

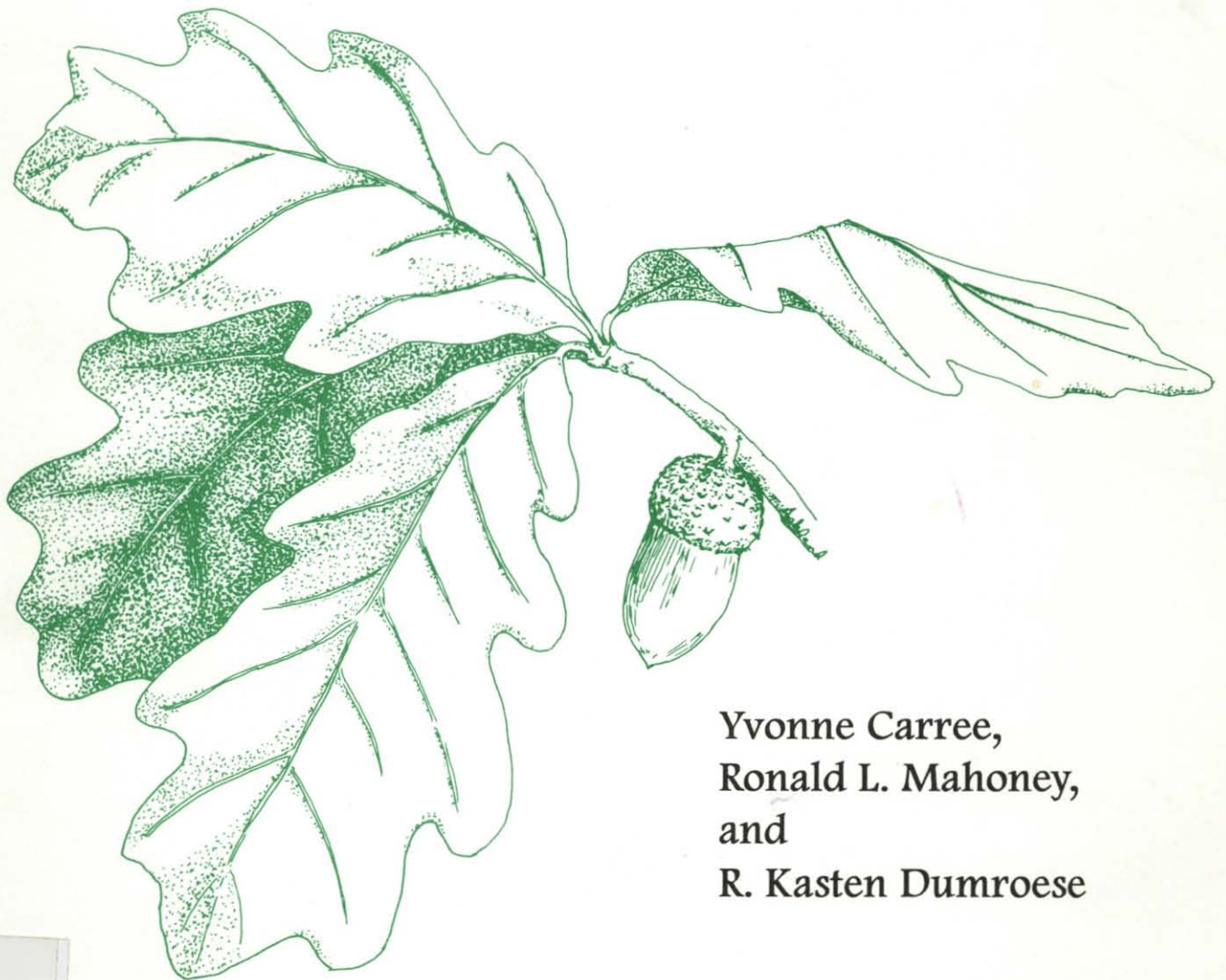


December, 1995

Bulletin No. 57

University of Idaho College of Forestry, Wildlife and Range Sciences

# Hardwood Plantations for the Inland Northwest



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and  
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COLLEGE OF FORESTRY, WILDLIFE AND RANGE EXPERIMENT STATION

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## **Acknowledgments:**

We would like to thank the following people for their critical review of this publication: Chris Schnepf, Area Educator - Forestry, University of Idaho; Bob Rackham, County Educator, Oregon State University; Don Hanley, Extension Specialist - Forestry, Washington State University; and Denise Ortiz, Editor, College of Forestry, Wildlife, and Range Sciences, University of Idaho.

**Graphic art:** Lorraine Ashland, College of Forestry, Wildlife, and Range Sciences, University of Idaho.  
**Production:** Yvonne Carree, Extension Associate - Forestry, University of Idaho.

This publication was funded by the Renewable Resource Extension Act (RREA).



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# Hardwood Plantations for the Inland Northwest

Yvonne Carree, Ronald L. Mahoney, and R. Kasten Dumroese

The sun glows on grandma's black cherry dining room table as white oak trim gleams in the curtain-filtered sunlight. The black walnut stock of dad's rifle shimmers in your hand. High-value hardwoods. Their beauty, strength, and workability are unmatched. Each has its own characteristics, uses, and value. Can we grow them in the Inland Northwest? You bet! Black cherry (*Prunus serotina*), black walnut (*Juglans nigra*), American chestnut (*Castanea dentata*), and many of the oaks (*Quercus*) have been established throughout the Inland Northwest and British Columbia. With 6 different USDA climate zones and elevations ranging from 350 to over 7,000 feet, the potential for many hardwood species to grow successfully in this part of the country is outstanding.

Hardwoods can be 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. Many have a wide variety of uses. 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.

So you are convinced you want to establish an alternative tree plantation using high-value hardwood species. Where do you put it? How much will it cost? How much time will it take? How do you maintain it? This publication will address these questions, and others, about the establishment of a high-value hardwood plantation.

## Planning your plantation

Some of the most important factors of a successful hardwood plantation are species selection, site location, weed control, and animal damage control. Thoroughly planning every aspect of your high-value hardwood tree plantation will save you considerable time and money. Having to replant because you did not prepare your site adequately or failed to provide animal damage protection can increase the time and money you spend to successfully establish hardwoods.

