Woodland Owners' Guide to Oak Management

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NATURAL RESOURCES

Introduction

Oaks have long dominated woodlands in the Driftless Area of western Wisconsin, southeastern Minnesota, and northeastern Iowa (Figure 1). Generations of area residents and visitors have lived and played beneath the oak's sheltering branches. Oaks have been a dependable source of food and shelter for wildlife. They have provided strong, beautiful wood for a multitude of forest products. These majestic trees appear to be well adapted to growing conditions in this rugged yet beautiful terrain of steep hillsides and plunging coulees.

But oaks are a vanishing resource. Harvesting and losses due to diseases, insects, and other causes annually exceed red oak growth by as much as 30 percent. A major reason for this is that oaks are difficult to regenerate.

Oaks are harvested to produce income, regenerate a stand, accelerate growth of residual trees, and change the species mix to benefit wildlife or future timber value. However, harvesting must be planned with an eye toward the next generation of trees. All too often oak forests suffer from high-grading—taking only the best. The residual poor-quality trees have little potential for developing into merchantable timber and oaks cannot regenerate in the small openings that are created.

Figure 1. The Driftless Area is an island of unglaciated land. It is much hillier than the surrounding area.

This publication describes how you can manage hardwood stands to perpetuate oaks. While it explains management options, it is not a substitute for personal advice from a professional forester. As you plan a management strategy, seek the advice of a forester through your state natural resources department, local conservation district, or a consulting firm.

Management Considerations

A basic knowledge about oaks will help you make wise management choices.

History

Most oak forests in the Driftless Area developed because of the long history of repeated wildfires before European settlement of the region. Oaks have thick bark that insulates them from heat, and are able to resprout when fire kills the aboveground part of a tree.

On the prairie fringes, scattered bur, white, and black oaks survived fires that killed many other hardwoods. Periodic fires on moist, forested sites killed fire-sensitive species, allowing red and white oaks to replace them. When the repeated burning was interrupted by settlers, oaks quickly regenerated in the forest openings because there was little competition from other species.

Regeneration

Oaks regenerate naturally from seed (acorns) and from stump sprouts.

Large acorn crops occur every two to five years or more. Compared to many other tree species, however, oaks do not produce many seeds. Most acorns remain directly beneath the crown of the tree where they fall, although a few are spread by animals.

Fallen acorns deteriorate rapidly if not protected from drying. Leaf cover provides some protection, but several inches of mineral soil cover works even better for keeping the acorns moist and minimizing damage by insects and other animals.

Acorns from white, swamp white, and bur oak begin germinating in the fall immediately after the acorns drop; northern red, black, and northern pin oak acorns germinate the following spring. During germination and first-year growth, seedlings can survive in low light. Thereafter, they need more light to survive.

The ability to stump sprout vigorously after drought, fire, or other damage gives the oaks a distinct advantage over other hardwoods. This ability varies by species, age, diameter, and site quality. In general red oaks sprout most readily. Sprouting declines as trees grow older and as tree diameter increases. Few oaks larger than 17 inches in diameter will sprout. Oak trees are more likely to sprout on good-quality sites than on poor sites.

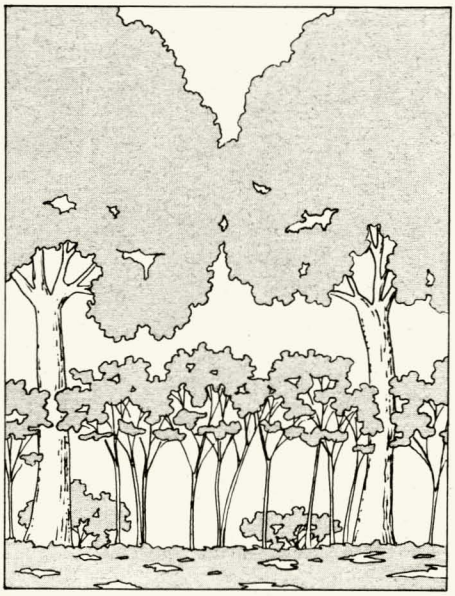


Figure 2. Young oaks cannot survive long beneath a dense understory or overstory.

