated on fewer, more desirable stems left in the stand. As trees grow and mature, their crowns will begin to compete for available sunlight. Eventually, this crown competition will result in a forest with a closed canopy, where sunlight does not reach



A drum chopper can be used to help breakdown logging slash and debris.

Photo courtesy: USDA Forest Service - Rocky Mountain Region Archive, USDA Forest Service, www.forestryimages.org

the forest floor. This indicates that the tree crowns no longer have space to grow and expand. A thinning should be applied.

Trees to remove will depend on the landowner's objectives. For timber production, undesirable species, poorly formed trees, and slow-growing individuals are removed. Some of the poorly formed or cull trees may be left to provide wildlife habitat. How much to thin will depend on objectives as well, but it must be enough trees for loggers to make a profit. A common mistake in thinning is to leave too many trees. Approximately 50 percent of the trees are harvested during a thinning. Several thinnings may take place before the stand reaches maturity.

Depending on when the stand is thinned, the cut can be deemed either a pre-commercial or commercial thin. Pre-commercial thins are generally required in stands that are naturally regenerated, where thousands of seedlings per acre are established. The goal of a pre-commercial thin is to reduce stocking to

400 to 600 seedlings per acre. There is no merchantable material removed during this thinning; thus, it occurs at an expense. However, the removal of the excess trees will prevent tree stagnation and improve stand growth and development. To minimize cost, pre-commercial thinnings should be conducted before the stand is four years old. Mowing strips across the stand, leaving seedlings in 1- to 2-foot-



Row thinning can generate revenue and increase the growing space for the remaining trees.

Photo courtesy: James H. Miller, USDA Forest Service, www.forestryimages.org

wide rows, will quickly reduce the total number of seedlings. Row width is dependent on seedling density. Commercial thinnings occur typically when the stand is 12 to 18 years of age and can provide some intermediate return on long-term forest investments. In plantations, this can be accomplished using a row thinning where whole rows of pines are commercially harvested. Another option is to use selection thinning, typically called a release treatment, which requires a more acute eye. Release requires that good individual trees (crop trees) be located and that poorly formed and less valuable trees competing with the crop trees be removed. Release favors only the best trees by removing the inferior individuals and producing a consistent spacing around the crop trees. This allows the favored crop trees to use the additional growing space and to mature into the desired size.

Pure and Mixed Pine/Hardwood Stands

Pine management in the South is often done with one species in a plantation or a naturally regenerated area. However, there are opportunities to develop mixed stands of pine and hardwood species. In areas where strong markets exist for pine pulpwood, poles, sawlogs, and other products, pine plantations with one species can make sense. Where markets are weaker or where non-timber objectives are important, a mixed stand can be developed. This is normally accomplished by changing the intensity of operations to allow for more natural hardwood development to occur among the regenerating pine seedlings. For example, during clearcutting, more hardwoods are left, seed-tree cuts leave fewer seed trees, or plantations are established with fewer pines per acre. Site preparation treatments can also be limited or planned to allow for more hardwood sprouting and growth. All of these options will result in fewer pine trees per acre and a higher percentage of hardwoods.

Pine Markets in Kentucky

If pine is being managed for timber products, it is important to understand where pine markets exist and whether they will be available in the future. There are markets for pine in the form of sawlogs, peeler logs, logs for cabins, chip logs, posts and pulpwood. However, pine markets in Kentucky are not as widespread as those for hardwood trees, so woodland owners are encouraged to consult with a professional forester for marketing guidance. To make sound management choices, landowners need to know what their timber investment choices are and the return they are expecting. Sometimes overlooked are recreation, hunting, and other non-timber opportunities associated with the investment. Risk is also unique with timber investments, for there is a real risk of a complete and unexpected loss in the value of the investment due to fire or insect damage.

Summary

Working with pines can provide landowners with an additional opportunity to achieve their management objectives. They must decide how to regenerate pines, either naturally or artificially, and what species are most appropriate for a soil type and ownership objective. They also need to consider how much site preparation is required to establish the correct number of pines per acre and when and how to initiate thinnings or release. This article describes the management opportunities with the goal of encouraging proactive management of pines where applicable. If you are serious about pine management, consult *A Southern Pine Management Guide for Tennessee Landowners* by the University of Tennessee available at www.utextension.utk.edu/publications/pbfiles/PB1751.pdf, although this publication was developed for a Tennessee audience, a state where more intensive pine management is common, many of the concepts and details on pine management will apply in Kentucky.

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Forest Health



Invasive Plant Hit List: Bush Honeysuckle

by Jeff Stringer, John Cox, and Billy Thomas

Bush honeysuckle refers to several species; the most common to Kentucky is the Amur honeysuckle (*Lonicera maackii*). This native to northern China, Korea and parts of Japan was introduced to the U.S. in 1897. Escapes from ornamental plantings were recorded in the 1920s and promoted for conservation and wildlife uses in the 60s and 70s. This effort coupled with ornamental plantings led to range expansion from the Midwest to areas south and east.

Bush honeysuckle is spread by seed. Amur flowers in June, and the white and yellowish flowers can result in more than

1 million red seeds on mature (25-year-old), 20-foot tall plants. The seeds are consumed and spread by some species of songbirds only after other more nutritious native foods are gone. As with many invasive species, bush honeysuckle can grow and thrive over a wide range of



Photo courtesy: Chris Evans, River to River CWMA, www.forestryimages.org

Bush honeysuckle is one of the first plants to leaf out and one of the last to drop its leaves; leaves are 2-3 inches long and are arranged on opposite sides of the branches.

It blooms starting in May with flowers that are white to yellow and approximately 1" long; the flowers are very fragrant. The bark of bush honeysuckle is gray to tan and has tight vertical strips.



Photo courtesy: James H. Miller, USDA Forest Service, www.forestryimages.org

which it can be confused, and all shrub-sized honeysuckle are exotic and invasive.

Woodlands at Risk

Because bush honeysuckle can grow under moderate light conditions and tolerate a range of soils, all of Kentucky is at risk from these species. The greatest occurrence of Amur honeysuckle is in northern and central Kentucky. Once thought to be restricted to central Kentucky soils, Amur and other species are starting to be found in eastern and western Kentucky. It is now believed that it can and will spread throughout the state.