"*Planning Your Plantation*" (Appendix A, page 13) will help you plan a hardwood plantation, and the activities, costs, and time necessary for establishment and maintenance. All costs listed are estimated average costs developed from actual plantations. A map of your site, with areas of concern noted, will help in the planning process.

**Species selection:** Hardwoods have their own sets of preferred characteristics, which vary somewhat by species and seed source. Species suited to wet sites will probably not have enough moisture to survive on a dry, southern exposure, and dry site species may decline and die on a wet site. Consider aspect, soil type, soil pH, amount and timing of annual precipitation, length of the growing season, average dates of first and last frosts, and desired uses of the planting. With this information you can establish criteria to select the best hardwood species for your plantation. See "*References and Further Reading*" (Appendix A, page 16) for some suggested resources,



and "*High-value Hardwoods: Tolerances, Characteristics, and Uses*" (Appendix B, page 17) for a selected species summary. Most references provide native range maps and a description of the types of sites particular species are 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 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 where the soils are very moist and conditions are usually shady. But this species does very well on drier sites with full sun when not in competition with other species.

**Site location.** Site location is a primary factor in 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 the trees alive. In general, hardwoods prefer the following site characteristics:

1. **SOIL TYPE.** Hardwoods, as a group, thrive in a wide range of soil conditions, from swamps to sandy desert soils, and tolerate pH levels from 4.1 to 8.2. Some hardwood species will tolerate soil nutrient deficiencies better than others. The most important soil factors are structure, depth, drainage, and pH. Well drained soils are necessary for successful plantations. Deep, loose, well drained soils without hardpan layers are best. Many hardwood species "drown" if planted on a site with standing water for more than 1 to 2 weeks per year. A soil test of your potential planting sites will provide valuable information such as the amounts of available nitrogen (N), phosphorus (P), and potassium (K), organic matter, and micronutrients (iron, magnesium, copper, and zinc) present. You may 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.

2. **ASPECT/SLOPE.** East- and north-facing slopes favor the more shade-tolerant, moisture-demanding hardwood species. Gentle slopes or flat ground with adequate drainage are 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 (low-lying areas where cold air pools, having colder temperatures than the surrounding areas) will greatly limit species selection.

3. **ACCESS.** Your plantation should be accessible by pick-up truck and tractor. This will simplify site preparation, planting, annual maintenance, and the eventual harvest of your plantation.

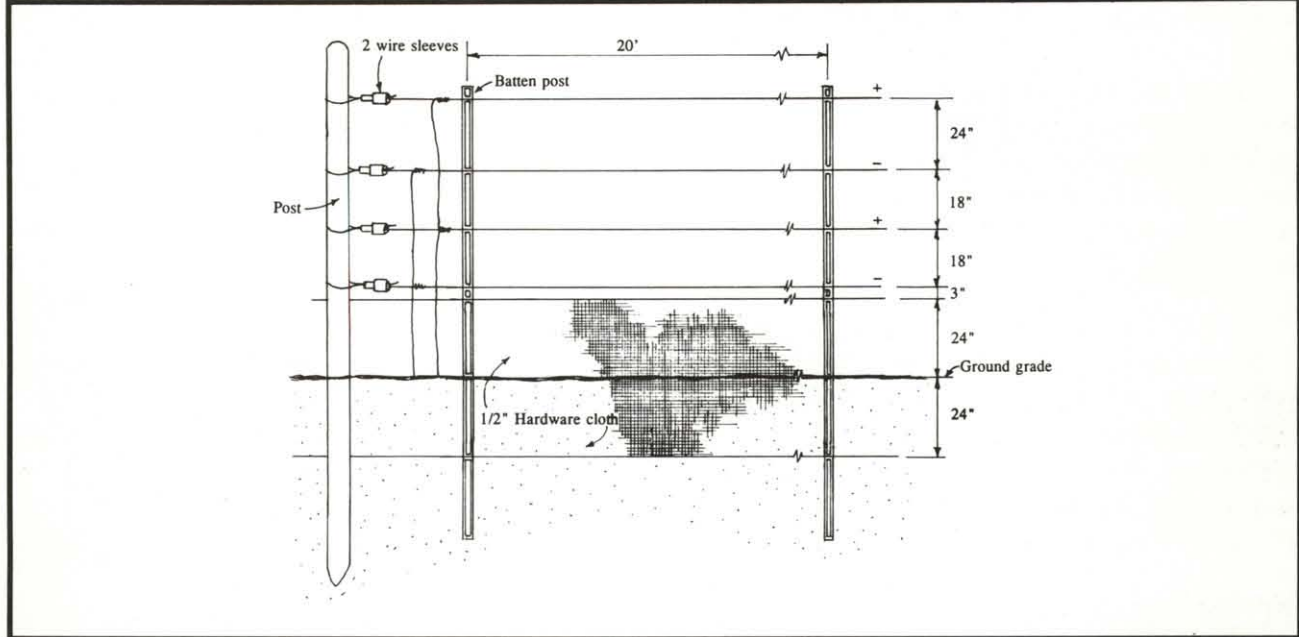
**Irrigation.** Will you want or need to irrigate your plantation? If so, remember the distance from the nearest water source and plan accordingly. Seedlings that receive supplemental moisture the first 3-5 years have been shown to have better survival and growth rates than non-irrigated seedlings, especially during drought years. Surface, sub-surface, or drip irrigation is recommended over sprinkler irrigation because they are more efficient water users and more economical in the long run. Sprinkler systems are not only inefficient, but also moisten leaves and branches, providing ideal conditions for diseases to proliferate.

**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 eat roots. How do you protect your hardwood investment from these natural, but pesky, creatures? A wide variety of animal damage control methods are available, with various rates of costs and success.

