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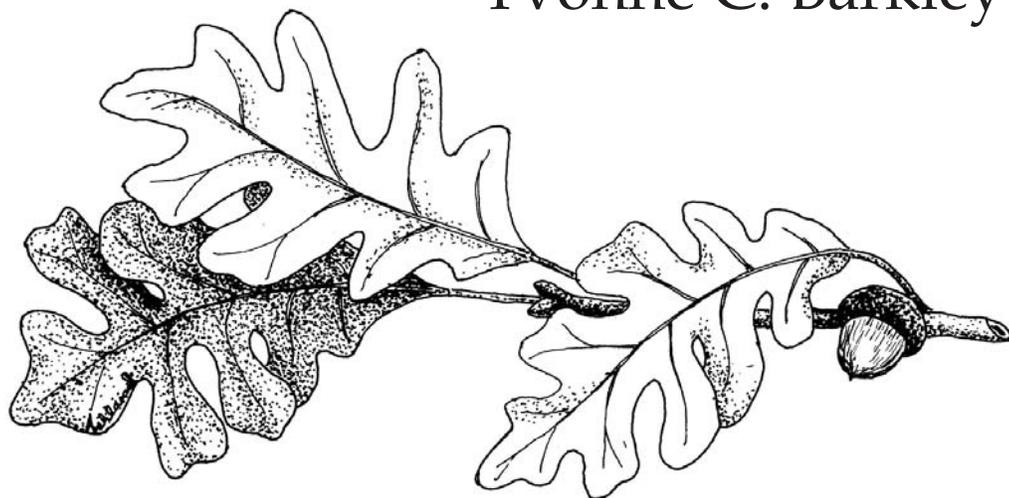
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Hardwood Plantations for the Inland Northwest

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Hardwood Plantations for the Inland Northwest

Yvonne C. Barkley

High-value hardwoods - their beauty, strength, and workability are unmatched. The Inland Northwest, also known as the Inland Empire, is an area of the Pacific Northwest centered on Spokane, Washington, and includes the surrounding Columbia River basin and all of North Idaho. And with six different USDA climate zones and elevations ranging from 350' to over 7,000', the potential for many high-value hardwood species to grow successfully in the Inland Northwest is outstanding.

Hardwoods are defined as *the wood of a deciduous tree* and softwoods as *the wood of a coniferous tree*. Each species of tree, whether it be a hardwood or softwood, has its own set of characteristics, uses, and values. Hardwoods not only provide high-value timber, but also produce commercial nut crops, contribute to biological diversity and wildlife habitat, are useful in conservation plantings, such as windbreaks and riparian plantings, and are aesthetically pleasing.

Choosing your site

Site location is a primary factor for a successful hardwood plantation. If your site is unsuitable for the species you intend to plant, no amount of site preparation or care will keep trees alive. You will need the following information about your site: soil type and pH; aspect and slope; amount and timing of annual precipitation; and access.

Soil type.

Hardwoods, as a group, thrive in a wide range of soil conditions in their native ranges, from swamps to sandy desert soils, and tolerate pH levels from 4.1 to

8.2. Deep, loose, well-drained soils without hardpan layers are best. Many hardwood species "drown" if planted on sites with that have standing water for more than one- to two-weeks per year.

A soil test of your potential planting site(s) will provide valuable information such as the amounts of available nitrogen (N), phosphorus (P), potassium (K), organic matter, and micronutrients (iron, magnesium, copper and zinc) present. You should also request soil pH and a physical description, whether it be silty, loamy, sandy, or clay. Nutrients are generally not a limiting factor in tree growth unless the soil pH has rendered them unavailable for plant use. Knowing your soils will help you to choose suitable hardwood species for your site.

Aspect and slope.

East- and north-facing slopes favor more moisture demanding hardwood species. Sites with gentle slopes, or flat ground with adequate drainage, will be suitable for the widest range of species. The steeper the slope, the harder you will have to work at planting, maintaining, and harvesting your plantation. South- and west-facing slopes, areas with poor drainage or standing water, and frost pockets will greatly limit species selection.

Annual precipitation.

The amount and timing of annual precipitation, as well as the availability of a water source to provide supplemental irrigation, will play a big part in your species selection. Seedlings that receive supplemental irrigation the first three- to five-years after planting have been shown to have better survival and

growth rates than non-irrigated seedlings, especially during droughty years. Surface, sub-surface, or drip irrigation is more efficient and more economical than sprinkler irrigation. Sprinkler irrigation is not only inefficient, but also moisten leaves and branches, providing ideal conditions for fungal diseases to thrive.

If you do not, or cannot, irrigate, plan on providing supplemental moisture to your trees for at least the first year. Most people attach a water tank to the back of an ATV or truck bed and water each tree by hand. Do not use a tank that has had pesticides in it – it is just too easy to make an error that could be fatal to your tree.

It is better to water deeply, and not as often, rather than shallowly and more frequently. Plan on giving each seedling enough water to percolate to a depth of *at least* six inches. Most of the root system will be in this zone and excess water will just move out of reach and be lost for seedling use.

Access.

Your plantation should be physically accessible by pick-up truck and tractor. This will simplify site preparation, planting, annual maintenance, and the eventual harvest of your plantation. If you will be irrigating your plantation you will also need to have access to water, whether that be a well or a spring that you have the water rights to.

Once you have chosen a site, get some maps from your local Soil Survey agency. Maps are now available online at: <https://websoilsurvey.sc.egov.usda.gov/app/HomePage.htm> . These maps provide critical information about soils and their recommended uses, as well as provide you with the topographical information of your site that is useful for planning and maintenance activities.

Do you have the time?

Once you've determined that your site is suitable for growing hardwoods, decide if you have the necessary time to establish and maintain a tree plantation. Refer to **Table 1. Planning a High-value Hardwood Plantation** (page 13) to estimate the necessary time needed for each activity, each year.

Planning your Plantation

Thoroughly planning every aspect of your plantation will save you considerable time and money. The main purpose of establishing a high-value hardwood plantation is to grow trees for their high-value wood. This means a tree with a straight trunk and few, to no, knots for the first eight, if not 16, feet of trunk. Any damage to young trunks and leaders will result in less than ideal trees, decreasing both the value and number of uses of the wood.

Animal Damage Protection.

Hardwood trees are extremely susceptible to animal damage. Deer, elk, moose, porcupines, mice, and rabbits eat foliage, buds, and/or bark, while pocket gophers and voles eat roots.

You will need to plan on the method(s) you will use to control animal damage *before you plant any trees*. A wide variety of animal damage control methods are available, with various rates of costs and success.

Barriers.

Barriers are mechanical means of protecting your growing hardwood trees from being eaten and/or broken by large and small animals. There are many types, and all can be effective if installed correctly and properly maintained.

Fences. (*Advantage:* most effective, low maintenance; *disadvantage:* high cost.)

Nothing will protect your hardwood plantation better than a good fence. Unfortunately, fencing is also the most expensive way to eliminate animal damage.

Many types and styles of fencing are available. Consider what types of animals you are trying to exclude and whether the fence will be permanent or not. Figure 1 (page 5) shows an ideal permanent fence, designed to exclude not only deer and elk, but rabbits and pocket gophers as well. This type of fence is appropriate for areas that need complete and continual protection from not only feeding damage, but also from deer, elk, and moose using tree trunks to rub the velvet off their antlers.