Control

Feasible and effective control options depend upon plant size, number and location. Because bush honeysuckle can sprout prolifically from the stump, any control method must ensure that the stump is removed or deadened. Most removals will require the hand application of herbicides.

Mechanical control that removes the stump is an option, and any lateral roots left are unlikely to sprout a new plant. Small, knee-high plants can be pulled by hand. Larger plants can be removed with devices (weed wrenches and poppers) that are designed to remove shrubs. The larger versions of these devices are typically effective on bushes up to two inches in diameter, which is roughly a plant six to eight feet in height. The disadvantages of mechanical control are the significant labor times (see treatment cost section) and the size limitation.

Effective herbicide control methods include foliar spray, cut stump application, tree injection and full basal bark. However, foliar applications for small plants and cut stump treatments for large plants are generally recommended and can be used in most situations.

Foliar spray can be effective for plants less than head height unless a machine-mounted power sprayer is used. Typically power spraying is reserved for fence lines or edges of woodlands. While it is relatively fast to foliar spray, this method often results in damage to native plants, and foliar spraying should not be used if native seedlings and forbs are present. Typically, common brush herbicides such as glyphosate can be used at recommended foliar rates (for example, two percent solution from concentrated glyphosate [> 40 percent active ingredient]). Because plants often have several stems, it is important to ensure that all leaves and branches are sprayed. The early leaf-out of bush honeysuckle can widen the spraying window and help to avoid native plants.

The most common method to treat bush honeysuckle and the method of choice for larger plants is cut stump. This requires cutting of the shrub close to the ground

habitats. Amur is one of the first colonizers of disturbed areas in its native China and easily can invade disturbed areas in the U.S. Unfortunately, seeds can also germinate and grow in moderately shaded woodlands. Because of this, bush honeysuckle growing in the understory in wooded areas need to be controlled prior to creating openings in the forest canopy that increases the light they receive. Bush honeysuckle also have the competitive advantage of being one of the first species to leaf out in spring, and they retain their leaves in fall later than most native species. There is also increasing evidence that Amur produces chemicals that hinder native plant growth, a condition referred to as allelopathy. Collectively, these attributes have caused Amur to have severe ecological and economic impacts where it has successfully established. Fortunately, there are no native bush honeysuckle species with

and application of herbicide within one to two hours of cutting. Use a full strength (greater than 40% active ingredient) glyphosate herbicide (Accord™ is labeled for use in woodlands, agricultural brands can be used for fence rows and field edges) or other concentrated forestry chemicals such as Pathway™ (Tordon™ labeled for forestry use and composed of picloram and 2-4, D™), Arsenal™ (imazapyr), or Garlon 3a or 4™ (triclopyr). Spray the entire stump until runoff and any branches or stems that were cut at the ground line. This method is appropriate for larger size plants one inch or more in diameter. Also, this method should not be used in late winter or early spring prior to leaf-out, as sap rising at this time will reduce the amount of herbicide taken up by the plant.



A specialized tool (EZ-Ject herbicide lance) can be used to inject herbicide capsules directly into targeted plants. This control technique is expensive in comparison to other techniques and its effectiveness is inconsistent.

Photo courtesy: Laurie Taylor Thomas

Tree injection using the E-Z-Ject™, a relatively new dry granular injector, has also been used.

It can be more time consuming than cut stump treatments because the injector has to be lined up fairly precisely to inject a capsule, which requires maneuvering under the bush. Further, research using glyphosate capsules has shown it to be inconsistent with relatively high levels of resprouting using the recommended rate of herbicide. Doubling the rate is required to achieve good kill.

Basal bark treatments require spraying the outer bark of small trees and shrubs (less than four to five inches in diameter). The herbicide penetrates the relatively thin bark and

is an effective option, but only if special chemical carriers and mixes are used. Normally, Garlon 4 is mixed in crop oil or diesel fuel to form a 25 percent Garlon 4 solution. However, this traditional basal bark mix provided inconsistent results. The current recommendation from Purdue University requires the use of Ax-it™ basal oil (instead of diesel fuel or crop oil) and 15% Garlon 4 and three percent Stalker™. If native species, either large or small trees, or native herbaceous plants are present and a large amount of honeysuckle must be controlled this technique is not recommended as there is a potential of Garlon 4 and Stalker poisoning native plants.



Mechanical control of bush honeysuckle can be performed anytime of the year and may be most applicable in areas where herbicides cannot be used. However, mechanical control is typically the most time consuming control technique (see Figure 2).

Photo courtesy: Billy Thomas

Mechanical removal and follow-up foliar spray can be used for severe infestations when a rotary brush hog can be driven through the woods, cutting down and effectively mulching all of the bush honeysuckle. Implement this procedure directly after the bush honeysuckle has leaved out. Follow this with a foliar glyphosate spray of the

stump sprouts at or near the end of the growing season. This time lag allows for enough leaf area to be present to provide for effective control. However, this method functionally restarts the woodland regeneration, killing the bush honeysuckle and co-occurring plants (native or otherwise). It is not feasible on steep terrain but has been used by Purdue University for woodland savanna restoration with native warm-season grasses under sparse overstory trees.

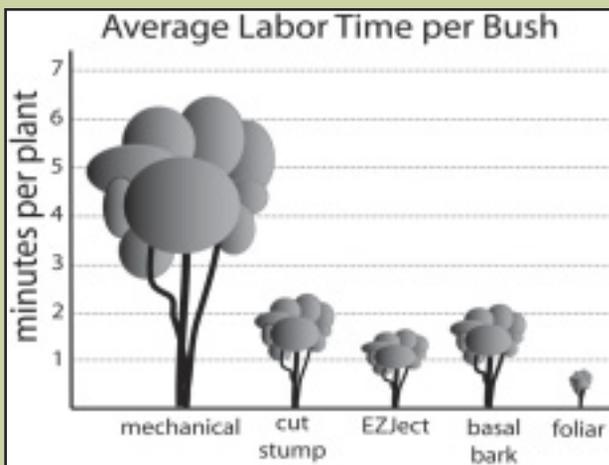


Figure 2. Average labor time to apply treatments to bush honeysuckle.