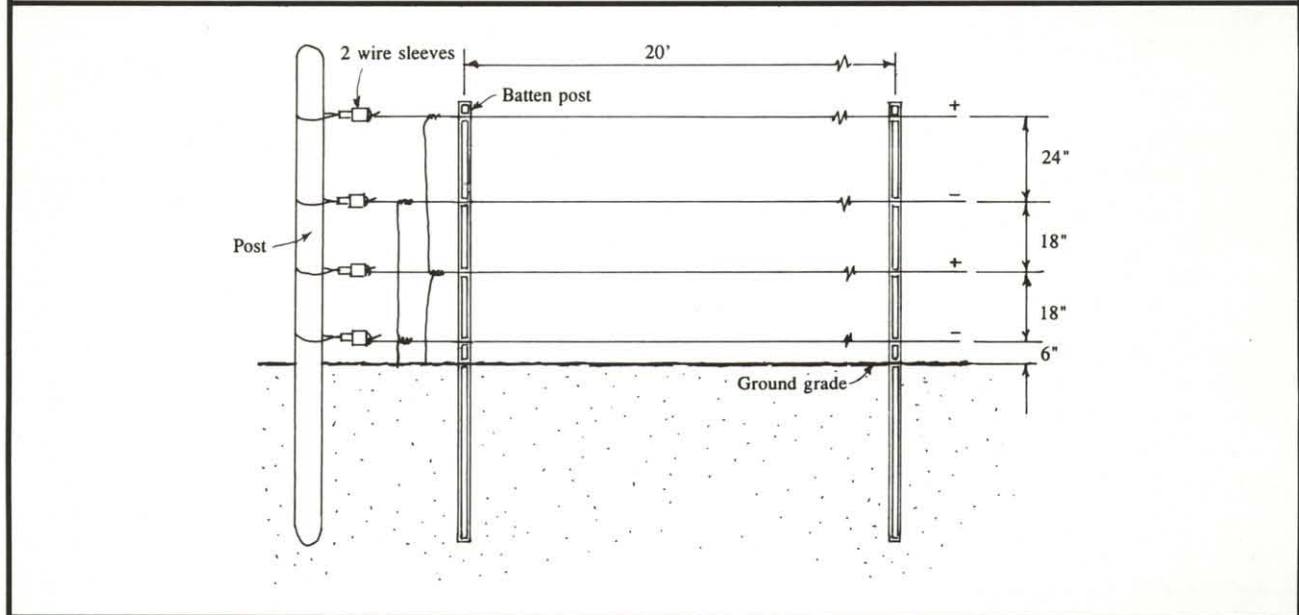
**BARRIERS.** (*Advantage: most effective; disadvantage: high cost*). Nothing will protect your hardwood plantation better than a good fence. Unfortunately, fencing is also the most expensive way to eliminate animal damage. Many types and styles of fencing are available. Consider what types of animals you are trying to exclude, and whether the fence will be permanent. Figure 1 shows an ideal permanent fence, designed to

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**Figure 1. Permanent electric fence.**



**Figure 2. Temporary electric fence.**



exclude not only deer and elk, but rabbits and pocket gophers as well. This type of fence would be appropriate where you would want complete and continual protection from not only feeding damage, but also from deer and elk using tree trunks to rub the velvet off their antlers in late summer. A hardwood nursery, or a chestnut or black walnut plantation may economically justify the investment in this type of fence. Figure 2

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. Other control methods will need to be used to protect trees from mice and pocket gopher damage.

Individual tree shelters are also effective protection against animal damage. Solid plastic shelters that can be folded around the tree work well and

can be reused. For best results, position the bottom of the shelter on or below ground level and secure with a sturdy, weatherproof stake. Chicken wire cages, sleeves of PVC pipe, and aluminum foil wrapped around the bottom 12" of the trunk have also worked well for mice 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.

**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 contact or area 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. Begin applications when trees are dormant, usually immediately after planting. New spring growth will not be protected and repellents must be re-applied. Area repellents are applied around trees and repel animals by smell alone.

The effectiveness of repellents depends on several factors. Rainfall will dissipate some repellents so reapplication will be necessary after rain. Other products or remedies do not weather well, even in the absence of rain. The availability of palatable food plays an important role in the success of any repellent. If there is a shortage of available food, animals will ignore both taste and smell repellents, and happily browse your trees to the ground. Repellents are not likely to deter pocket gophers.

**TOXICANTS.** (*Advantages: quick knock-down of a population; disadvantages: incomplete kill, non-target poisonings, environmental hazard*). Poisoning animals, especially large ones such as deer and elk, is a very controversial issue. 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 the effectiveness of toxicants in controlling animal populations are key issues with this type of animal control. On the other hand, poisoning

mice, voles, moles, and pocket gophers can be effective, and seems to be more socially acceptable. Placing bait according to product instructions in runways and burrows can avoid non-target animals and usually (with repeated applications) will decrease rodent populations to an acceptable level. And realize, you will never get them all.

**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. 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 METHODS.** (*to be used alone or in conjunction with other methods, depending on population levels*). Cultural methods for controlling animal damage usually involve providing food in other locations away from your tree plantation, while removing habitat and food near it. Eliminating ground cover will reduce rodent habitat. Cultural methods are usually not effective in deterring elk and deer.

**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. Initial costs can include:

- soil testing
- purchasing seedlings
- site preparation
- tree planting
- landscape fabric
- installation of irrigation system
- animal damage protection (fencing or tree shelters)
- weed control
- establishment of a cover crop
- labor



Annual costs after establishment can include:

- fertilizers
- weed/vegetation control
- irrigation expenses (water, plus maintenance)
- animal damage control
- pruning
- labor

**How Much Time Will It Take?** 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, "Plantation Activity, Costs, and Time Summary" (Appendix A, page 15) to estimate the hours necessary for each activity, each year. The establishment year will necessitate many more hours than maintenance years.

**How Many Trees Do I Order?** Using your site map, first decide how you want to space the 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. 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. Many people prefer a 10' x 16', or a 14' x 14' spacing. This allows room between rows to do maintenance activities, and for a commercial thinning of every other tree within the rows when they reach merchantable size. Allow additional room for aisles around the outside of the planting, especially if the plantation is fenced.

Once you've determined your spacing, you can calculate how many trees you need. Start by figuring out how many trees will fit on your site using your determined spacing. It is a good idea to order 5% to 10% 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:

$$\frac{\text{Square footage of plantation}}{\text{Spacing of trees (sq. ft.)}} = \text{number of trees}$$

*Example:*

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

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.

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.