Figure 2 (page 5) illustrates a very effective temporary fence that will protect your hardwoods from deer and elk until the trees can gain enough height to put the leaders out of browse range. With this option, other

control methods are necessary to protect trees from mice, vole, and pocket gopher damage.

Tree shelters. (*Advantages:* easy to install, moderate cost; *disadvantages:* poor protection from browsers, high maintenance once installed.)

Plastic tree shelters come in a variety of forms. Some are open mesh and are made to protect seedlings from larger browsers, while smaller animals such as mice and voles have free access to the trunk. Other tree shelters are solid plastic, with some coming to the field flat and being folded around the tree and others made of a single sleeve of plastic that slips over the tree.

Sheltering trees with chicken wire, PVC pipe, or aluminum foil wrapped around the bottom 12" to 16" of the trunk can also work well for mice, vole, and rabbit control, especially during winter months when there is continual snow cover. When wrapping trees, do so in late fall and remove the wrap in early spring.

There are several disadvantages of using tree shelters. They do not protect growing trees from animal browsing once the foliage emerges from the top of the shelter. Larger browsers quickly eat all available vegetation, leaving a crop of trees with no defined leaders. Another problem is that once a tree shelter is knocked over or starts to lean, trees bend and grow incorrectly.

For the best results when using any style of tree shelter, install the shelter at planting time and position the bottom of the shelter on or below ground

level. Secure each shelter with a sturdy, weatherproof stake.

It is extremely important to diligently maintain each shelter, making sure they remain upright and secure. Knock wasp and yellow-jacket nests out of the shelters and remove shelters once they have served their purpose.

Repellents. (*Advantages:* readily available, inexpensive; *disadvantages:* proper timing of application, frequent reapplication necessary.)

Repellent success is measured in the reduction, not elimination, of browse damage. There are many commercial repellent products on the market and an even greater number of "home-brewed" varieties.

- Contact repellents are applied directly to plants and repel by taste or smell.
- Area repellents are applied around trees and repel animals by smell alone.

Begin repellent applications when trees are dormant, usually immediately after planting. Reapply repellents when new spring growth emerges and again as directed on the product label.

The effectiveness of repellents depends on several factors. Rainfall will dissipate some repellents so reapplication will be necessary after each rain event. Other products or remedies do not weather well, even in the absence of rain. The availability of palatable food also plays an important role in the success of any repellent. If there is a shortage of food, animals will

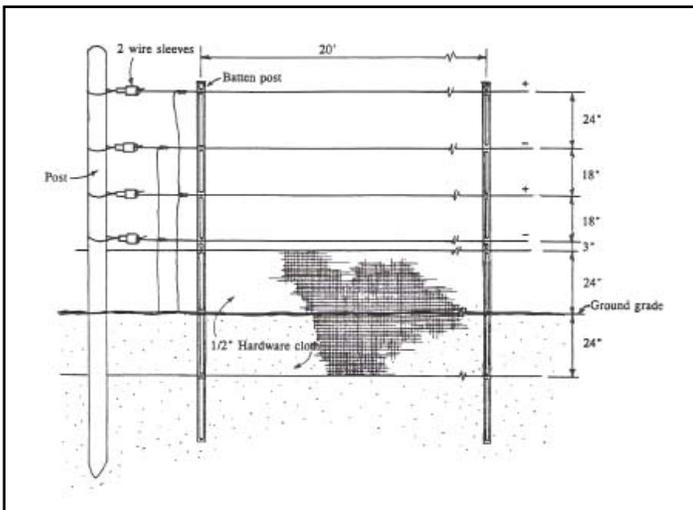


Figure 1. Permanent electric fence.

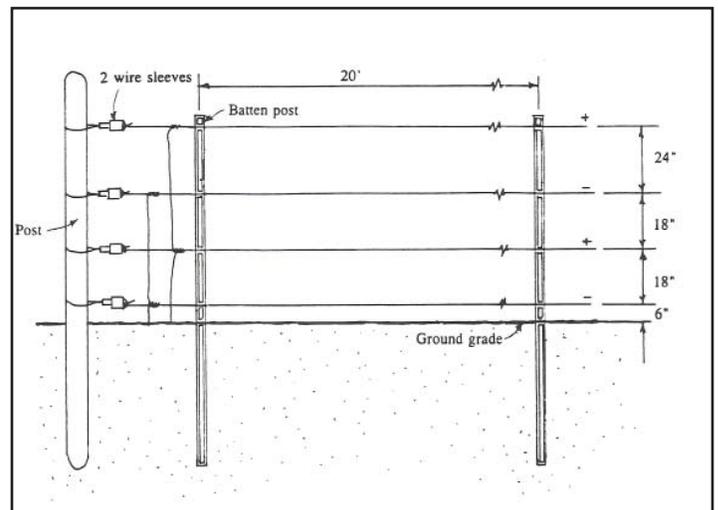


Figure 2. Temporary electric fence.

ignore both taste and smell repellents and happily browse your trees to the ground. Repellents are not likely to deter root feeding animals such as pocket gophers.

Toxicants. (*Advantages:* quick knock-down of a population; *disadvantages:* incomplete kill, non-target poisonings, environmental hazards.)

Overall, the number of legally registered toxicants is rapidly declining; for example, no toxicants are currently registered to control porcupines.

Non-target poisoning, legalities, disposal, and effectiveness of toxicants in controlling animal populations are key issues with this type of animal control. Non-targeted poisoning of large browsing animals, such as deer and elk, is a very controversial issue and not legal in many states. However, targeted poisoning of mice, voles, moles, and pocket gophers is effective and more socially acceptable.

When baiting rodents, place bait according to product instructions in runways and burrows to avoid non-target animals. You will never get them all, but with repeated applications you can decrease rodent populations to acceptable levels.

Trapping/shooting. (*Advantages:* very effective in controlling small populations; *disadvantages:* time, legalities, release or disposal of catch.)

Trapping is another controversial animal control method. Many states do not allow trapping, while others have a set season and regulations. Check your state regulations before using this method of animal control.

Non-target trapping, animal cruelty, disposal, and effectiveness are also key issues when it comes to trapping. Hunting can effectively control deer, elk, and porcupines, but is usually limited by a hunting season or safety factors.

Cultural controls. (*Advantages:* inexpensive, site specific; *disadvantages:* labor intensive, must be repeated.)

Cultural controls are used alone or in conjunction with other methods, depending on population levels, and usually involve providing food in other locations away from your tree plantation while removing habitat and food near it. Eliminating ground cover

can reduce rodent habitats. Cultural methods are usually not effective in deterring deer and elk.

Selecting your Hardwood Species.

Hardwoods have their own sets of preferred characteristics which vary by species and even seed source. Your site characteristics will help you select the best hardwood species for your plantation.

Most references provide native range maps and a description of the types of sites a species is usually found growing. Compare these characteristics with those of your potential site, but remember, just because a species is found in a certain set of growing conditions, does not mean it will not grow elsewhere.

Many species found on poor sites often grow better on good sites, but are not found there because they cannot compete as successfully for those sites as other species. One example is swamp white oak. This species is usually found in bottomlands in its native range, where the soils are very moist and conditions are usually shady. But demonstration trials in Idaho found that this species does very well on drier sites in full sun when not in competition with other species.