Site Quality

The relative abundance, quality, and growth rates of oaks depend on site quality.

Oaks grow best on north- and east-facing, gently sloping, lower slopes where soils are at least 36 inches deep. Medium-quality sites have moderately deep soils (20 to 36 inches) on upper and middle slopes facing north and east. Oaks survive but grow poorly on narrow ridgetops or south- and west-facing, steep, upper slopes where soil is less than 20 inches deep.

Oaks survive better than most other tree species on dry sites, but they do not produce much merchantable timber on such sites. On the best sites there is fierce competition among tree species, so oaks are difficult to regenerate there.

Shade Tolerance

Oaks are only moderately tolerant of shade, and young oaks need full sunlight to outgrow their competitors. This means that in oak stands that have a dense overstory and understory (Figure 2) there will be few oaks in the understory. When overstory trees are harvested or die of natural causes, the understory trees (called advance reproduction) are released to grow, creating a stand of shade-tolerant tree species and a few oaks that originate from stump sprouts.

Harvest

If you want to perpetuate oaks, a carefully planned harvest will provide the sunlight and space oak seedlings need to survive. Oak stands are ready to be harvested and regenerated when trees are economically mature, when large numbers of oaks are dying from any cause, or when a stand is stocked with poor-quality or undesirable trees.

Oaks reach economic maturity when they are about 16 inches in diameter (measured 4-1/2 feet above ground) on poor sites, 20 inches on good sites, and 24 inches on the best sites. It will take 60 to 90 years to produce such trees on good sites and 90 to 120 years on poor sites.

Natural Regeneration

Natural regeneration is the least expensive way to grow oaks. To regenerate oaks in a mixed hardwood stand, work with a forester and follow these steps:

1. Measure potential sources of oak regeneration: advance reproduction, oaks capable of producing stump sprouts, and acorn crop potential.
2. Evaluate competition from undesirable trees and other plants and plan how you will control it.
3. Apply a regeneration system that encourages oak and meets your other management goals.
4. Monitor the stand, controlling competition as needed.

1. Measure Regeneration Potential

Have a forester inventory the advance reproduction and the overstory to determine the ability of the stand to regenerate itself. The number of oak seedlings needed to stock a stand depends on their height, since large seedlings are more likely to survive than small seedlings:

Seedling Height (feet)	Seedlings per Acre
<1	15,435
1 - 2	3,087
2 - 4	1,029
>4	514

When seedling numbers do not meet stocking goals, the forester should evaluate stump sprout potential. If both seedling numbers and stump sprout potential are inadequate, you still may get satisfactory regeneration from acorns. Rely upon acorns for regeneration only in years when there is a good acorn crop. As a general rule, a stand must be at least 50 percent mature oak to be a good acorn producer.

2. Evaluate and Plan to Control Competition

Plants that overtop oak seedlings eventually will eliminate them. Control competitors by chemical or mechanical treatment depending on the size, density, and species of plants. A forester can determine whether control is warranted.

Foliar herbicides will control ferns, shrubs, and trees less than 10 feet tall. They work best when applied in late summer or early fall. Protect oaks by cutting oak stems taller than 3 feet before applying the herbicide. Cut stems will resprout.

Control large shrubs and saplings by applying herbicides as a basal spray or stem injection. Kill larger trees by felling and applying herbicide to the stump or by girdling with an axe or chainsaw and applying herbicide to the girdle. These treatments are most effective in mid- to late summer.

Caution: Be sure to contact a forester for regulations and recommendations concerning herbicides and their application!

Undesirable shrubs and small trees also can be killed by mechanical uprooting before, during, or after logging. Expose the roots but do not cut or break off the stems because that leads to sprouting. Oaks generally survive this treatment because of their deep roots and ability to sprout after top injury. Apply this treatment when the ground is not frozen, avoiding severe soil displacement.

You should not need to control ground vegetation that grows up following the final harvest. The oak reproduction may appear to be buried under dense growth, but it will emerge after four to six years.

3. Apply a Regeneration System

A regeneration system is a combination of harvest and other activities that creates conditions favoring tree regeneration.