## Site Preparation

Site preparation requirements depend on the type of vegetation presently on the site. Also, people have different opinions about how a plantation should be prepared. Some believe clean cultivation (an eradication of all vegetation), followed by an application of a pre-emergent herbicide is the best way to go. Others believe minimum tillage practices, with the least amount of disturbance to the existing cover, is best. Many times the site will dictate the type of necessary preparation. A recently converted agricultural site takes less preparation for planting than a site with

dense shrub or grass cover. However, agricultural lands tend to have an accumulation of annual weed seed, so follow-up control will be required.

Regardless of your site preparation method, remember that weed control is one of the important factors determining the success or failure of your hardwood plantation. Weeds grow astonishingly fast and planning how to deal with them before planting will give you a head start. A completely weed-free planting site is the best way to get a jump on this problem. After eradicating existing weeds, a pre-emergent herbicide is usually the best way to keep them from re-establishing. 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, persistent tilling and hoeing, landscape fabric, or mulch can reduce weeds in your planting area. Landscape mats and mulch not only control weeds immediately around trees, but also have the added benefit of conserving soil moisture directly around the tree. There are many landscape mats and mulches to choose from. Both organic and fabric mulches block light from reaching the ground around each tree, reducing germination of new weeds. Sawdust, straw, and bark are popular organic mulches. They are readily available, moderately priced, and easy to apply. Organic mulches biodegrade and need to be replenished with another layer every 1 to 3 years. Once they degrade, organic mulches become part of the soil and you will need to fertilize to compensate for nitrogen lost during decomposition. Man-made fabric mulches are made of high-tech materials such as polypropylene or polyethylene, are usually treated for protection against ultraviolet degradation, and are micro-perforated to allow water and air exchange with the root zone. Fabric mulches give you all the benefits of organic mulches with less maintenance. However, fabric mulches are expensive and some types need specialized machinery to install.

## Planting your plantation

Spring planting conditions are optimal when soil temperature is 40°F or warmer 4-6 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 fill the hole back in, 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 require watering immediately after planting.

When seedlings arrive, 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.

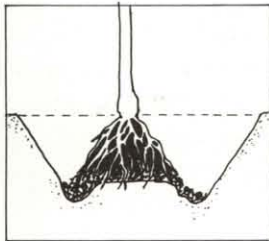
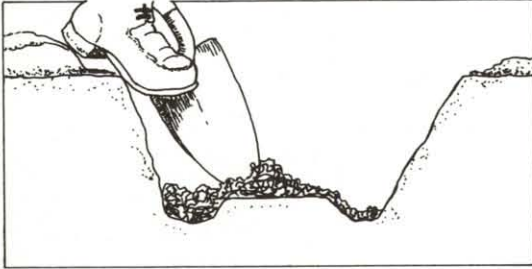
**Keep your seedlings cool and moist at all times!!** Seedlings can be held in cold storage at temperatures of 32°F to 35°F for up to 6 months, or kept in a dark, cool place (such as a basement or cellar) that is approximately 50°F for up to 1 week. When planting, be careful how you shade your field 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 box to provide shade while allowing air movement between the box 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." Check to make sure you haven't "glazed" the sides of the hole, making it difficult for smaller root hairs to penetrate the soil. After planting, prune any broken, crossed, or rubbing branches, and define a leader if necessary. **Do not** prune the root system.

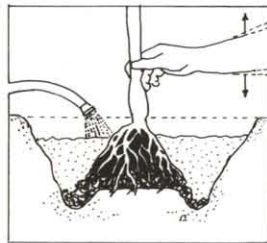


**Figure 3. Bareroot planting.**

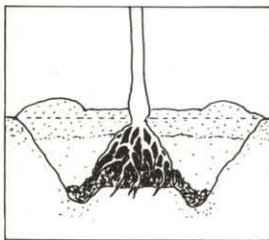
a) For bareroot, non-taprooted species such as black cherry, form a cone of soil in the center of the hole. The top of the cone should reach to nearly the top of the hole. Tamp it with your hands to make it firm.



b) Spread the roots over the cone, pointing the tips away from each other and towards the bottom of the hole. Make sure the biggest root is 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.



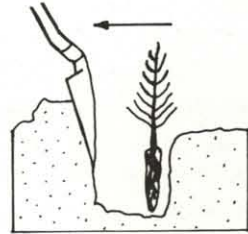
d) Make sure the root collar of the seedling is just below the soil line. The root collar is the area where the soil surface was at the nursery, usually indicated by a change in the color and texture of the bark.

Always use your hands or a hand-held tool to press the soil firmly around the tree to eliminate air pockets and bring roots into contact with the soil, **but do not step around the trunk of the seedling!** This is referred to as the “death stomp,” and can be fatal to your tree.

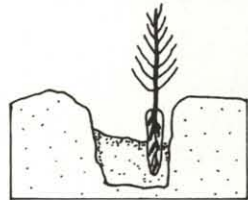
**Figure 5. Planting container grown stock.**

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

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 as long as foliage will not be buried.



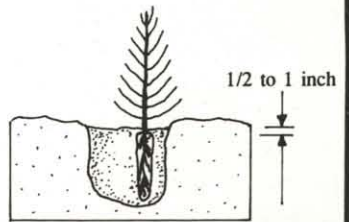
b) Hold the seedling in place and fill the hole half way with moist soil.



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

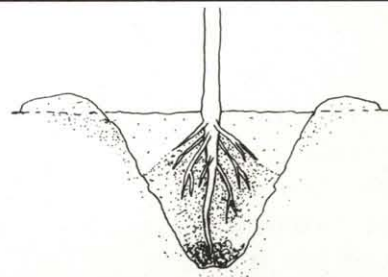


d) This properly planted seedling had its original plug buried 1/2 to 1 inch below the soil line. None of its foliage is buried.



**Figure 4. Planting species with a tap root.**

For taprooted tree species such as oak and hickory, make the 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 any rocks or debris. Firm the soil around the roots as you continue to fill the hole, making sure the tree is planted straight.



## Care of your plantation

**Weed Control.** Weed control is an important factor in the success of your hardwood plantation. Once planted, it is important to keep an area about three feet in diameter around each tree free from competing vegetation. 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.

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 disease, and can girdle the tree and kill it. 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.