See **Appendix A: High-value Hardwoods: Tolerances, Characteristics, and Uses** (page 15) for a summary of selected high-value hardwood species.

Costs.

A high-value hardwood tree plantation is an investment and should be treated as one. Planning for initial costs, plus annual maintenance costs, will reduce future cash flow problems. Costs can vary widely, depending on how you prepare and maintain your plantation. See Table 1. *Plantation Planning Example* (page 8) for more information about establishment and annual maintenance activities, costs and time needed to accomplish each.

Ordering trees.

Bareroot nursery stock is sold as 1 + 0, 1 + 1, 2 + 0, 2 + 1, etc. The first number represents the number of years a seedling has spent in a seed bed. The second number represents the number of years a seedling has spent in a transplant bed. We have found that the taller, higher grade 2 + 0 seedlings are worth the additional cost as compared to the smaller "conservation grade" seedlings of the same age.

Container-grown hardwood seedlings are becoming more readily available. Sizes vary, with seedlings having a larger caliper doing better, especially on harsh sites. Container-grown seedlings are usually more expensive than bareroot stock, but the cost of these seedlings may be offset by ease of transport, storage and planting.

In their native environment, hardwoods grow in competition with many other species of plants and animals. This competition plays a vital role in determining the form of timber trees. Economically, you want to grow as many trees per acre as possible while controlling competition for light, moisture, and nutrients.

Using your site map, decide how you want to space your trees. If you planted your trees so each one had sufficient space to grow without competing with others, you would have very few trees per acre. Many people prefer a 10' x 16', or a 14' x 14' spacing. This allows room between rows to do maintenance and for a commercial thinning of every other tree within the rows when they reach merchantable size. Allow additional room for aisles around the interior of fenced plantations.

Once you've determined your spacing, you can calculate how many trees you need. Start by determining how many trees will fit on your site using your chosen spacing. It is a good idea to order five to ten percent more seedlings than the total number of trees needed to allow for trees damaged during shipping and handling, mistakes made in calculations, and trees damaged during planting.

An easy formula to follow is:

$$\frac{\text{Square footage of plantation}}{\text{Spacing of trees (sq.ft.)}} + 10\% = \text{total \# trees}$$

Example:

$$\frac{200' \times 200'}{10' \times 16'} = \frac{40,000 \text{ sq.ft.}}{160 \text{ sq.ft.}} = 250 + 10\% (25) = 275 \text{ trees}$$

Order stock from a nursery that knows the seed source used to grow their seedlings. Seedlings from northern seed sources and/or higher elevations than your particular site will tend to have greater frost tolerances and hardiness, desirable characteristics for hardwoods planted in the Inland Northwest.

Table 1. Planning a High-value Hardwood Plantation (page 143 illustrates a fairly common scenario of the anticipated activities, costs, and hours necessary for a landowner to establish and maintain a one-acre, high-value hardwood plantation.

Site Preparation

Site preparation will depend on the type and amount of vegetation presently on your site. In some cases it may be best to eradicate all existing vegetation and either keep the site under clean cultivation or plant grass in rows after the trees are planted. Others sites will be suitable for minimum tillage practices with less disturbance of the existing cover.

Controlling unwanted vegetation, especially noxious weeds, will be an important factor in the success of your hardwood plantation. Your planting site should be weed-free and you should have an annual vegetation and weed control program planned. Pay special attention to patches of noxious weeds like thistles, as they are very hardy and difficult to control. Contact a local Extension Educator or licensed pesticide distributor or consultant for specific weed control recommendations.

For those preferring not to use chemicals, a combination of persistent tilling, hoeing, mowing, and/or mulching can reduce unwanted vegetation and weeds. If your plantation will be kept under clean cultivation, you can till the rows and hoe between trees to remove unwanted vegetation. Some people choose to sow a mix of native grasses in the rows between their trees to decrease soil erosion and provide habitat for pollinators and other beneficial insects. Maintenance is done by mowing rows and hoeing between trees during the summer months for easy access to the site.

Mulch applied around the base of each tree can control unwanted vegetation by preventing light from reaching the ground around each tree and reducing germination of weed seeds. Mulch can also conserve soil moisture. Sawdust, straw, and bark are popular organic mulches and are readily available, moderately priced and easy to apply. Make sure you buy certified weed-free products. Organic mulches are biodegradable and need to be replenished every one- to three-years.

Man-made fabric mulches made of high-tech materials such as polypropylene or polyethylene can also be used to control weeds and other unwanted vegetation. Most sites in the Inland Northwest are NOT SUITABLE for this type of vegetation control. Soils high in silt and organic matter eventually block the pores in these fabrics, resulting in poor drainage, compaction, and low oxygen availability for root systems. A soil test and some research of the type of landscape fabrics suitable for your site is important if you choose to use fabrics. Landscape fabrics do degrade and will eventually need to be replaced. They are also quite expensive and some need specialized equipment to be installed properly.

Planting your Plantation

Spring planting conditions are optimal when soil temperatures are 40°F, or warmer, four- to six-inches below the soil surface. Plant when the soil has just enough moisture. To determine this, dig a hole.

- If you do not have enough soil to refill the hole, the soil is too wet and you risk poor root-to-soil contact and compaction.
- If you have a little soil left over, the soil is just right for planting and optimal for plant growth. Very dry conditions will require watering immediately after planting.

When seedlings arrive, open all of your boxes and inspect them to make sure they are the species you ordered and are in good condition.

- Bareroot seedlings should be moist, with good color, dormant buds, and a well-developed root system.
- Container-grown seedlings should also be moist, with good color, and have an intact soil plug interwoven with roots.

Keep your seedlings cool and moist at all times. Seedlings can be held in cold storage at temperatures of 32°F to 35°F for up to six months or kept in a dark, cool place (such as a basement or cellar) that is approximately 50°F for up to one week.

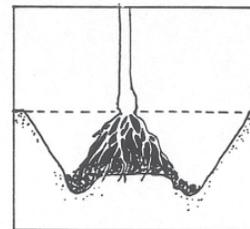
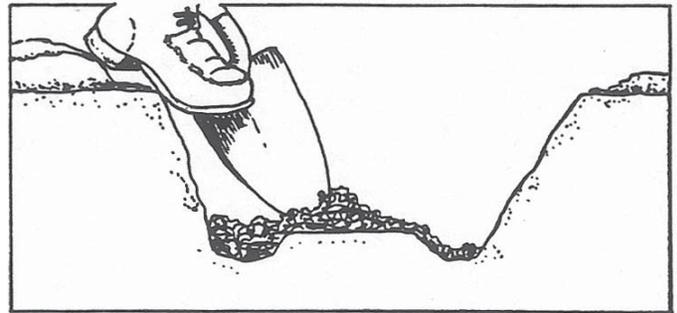
When planting, be careful how you shade your field-stored seedlings or you may do more harm than good. Seedlings will be warmer in a box covered with a canvas or plastic tarp than if placed directly in the sun.

The best place for your seedlings is under heavy shade. If there is no shade at the planting site, suspend a tarp at least three- or four-feet above the boxes to provide shade and allow air movement between the boxes and tarp. If possible, avoid direct exposure to sun or wind. By putting bareroot seedlings in a bucket of water on planting day, you not only keep the roots wet, but have a handy way to carry the seedlings.