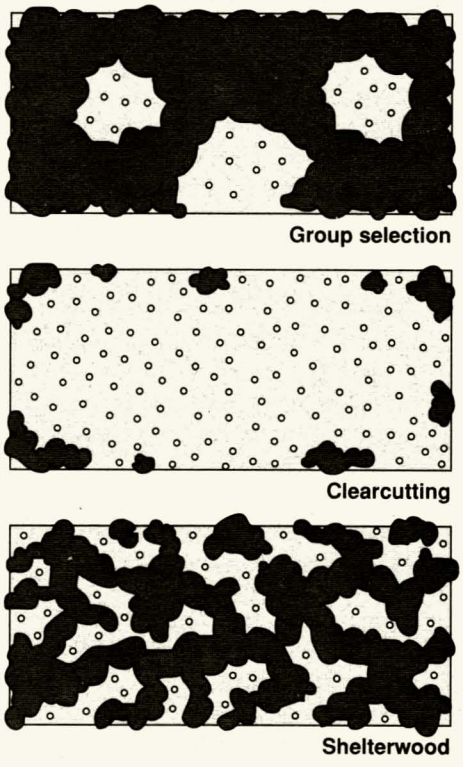


Figure 3. Group selection, clearcutting, and shelterwood harvesting provide sunlight needed for oak regeneration.

To satisfy oak seedling light requirements, harvest areas must be at least 1/2 acre (160-foot diameter circles). A harvest area of at least 2 acres (200 feet wide) is recommended, however, because smaller openings are costly to manage and harvest and have a larger proportion of their area in "edge," increasing the potential for adverse edge effects (reduced oak seedling growth due to shade from border trees; increased branching of border trees, reducing their wood quality). If deer browsing is a problem, harvest areas of at least 4 acres.

If your main objective is to grow timber, there is no reason to limit stand size. If your objective is to provide periodic timber harvests and encourage wildlife diversity, harvest small blocks of timber at planned intervals (e.g., 10 to 15 years) to create a mix of stand ages. Across a forested landscape only one to two percent of the forest needs to be regenerated each year.

Regeneration systems that will satisfy oak light requirements are group selection, clearcutting, and shelterwood (Figure 3).

Group Selection. Group selection is cutting all trees larger than 2 inches diameter in an area from 1/2 to 2 acres. This system leaves too much shade for continued survival and growth of numerous oak seedlings, but it is superior to harvesting individual mature trees scattered throughout the woodland. The relatively small openings may be desirable for aesthetics or encouraging wildlife.

Select areas to be cut that contain advance oak reproduction and mature trees. If advance reproduction is lacking, either (1) delay harvest until a year when there is a good acorn crop, (2) apply a shelterwood harvest followed several years later by a group selection, or (3) harvest by group selection and plant oak seedlings.

If necessary, control understory vegetation before or during the harvest. During or after the harvest, remove or kill all trees larger than 2 inches in diameter. Cut unmerchantable oaks as low as possible to encourage sprouting from near

ground level. Use herbicides on undesirable species that produce vigorous stump sprouts.

Prepare for the next harvest by controlling understory competition and applying a shelterwood cut in another 10 percent of the stand. In this way, the entire stand will have been regenerated to oak after 10 cuts.

Clearcutting. Clearcutting here means to cut all trees larger than 2 inches in diameter in an area larger than 2 acres. Clearcutting is recommended when regeneration potential is adequate.

Clearcut areas that contain advance reproduction and mature trees. If advance reproduction is lacking, delay harvest until there is a large acorn crop or harvest and plant oak seedlings.

Before or during the harvest, control understory vegetation if necessary. During or after the harvest, remove or kill all trees larger than 2 inches diameter. Cut unmerchantable oaks as low as possible to facilitate sprouting from near ground level. Use herbicides on undesirable species that produce vigorous stump sprouts.

Shelterwood. The shelterwood system is recommended when oak regeneration potential is inadequate or uncertain. It involves two or more harvests several years apart in the same stand. The first harvest is a thinning and the final harvest is a clearcut or group selection.

