Chapter 4:

Regenerating Woodland Stands

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There are many reasons to harvest and regenerate a woodland stand:

- The trees are mature
- There is low potential for future value growth
- To improve wildlife habitat
- To salvage and renew the stand after a severe windstorm, insect outbreak, fire, or other natural disturbance.

Choosing the right harvest and regeneration method, however, requires an intimate knowledge of the ecological processes underlying woodland stand development, as well as site conditions, stand size, timber value, current and desired tree species on the stand, landowner objectives, and other factors.

Most natural stands are composed of many tree species at various stages of growth. Woodlands constantly change as trees grow and die, moisture conditions vary, natural disturbances occur, people plant and cut trees, and so forth. Variations in stand age and origin, soil type, aspect, disturbance history, and species make every stand unique.

The various harvest and regeneration methods are not a discrete set of choices, but a spectrum of alternatives. At one end of the spectrum is the removal of all woody vegetation, leading to dramatic changes in soil temperature, moisture, and light conditions. These post-harvest conditions favor fast-growing species that need full sunlight such as aspen, jack pine, and red pine. At the other end of the spectrum is removal of single trees at scattered locations throughout the stand. This kind of harvest creates small canopy gaps favoring regeneration of shade-tolerant species such as sugar maple, balsam fir, and hemlock (where it exists). Between the two ends of the spectrum lies an infinite variety of treatments that vary by the number of trees harvested and how they are distributed around the stand.

Woodlands can be regenerated by natural or artificial means.

Natural Regeneration

Trees reproduce naturally from seed, root suckers, stump sprouts, or layering (Figure 4-1).

Seed

All tree species can reproduce from seed, but only a very small percentage of seeds will become established seedlings. Success depends on:

- The supply of viable seed
- Effective seed dispersal
- Seedbed condition
- Weather
- Competition from other plants
- Damage from insects and diseases
- Predation by animals

The amount of seed available depends on tree species, age, health, and weather. Tree species with very large seeds (such as oak, walnut, and hickory) produce relatively few seeds, while species with small seeds (such as aspen and cottonwood) produce abundant seed. Very young and very old trees produce few viable seeds. Healthy trees with large crowns produce more seeds than trees that are unhealthy, have small crowns, or are suppressed by taller trees. Seeds from some tree species remain viable for only a few days after dispersal while seeds from other species may survive for several years on the tree or on the forest floor. The frequency of good seed crops depends on the tree species, overall tree health, and weather during pollination and seed growth. If your regeneration strategy relies on tree seeds to regenerate the new stand, time your harvest and regeneration treatments to coincide with a good seed year.

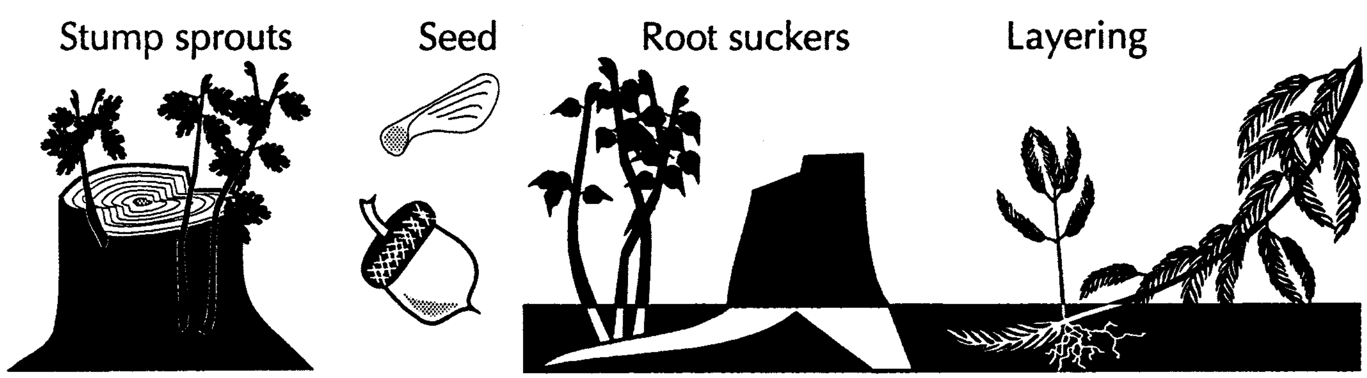

Figure 4-1. Natural regeneration methods.

Tree seeds are dispersed in a variety of ways. For example, aspen and cottonwood seeds are covered with cotton-like down and may be carried several miles by wind. Maple and pine seeds have wings allowing them to glide in the wind. Cherry seeds frequently are dispersed by birds that eat the cherries and drop the seeds far from parent trees. Walnuts, acorns, and pinecones are carried away and buried by squirrels. Seeds from willows and other shoreline species may be dispersed by water.