Dig or auger a hole large enough to accommodate the tree's entire root system, with plenty of room to spread roots out so they do not overlap or J-root. Do not prune the root systems - if the root ball does not fit, your hole is too small. Check to make sure you

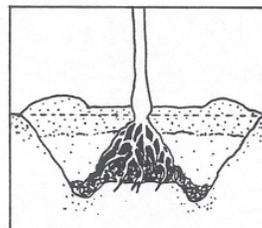
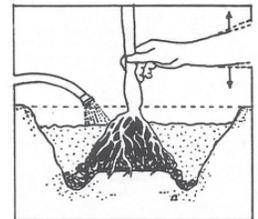
Figure 3. Bareroot planting.

a) For non-taprooted, bareroot species such as black cherry, form a cone of soil in the center of the hole. The top of the cone should reach to nearly the top of the hole. Tamp it with your hands to make it firm.



b) Spread roots over the cone, pointing the tips away from each other and towards the bottom of the hole, with the biggest roots lying in the direction of the prevailing winds.

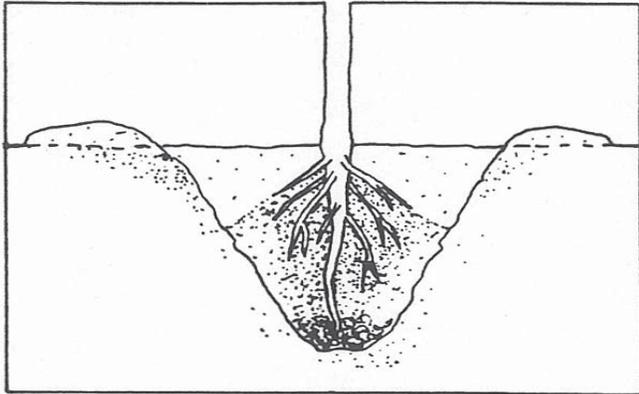
c) Fill the hole with the remaining soil, breaking up any clods and discarding rocks and debris.



d) Make sure the root collar of the seedling is just below the soil line. The root collar is the area where the soil was at the nursery, usually indicated by a change in the color and texture of the bark.

Figure 4. Planting tree species with a taproot.

For taprooted tree species, such as oak and hickory, make the planting hole slightly larger than the spread-out root system. Set the seedling in the hole so the root collar is slightly below the top of the hole. Partially fill the hole, breaking up clods and discarding rocks and debris. Making sure the tree is straight, firm the soil around the roots as you continue to fill the hole with soil.



haven't glazed the sides of the hole, making it difficult for smaller root hairs to penetrate the soil. See Figures 3, 4, and 5 for specifics.

Always use your hands to press the soil firmly around the tree to eliminate air pockets and bring roots into contact with the soil. *Do not step around the trunk of the seedling* - this is referred to as the "death stomp," and can be fatal to your trees.

On planting day you should also prune broken, crossed, or rubbing branches and, if necessary, define a leader (See Figures 6, 7, and 8 for details).

Maintenance

You have spent a lot of time and money to establish your high-value hardwood plantation and now the real work begins. Diligent maintenance is vital for healthy and vigorous tree growth.

Weed control.

Weed control is an important factor in the success of your hardwood plantation. Once planted, it is important to keep a three-foot diameter area around each tree free from competing vegetation. When using tools or machinery around your trees take care not to damage or scrape the bark. Mechanical injury can provide entry for insects and diseases and can girdle the tree and kill it.

There are many ways to control weeds in tree plantations.

- Mowing between rows and hoeing around trees works well, but can be time consuming and often damages tree trunks and roots.
- Clean cultivation also works well, but hoeing and hand pulling weeds immediately around trees is still necessary to avoid damage and achieve complete control.
- Applying pre- and post-emergent herbicides can be very effective, but are costly and can damage or kill trees if not selected and applied properly.

The best weed control program integrates all of the above methods. Whatever method or combination of methods you choose, do them often. Skipping even one weeding can give weed populations the opportunity to explode and become a serious problem.

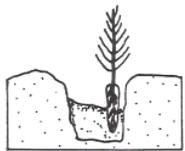
Figure 5. Planting container grown stock.

For container-grown seedlings, insert the shovel vertically into the soil with the blade reversed, then pull soil back and out of the hole. The hole should be large enough so the entire root plug fits easily.

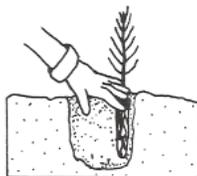
a) Straighten the back of the hole and insert the seedling at the proper depth. The top of the root plug should be at least 1/2- to 1-inch below the soil line, making sure to not bury any foliage.



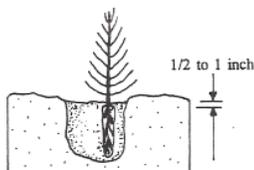
b) Hold the seedling in place and fill the hole halfway with moist soil.



c) Finish filling the hole with moist soil, tamp with your hand, and cover the surface with a mulch of loose, dry soil.



d) This properly planted seedling had its original plug buried 1/2- to 1-inch below the soil line. None of the foliage is buried.



Irrigation.

High-value hardwood plantations have thrived in the Inland Northwest without supplemental irrigation. Given the droughty conditions of our summer months and the cost of buying and applying water, this is a good thing. Should you choose to irrigate, drip system with emitters at each tree are best. Maintain lines and replace emitters as needed.

Fertilization.

Research has shown that fertilizing trees before they are three- to five-years old is not beneficial unless your soil test shows a serious nutrient deficiency. Should you need to fertilize, apply your product in spring as soon as soil is frost-free. *Fall applications are not recommended* as they can cause trees to break dormancy, causing winter damage on succulent new growth.

Fertilization focuses on three main nutrients.

- *Nitrogen (N)* is involved in all physiological processes of a tree and usually results in the greatest growth response. Nitrogen deficiencies will cause a decrease in vigor and yellowing of foliage, with older leaves showing symptoms first. Excessive nitrogen will cause overabundant growth and decreased flowering and fruiting.
- *Phosphorus (P)* is needed for root development, flowering, and fruit formation, and is essential for cell division. Phosphorus deficiencies stunt plant growth, with early symptoms being a bronze to purple discoloration of the petioles and underside of leaves, followed by yellowing. Phosphorus deficiencies are rare in trees.
- *Potassium (K)* is important in modifying the absorption of other nutrients. Potassium also influences the carbon-to-nitrogen relationship and is thought to influence water absorption, which in turn affects drought and cold tolerance. A lack of potassium in broadleaf plants is first expressed by yellowing, followed by scorching and shedding of the older leaves.

Many fertilizer formulations can meet nutrient needs. Fertilizer formulations are described using a series of numbers such as 12-12-12 or 20-12-12. These numbers tell you the percent, in order, of N, P, and K. All fertilizer products do not contain micro-nutrients, many of which are essential to tree growth. A fertilizer product that includes micro-

nutrients such as calcium, magnesium, sulfur, and other microelements offer broader nutrient supplementation.

A general application rate for hardwoods is three pounds of nitrogen per 1,000 square feet of area under the crown of each tree.