Treatment Cost

Treatment of significant infestations of invasive plants can be expensive. This is particularly true when the plants occur in wooded areas. Research at the University of Kentucky indicates an average mechanical removal time of 6.3 minutes using a Weed Wrench™ or similar device for head-high bushes. This compares to 2.1 minutes for cut stump, 1.4 minutes for basal bark, 2.2 minutes for EZ-Ject and 0.55 minutes for foliar treatments (Figure 2).¹ Herbicide treatments also include the cost of herbicide. On average the cut stump treatment used 0.18 ounces of concentrated glyphosate per plant, foliar 0.03 ounces per plant, and the EZ-Ject used 5.5 capsules per plant. If there were 500 plants per acre (a low number for infested stands) the herbicide cost would be \$49.21 per acre for cut stump, \$8.19 per acre for foliar and \$498.87 for EZ-Ject pellets. The total cost for this stand would be \$421 for mechanical (52 hours at \$8 per hour), \$187 for cut stump

(17.2 hours at \$8 per hour [\$138] and \$49 for herbicide), \$644 for EZ-Ject (18 hours at \$8 per hour [\$144] and \$498 for herbicide), and \$45 for foliar (4.6 hours at \$8 per hour [\$37] and \$8.19 for herbicide).

For most situations it is recommended to use two methods of control – foliar spray for small plants (less than head height) and cut stump for large plants. Since it is almost impossible not to miss plants during an initial treatment, especially if heavily infested, a follow-up treatment should be scheduled for the next growing season. Many times the escapes are small plants that were missed or were not thoroughly treated and stumps that were not sprayed. Follow-up foliar treatments should not occur until the stumps have had time to put on a significant amount of leaf area, generally July through September.

Table 1. Control methods for bush honeysuckle (*Lonicera* spp.)

Method	Timing	Details and Cautions
hand pulling	Anytime	Plants less than 3 feet high.
mechanical puller or popper	Anytime	Plants 3 feet to head height.
herbicide ¹ - foliar	April - September	Plants head height or less. Foliar applications of 2% glyphosate. Accord is labeled for use in woodlands. Use other glyphosate products for other areas.
herbicide ¹ – cut stump	June – January	Plants greater than 1 inch in diameter. Thoroughly wet stump with concentrate less than 2 hrs after cutting. Example: Accord herbicide concentrate (> 40 percent active ingredient - glyphosate) spray on stump mildly diluted to facilitate spray. Glyphosate poses the least carry-over problems to native plants.
herbicide – basal bark	fall, winter, early spring	Plants greater than head height. Wet lower 18 inches of ALL stems on a plant. 15 percent Garlon 4, 3% Stalker in Ax-it basal oil. Do not use when large amounts of honeysuckle are present among or underneath native trees as carryover from large application rates of these herbicides could occur.

¹Other herbicide brands can be used for control. The herbicides that are listed are those commonly used regionally and are labeled for use in forests (woodlands).

¹Data from research and demonstration project “Invasive Species Reduction in Bluegrass Woodlands” UK Department of Forestry, Kentucky Division of Forestry and Lexington Fayette Urban County Government Department of Parks and Recreation, 2008.

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www.KyForestHealth.org

COMPARING WOOD FOR ENERGY

by Terry Conners

Energy can be produced from woody biomass in various ways, and wood-fueled power plants can be a renewable alternative to many current power facilities that are using fossil (or nuclear) fuels. Woody biomass can also be used to produce heat and power at facilities such as hospitals and schools. After hydroelectric power, biomass has been the largest non-hydro renewable energy source for electricity in the United States, and as technology improves, biomass will likely become an even more attractive alternative to fossil fuels. There are issues with collecting sufficient supplies and collection in many areas, but woody biomass ultimately might become a source of local revenue for both landowners and small power companies.

Supplies of Fossil Fuels and Wood for Fuel

Kentucky is blessed with an abundance of coal, but 58% of our daily needs for oil and refined petroleum products were imported in 2007. Energy independence has been a popular topic in this election year, and it surprised me to learn that almost 50% of U.S. crude oil and petroleum products imports came from the Western Hemisphere (18% from Canada alone) during 2006 (see Figure 1). We imported only 16% of our crude oil and petroleum products from the Persian Gulf, but as we've recently learned, even slight disruptions in global supplies can affect availability and prices in the U.S.

Facilities that use renewable sources of energy can promote energy independence and provide a supply of energy that isn't subject to international situations. Biomass can be collected from any location that supports agricultural or

silvicultural production, so biomass power facilities can be located almost anywhere in the country. Kentucky is potentially a good location for a biomass power plant because of its acreage of timberland.

Most wood "residue" from manufacturing operations already has a buyer (for horse bedding, for example), and there isn't enough unused waste wood from used pallets and so forth to generate a significant part of our energy needs. More wood would have to be collected from forest operations to make energy generation from wood practical. Equally important, any power generating station that wants to use wood will require a guaranteed supply for a sustained period of time.