Each tree species requires certain seedbed conditions for seedling survival. For many species seed must be in contact with mineral soil so the seed can absorb enough moisture to germinate and grow. Seeds from other species may germinate on leaf litter, rotten logs, or moss, but if those materials dry out, the seedlings will die.

Soil temperature must be high enough so seeds will germinate, but not so high that the seedlings will be killed. Annual weather conditions and the amount of sunlight versus shade will affect soil temperature. Shade may be produced by living plants or harvest debris.

Competition from other vegetation may greatly affect seedling survival. Trees, shrubs, and herbaceous plants may rob delicate tree seedlings of needed sunlight and moisture.

Insects and animals consume large amounts of tree seeds and may eat most of the supply in poor seed years. Damping-off disease kills emerging seedlings too, but its effect varies greatly among tree species.

When you want to regenerate a stand by natural seeding, you'll need to know how the species you wish to encourage disperses seed, how far its seed travels, how abundantly it produces seed, and what type of seedbed it needs for germination and seedling survival. This information will affect how you harvest and prepare the site. Chapter 6: Managing Important Forest Types provides basic regeneration information for important tree species.

Root Suckers

Some hardwoods (such as aspen and black locust) can regenerate from root suckers, usually after the parent tree has been cut down. Root suckers grow from live roots, not from exposed stumps. Trees that grow from root suckers are genetically identical clones of the parent tree. A single parent tree may produce several hundred suckers, creating a dense new stand (Figure 4-2). The number of suckers may be reduced if there is too much shade on the forest floor from residual trees left after a harvest; the parent tree is particularly large, old, or in poor health; or timber harvesting damages the root system by cutting or soil compaction.

Figure 4-2. Stand of aspen suckers.

Stump Sprouts

Oak, basswood, birch, maple, and some other hardwoods sprout from stumps. Like root suckers, stump sprouts are genetically identical to the parent tree. The difference is that stump sprouts grow from exposed stumps, not roots. The most vigorous sprouts arise from relatively young stumps cut close to the ground in late fall or winter when there are food reserves stored in the roots. Stumps often send up numerous sprouts, but these usually thin naturally to two or three main stems. You can speed up this process and encourage the strongest stump sprouts by cutting excess sprouts when the sprouts are five to ten years old (12 to 20 feet tall).

Layering

Layering occurs when a buried branch on a living tree takes root and develops into a new tree. The lower limbs of black spruce, balsam fir, and northern white-cedar sometimes touch the ground and become covered with organic matter. Roots develop on those buried branches. Layering is not usually an important reproduction method in forests, but may provide additional northern white-cedar for deer browse.

Artificial Regeneration

Artificial regeneration refers to the planting of seeds, seedlings, or cuttings. Artificial regeneration usually is more expensive than natural regeneration, but permits better control over species selection, genetic characteristics, and tree spacing.

Direct Seeding

Direct seeding is the process of sowing or planting seeds. It often is used to establish jack pine and black spruce, as well as some hardwoods, including black walnut. Direct seeding of black spruce is preferred to planting seedlings on sites with poor access, such as spruce bogs. The appropriate site preparation, moisture, and temperature requirements vary by species and are similar to those necessary for natural seeding. Often the seed is chemically treated to protect it from diseases, rodents, and birds.

Seedlings

Planting seedlings, either bare-root or container-grown stock, is the most reliable way to regenerate a stand, especially for conifers. Bare-root seedlings are dug from the nursery bed and shaken to remove most of the dirt around their roots. They frequently are designated as 1-0, 2-0 or 2-1 stock, with the first number referring to how many years they were grown in the original nursery seedbed and the second to how many years they were grown after being transplanted to another nursery bed. Transplants generally have a more fibrous root system and larger stem diameter than seedlings that are not transplanted. Transplants are recommended for regenerating slow-growing conifer species such as spruce and fir, and for harsh planting sites where survival is likely to be a problem.

Seedling costs vary depending on tree age, grade, species, and quantity ordered. Transplants survive very well, but are expensive and, therefore, are not widely used. One- or two-year-old seedlings are less expensive than transplants and are recommended for most hardwood and conifer plantings. Tree seedlings sometimes are graded and sold by height class, stem diameter, or root condition.

Container-grown seedlings usually are grown in a greenhouse in 1- to 2-inch diameter containers. Some biodegradable containers may be planted in the ground with the seedling in them. Other seedlings must be removed from the container before they are planted. Container-grown stock can be very useful for dry planting sites or for late season planting.