The first harvest removes some merchantable timber as well as undesirable species. It creates holes in the canopy that permit sunlight to reach oak seedlings and stimulate their growth and may encourage residual oaks to produce more acorns. Light levels can be regulated by the amount of thinning to favor acorn germination and oak seedling survival while suppressing competition from undesirable trees and shrubs.

Make the first cut after a large acorn crop, if possible. Leave the best trees of any desirable species and all unmerchantable oaks capable of producing stump sprouts. Remove all other trees larger than 2 inches diameter, including seed-producing trees of undesirable species. This cut should leave a parklike stand with a 60 to 70 percent canopy having no major gaps. It is better to leave too many trees than too few, or you may encourage competition.

A good acorn crop within two years of understory removal usually will assure adequate reproduction. If a good acorn crop does not occur within three years, control understory competition a second time, preferably during a good acorn year.

Take the final cut when a forester determines that the advance reproduction is adequate. This cut releases seedlings and yields more merchantable timber.

All Regeneration Systems. The following suggestions apply no matter which system you use:

- When relying on acorns to reestablish oaks, harvest and disturb the soil after the acorns drop, but before the ground freezes. Soil disturbance helps to bury the acorns and uproot competing vegetation.
- When relying on advance reproduction and stump sprouts, minimize soil disturbance by harvesting when the soil is frozen. If you need to harvest in other seasons, restrict log skidding to narrow corridors. This will reduce soil disturbance that favors germination of undesirable species.

4. Monitor Competition and Oak Development

Inspect the stand the first year after applying a regeneration system. Determine whether the number of oak seedlings and stump sprouts is adequate and evaluate competition from undesirable vegetation. If oak regeneration is not adequate, plant oak seedlings.

Control any competition from undesirable trees and shrubs. Oaks seemingly buried under dense herbaceous vegetation probably will emerge after four to six years.

Artificial Regeneration

Artificial regeneration refers to planting tree seedlings or seeds. Use it only as a last resort for establishing oak, since planting seedlings is expensive and direct seeding is not dependable. However, you may need to plant or seed to reforest open fields, to supplement natural regeneration, or to introduce oaks where acorn-bearing oaks are scarce.

Plant northern red oak when growing oaks for timber production on good sites. Consider planting a mixture of desirable species such as oak, walnut, and white ash if they are suitable for the site and seed sources are not present. This will create a more diverse stand, reducing the potential for insect and disease problems.

Plant white, black, or bur oak on poor, dry sites for wildlife or aesthetic purposes. If there is a market for pine in your area, plant alternate rows of pine and oak on field sites. Pines will provide early weed control and may produce merchantable timber much sooner than the oaks.

Oak seedlings are the most common planting stock, but acorns are sometimes planted.

Planting Seedlings

Plant large seedlings (at least 3/8-inch stem diameter) with fibrous root systems (Figure 4). For ease of handling, clip tops and roots to about 8 inches each. Clip tops not more than 10 days before planting; roots may be clipped earlier. During transport and planting, keep seedlings cool and roots moist and protect them from direct sunlight and wind. A planting bar works fine for small seedlings; plant seedlings with large root systems in holes using shovels or augers.

Dense, young stands force trees to grow straighter and to self-prune branches at an early age. On forest sites plant oaks 20 to 25 feet apart; other trees (even though they may not be oak) will create the necessary density.

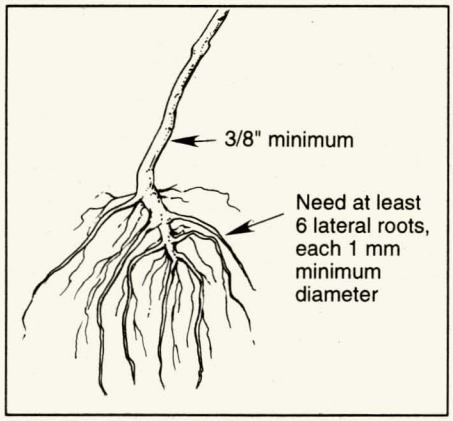


Figure 4. Large-diameter oak seedlings with a fibrous root system survive best.