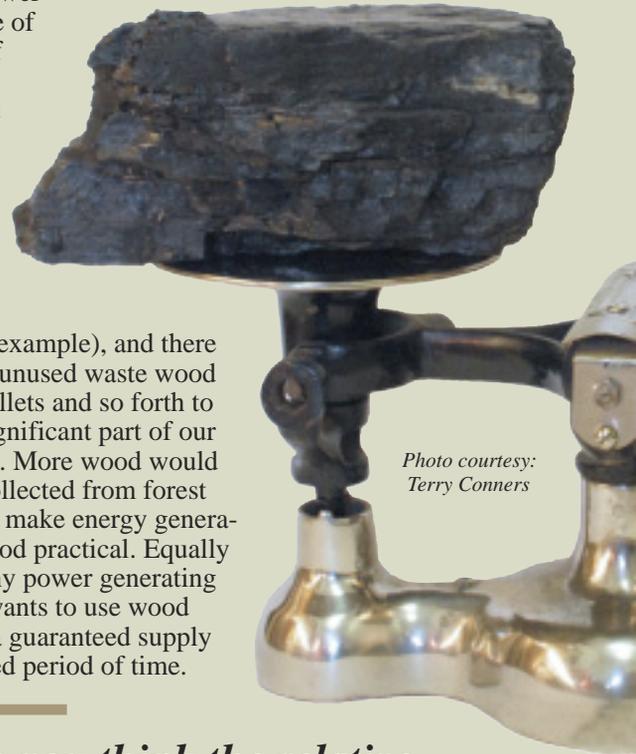


Photo courtesy: Terry Conners

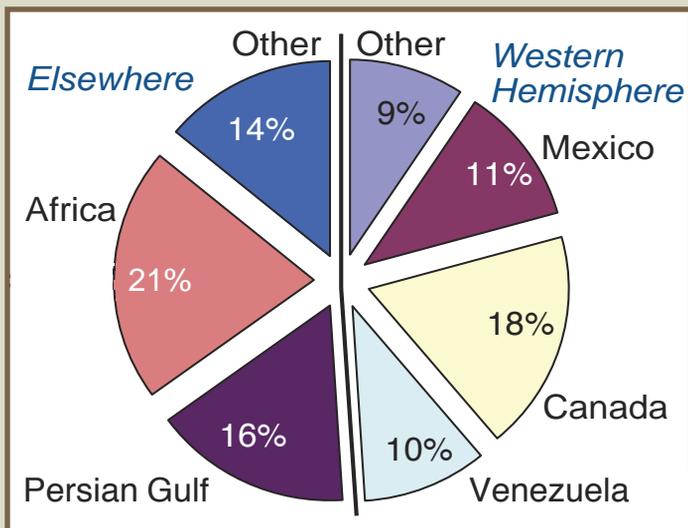


Figure 1: Import source of U.S. crude oil and petroleum products during 2006. Data from EIA's Energy in Brief: How dependent are we on foreign oil? Accessed 11/08

What do you think the relative importance of wood energy and coal should be in Kentucky?

This would be difficult to provide in a state such as Kentucky with few large landowners, so potential power stations using biomass would likely have to contract with a mix of landowners, municipalities, tree service companies, etc. to assure a large enough supply.

Gas and Particle Emissions from Burning Wood and Fossil Fuels

The kind of emissions from wood-fueled power generation will vary, depending on whether softwoods (like pine) or hardwoods (like oaks or maples) are used. As anyone who has ever touched a bleeding wound on a pine tree knows, pines contain a sticky resin. Pine resin resembles maple syrup, in that it contains a solvent and some soluble compounds that harden in air as the liquid evaporates; instead of water and maple sugar, though, wood resin is made up of turpentine and rosin – when the tur-

AND FOSSIL FUELS PRODUCTION



mentine evaporates from the bleeding wound, the rosin is left behind to act as a stopper for the sap. Turpentine is a volatile organic compound (VOC), and if it is released into the air because of poor combustion controls, it can combine with other compounds in the air to form ozone. Evaporation of turpentine from forests is spread out, and ozone formation is usually not a significant problem; turpentine released from a power plant is a point source, however, so local ozone concentrations can be higher if emissions are uncontrolled.

Hardwoods don't contain turpentine, but they do contain chemicals that break down when the wood is dried. Some of the resulting chemicals are classified as hazardous air pollutants (HAPs) by the EPA (for example, formaldehyde). Additionally, both softwood and hardwood burning will result in the creation of small particles that are harmful to our health. Gas and particulate emissions like these HAPs aren't unique to wood burning, and pollution control equipment is available to handle these potential problems. In terms of the amount of greenhouse gases produced by different fuels, however, wood has a much smaller impact than other fuels (see Figure 2), and pollution control equipment becomes somewhat less expensive. This is one of the reasons why some power plants choose to replace some of their coal fuel with wood ("co-firing").

The combustion of wood releases carbon dioxide into the atmosphere, but through the cycle of growing trees—using the wood—replanting more trees, the carbon dioxide is recycled from the atmosphere. As long as trees are replaced at the same rate they are harvested and used, they take in approximately the same amount of carbon dioxide as is released during combustion. Therefore, using wood for energy does not contribute to climate change by increasing the amount of carbon dioxide to the atmosphere.

Possible negative effects of managing forests for energy production are the change in wildlife habitat from harvesting operations and decreases in soil fertility over a prolonged period of

time (most of the mineral nutrients are left behind when tree stems are harvested). These effects can be addressed with proper forest management.

Summary

Both wood and fossil fuels offer certain advantages as fuels for energy production. Fossil fuels can be used with familiar technology, but woody biomass appears to be a more environmentally sound option. While wood may not be a feasible or sensible energy option for every community, it can support efforts to promote more sustainable and locally-generated sources of energy.

Thanks to Sara Sillars, Phillip Badger and Martha C. Monroe for their contributions to this article.

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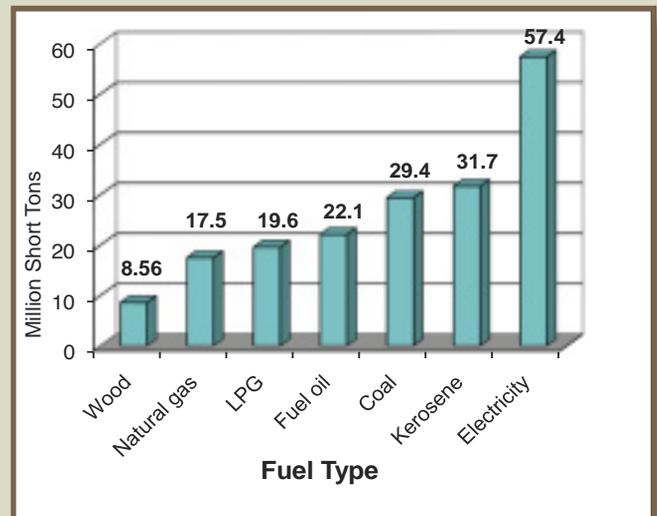


Figure 2: Carbon equivalents of greenhouse gases per quad of heat delivered. (A quad is equal to 1,015 BTUs.) Redrawn from data contained in: *Air Emissions from Residential Heating: The Wood Heating Option Put into Environmental Perspective*. J.E. Houck, P. E. Tiegs, R.C. McCrillis, C. Keithley and J. Crouch. In *The Proceedings of a U.S. EPA and Air Waste Management Association Conference: Emission Inventory: Living in a Global Environment*, v. 1, pp. 373–384, 1998.