EXAMPLE: a tree with an average crown width of four feet, using a 20-12-12 fertilizer formulation.

$$4' \times 4' = \frac{16 \text{ sq. ft. per tree}}{1,000 \text{ sq. ft.}} = .016 \times 3 \text{ lb. N} = .048 \text{ lb. N per tree}$$

$$\frac{.048 \text{ lb. N}}{1 \text{ tree}} \times \frac{1 \text{ lb. fertilizer}}{.20 (20 \%N)} = \frac{.24 \text{ lb. fert.}}{\text{per tree}} = \frac{3.84 \text{ oz. fert.}}{\text{per tree}}$$

Pruning.

Pruning is a very important aspect of hardwood tree care and maintenance. Often this job gets put off for too many years and then becomes a huge chore to accomplish. If left too long, the form, health, and vigor of your trees will be affected.

Species with a large sap flow in spring, such as beech, birch, and maple, should be pruned in December or January, whereas other hardwood species, such as black cherry, walnut, and oak, can be pruned in February or March.

Clean tools are a must when pruning. Many diseases can be spread from tree to tree by pruning with infected tools. A bleach solution (one part bleach to nine parts water) sprayed on your tools between cuts will kill any diseases. When using a bleach solution, thoroughly wash and oil your tools after you have finished the job to prevent rust. Another way to sterilize tools is by using methyl alcohol, with the right amount being conveniently found in undiluted winter strength windshield wiper fluid (the blue kind), available at most grocery and auto supply stores.

The first winter, pruning should concentrate on trimming crooked leaders back to upright buds, shortening lateral branches to 10- to 12-inches and removing any crossed or rubbing branches. This is also a good time to stake up drooping leaders.

Water sprouts in the interior and sprouts at the base and on the trunk should also be removed (Figure 7). Water spouts and suckers grow upright rapidly and are weakly attached. They usually use more

energy than is returned to the tree and break easily, providing an entryway for insects and disease.

Additional good pruning rules include:

- Making cuts just outside the branch collar and never leaving a stub.
- Undercutting large branches approximately four- to five-inches from the lateral cut to prevent tearing the bark.
- Making cuts at lateral buds or branches when shortening a branch.
- Making clean, sharp cuts, 1/4-inch above a bud and favoring buds or lateral branches that grow outwards.

Successive pruning should concentrate on removing excessive side branches, those that cross or rub other branches and those with narrow crotch angles (Figure 8). Removing the lowest whorl of branches each year will decrease knots and improve the quality of timber eventually harvested from your plantation. Maintaining about two-thirds of the tree height in green crown will produce the best growth and form. The application of tree paint to pruning cuts is not necessary or recommended.

Sometimes a young tree will need additional temporary support to grow upright. Staking tends to

promote growth in the upper portion of the tree to the detriment of lower portions. When trees sway in the wind, the resulting movement actually encourages the trunk to grow in diameter. When movement is decreased or removed, diameter growth will slow down and result in a spindly tree that is unable to support the weight of its own crown.

When staking, use two or three stakes for each tree, and protect the tree from being girdled or damaged by running guy wires or ropes through a piece of rubber hose (Figure 9). Attach the guy wires or ropes tightly enough to support the tree, while still allowing some trunk movement. Remove stakes after one or two years.

Sunscald.

Sunscald usually occurs on the south- and west-sides of a tree's trunk, which is exposed to the sun's direct afternoon rays when temperatures are usually the highest. Symptoms include split bark and dead inner bark, which can provide entry for insects and disease and cause secondary problems that could be fatal.

The actual causes of sunscald are thought to be related to rapid temperature changes, repeated freezing and thawing and a bleaching effect caused by intense sunlight. Snow cover can often increase the

Figure 6. Pruning.

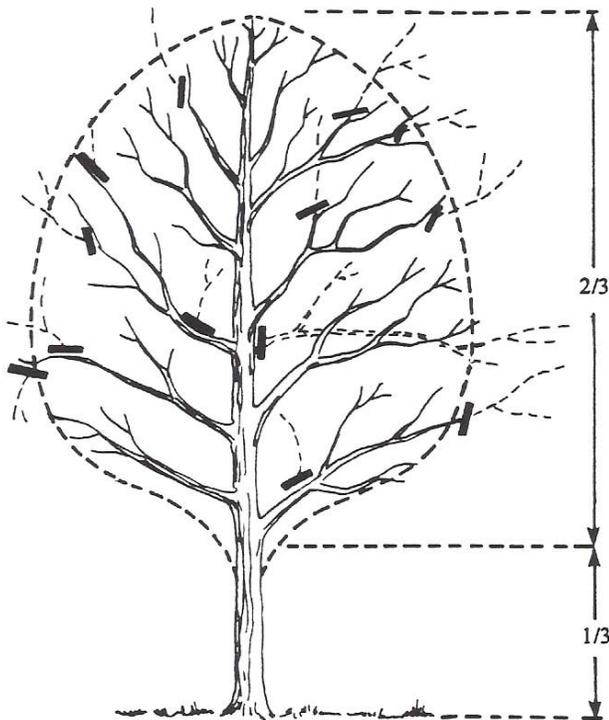


Figure 7. Water sprouts.

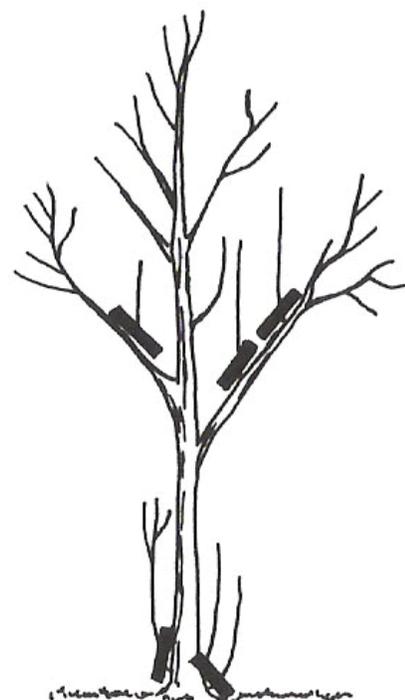
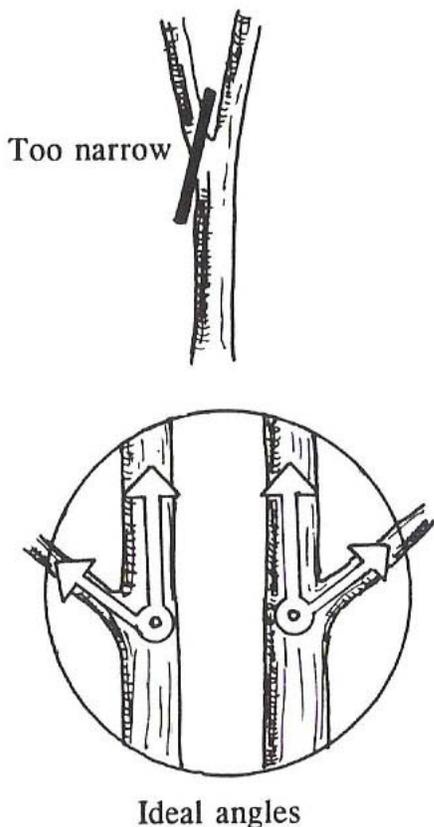


Figure 8. Crotch angles.