In open fields, plant trees 5 to 8 feet apart within rows and 10 to 12 feet apart between rows. This closer spacing will promote earlier crown closure, which will shade out understory weeds while producing high-quality trees. Spacing can be varied to permit access by weed-control equipment.

Animals may harm oak seedlings. Discourage rodents by keeping the area immediately surrounding the seedlings as weed-free as possible during the early years. Moderate browsing by larger animals usually can be tolerated. However, to discourage severe browsing, you may need to fence entire stands or use tree shelters.

Tree shelters are tubes about 3 to 4 inches in diameter and 2 to 5 feet high that can be placed over oak seedlings. They protect seedings from animals. They also modify the microclimate around seedlings much like a miniature greenhouse.

Tree shelters stimulate seedling growth, but are expensive. On harsh planting sites, or sites where animal damage is likely to be severe, use 50 to 100 shelters per acre to assure the survival of a minimum number of oak seedlings.

Control competition for about three years after planting. Herbicides are practical and economical; cultivation may be used in field plantings. Contact a forester for specific advice.

Planting Under Shelterwood. Planting under shelterwood gives oak seedlings time to become established before the overstory is removed and competing vegetation invades. Before planting follow the harvest and understory control procedures described previously for the shelterwood system.

Plant in early spring following the first shelterwood cut. Irregular spacing is acceptable. Plant in spaces lacking acorn-bearing trees or where competition is minimal. If the seedlings are 3/8 inches in diameter or greater, plant two for each crop tree wanted; if smaller, plant three times as many seedlings as crop trees desired.

Remove the overstory during the dormant season three to six years after planting when seedlings are at least 2 feet tall. Any seedlings damaged during harvest will resprout. Control stump sprouts of undesirable species. Remove competing trees that invade after overstory removal when they are 1 to 4 inches diameter (about 10 years old).

Planting in a Clearcut or Group Selection Opening. Control understory vegetation before or immediately after overstory removal. Harvest the merchantable trees and remove or kill all residual trees. Control stump sprouts of undesirable species.

Plant seedlings in early spring following the harvest where desirable reproduction is lacking. Irregular spacing is acceptable. Control invading competition around planted seedlings for about three years.

Planting in an Open Field. During the fall before planting, control vegetation with herbicide followed, when feasible, by plowing, disking, or rototilling. Treat either the entire site or strips at least 6 feet wide. After planting control competing vegetation as needed, usually for three years.

Planting Acorns

Acorns are less expensive to acquire and plant than seedlings. Acorn planting is rarely successful, however, because of pilfering by rodents and lack of competition control. The following procedures should increase your chance of success.

Collect mature acorns as soon as they drop. Keep them cool and moist. Place them in a tub of water and discard the floaters. Sow white oak in the fall, as soon as possible after collecting; sow red oak immediately in the fall or, if necessary, delay until the following spring.

For spring sowing of red oak, store acorns over winter in 4-mil polyethylene bags. Keep the bags at 35°-37° F or buried several feet deep in well-drained soil. In the spring remove the acorns from storage and keep them moist at about 40° F. for 10 to 14 days.

Germination probably will begin in storage and accelerate when the temperature is raised. Only plant acorns that develop small white roots (broken roots will resprout).

After controlling understory vegetation, plant acorns in openings at least 1/2 acre in size (the larger the better) that are fairly free of litter and logging debris. Plant acorns 1 to 2 inches deep in spots several feet wide, 3 or 4 acorns to a spot. Sow at least twice as many spots as trees wanted. For added insurance, cover some of the planted acorns with small tree shelters. Bury the bottoms of the shelters several inches deep to discourage digging by squirrels.

Improving Stands

As oak stands grow, they may need some cutting or other cultural practices to encourage desirable trees, increase growth rates, control species composition, improve tree quality, or enhance wildlife habitat.

Improvement cuts often remove trees that are too small or low quality to be sold as timber. Such cuttings are most economical when marketable pulpwood or fuelwood can be produced or when the potential value of residual trees significantly increases.