**Fertilization.** Fertilizing trees before they are 3 to 5 years old is not beneficial unless your soil test shows a serious deficiency. Fertilizer should be applied in the 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.

Nitrogen (N) is involved in all physiological processes of a plant. 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 decrease flowering and fruiting.

Phosphorus (P) is needed for root development, flowering, 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-nitrogen relationship and is thought to influence water absorption, which in turn affects drought and cold tolerance. A lack of potassium in broad-leaf plants is first expressed by yellowing, followed by scorching and shedding of the older leaves.

Many fertilizer formulations can meet nutrient needs. Nitrogen usually gives trees the greatest growth response. 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 nitrogen, phosphorus, and potassium. These types of products are referred to as complete fertilizers, but do not contain all of the essential elements, although some calcium, magnesium, sulfur, and other microelements could be present as carriers or containments. A general application rate for hardwoods is 3 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 4 feet, using a 20-12-12 fertilizer formulation.

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

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

**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.

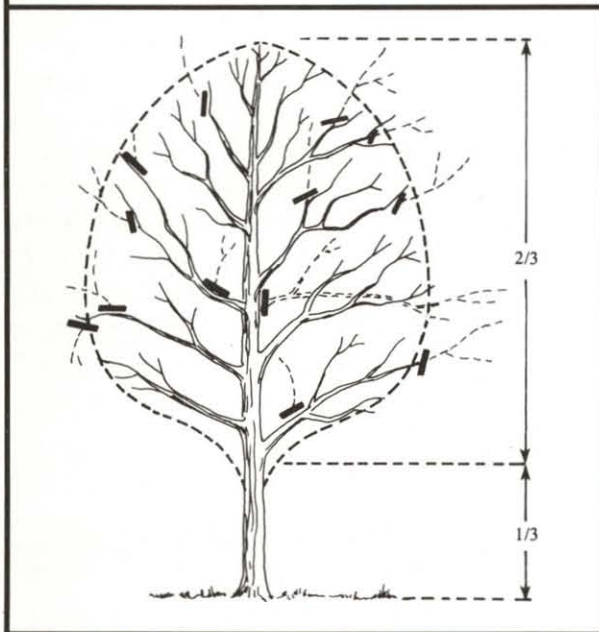
Species with a large sap flow in spring, such as beech, birch, and maple, should be pruned in December or January, whereas other hardwood species, such as black cherry, walnut, and oak, can be pruned in February or March. **Clean tools are a must when pruning.** Many diseases can be spread from tree to tree by pruning with infected tools. A bleach solution (1 part bleach to 9 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,



found in "winter strength" or undiluted windshield wiper fluid at your local auto supply store.

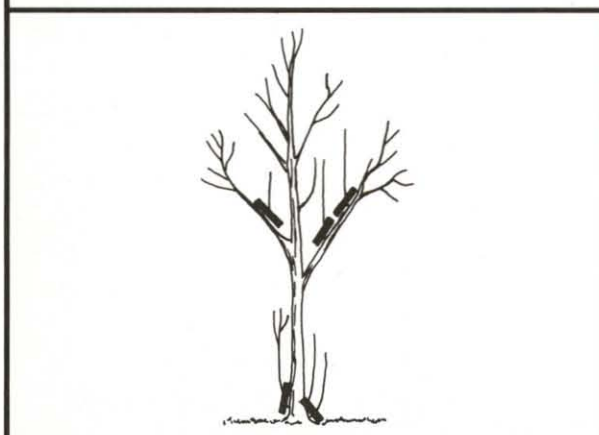
The first winter, pruning should concentrate on trimming crooked leaders back to upright buds, shortening lateral branches to 10-12 inches, and removing any crossed or rubbing branches (Figure 6). This is also a good time to stake up drooping leaders.

**Figure 6. Pruning.**



Water sprouts in the interior and sprouts at the base and on the trunk should also be removed (Figure 7). Water sprouts 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.

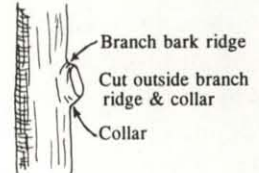
**Figure 7. Water sprouts.**



A few good rules to follow when pruning are illustrated in Figure 8.

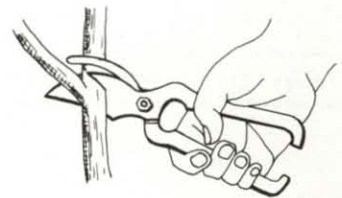
**Figure 8. Pruning rules.**

1) Make your cut just outside the branch ridge and collar so as not to leave a stub.

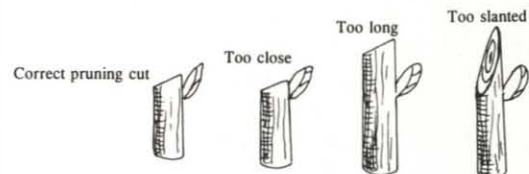


2) On larger branches make sure you undercut the limb approximately 4 to 5 inches from the lateral cut.

3) When shortening a branch, make the cut at a lateral bud or another lateral branch.

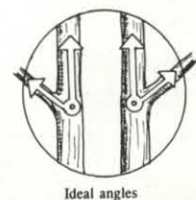


4) The cut should be clean and sharp, and made at a slight angle about 1/4 inch above any bud. You should favor buds or lateral branches that will grow outward.



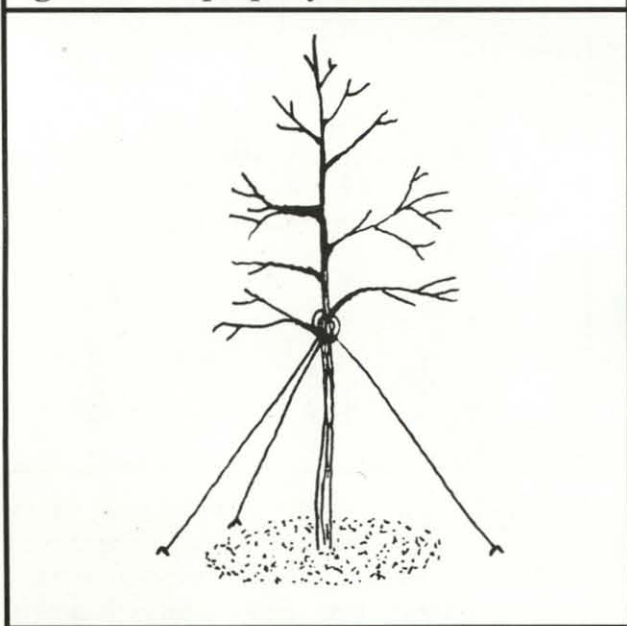
Successive pruning should concentrate on removing excessive side branches, those that cross or rub other branches, and those with narrow crotch angles (Figure 9). Removing the lowest whorl of branches each year will improve the quality of timber eventually harvested from your plantation. Maintaining 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 recommended.