Cuttings

Cuttings are exact genetic replicas of the parent tree. They commonly are used to regenerate poplars, but also can be used to regenerate willow and green ash. Cuttings are usually 8- to 12-inch lengths of tree stems about 1/4- to 3/4-inch in diameter (longer cuttings may be used on drier sites). They are cut during the late winter from the previous year's growth of vigorous seedlings or stump sprouts. Cuttings usually have no visible roots, but when buried vertically with just an inch of the stem protruding above ground, they will form roots. Rooted cuttings also may be available for purchase. Cuttings grow best where the soil remains moist throughout the growing season.

Tree Spacing

When designing a plantation, you need to determine an appropriate spacing between mature trees. Consider the typical crown width of a tree species when individual trees reach a useful size. For example, when growing trees for timber, you'll need to allocate enough space so the individual trees will be just beginning to crowd each other when they are large enough to support a commercial thinning. A forester can help you determine the correct spacing depending on the species and purpose for the plantation.

Table 4-1 shows the number of trees needed per acre for various spacings. To calculate the number of trees per acre for other spacings, multiply the planned spacing (in feet) within rows by the spacing (in feet) between rows and divide that number into 43,560 (the number of square feet in an acre). For example, a plantation with trees 8 feet apart within rows and 10 feet apart between rows would require 545 trees per acre:

$$\frac{43{,}560}{8\times10} = 545 \text{ TREES PER ACRE}$$

Table 4-1. Number of trees per acre at different spacings.

SPACING (IN FEET)	TREES PER ACRE
4 x 4	2,722
5 x 5	1,742
6 x 6	1,210
7 x 7	890
8 x 8	680
9 x 9	538
10 x 10	436
11 x 11	368
12 x 12	303

Site Preparation

Site preparation often is necessary to create a good environment for natural or artificial regeneration. Its purpose may be to expose mineral soil for natural or artificial seeding or to reduce competition from undesirable vegetation or both. Site preparation may best be done before a stand is harvested (especially for hardwoods) if it is likely that large amounts of woody debris will remain after the harvest. Such debris would make it hard for site preparation equipment to reach the area. If woody debris will be piled or windrowed, it may be best to do site preparation work after the harvest. Ask a forester which treatments fit your conditions. Mechanical scarification may be needed to expose the mineral soil and mix it with duff. This can be accomplished by whole tree harvesting (where the whole tree, branches and all, is skidded to the landing rather than just the main stem) and dragging harvested trees over a different route with each load or by dragging a tree top around the stand after harvest. Machines also are available for disking, scalping, rock raking, and trenching.

Burning may be prescribed to remove logging debris or a heavy layer of organic material (such as moss and leaves) or to suppress existing woody vegetation. Prescribed burning requires a burning permit and must be done by a competent and well-equipped fire crew. Fire will kill young conifers, but many hardwood trees and shrubs, particularly oak, will resprout after a fire. Burning may give seedlings a fair chance to compete with resprouting vegetation. Burning is occasionally done before a harvest, but more often is done afterward.

Herbicides are available to kill most any herbaceous or woody vegetation. However, they may not discriminate between your crop trees and weed trees. Foliar applications (spraying herbicide on the leaves) are commonly used for site preparation. Depending on the herbicide, target species, and stand density, herbicides may be applied as a spray (large droplet size) or mist (small droplet size). Backpack sprayers are appropriate for small areas while large areas will require tractor-drawn sprayers. Herbicides are sometimes applied before harvest (especially in hardwoods) to kill vegetation that will compete with natural or artificial seeding. Herbicide usually is applied to young conifer stands after harvest to reduce competition from hardwoods. It may make sense to delay such an application until one or more years after harvest. In addition to depleting root energy reserves, the delay gives woody vegetation a chance to sprout after logging, thereby exposing more leaf surface to contact with the herbicide.

To avoid killing desirable young hardwood trees, cut them off close to the ground before applying herbicide. They will resprout the next year. To avoid killing desirable herbaceous plants, apply herbicide late in summer or early fall after they have produced seed and their tops have naturally died back.

Planting

The best time to plant trees is in spring, soon after frost leaves the ground. At this time the soil is moist, the climate is somewhat mild, and normally there is ample rainfall. If you must plant in late spring or early summer, use container-grown seedlings, because they tend to experience less transplant shock than direct-sowed seedlings. Fall planting usually is less successful because root growth is slowing, frost heaving may occur over the winter (especially in clay or wet soils), and growth regulators in the tree may become imbalanced, leading to top dieback.