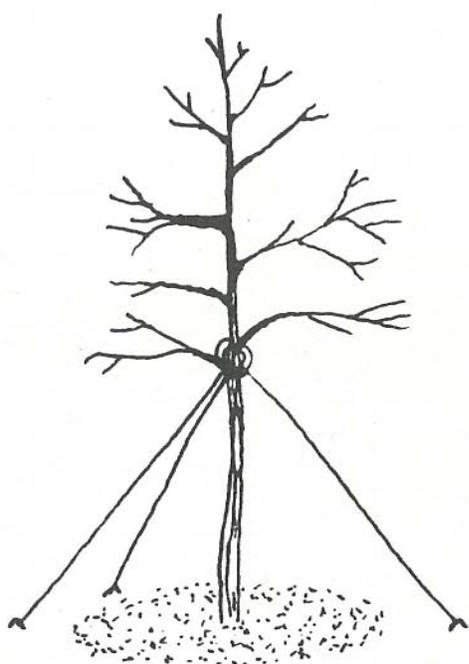
incidence of sunscald by reflecting intense sunlight against trunks. Susceptible species usually have thin, smooth, and often dark-colored bark, and include cherry, beech, oak, and walnut. Young trees are more susceptible than older plants that have developed thicker bark.

Several methods can protect tree trunks from direct, high-intensity sunlight.

- Tree shelters, milk cartons, boards, burlap sacks, split PVC pipe, shade cards, and other devices are often used to shield trunks from afternoon sun. Be sure to shade only the portion of the plant susceptible to sunscald.
- White, waterproof tree wrapping tape is available from horticultural suppliers. When wrapping trees, do not fasten materials tightly around the trunk as this can cause splitting and girdling. Wrapped trunks also provide a hiding place for boring insects, so wrap should be removed yearly for a complete trunk inspection and rewrapped if necessary.
- White *interior latex paint*, which is painted on the trunk, reflects some of the light and heat generated by sunlight away from the tree.

A common recommendation is to shield trunks of susceptible trees two years after transplanting to their permanent location.

Figure 9. A properly staked tree.



Insect and disease problems.

High-value hardwood species have their own set of insect and disease problems. Details for each species are given in **Appendix A - High-value Hardwoods: Tolerances, Characteristics and Uses.**

Table 1. Example Plan for a High-value Hardwood Plantation.

The site is gently sloping, converted agricultural land with a current cover of mixed grasses. There are no particular nutrient deficiencies and the average pH is 6.9. The potential for animal damage and sunscald is high and a year-round source of water is located on the site. The entire acre will be surrounded by a temporary electric fence. Trees will be planted every 12-feet, in rows 12-feet apart. Three-by-three foot square planting spots will be treated with glyphosate the fall before planting to remove all vegetation. The landowners are hand-planting 20 cu. in. containerized seedlings, installing shade cards at each tree, and pruning broken branches and defining leaders as they go. Irrigation will be provided throughout the growing season. Grass will be mowed three- to four-times yearly to limit competing vegetation. Weeds and gophers will be controlled as necessary.

DATE	ACTIVITY	HOURS	COSTS
<i>The fall before planting.</i>			
August	Soil analysis ¹	1	\$45.00
	Fence entire acre with a temporary fence. ²	25	\$1,750.00
September	Order trees (303 trees/acre x 10% = 333 trees; must order trees in bundles of 5, so round to 330 trees).	1	\$825.00
	Site preparation		
	• Lay our rows and mark planting spots.	2	-
	• Chemical spot treatments.	2	\$24.95
	• Bait gophers.	4	\$24.09
<i>Spring of planting year.</i>			
January/ February	Purchase shade cards.	1	\$72.28
	Plan drip irrigation system and purchase materials.	2	\$1,445.59
	Review plans; purchase or reserve rental equipment needed for planting day.	1	variable
	Inspect trees upon arrival; store appropriately until planting day.	1	-
March/ April	Plant trees; install shade cards; prune broken branches and define leaders as needed.	6	-
	Install drip irrigation. ²	8	-
As needed	Spot treat weeds.	1	\$11.24
	Mow.	10	-
	Bait gophers.	4	\$24.09
December	Prune for form.	3	-
Total costs and hours for plantation establishment.		72	\$4,222,24
<i>Annual maintenance.</i>			
March	Check for winter damage, prune broken branches, define leaders and maintain fencing.	5	-
As needed	Irrigate. ⁴	20	\$56.20
	Mow; spot treat weeds, bait gophers.	20	\$35.33
	Prune for form.	3	-
December	Prune for form.	3	-
Total hours and costs for each maintenance year.		48	\$91.53

Costs are based on the Natural Resource Conservation Service (NRCS) prices used for cost-share programs, such as the Conservation Reserve Program (CRP), unless indicated. Labor is being done by the landowners and is not included.

- 1 FROM: Current University of Idaho Analytical Laboratory Services Fee List.
- 2 These are estimates for building materials only and do not include labor.
- 3 FROM: University of Idaho Forest Research Nursery Super-stock containerized seedlings.
- 4 Cost estimate is for water only; maintenance done by landowners.

Appendix A: High-value Hardwoods: Tolerances, Characteristics, and Uses

American beech

American beech is an attractive forest tree of lower elevations common throughout its native range. The large, oily seeds are important food for many wildlife species, including ruffed grouse, wood ducks, turkeys, squirrels, and black bears. Beech wood is excellent for turning and bending, and because of this elasticity, is a favorite material for the curved and turned parts of chairs, toys, and spools. The wood wears well, is easily treated with preservatives and is also used for flooring, veneer, and containers. Its high caloric value makes it valuable in charcoal production and for firewood.

Species: *Fagus grandifolia*.

Common name: American beech.

Native range: although now confined to the eastern United States (except for the Mexican population), beech once extended as far west as California and probably flourished over most of North America before glacial periods.

Climate: will tolerate temperatures to -44°F, 23" annual precipitation and 100-day growing season; found in one county in Michigan that has a 92-day growing season.

Soil type/pH tolerances: grows best in rich, moist loam soils with high humus content; encountered more frequently on cooler and wetter north-facing slopes; is found up to 6,600 feet in elevation in the Appalachian Mountains.

Shade tolerances: very intolerant of shade.

Form: slow-growing, long-lived (may attain ages of 300- to 400-years); 100' tall with a narrow to spreading rounded crown.

Insect and disease problems: many decay fungi, oystershell scale.

Objectionable characteristics: susceptible to long frost cracks in areas with low winter temperatures; sensitive to flooding; highly susceptible to damage from fire.

Other: high moisture requirements - uses twice as much water for transpiration and growth processes compared to some drought-tolerant oaks; not readily browsed by deer; nuts are an important food for wildlife; wood is versatile and valuable; creosote made from beech wood is used internally and externally as a medication for various human and animal disorders.

Black cherry

One of our most handsome domestic woods, black cherry has long been sought after for its reddish-brown color and luster when properly finished. These characteristics, plus its good working qualities, low shrinkage, and freedom from warping and checking, have made it a cabinetmaker's first choice in materials. Black cherry is also used for furniture and professional and scientific instruments. Hardiness, high wildlife value, and the relative scarcity of this species make it an ideal tree for planting in plantation and conservation settings.

Species: *Prunus serotina*.

Common names: wild black cherry, mountain black cherry.

Native range: Nova Scotia to Minnesota, south to Central Texas, and east to Florida; also native in southern New Mexico and western Arizona to Guatemala; found up to 5,000 feet elevation in Appalachian Mountains.

Climate: tolerates a wide range of climatic conditions.