**Figure 9. Crotch angles.**



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 10). 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.

Figure 10. A properly staked tree.



**Sunscauld.** 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 unknown, but seem to be related to rapid temperature changes, repeated freezing and thawing, and a bleaching effect caused by intense sunlight. Snow cover can sometimes increase 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. For large plantings, 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 rewinding if necessary. You can also protect trees from sunscald by painting the trunk with white interior latex paint, which 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.

## Conclusion

High-value hardwoods can potentially provide an alternative income for many Inland Northwest landowners. Used for everything from manufacturing of fine furnishings to firewood, each species is desired for its own particular characteristics and uses. Hardwoods not only provide high-value timber, but also produce fruit and nut crops, contribute to biological diversity and wildlife habitats, are useful in conservation plantings such as windbreaks and riparian plantings, and are aesthetically pleasing. With the right planning, planting, and maintenance you too can enjoy the many benefits of high-value hardwoods.

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# Appendix A

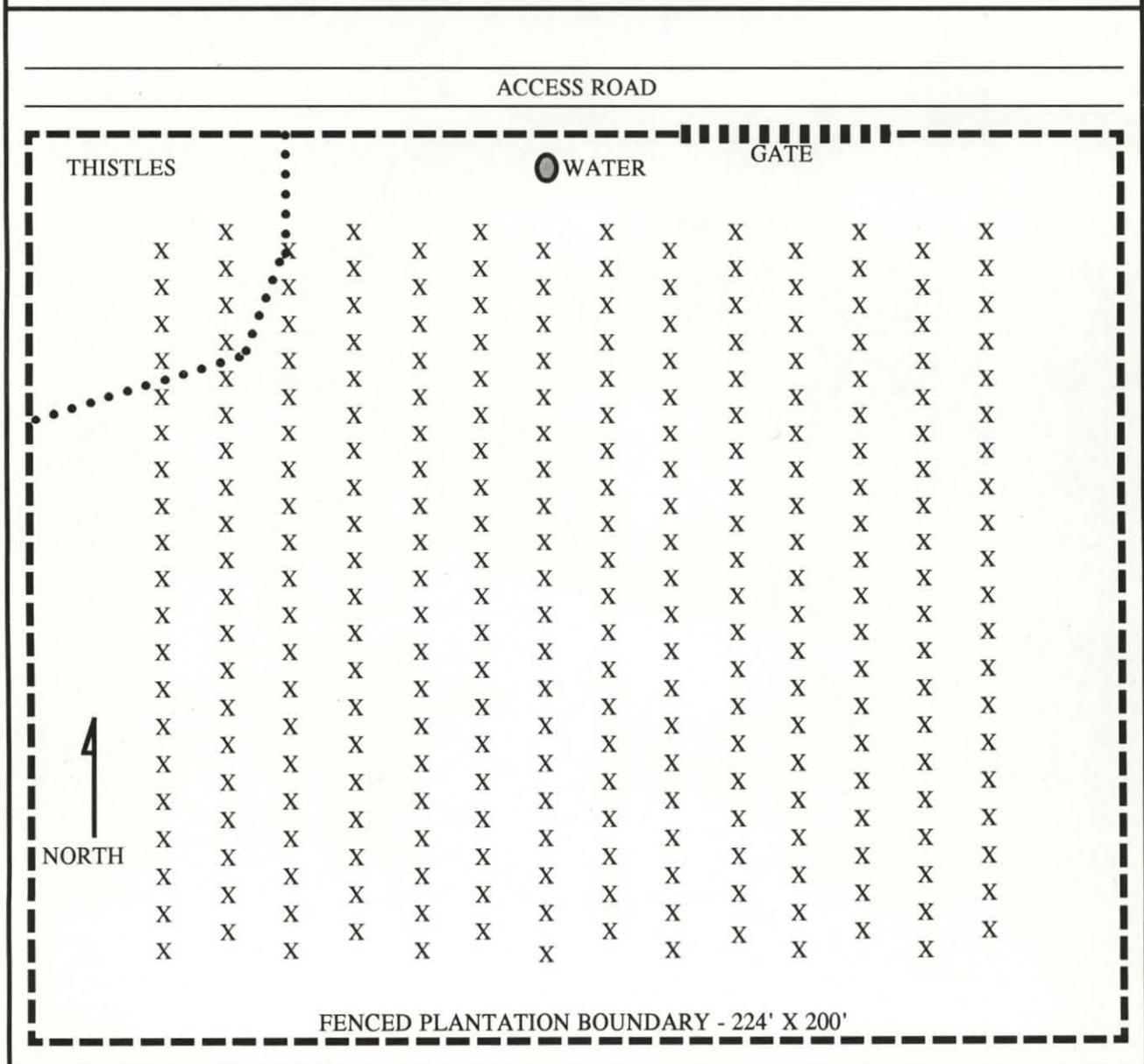
## *Planning Your Plantation*



## Plantation planning example

This example is for a one-acre, mixed hardwood plantation in northern Idaho. The site is gently sloping, converted agricultural land with a vegetative cover of mixed grasses. One corner of the site has a thistle problem. Soils are loamy and deep, well-drained, and have no particular nutrient deficiencies or hardpan layers. The site is not in a frost pocket, nor does it experience any annual flooding. Animal damage potential is high from deer, elk, mice, rabbits, and pocket gophers. The potential for sun-scald is also high. A year around source of water is located on the site. The entire area will be cultivated, and a grass cover crop will be established in the aisles between the rows of trees after planting. Fabric mulch squares will be used for weed control in a 3' x 3' area around trees, and the entire plantation will be surrounded by a temporary electric fence. Bareroot trees will be hand-planted in machine-augured holes every 10 feet in rows 16 feet apart. Fertilizer will be applied starting at year 3. Shade cards will be placed at the base of each tree to protect from sunscald. The grass cover crop in the aisles will be mowed three to four times yearly. Gophers will be baited as necessary. All labor will be done by the owner and family members.