Practices will vary depending on tree size. Tree stands commonly are classified by the average

diameter of their dominant trees as follows:

< 1"	=	seedling
1" - 4"	=	sapling
5" - 9"	=	poletimber
10" +	=	sawtimber

Identifying Crop Trees

To improve a hardwood stand containing oaks, you need to identify crop trees —those you wish to favor. If timber production is your main goal, then a potential crop tree should be:

- a marketable species
- well formed, with a vigorous crown in the main canopy
- larger in diameter than surrounding trees
- straight stemmed and nearly free of live branches and large dead branches for the lowest 20 feet of poletimber or larger trees and for half the total height of saplings
- without V-shaped forks in the stem (U-shaped forks above 25 feet are acceptable)
- without large cracks, seams, or wounds in the bark

Stump sprouts are acceptable if they originate at or below ground level and meet the above criteria.

If wildlife is the primary goal, then crop trees may include:

- tree species that produce edible seeds (mast), e.g., oak, walnut, hickory, cherry
- trees with holes and cavities that may serve as dens

If aesthetics is your main goal, you may wish to favor trees that produce beautiful flowers, radiant fall colors, interesting bark color or texture, diverse types of branch structures, or a mixture of tree species including hardwoods and conifers.

Releasing Crop Trees

Crop trees need to be released from competition if they are to remain healthy and grow fast.

Seedling and Sapling Stands. In seedling and sapling stands you may need to control trees that suppress crop trees, to eliminate undesirable species, and to thin stump sprouts.

Overhead shade can kill young oaks or cause them to develop poor form as they bend toward the light in canopy openings. During or immediately after a harvest, control undesirable sapling-, pole-, and sawtimber-size trees that shade desirable reproduction. You may leave scattered large trees for several years for wildlife or aesthetic purposes, but kill them later if they create too much shade over desirable trees.

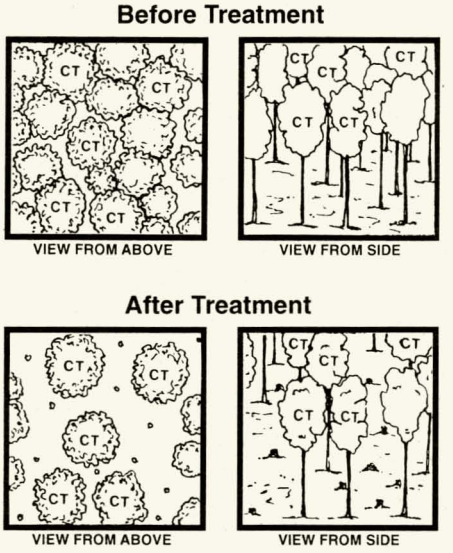
Control undesirable tree species that compete with crop trees when stand height averages at least 25 feet (10 to 20 years old). By delaying removal until this stage, there will be fewer trees to remove and stands will be more accessible. Stump sprouting by undesirable trees will not be a problem in the shaded understory of these young, dense stands, so chainsaw felling will be effective and may cost less than applying herbicides.

When growing trees for timber production, thin sprouts growing from a single stump to one or two dominant sprouts that have good form and are connected to the stump below or near the ground. Thin when sprouts are about 10 years old (2 to 3 inches in diameter).

Poletimber and Sawtimber Stands. Oak stands managed for timber should be kept fairly dense until the bottom 20 to 25 feet of the stems are essentially free of live branches. This generally will occur when trees are 40 to 50 feet tall (30 to 45 years old). At this stage thin stands to stimulate diameter growth of crop trees.

Release no more than 100 crop trees per acre. Ideally, crop trees should be 20 to 25 feet apart. However, if they are scarce or unevenly distributed, you can leave two trees as close as 10 feet as long as you treat them as one tree when thinning.

Remove trees with crowns that encroach on those of crop trees (Figure 5). Free all sides of sapling and small poletimber size trees and at least three sides of larger trees. Trees below the main canopy will not affect crop tree growth, but you may cut them if they are marketable. Do not damage crop tree stems and roots while thinning stands. Repeat thinning every 15 to 20 years.