Take good care of seedlings before planting! Ask the nursery to ship them using the swiftest transportation method available. If you transport the seedlings yourself, protect them from wind and sun during transit. Inspect the seedlings upon arrival. They should be dormant (that is, the buds and roots should not have begun to break, and should have no mold, be moist and flexible, and show no significant browning (especially on conifer needles). If you cannot plant the seedlings immediately, store them in their original container at a temperature of 35° F to 45° F.

If you need to postpone planting bareroot seedlings for more than three to five days, remove them from the container and heel them into a trench (Figure 4-3). Store seedlings in this manner only so long as they remain dormant. Once they begin to grow, take extreme care to prevent their roots from drying out when you dig them up, transport them to the planting site, and replant them.

While planting, keep the seedling roots moist, but do not immerse them in water for more than 30 minutes, as this can lead to root damage and loss of beneficial microorganisms. Exposing tree roots to hot sunlight and drying winds for three to five minutes may be fatal.

Plant trees by hand or machine following these rules:

1. Plant only when soil moisture is adequate to ensure survival.
2. Make a planting hole large enough to easily accommodate the seedling root system.
3. Place roots in the planting hole without twisting, curling, or bending them. If necessary use a hatchet or heavy knife to trim any long roots on small bundles of trees.
4. Plant the tree in a vertical, upright position to lessen the chance of it growing a crooked stem.
5. Plant the tree at the same depth that it grew in the nursery. Look for the root collar where the root meets the upper stem (Figure 4-4).
6. Firm the soil around the roots to eliminate air pockets.
7. Water seedlings thoroughly after planting.

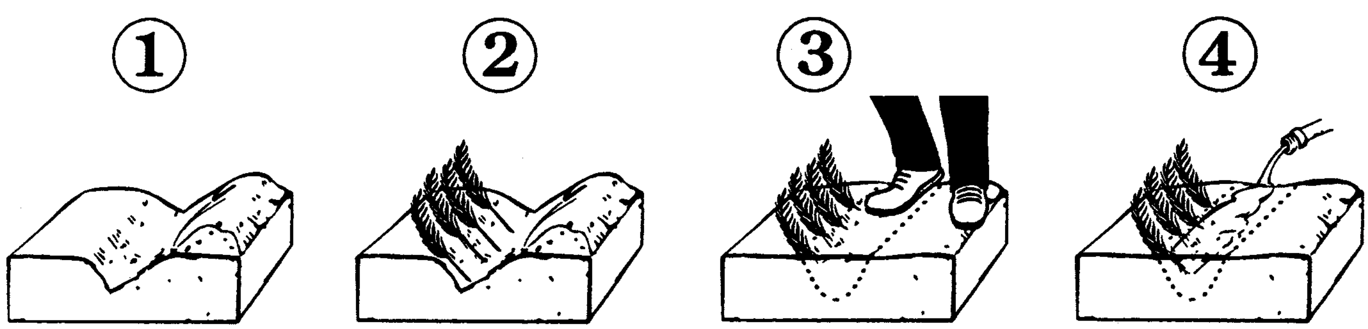

Figure 4-3. Heel-in bareroot seedlings for temporary storage. (1) In a cool, shady location, dig a V-shaped trench that is deep enough so the earth will cover the entire root system and part of the lower stem. (2) Remove the seedlings from their container and spread them along the sloping side of the trench in two or three layers. (3) Pack soil around the roots. (4) Water as necessary to keep roots moist.

Figure 4-4. Plant seedlings only as deep as the root collar.

There are two general methods of hand planting trees. One of these is the hole method. Dig a hole with a shovel, mattock, grub hoe, or mechanized auger. Make it large enough to accommodate the tree roots without bending them. Place the tree in the hole, distribute the roots evenly, and pack soil firmly around the roots. This method usually results in a high rate of seedling survival, but it is slow and not practical for planting large numbers of trees.

Using a planting bar or other tool is a faster method of hand planting a large number of trees. Insert a spade, planting bar (dibble), hoedad or similar tool into the soil and move it back and forth to form a V-shaped slit. Remove the tool and insert the tree seedling deep enough into the slit that it will be buried to the root collar. Remove the planting bar and reinsert it about three inches behind the seedling. Pull the bar away from the seedling to firm soil around the roots, then push it toward the seedling to seal the top of the planting hole. For a still better seal, create a third slit a couple of inches away and seal its top by pressing down firmly with your boot. Using this method, you can plant 1,000 to 3,000 seedlings a day, depending on your experience and the condition of the planting site.