Forestry 101

Forestry for Woodland Owners

Conifers of Kentucky

by Doug McLaren

Kentucky is dominated by hardwoods. Annually, Kentucky ranks within the top five hardwood lumber producing states in the nation. This success is a result of the state being nearly 50% covered in forests, producing some of the finest assorted species of oak, hickory and yellow-poplar. Conifers only make up a very small percentage of Kentucky's forest base, unlike that of the pine-producing states of the deep South.

Many people enjoy having the opportunity to visit Kentucky's woodlands, and they have a much better appreciation of the visit if they are able to identify the trees. At times trying to learn all of the hardwood species can be overwhelming, due to the sheer numbers, but learning the conifers native to Kentucky can be less intimidating, since there are only a handful. Here is a quick summary of Kentucky's conifers and how to identify them on your next visit to a Kentucky woodland.

Many of the pines have needles that grow in bundles or clusters (this page), the more scientific term is fascicles. While other conifers have needles that are arranged individually (next page).

Virginia pine (*Pinus virginiana*)

has two short slightly twisted needles per fascicle and the needles are approximately one-and-a-half to three inches long. Virginia pine is found throughout the state.



Photo courtesy: Chris Evans, River to River CWMA, www.forestryimages.org

Shortleaf pine (*Pinus echinata*)

is found on the drier sites of eastern Kentucky's landscape and is identified by having two to three needles per fascicle, with each being three to five inches in length.



Photo courtesy: Steve Baskauf, <http://bioimages.vanderbilt.edu/>

Loblolly pine (*Pinus taeda*)

although not a native species, is a visible member of Kentucky's conifer family due to the extensive plantings found in western Kentucky. Loblolly pine can be identified by having the longest needles, varying in length from five to 10 inches and three needles per fascicle.



Photo courtesy: Paul Bolstad, University of Minnesota, www.forestryimages.org

Eastern white pine (*Pinus strobus*)

is found generally in eastern Kentucky and also in many Kentucky home landscapes. White pine can easily be identified by being the only five-needled native conifer in Kentucky. Each needle is approximately three to five inches long.

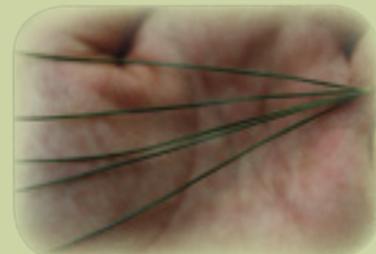


Photo courtesy: Bill Cook, Michigan State University, www.forestryimages.org

Pitch pine (*Pinus rigida*)

has the unique distinguishing feature of having three needles per fascicle, with the length from one-and-a-half to five inches. Pitch pine is found on the drier upper sandy ridge tops.



Photo courtesy: Keith Kanoti, Maine Forest Service, www.forestryimages.org

Kentucky Trees and How To Know Them is available for \$1.50. This booklet covers 87 of the most common trees in Kentucky and provides information on where they grow and ID characteristics. To purchase one, please send a check for \$1.50 made out to UK Forestry to: UK Forestry Extension, 216 T. P. Cooper Bldg., Lexington, KY 40546.



Eastern hemlock (*Tsuga canadensis*)

is found almost exclusively along the streams of eastern Kentucky.

The needles are arranged on the stem individually, are flat and are less than an inch long. The best way to confirm eastern hemlock is to turn the individual needle over and look for the two pale white lines running the length of the needle.

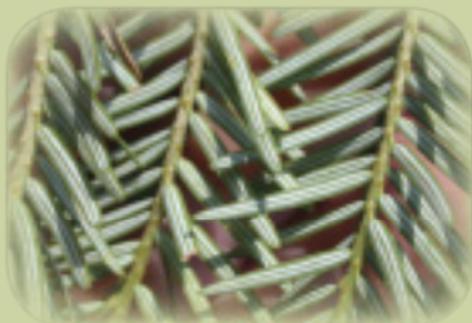


Photo courtesy: Pennsylvania Department of Conservation and Natural Resources - Forestry Archive, www.forestryimages.org

Baldcypress (*Taxodium distichum*)

is found exclusively in very watery sites and swamps of western Ken-

tucky. The easiest way to identify the tree is the extremely flared base of the tree when it is viewed from a distance. The needles grow individually and are less than one inch long. The tree is deciduous, losing its needles in the winter.



Photo courtesy: Paul Wray, Iowa State University, www.forestryimages.org

Eastern redcedar (*Juniperus virginiana*)

is a tree found throughout Kentucky, but found extensively in those areas that have limestone outcrops. Eastern redcedar has a very dense foliage with a small, scale-like prickly needles less than a 1/2 of an inch in length on new growth.



Photo courtesy: Paul Wray, Iowa State University, www.forestryimages.org

About the Author:

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Kentucky Big Tree Program

Mammoth's Own Giant

by Diana Olszowy

Mammoth Cave National Park is already known to have the longest cave system in the world, some 365 explored miles long, to be exact. The park now controls the bragging rights to the new state champion eastern white pine. Though only native to the Appalachian region of the state, eastern white pine has made itself at home and has become naturalized throughout the forests of central and southern Kentucky as well.

This newest state champion is hidden within the 52,830 acres of Mammoth Cave's biologically diverse forest. The pine was planted by Edmonson/Hart County's local legend, Edley "Red Buck" Esters, who once owned and eventually sold his acreage to the park in the mid 1930s. This living memorial now measures nearly 12 feet in circumference and stands 13 stories high.

Eastern white pine was historically referred to as "the monarch of the forest." The first settlers to New England were greeted with specimens 250 feet in height and 18 feet in circumference. They were a bonanza for England in Colonial times, as they met a vital military and commercial need for sailing ship masts. Since the colonists were rapidly using up the existing supply of trees close to the ocean that were large enough for masts, the Royal Navy appealed to Parliament. As a result, in 1691 Great Britain imposed the first of the so-called "broad arrow" acts, so named because of the axe mark placed on the reserved trees by the king's men that reserved these trees for the English government. Growing resentment to the crown's appropriation of the choicest white pines helped precipitate the Revolutionary War, and the first flag of the Revolutionary forces even had a white pine as its emblem.

The wood of white pine is light and strong, resists warping and is easily cut in any direction. It is currently used for flooring, paneling and dimension lumber and is a popular choice for log cabin construction. The species provides excellent cover and food for many forms of wildlife, including songbirds, turkey, elk and deer.