CT = Crop tree. Source: How to release crop trees in precommercial hardwood stands. USDA Northeastern Forest Experiment Station pamphlet NE-INF-80-88.

Figure 5. Crown release will stimulate crop tree growth.

High-Graded Stands. If you are starting with a stand that has been previously high-graded, you may be able to rehabilitate it by applying several improvement cuts. Release crop trees and thin heavily if there is a market for pulpwood or fuelwood. If not, apply a noncommercial crop-tree release. When the few good trees reach harvest size, regenerate the stand.

Pruning

Hardwood trees grown for timber are most valuable when their lower 20 to 25 feet are straight and free of limbs. Proper density will help; however, hand-pruning may be needed in understocked stands and plantations. Pruning is time-consuming and therefore expensive. Prune only high-value species such as black walnut and northern red oak.

When a seedling or sapling stem develops a fork, cut off one side of the fork to create a single central leader. When trees reach poletimber size, remove lower limbs. Using a saw, cut live branches close to the

stem without wounding the stem; prune dead branches close to their base, but do not cut through any live wood. Confine pruning to the first 16 feet or to half the total tree height, whichever is less. Thus, a 20-foot tree may need a second or third pruning as it grows in height.

Caution! Do not prune oaks between mid-April and mid-July to minimize risk of oak wilt.

Managing for Wildlife

Hardwood stands with a high percentage of oaks can provide excellent food and cover for wildlife. Regeneration and management practices discussed so far will sustain a healthy forest with a high percentage of oaks, but there are additional practices that will enhance wildlife habitat.

Each wildlife species has unique habitat requirements, so start by learning more about the species that interest you most. The following practices are aimed at producing wildlife diversity:

- Provide more edge habitat by creating a patchwork of small stands harvested at different times. Favor wildlife that use the interior of large forest areas by making large clearcuts.
- When clearcutting, leave scattered live trees with narrow crowns to provide more vertical habitat. (Kill these trees before they begin to suppress the reproduction.)
- Leave corridors of standing trees through large clearcuts to provide cover for wildlife that need to cross over them.
- Thin sapling and pole stands more heavily than necessary for timber production to provide more sunlight and thus stimulate growth of vegetation near the forest floor.
- Retain live trees with cavities for squirrels, raccoons, and other cavity dwellers.
- When thinning or harvesting stands, leave or create dead standing trees (snags). They provide insects and nesting cavities for birds.
- Favor tree and shrub species that produce edible seeds, berries or fruits (e.g., oak, black cherry, hickories, dogwood, hazelnut). Thin oak stands regularly to encourage acorn production. Plant fruit-bearing trees in openings.
- Seed log landings and skid trails with grass and clover.
- For added diversity and winter cover, plant scattered groups of slow-growing conifers such as spruce and redcedar.

Protecting Soil and Water

Most soil erosion and water quality problems associated with woodland management result from soil disturbance during road construction, harvesting, and site preparation for regeneration. Water quality also can be affected by herbicides and pesticides.

Best management practices (BMPs) reduce the impacts of forestry activities on soil and water. Contact a forester for BMP guidelines in your area. Here are a few general rules to follow:

- Do not scrape away the topsoil when clearing sites for regeneration. Use equipment that will mix the soil in place or scarify patches (e.g., disks, rock rakes, anchor chains, or patch and row scarification machines).
- When skidding logs, stay away from stream channels and avoid long, straight, steep grades. Keep skidders off steep slopes as much as possible by winching logs to a more level area.
- Construct broad-based dips and lead-off ditches to channel water off roads and skid trails.
- On highly erodible soils, log when the soil is dry or frozen.
- Locate log landings on level or nearly level sites, away from streams and poorly drained areas.
- Leave buffer strips between the harvest area and streams or lakes. You may selectively harvest trees in buffer strips if you do not disturb the surface litter and vegetation. Promptly remove tree tops from water bodies.
- Do not harvest trees that shade trout streams.
- Minimize stream crossings. Build appropriate structures when crossing streams to protect stream beds and banks and permit free flow of water.
- Follow federal and state regulations for herbicide and pesticide use to prevent contamination of surface and ground water.