Figure 11. Hardwood plantation field site (map not to scale).



**Table 1. Plantation Activity, Costs, and Time Summary - in order of execution. Costs<sup>1</sup> estimated from establishment of actual plantations.**

DATE	ACTIVITY	COSTS (in dollars)	HOURS
<b>YEAR 0</b>	<b>(establishment year)</b>		
August	Soil analysis	33	1
September	Order trees	240	1
September	Site preparation		
September	Spray Roundup on entire acre	78	1
September	Fencing	1090	25
April	Plow, disc, till	200	4
April	Lay-out rows	-	2
April	Planting		
April	Auger holes	250	5
April	Plant trees	-	6
April	Prune broken branches, define leaders	-	2
April	Landscape mats	195	2
April	Install drip irrigation line	900	8
April	Shade cards	45	2
April	Purchase grass	40	2
April	Sow grass	-	3
as necessary	Spot treat problem weed areas	7	1
as necessary	Mow	-	10
as necessary	Bait gophers	15	4
December	Prune in winter	-	3
	<b>TOTAL FOR ESTABLISHMENT YEAR</b>	<b>\$3,123</b>	<b>83</b>
<b>YEAR 1 &amp; 2</b>			
March	Check trees for winter damage & prune broken branches	-	5
as necessary	Irrigate (includes maintenance)	35	20
as necessary	Spot treat problem weed areas	15	4
as necessary	Mow	-	10
as necessary	Bait gophers	15	4
December	Prune for form in winter	-	8
	<b>TOTALS FOR EACH YEAR - 1 AND 2</b>	<b>\$65</b>	<b>51</b>
<b>YEAR 3,4,5</b>			
March	Check trees for winter damage & prune broken branches	-	5
as necessary	Irrigate (includes maintenance)	35	20
April	Fertilize	20	4
as necessary	Spot treat problem weed areas	15	4
as necessary	Mow	-	10
as necessary	Bait gophers	15	4
December	Prune for form in winter	-	10
	<b>TOTALS FOR EACH YEAR - 3,4,5</b>	<b>\$85</b>	<b>57</b>
	<b>TOTALS FOR ALL YEARS</b>	<b>\$3,508</b>	<b>356</b>

1. Costs based on 1995 figures.

## References and Further Reading

**The following publications are available from Agricultural Publications, Idaho Street, University of Idaho, Moscow, ID 83844-2240.**

*Using Bark and Sawdust for Mulches, Soil Amendments and Potting Mixes.* 1991. CIS No. 858. \$0.35

*Principals of Soil Sampling.* 1981. WREP 9. \$0.50.

*Fertilizing Shade and Ornamental Trees.* 1986. EXT 616. \$0.50.

*Controlling Sunscald on Trees and Vines.* 1990. CIS No. 869. \$0.25.

*Chemigation in the Pacific Northwest.* 1992. PNW 360. \$1.50.

*Pruning Landscape Trees and Shrubs.* 1985. CIS No. 766. \$0.45.

*How to Prune Deciduous Landscape Trees.* 1993. EXP 621. \$2.50.

**The following publication is available from the University of Idaho Research Nursery, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, ID 83844-1137.**

*A Guide to Seedling Selection.* 1995. Misc. No. 18. Free.

**The following publications are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.**

*Northern Hardwood Notes.* USDA Forest Service North Central Forest Experiment Station.

*Central Hardwood Notes.* USDA Forest Service North Central Forest Experiment Station.

*Walnut Notes.* USDA Forest Service North Central Experiment Station.

**The following publications are available from Tree City USA, The National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410. (Single copies are available free of cost.)**

*No. 1 - How to Prune Young Shade Trees.*

*No. 19 - How to Select and Plant a Tree.*

**For information on specific hardwood species, refer to the following books:**

*Silvics of North America - Volume 2. Hardwoods.* USDA Forest Service Agricultural Handbook 654.

*North American Trees.* R.J. Preston, Jr. Iowa State University Press, Ames, IA.

*Grolier's Field Guide to North American Trees.* T.S. Silius. Grolier Book Clubs, Inc., Danbury, CT.



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# Appendix B

*High Value Hardwoods:  
Tolerances,  
Characteristics,  
and Uses.*



## High Value Hardwoods - Tolerances , Characteristics , and Uses.

### The oaks.

The oaks are a large genus 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. 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 branches. The wood of the white oak group is favored for tight cooperage and railroad ties, because of its strength, impermeability to liquids, and durability. 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 oak, stave oak.

**Native range:** eastern United States.

**Climate:** will tolerate temperatures to -50°F, a 5-month frost-free season, and 30" annual precipitation in northern part of native range.

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

**Shade tolerance:** intolerant of shade.

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

**Insect & disease problems:** oak wilt; anthracnose.

**Objectionable characteristics:** difficult to transplant.

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

**Species:** *Quercus bicolor*

**Common names:** 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 (if known):** tolerates poorly drained soils.

**Shade tolerance:** intermediate to tolerant of shade.

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

**Insect & disease problems:** anthracnose, oak wilt.

**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 short periods of standing water or flooding.

**Species:** *Quercus macrocarpa*

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

**Native range:** eastern North America, with extensions 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 (if known):** from moist bottomlands to dry hillsides, mainly in limestone soils.

**Shade tolerances:** intermediate tolerance to shade.

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

**Insect & disease problems:** oak wilt.

**Objectionable characteristics:** will not tolerate flooding.

**Other:** resistant to injury by fire; drought resistant; large seed crops produced every 2-3 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 (if known):** thrives in clays soils, but adapts well to lighter, stonier soils.

**Shade tolerances:** intermediate tolerance to 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, when grown in the open, have poor form.

**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/black oak group

**Species:** *Quercus coccinea*

**Common names:** scarlet oak, black oak, red oak, 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 (if known):** 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; 60-80' tall with an open, rounded crown.