Eastern white pine's graceful habit and long, bluish-green needles give this tree a soft look. It is considered one of the most attractive evergreens and is often planted in the landscape as a living screen and windbreak. It is also a popular Christmas tree because of its fragrant foliage and its needle retention. It is a fast-growing tree, averaging 50 to 80 feet in height, with a spread of 30 to 50 feet. The very straight trunk of white pine is punctuated by a whorl of lateral branches every one to two feet. From this sequential arrangement, a close approximation of the age of the tree can be determined by simply counting the number of whorls from bottom to top. It grows best in fertile, moist, slightly acidic, well-drained soil in full sun. It can tolerate some shade but suffers in saturated, dry, compacted or heavy clay soils. These conditions cause a physiological problem in young and recently transplanted trees known as white pine decline, which will eventually cause death.



Though "Red Buck" Esters planted his own living legacy; it is Mammoth Cave National Park that is benefiting from the introduction of this beautiful evergreen and the perpetuation of its superior genetic traits into the park's ecologically-diverse forest.

Eastern white pine cone. Photo courtesy: Keith Kanoti, Maine Forest Service, Bugwood.org

About the Author:

Diana Olszowy is Stewardship and Education Branch Manager with the Kentucky Division of Forestry. She is also an editor of the Kentucky Woodlands Magazine.

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Test Your Knowledge

Photo courtesy: Alexey Sergeev, Department of Physics, Texas A&M, www.asergeev.com



A. Am I some funny-looking tomato, or a new breed of apple? Chances are the deer and turkeys on your property know me well and wait for me to ripen. My wood is fairly hard and is used for golf clubs, pool cues and interior home products. If you were impatient and tasted me before I was ripe, you'll never do it again! Do you know me?



B. I'm often called a shelf mushroom, but I'm not edible. I grow on many types of trees, especially maples, birches, beech, apple, poplars, cherry, plum, oaks, willows and elm. If you're seeing me, I'm in the process of eating my host alive from the inside out. There are many varieties like me, but I'm the only one you can carve pictures on and they stay. Have you seen me?

Photo courtesy: Dave Powell, Pike and San Isabel National Forests, www.forestryimages.org



C. It doesn't matter how well you've insulated your double or triple-pane windows, I'll find a way to get in there. I am not from the U.S., but I was brought over from Asia to help in controlling agricultural pests that attack apples and pecans during the 1960s. I've migrated north to Kentucky and I prefer warm, sunny places to overwinter. Do you know who I am?

Photo courtesy: Iowa State University Extension, www.extension.iastate.edu



D. I am an evergreen, parasitic plant that only grows in the crowns of deciduous trees. Since I'm plugged into my host's resources, I have no need to fend for myself. Most folks don't pay attention to me until the holidays, but I'm always there. When brought inside, I'm frequently found hanging over doorways and am the impetus for amorous couples. Do you know me?

Photo courtesy: Southern Gardener, Mississippi State University Extension Service, www.msucare.com

Photo courtesy: William Vann, EduPic Graphical Resource, www.edupic.net



E. Some folks call me an orange, while others call me an apple, but I'm neither. I was planted originally as a "living fence" prior to barbed wire and the Native Americans used my wood for their bows and my sap for medicine and dyes. My fruit is said to repel spiders and roaches. Better wear a hard hat if you're working around me. Do you know me?

Answers to Test Your Knowledge can be found on page 25.

Non-Timber Forest Products

Forest Farming: Christmas Trees

by Deborah B. Hill

Christmas trees don't fit precisely into the definition of forest farming, but they are a non-timber forest product (NTFP) and produce income for the grower in a shorter time frame than timber.

Kentucky has always had a Christmas tree industry, although at a very small scale. Two extension specialists, about 25 years ago, Dr. Bonnie Appleton, then a horticulturist at Kentucky State University, and I began to develop this industry with a combination of workshops and materials (print and video). The benefits of producing Christmas trees include guaranteed market every year, a short growing period relative to other tree crops, periodic intensive management (planting, shearing, marketing) but otherwise not much time required in management, and a good return on investment.

Today we suggest that Christmas trees are grown in agroforestry systems. This could include growing trees along fence rows (as in a silvopasture system), in single or multiple rows intercropped with annual agronomic crops (as in alley cropping systems), or in the "shrub" area in a riparian buffer strip

or windbreak system, as the trees will be removed when they are relatively small (six-eight feet tall). Planting every year in these last two systems would ensure that there would always be trees in the ground, where they serve the purpose of protecting against soil erosion and where their presence in the intercropped system succeeds in diversifying or strengthening the whole system.

Business Side of Christmas Tree Operations

Potential growers need to know that the Christmas tree business demands a lot of interaction with the public. Although all Christmas tree farms can determine when they will be open for customers, growers are VERY busy between Thanksgiving and Christmas Day, so be advised! Also, choose-and-cut growers (most profitable method) must have appropriate liability insurance for having the public on their property with sharp objects like saws and hatchets around. Many growers have developed Christmas tree sales on their property into a whole family outing experience. Growers offer hot coffee, cocoa or cider; some offer hay rides into the plantation and some have small shops where they sell wreaths, ornaments, tree skirts, homemade foods or other items. Some growers have said that their shops make more money than the trees!



Blue spruce.