Aesthetic Considerations

Some woodland management activities create conditions that some people consider to be unsightly. Here are some practices that will help protect the beauty of oak woodlands:

- For visually sensitive areas, use group selection rather than clearcut or shelterwood systems.

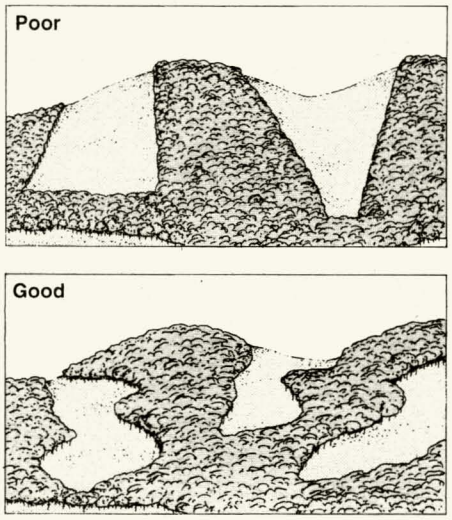


Figure 6. Design cuts to blend with the topography.

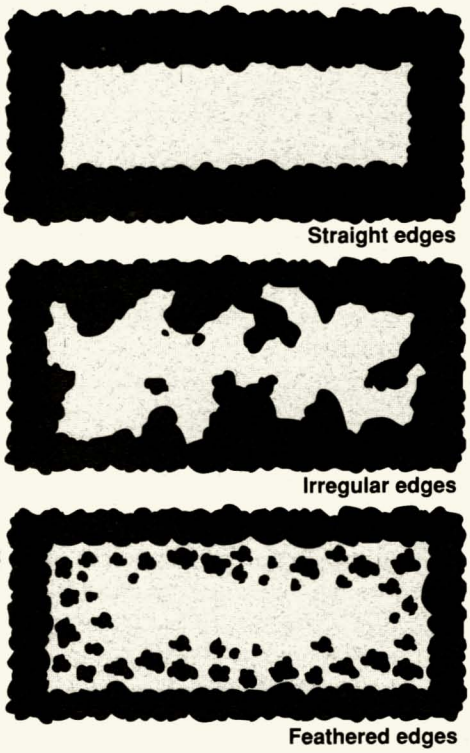


Figure 7. Irregular or feathered woodland edges are more appealing than straight edges around clearcuts.

- Minimize logging residue by using as much of the felled material as possible. Cut the remaining branches and unusable logs so they lie close to the ground and scatter large accumulations. Remove woody debris and other trash from landings.
- Screen clearcuts along roads and streams with uncut or partially cut buffer strips.
- Create irregular-shaped borders around clearcuts that harmonize with the topography and minimize the area of the clearcut that can be seen from one viewpoint. Feather forest edges by thinning into the adjacent stand (Figures 6 and 7).
- Leave scattered groups of trees in clearcuts.
- Clear sight lines to scenic attractions by removing trees or by pruning lower branches.

Pest Management

The two-lined chestnut borer, oak wilt, red humped oakworm, and shoestring root rot are major oak pests. Other pests may be locally important.

Two-lined chestnut borers are insects that feed beneath the bark and girdle oaks. They affect trees weakened by crowding, drought, or physical damage. To minimize borer damage, thin stands regularly to maintain vigorous trees and avoid damaging trees.

Oak wilt is a disease that plugs water-conducting vessels in oaks, killing the trees. Red oaks are most susceptible; white and bur oaks are not commonly affected. To minimize infections, do not thin or prune oaks from mid-April through mid-July. Harvest infected and adjacent healthy trees before the following spring. In residential areas and high-value timber stands, hire a trenching machine or vibratory plow to break root grafts that might spread the disease.

Red-humped oakworms defoliate oaks in mid- to late summer. They cause little growth loss, but weaken trees and make them more susceptible to shoestring root rot and two-lined chestnut borer. Maintain stand vigor to minimize damage. Spray high-value stands with an insecticide if repeated defoliations occur.

Shoestring root rot kills roots and leads to tree death. Maintain vigorous, well-stocked stands to minimize damage from this disease.

Recommended Reading

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