Soil type/pH tolerances: grows in a wide variety of soils but prefers moist, fertile conditions on north- and east-facing slopes and in protected coves; does not like "wet feet" and will die quickly in saturated soils.

Shade tolerances: intolerant of shade.

Form: fast-growing, moderately long-lived; 100' tall, with a narrow to broadly rounded crown.

Insect and disease problems: tent caterpillars, black knot.

Objectionable characteristics: prolific basal sprouter; cyanic acid in wilted foliage toxic to domestic livestock; browsed heavily by wild mammals of all types.

Other: surprisingly drought tolerant; leaves and inner bark contain almond-flavored hydrocyanic acid, used in cough medicine and tonics; important food source for wildlife.

Chestnut

Though one species of this distinctive genus, the American chestnut, has been brought to the point of extinction in parts of its native range by chestnut blight, it is alive and growing well in blight-free areas of the U.S. American chestnut is still a leading furniture wood due to its outstanding durability, striking appearance, and good working qualities. Chestnuts not only provide food for wildlife, but also provide ample crops of tasty nuts especially popular during holidays (what Christmas would be complete without chestnuts roasting over an open fire?). Newer hybrids excel at nut production and blight resistance. Efforts to breed resistant varieties of American chestnut that produce trees with outstanding timber qualities and adequate blight resistance continue.

Species: *Castanea dentata*.

Common name: American chestnut.

Native range: northeast United States into the Appalachian Mountains.

Soil type/pH tolerances: grows in variety of soils except wet, poorly drained types.

Shade tolerances: mostly intolerant.

Form: fast-growing, large tree.

Insect and disease problems: chestnut blight.

Objectionable characteristics: none.

Other: chestnut split rail fences can still be found throughout the eastern U.S., due to the extreme decay resistance of this species wood.

Hickory

Unsurpassed for its inherent qualities of hardness, toughness, and resilience, hickory wood has long been a favorite material for tool handles, especially impact tools such as hammers, axes, picks, and sledges. It is also used for skis, gymnastic equipment, and other products that require tough, strong elastic wood. Due to its high caloric values and unique flavoring capabilities, hickory is also used extensively for smoking meats and for fuel wood. Hickory nuts provide ample food for mallard and wood duck, quail, wild turkey, a variety of other birds, black bear, fox, squirrel, and white-tail deer.

Species: *Carya ovata*.

Common names: shagbark, shellbark, scalybark, and upland hickory.

Native range: eastern United States.

Climate: will tolerate temperatures to -40°F, 30" annual precipitation and 140-day growing seasons.

Soil type\pH tolerances: ability to adapt to wide range of conditions.

Shade tolerance: intermediate shade tolerance.

Form: slow-growing, medium-sized tree; 70' to 80' tall, with a narrow, open crown and large branches.

Insect and disease problems: anthracnose.

Objectionable characteristics: susceptible to damage by fire.

Other: wildlife food, very hard wood; not a preferred forage for deer.

The Oaks

The oaks are a large group of about 500 species of trees and shrubs, with 58 species of oaks native to North America (exclusive of Mexico, which has over 150 species of oaks itself). The genus is divided into two groups:

- The *white oak group* includes all oaks that have acorns that develop and mature at the end of one growing season and are borne on the current year's branches. Owing to their impermeability to liquids, strength, and durability, wood from the white oak group is favored for tight cooperage and railroad ties.
- The *red and black oak group* contains all oaks that have acorns that develop and mature at the end of two growing seasons and are borne on the previous year's branchlets.

The wood from all oaks is prized for its hardness, resistance to abrasion, smooth finishing qualities, and good nail holding capacities. Oak is used to make beautiful furniture, cabinets, and flooring. Red and gray squirrels, white-tail deer, wood ducks, wild turkey, and a variety of woodpeckers, jays, and nuthatches all benefit greatly from the food provided by oaks.

White oak group.

Species: *Quercus alba*.

Common names: white and stave oak.

Native range: Eastern United States.

Climate: will tolerate temperatures to -50°F, a five-month frost-free season and 30" annual precipitation in northern part of native range.

Soil type\pH tolerances: wide variety of soils and sites; will tolerate dry soils, mildly alkaline pH and moderate soil compaction; good growth on all but rocky, wet or poorly-drained sites.

Shade tolerance: intolerant of shade.

Form: slow-growing, large semi-formal tree; 50' to 80' tall.

Insect and disease problems: oak wilt, anthracnose.

Objectionable characteristics: strong tap-root, difficult to transplant.

Other: nuts provide mast for wildlife; wood very valuable, used for furniture and cooperage.

Species: *Quercus bicolor*.

Common name: swamp white oak.

Native range: northeastern United States; found in wet areas subject to flooding, though not in areas permanently under water.

Climate: will tolerate temperatures to -30°F, 120 frost-free days and 25" annual precipitation in northern part of range.

Soil type\pH tolerances: tolerates poorly drained soils.

Shade tolerance: intermediate to tolerant of shade.

Form: rapid-growing, long-lived medium-sized tree; 50' to 70' tall with an irregular, open crown.

Insect and disease problems: anthracnose, oak wilt fungus.

Objectionable characteristics: does not tolerate extended drought.

Other: wood similar to white oak in character and value; acorns provide food for wildlife; good species for low-lying areas subject to standing water or flooding.

Species: *Quercus macrocarpa*.

Common names: blue, mossycup, mossy-overcup, and scrub oak.

Native range: eastern North America, extending into south-central U.S., where it is a pioneer species and frequently planted in windbreaks.

Climate: will tolerate temperatures to -20°F, 15" annual precipitation and a 100-day growing season in northern part of range.

Soil type/pH tolerances: from moist bottomlands to dry hillsides, mainly in limestone soils.

Shade tolerances: intermediate tolerance of shade.

Form: slow-growing; medium to tall tree; 65' to 132' tall, with a broad, spreading crown.

Insect and disease problems: oak wilt.

Objectionable characteristics: will not tolerate flooding.

Other: resistant to injury by fire; drought resistant; large seed crops produced every two- to three-years offer excellent food supplies to a wide variety of wildlife; wood is very hard, heavy, strong, and durable - usually marketed as white oak.

Species: *Quercus robur*.

Common names: English oak.

Native range: England; escaped widely in the United States.

Climate: variable.

Soil type/pH tolerances: thrives in clays soils, but adapts well to lighter, stonier soils.

Shade tolerances: intermediate tolerance of shade.

Form: large tree; 150' tall or more, with wide-spreading crowns rising from sturdy, fairly short trunks.

Insect and disease problems: oak wilt.

Objectionable characteristics: some seed sources have poor form when open grown.

Other: many English ships have been constructed from English oak, as were countless interiors of castles and churches; the preferred wood for wine barrels.

Red oak group.

Species: *Quercus coccinea*.

Common names: scarlet, black, red, and Spanish oak.

Native range: eastern United States, from southwestern Maine west to southern Michigan and south to central-Mississippi; found up to 5,000 feet elevation in Appalachian Mountains; native range within humid region.

Climate: will tolerate temperatures to -28°F, 30" annual precipitation and 120-day growing season in northern part of range.

Soil type\pH tolerances: on dry, sandy sites; will tolerate a wide variety of soils; low to moderate moisture requirements.

Shade tolerance: very intolerant of shade.

Form: rapid growing, medium-sized tree; 60' to 80' tall with an open, rounded crown.