Photo courtesy: Steven Katovich,
USDA Forest Service, www.forestryimages.org

Species Selection

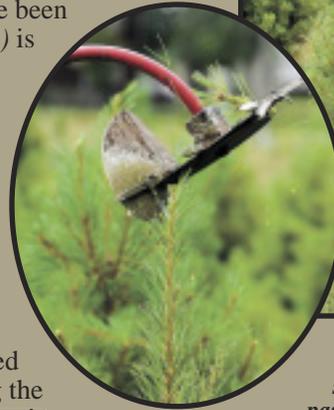
Christmas trees (pines, spruces, firs) grow successfully on soils that may not be suitable for other crops. Conifers prefer a more acid soil than is common in parts of Kentucky, but many Christmas tree species have been grown successfully all over the state. White pine (*Pinus strobus*) is the most desirable disease-resistant pine species to grow. Since its needles are long and soft, they must be sheared tightly so that ornaments can be successfully hung on the branches. Virginia pine (*Pinus virginiana*) is another possibility; it grows very rapidly and needs careful management in its early growth. Norway spruce (*Picea abies*), Colorado blue spruce (*Picea pungens*) and Douglas-fir (*Pseudotsuga menziesii*), although slower growing than the pines, have been reliable species for Kentucky growers. An advantage of these last three species is that their normal growth habit is conical, so they require less shearing and pruning for market and can be managed during the dormant season. The pines need to be sheared during the growing season to encourage appropriate bud set for the next year's growth. Recently, several Kentucky growers looked at a variety of other exotic tree species to grow as Christmas trees here. After several years, the growers concluded that Nordmann fir (*Abies nordmanniana*) and Meyer's spruce (*Picea meyeri*) could be successful. The Cadillac of Christmas trees, Fraser fir (*Abies fraseri*) needs to be either further north in latitude or higher in elevation to grow successfully with minimal insect and disease problems. Canaan fir (*Abies balsamea* var. *phanerolepis*), a variety of balsam fir (*Abies balsamea*), can be grown in Kentucky and has been popular with several of our growers. Another possible species for our area is Leyland cypress (*X Cupressocyparis leylandii*). Its natural growth habit is also columnar or conical, and it grows rapidly – possibly producing a marketable tree (six-foot industry standard) within three or four years.

Planting Christmas Trees

To start, plan where you want the trees to be, both immediately and in the future. A variety of commercial nurseries in nearby states sell growing stock for Christmas trees. Pine species are available through the Kentucky Division of Forestry nurseries. Planting is done in the early spring (late February-early March) so that trees can establish their roots before the warmer (and often drier) weather begins. Pine seedlings are 1-2 years old in the nurseries; spruce and fir seedlings are two to three years older, as their seedlings take longer to grow to transplant size. Growers use herbicide to clear the planting spots for the seedlings, or they cultivate and then mulch the seedlings heavily with woody mulch (chips or sawdust) once planted. Mulch is important for the first year or two as the seedlings become established, but applying mulch is labor intensive. Mulch retains water in the root zone for the seedlings, keeps the soil temperature cooler, discourages weed growth around the base of the seedlings, and eventually decays into nutritious organic matter. Most growers find that they need to re-apply mulch every two or three years in the normal five- to eight-year growing cycle for Christmas tree production.

Repeat Customers

Christmas is an annual holiday, and people who buy real Christmas trees buy a new one each year, so many growers do very little advertising. Growers find their clientele grows annually through word of mouth from satisfied customers. Many growers advertise only the week before Thanksgiving or the weekend just after Thanksgiving. That is when the season "officially" opens and when potential buyers are looking for trees. With greater concerns about the cost of gas mileage, locally grown trees will become more attractive. Providing "extras" such as tree disposal bags, netting or twining of the purchased tree, and shaking out of dead needles will all encourage your buyers to return. Keeping a mailing list of your customers and sending them a reminder the following year also retains and grows your client list.



Pete Kovalic of Kovalic's Christmas Tree Farm in Winchester, KY was busy shearing his pine Christmas trees this past summer. Pine Christmas trees need to be sheared during the growing season to encourage appropriate bud set for the next year's growth.

Photos courtesy: James Mann, Winchester Sun

How Can I Learn More?

If you are interested in Christmas tree production, there is a Kentucky Christmas Tree Production Workbook available either online (http://www.ca.uky.edu/forestryextension/publications_nontimber.php) or from UK Forestry Extension in hard copy (\$10). There is a video available from the Department of Agricultural Communications at UK on Pruning and Shearing Christmas Trees. There is also a small but active Kentucky Christmas Tree Association (www.kychristmas-treefarms.com). The organization has been tremendously helpful to its members, sharing both successes and failures and giving advice freely! The association sponsors an annual plant auction in Lexington each spring and has a second meeting in the fall on one of the Christmas tree farms. Growing Christmas trees is a rewarding experience but requires patience and a willingness to serve the public. However, during the holiday season, there is nothing like the smell of a fresh Christmas tree in the home...

About the Author:

Deborah Hill, Ph.D. is a forestry extension professor and forestry extension specialist at the University of Kentucky Department of Forestry, she is responsible primarily for programs in non-timber forest products. She also works with 4-H and youth, and in the areas of urban forestry, agroforestry, and permaculture. She has developed landowner programs in Christmas tree and shiitake mushroom production.

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Kentucky Woodland

Emerald Ash Borer Trapping in Kentucky

In 2008, trappers set 3,066 purple prism traps around Kentucky, primarily north of I-64, but also throughout the state in high-risk areas such as campgrounds, state parks, and nurseries. The color of the traps and the lure, which smells like ash tree volatiles, are both attractive to emerald ash borer (EAB). Traps were in place from May through August. Personnel from the Department of Entomology at the University of Kentucky and USDA APHIS screened these traps for EAB. We have not found emerald ash borer on any of the purple traps. Many beetles in the same family (Buprestidae) were captured as well as a wide variety of insects, but no EAB.

The Department of Entomology at UK is planning to work with the USDA on this trapping program again in 2009 with nearly double the traps (6,000). In 2008, we hired several certified arborists to assist with the trapping program and paid them a fixed amount per trap. In 2009, we will again be looking to hire certified arborists that can identify ash trees and devote time to the trapping program. If you are interested, contact Joe Collins, Carl Harper, or Janet Lensing at 859.257.5838 or Joe.Collins@uky.edu.

Visit www.emeraldashborer.info for the latest information about this beetle. If you suspect emerald ash borer in your ash trees, call the USDA EAB hotline at 1.866.EAB.4512.

-- Janet Lensing, State Survey Coordinator, University of Kentucky



More than 3,000 of these traps were set in northern Kentucky to detect EAB.

Photo courtesy: Above: Joe Collins Left: Howard Russell, Michigan State University, www.forestryimages.org

Tax Tips for Forest Landowners for 2008 Available

Did you know that you may be able to claim income from a timber sale as long-term capital gains as opposed to ordinary income? This can be particularly advantageous to woodland owners as the long-term capital gains tax rates are lower rates than ordinary income. You can also deduct outright the first \$10,000 per year (\$5,000 per year for married couples filing separately) of reforestation expenses per qualified timber property and amortize (deduct) any additional amount over 8 years. Having the "right" information can save you money on your taxes!