**Insect & disease problems:** oak wilt, cankers, tent caterpillar.

**Objectionable characteristics:** susceptible to fire damage, sunscald, 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:** pin oak, swamp oak, water oak, and swamp Spanish oak.

**Native range:** middle Atlantic and central United States.

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

**Soil type/pH tolerances (if known):** primarily a low-land tree that thrives in poorly drained, claypan soils typical of floodplains; grows well in deep, well-drained soils also; becomes chlorotic in alkaline soils.

**Shade tolerances:** intolerant of shade.

**Form:** fast-growing, short-lived, medium sized tree; 49-82' tall with a broad, pyramid-shaped crown.

**Insect & 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 2-3 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 oak, eastern red oak, mountain red oak, 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 (if known):** 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; 60-90' tall with a spread of 40-60'.**Insect & 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; nuts provide important food for squirrels, wild turkeys, mice, and other mammals and birds.

### American beech.

American beech is a common forest tree of lower elevations throughout its native range. The large, oily seeds are important food for many species of wildlife including ruffed grouse, wood ducks, wild turkeys, squirrels, and black bears. Beech wood is excellent for turning and bending. Because of its elasticity, the wood from this attractive tree 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 names:** 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 seasons; found in one county in Michigan that has only 92-day growing season.**Soil type/pH tolerances (if known):** grows best in rich, moist loam soils with high humus content; encountered more frequently on cooler and wetter north-facing slopes, and is found up to 6,600 feet in elevation in the Appalachian Mountains.**Shade tolerances:** intolerant of shade.**Form:** slow-growing, long-lived (may attain ages of 300-400 years); 100 feet tall with a narrow to spreading rounded crown.**Insect & 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 as some drought-tolerant oaks; not readily browsed by deer; nuts are an important food for wildlife; wood versatile and valuable; creosote made from beech wood is used internally and externally as a medication for various human and animal disorders.

### 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 the most popular of all the native American hardwoods for veneer, furniture and cabinets. The nuts furnish food for squirrels and white-tail deer, and can provide a sound economic return for any grower of these large, distinctly flavored nuts for human consumption.

**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 (if known):** does better than black walnut on 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; 30-60' tall, with a broad, open crown.**Insect & 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 - highest concentration of chemical in roots and fruit husks.**Other:** edible nuts; strong, valuable wood; tolerates cold; easily grown; difficult to transplant; can take higher altitudes and poorer sites than black walnut; valued more for the nuts than the wood.**Species: *Juglans nigra*****Common names:** black walnut, eastern black walnut, American walnut.**Native range:** eastern United States.**Climate:** will tolerate temperatures to -45°F, 25" annual precipitation, and 140 frost-free days in northern part of range.**Soil type\pH tolerances (if known):** deep, rich, moist soils for maximum growth; will grow in drier, less fertile sites at a slower rate.**Shade tolerance:** intolerant of shade.**Form:** large, semi-formal tree; 50-100' tall.**Insect & disease problems:** aphids.**Objectionable characteristics:** juglone - see *Juglans cinerea* above; 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.

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## 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 bars and other products that require tough, strong, elastic wood. Due to its high caloric value and unique flavoring capabilities, hickory is also used extensively for smoking meats and for fuelwood. Made popular by Euell Gibbons, 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 hickory, shellbark hickory, scalybark hickory, 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 (if known):** one of hardiest hickories, with ability to adapt to wide range of conditions.**Shade tolerance:** intermediate shade tolerance.**Form:** slow-growing, medium-sized tree; 70-80' tall, with a narrow, open crown and large branches.**Insect & disease problems:** anthracnose.**Objectionable characteristics:** susceptible to damage by fire; difficult to transplant.**Other:** wildlife food; very hard wood; not a preferred forage for deer.

## Chestnut.

One species of this distinctive genus, American chestnut, has been brought to the point of extinction in the eastern portions of the United States by the chestnut blight. But in blight free areas it is alive and growing well. The wood from this species used to be a principal domestic source of tannin, a wood product used for tanning hides. It 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 at Christmas. What Christmas would be complete without chestnuts roasting over an open fire? Newer hybrids excel at nut production and blight resistance. Efforts continue to breed resistant varieties with American chestnut to produce a tree with outstanding timber qualities and adequate blight resistance.

**Species:** *Castanea dentata*

**Common names:** American chestnut.

**Native range:** NE United States into the Appalachian Mountains.

**Soil type/pH tolerances (if known):** grows in variety of soils except in wet, poorly drained types.

**Shade tolerances:** (probably) intolerant.

**Form:** fast-growing, large tree.

**Insect & 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.

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## 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, rum cherry, and 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 (if known):** grows in a wide variety of soils but prefers moist, fertile conditions on north- and east-facing slopes and in protected coves.

**Shade tolerances:** intolerant of shade.

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

**Insect & disease problems:** tent caterpillars, black knot.

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

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

## 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. It's 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 birch, gray birch, silver birch, swamp birch.

**Native range:** Newfoundland and Nova Scotia, NE 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 (if known):** moist, well drained soils and cooler marshlands.

**Shade tolerances:** intermediate tolerance to shade.

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

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

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

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

## White ash.

This is the most common and most valuable species of native ash. One of the earliest reported uses of white ash was as a snake bite preventive. Ash leaves in a hunter's pocket or boots were "proved" to be offensive to rattlesnakes. The seeds of the white ash are eaten by wood ducks, bobwhite, pine grosbeak and fox squirrels. The wood is light brown, strong, tough, and lightweight. It is used to make tool handles, furniture, veneer, paneling, and baseball bats.

**Species:** *Fraxinus americana*

**Common names:** white ash, Biltmore ash, 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, increasing rates of growth as it matures; medium-sized tree; 82' tall with a narrow to broadly rounded or pyramid-shaped crown.

**Insect & disease problems:** ash decline, oystershell scale.

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

**Other:** intermediate tolerance of flooding.

The above information was compiled from the following sources:

*Silvics of North America.* USDA Forest Service Agricultural Handbook 654

*Field Guide to North American Trees.* T.S. Elias. Grolier Book Clubs Inc., Danbury, Connecticut.

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