Insect and disease problems: oak wilt, cankers, tent caterpillar.

Objectionable characteristics: susceptible to fire damage, sunscald, and late spring frosts (as are others of the red oak group).

Other: lumber mixed and sold with other red oak species.

Species: *Quercus palustris*.

Common names: swamp, water, and swamp Spanish oak.

Native range: middle Atlantic and central United States.

Climate: will tolerate 32" precipitation and 120-day growing season in northern part of range.

Soil type/pH tolerances: primarily a low-land tree that thrives in poorly drained, clay pan soils typical of floodplains; grows well in deep, well-drained soils also; becomes chlorotic in alkaline soils.

Shade tolerances: shade intolerant.

Form: fast-growing, short-lived medium sized tree; 50 to 85 feet tall with a broad, pyramid shaped crown.

Insect and disease problems: oak wilt.

Objectionable characteristics: iron chlorosis in alkaline soils.

Other: transplants well; tolerates short periods of flooding; good for use in areas too wet to support other species; large acorn crops every two- to three-years valuable for wildlife, especially ducks; wood is coarse-grained, hard, heavy, and is used in general construction as posts and for firewood.

Species: *Quercus rubra*.

Common names: northern red, eastern red, mountain red, and gray oak.

Native range: eastern United States; only native red oak extending into Nova Scotia.

Climate: mean annual temperature is 40°F in north; will tolerate 30" annual precipitation and 100 frost-free days in northern part of range.

Soil type\pH tolerances: will tolerate moist or dry soils; does well in alkaline conditions with moderate irrigation.

Shade tolerance: intolerant of shade.

Form: one of the fastest growing oaks; large, semi-formal tree; 60 to 90' tall with a spread of 40 to 60'.

Insect and disease problems: oak wilt.

Objectionable characteristics: susceptible to damage from fire.

Other: less difficult to transplant than most oaks; tolerates air pollution, compacted soils; hardy throughout Idaho; the nuts are important food for squirrels, turkeys, mice, and other mammals and birds.

Walnut

Known for its strength, shock-resistance, durability, and course texture (which provides a good grip), black walnut is the number one choice of material for gun-stocks. These properties, along with its pleasing appearance, have made walnut one of the most popular of all the native American hardwoods for such uses as veneer, furniture, and cabinets. The nuts furnish food for squirrels, woodpeckers, and white-tail deer, as well as bring in a sound economic return for anyone growing these large, distinctly flavored forest products for human consumption.

Unfortunately, black walnut (*Juglans nigra*) is affected by a recently discovered wilt disease call *Thousand Cankers Disease* (TCD). TCD is caused by the combined activity of the walnut twig beetle (*Pityophthorus juglandis*) and a canker producing fungus (*Geosmithia morbida*). Since its discovery in late 2007, TCD has killed thousands of black walnuts. Initially confined to several western states, a well-established outbreak of the disease was found in the Knoxville, Tennessee area in late July, 2010, which was the first finding of TCD within the native range of black walnut. Because of this disease, we strongly discourage people from planting black walnut. Fortunately, other species of walnuts have not been found to be greatly susceptible.

Species: *Juglans cinerea*.

Common names: butternut, white walnut, oilnut.

Native range: northeastern United States.

Climate: will tolerate temperatures to -30°F, 25" annual precipitation and 105-day growing seasons.

Soil type\pH tolerances: tolerates dry, rocky soils, especially those from limestone origin; prefers well drained soils.

Shade tolerance: intolerant of shade.

Form: small to medium-sized tree, semi-formal; 30' to 60' tall, with a broad, open crown.

Insect and disease problems: butternut decline or canker; susceptible to fire damage.

Objectionable characteristics: produces a substance called *juglone*, which is selectively toxic to certain other species of plants; the highest concentration of juglone is found in the roots and fruit husks.

Other: edible nuts, strong, valuable wood; tolerates cold, easily grown, transplants easily when young; valued more for the edible nuts than the wood.

Species: *Juglans regia* var. *carpathian*.

Common names: Carpathian walnut, English walnut, Persian walnut.

Native range: The Carpathian Mountains of Central and Eastern Europe eastward to Korea.

Hardiness: USDA Zone 4 to 9.

Soil type: deep, rich, moist soils for maximum growth; will grow slower in drier, less fertile sites.

Shade tolerance: intolerant.

Form: large, semi-formal tree; 50' to 100' tall.

Regional insect & disease problems: aphids.

Objectionable characteristics: produces a substance called *juglone*, which is selectively toxic to certain other species of plants - highest concentration of chemical in roots and fruit husks; deep taproot, making it difficult to transplant; will not tolerate extreme heat and dryness.

Other: as quantities diminish, wood is used primarily for veneer; nuts have a distinct flavor that are in demand for baked goods and ice cream; ground shells are used in many products.

White ash

This is the most common and most valuable species of native ash. The seeds of the white ash are eaten by wood ducks, bob white, pine grosbeak, and fox squirrels. The wood is light brown and is strong, tough and lightweight. It is used to make tool handles, furniture, veneer, paneling, and baseball bats.

Species: *Fraxinus americana*.

Common names: Biltmore white ash.

Native range: from Cape Breton Island and Nova Scotia to southern Ontario, south to northern Florida and eastern Texas.

Climate: will tolerate temperatures to -30°F, 30" annual precipitation and 90 frost-free days.

Soil type/pH tolerances (if known): deep, rich, moist, well drained soils; often found along streams; to 3,500 feet elevation in the Cumberland Mountains.

Shade tolerances: pioneer species, shade intolerant.

Form: slow-growing when young, with increasing rates of growth as it matures; medium-sized tree; 82' tall with a narrow to broadly rounded or pyramidal shaped crown.

Insect and disease problems: ash decline, oystershell scale.

Objectionable characteristics: easily damaged by deer browsing; demanding soil fertility and soil moisture requirements.

Other: intermediate tolerance to flooding.

Yellow birch

One of the most important of the North American birches, yellow birch is highly valued as a source of high-grade lumber. This relatively fast-growing, long-lived tree is used in the manufacturing of furniture, paneling, cabinets, boxes, woodenware, handles, and interior doors. Its high moisture requirements make it an excellent choice for areas too wet to crop or support other hardwood species.

Species: *Betula alleghaniensis*.

Common names: yellow, gray, silver, and swamp birch.

Native range: Newfoundland and Nova Scotia, Northeastern United States, the Lake States, and into the Appalachian Mountains.

Climate: cool areas with abundant precipitation; will tolerate temperature extremes of -40°F to 100°F, 25" annual precipitation and 60- to 150-day growing seasons.

Soil type/pH tolerances: moist, well drained soils, and cooler marshlands.

Shade tolerances: intermediate tolerance to shade.

Form: medium-sized tree; 32' to 72' tall.

Insect and disease problems: bronze birch borer, birch dieback.

Objectionable characteristics: susceptible to fire, late spring frosts, drought stress, and sunscald.

Other: inner bark is aromatic and has a wintergreen flavor.



University of Idaho Extension

The information in *Appendix A: High-value Hardwoods: Tolerances, Characteristics, and Uses* was compiled from the following sources: *Silvics of North America*. USDA Forest Service Agricultural Handbook 654 and *Field Guide to North American Trees*. T.S. Elias. Grolier Book Clubs Inc., Danbury, Connecticut.

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