Tax time is fast approaching and fortunately there is some specific information available to woodland owners, foresters, loggers, forest product businesses, and tax practitioners. Linda Wang and John Greene with the US Forest Service recently released Tax Tips for Forest Landowners for the 2008 Tax Year. This publication is available at www.ukforestry.org (click on New Information) or by calling 859.257.7597 and requesting it. Of course, you should always consult your tax and legal professionals for advice on your particular tax situation.

2009 Kentucky Woodland Owners Association Annual Meeting

The annual meeting will be held on March 20-21, 2009 at General Butler State Resort Park in Carrollton, Kentucky. The agenda includes: Friday afternoon and evening -- Field trips to woodlands, log grading, veneer log valuation, reception and dinner. Saturday -- Presentations of topics of interest to woodland owners.

Please make your room reservations separately with General Butler State Resort Park at 866.462.8853. A block of rooms with a special rate has been reserved until Feb. 18, 2009. Please state that you are attending the KWOA MEETING when making your reservations. For more information or to register call Betty Williamson at 270.821.8657 or e-mail at willdan@bellsouth.net.

Dates To Remember:

Date:	Event:	Location:	Contact:
January 27, 2009	Certification for Kentucky Forests and Products	Lexington, KY	502.695.3979
March 2, 9, 16, 2009	Master Tree Farmer Series	Various	859.257.7597
March 20 - 21, 2009	KWOA Annual Meeting	Gen. Butler State Park	270.821.8657
April 1 - 3, 2009	KFIA Annual Meeting	Lexington, KY	502.695.3979
April 4, 2009	Ohio River Valley Woodland & Wildlife Workshop	Cincinnati, OH	614.688.3421

For more information about these programs, visit www.ukforestry.org

News To Use

Master Tree Farmer Series

The Master Tree Farmer Series: Forest Risks and Risk Management will be held on March 2, 9, and 16 from 6:30 to 9:30 p.m. (Eastern Time) at various county extension offices across Kentucky.

Program Overview

Risks exist with every endeavor we face in life and this is certainly true with forest management. This three-week event will concentrate on the risks associated with forest management and allow woodland owners and natural resource professionals to consider how they can manage forests and forestland to plan for and minimize problems they may face. Participants will receive an information binder with presentation and reference materials.



March 2, 2009: An Introduction to Managing Risk in Your Woodlands; Understanding and Managing Natural Disasters & Changing Climate

- Changing Times - what it means for the private woodland owner
- Introduction to risk and risk management
- Risk and landowner objectives – understanding the connection
- Wind, fire, drought and ice – examples and management/mitigation advice
- Global climatic change – what this means to woodland owners (carbon credits)

March 9, 2009: Managing and Mitigating Invasive Plant Species, Insects & Diseases

- Invasive Plants
- Insects & Diseases (Exotic and Native)
- Control issues (cost-share, technical assistance, cooperative agreements, landowner-to-landowner agreements)

March 16, 2009: Taxes, Policy, Regulations, Law and Land Use Change

- Trespass, timber theft and contracts, boundary marking, liability, etc.
- Regulations and Right-to-Practice Forestry Laws
- Federal and state taxes and risk
- What are my next steps for managing risk on my forest
- Making a difference – the importance of getting involved in woodland organizations

Registration is being handled locally by county extension offices hosting the series. At press time, locations included the following counties:

Bullitt (502.543.2257), Clark (859.744.4682), Letcher (606.633.2362), and Menifee (606.768.3866). Additional counties are being added, for the latest list of locations visit www.ukforestry.org or call 859.257.7597. You may also contact your local extension office to find the host site nearest you.

Answers to Test Your Knowledge on page 21.

- A. Persimmon
- B. Artist Conk
- C. Asian lady beetles
- D. Mistletoe
- E. Osage-orange or Hedge Apple

Certification for Kentucky Forests and Products Seminar

Certification for Kentucky Forests & Products Seminar



There will be a seminar on all aspects of forest and wood products certifications on Jan. 27 in Lexington.

Subject areas include: reasons for certification, options and recognition for certification efforts, improved forestry performance on ground, market opportunities, cost and benefits vs. pitfalls.

The seminar will be held from 9 a.m. – 4 p.m. on Jan. 27 at the Fayette County Cooperative Extension Office, 1140 Red Mile Place, Lexington. Advance registration fee is \$25 (due January 19). On the day of the program the fee will increase to \$35. For directions visit: <http://ces.ca.uky.edu/fayette/directions/> For more information or to register: call Kentucky Forest Industries Association at 502.695.3979.

Seminar partners include: Kentucky Forest Industries Association, Kentucky Tree Farm Committee, UK Department of Forestry Extension, Kentucky Division of Forestry, Kentucky Woodland Owners Association, Kentucky Farm Bureau and the KY SIC committee.



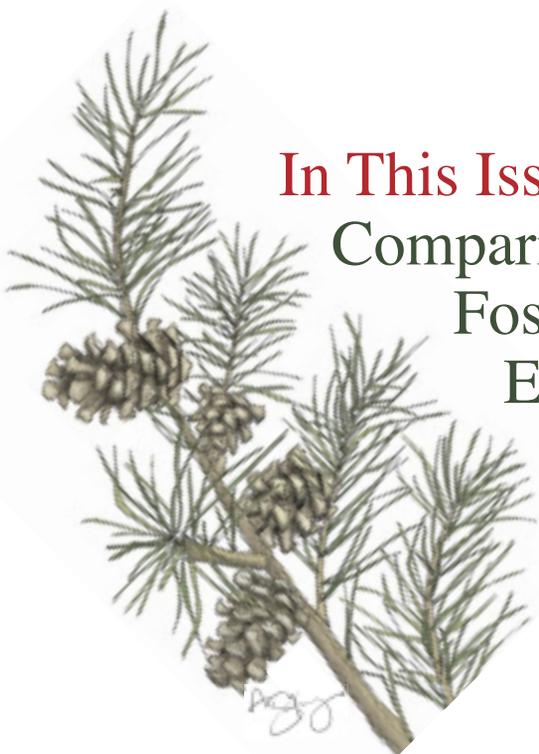
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Comparing Wood and
Fossil Fuels for
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