Using a tree-planting machine pulled behind a tractor (Figure 4-6) is faster than either hand planting method if the terrain is relatively level and clear of stumps, woody debris, and large rocks. The planter has a box to hold seedlings, a seat for the person planting, a coulter to break through the soil surface, a V-shaped blade to open a trench into which the operator places a seedling, and packing wheels that firm the soil around the seedling. Some machines have spray attachments to apply herbicides for vegetation control. A person sometimes follows the machine on foot to straighten seedlings or replant any that were planted too shallow. A three-person crew using one of these machines can plant about 10,000 trees in an eight-hour day.

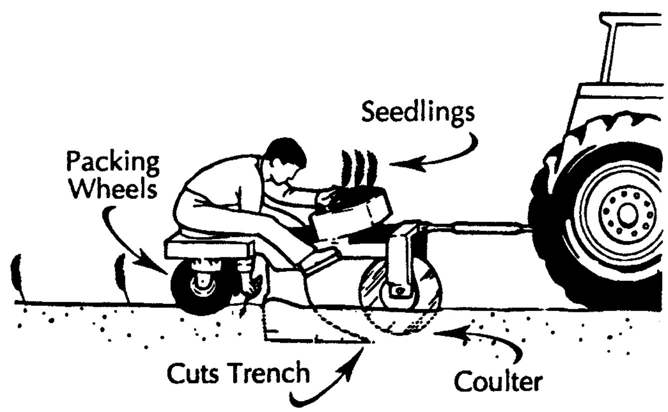

Figure 4-6. Tree-planting machine.

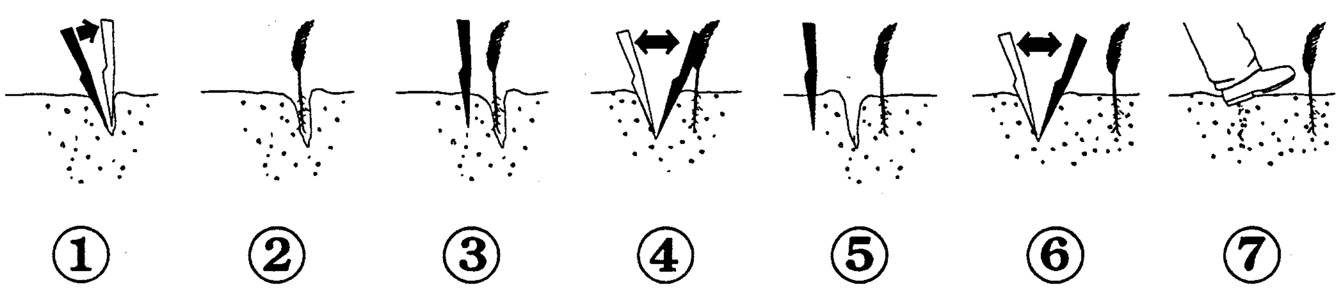

Figure 4-5. Planting a seedling with a bar.

Harvest and Regeneration Systems

A harvest and regeneration method (also called a silvicultural system) is a combination of timber harvesting and site preparation practices that prepare a site for natural or artificial regeneration. There are many different methods along a continuous spectrum to fit different site conditions, stand sizes, timber values, current and desired future tree species, landowner objectives, and other factors. Depending on the method you choose, the reproducing stand will be even-aged or uneven-aged.

Although the focus is often on the harvest, equally important are the conditions established by the harvest. These conditions, along with follow-up care and tending of the new stand, will determine the future development of the woodland. For this reason, foresters prefer the term "regeneration methods" (or systems) over "harvesting methods." A regeneration method focuses on the future stand. A harvest method focuses only on the arrangement and means by which mature trees are removed.

Even-aged Regeneration Systems

Even-aged harvest and regeneration systems require complete removal of the overstory resulting in a new stand where nearly all the trees are the same age. Even-aged systems usually are economical to implement because the landowner can remove a large volume of wood at one time for sale and they offer many options for site preparation. Even-aged systems are appropriate to:

- Create an even-aged stand.
- Regenerate tree species that need full sunlight and that can survive with high soil temperature and intense light.
- Regenerate shallow-rooted species in exposed locations where scattered trees left standing after a harvest would be uprooted or broken by wind.
- Regenerate species that naturally reproduce from seeds scattered by wind from adjacent stands, root suckers, stump sprouts, or seeds released from cones after fire.
- Salvage merchantable material when whole stands are over-mature or severely damaged by insects, disease, wind, or fire.
- Clear the site for conversion to another species by planting or seeding.
- Provide habitat for wildlife species that thrive in a high-density, even-aged stand.

These systems offer some, but not all, of the growing conditions that naturally occur following a major fire or windstorm.

Clearcutting

Clearcutting involves harvesting all the trees in a stand regardless of their species or marketability (Figure 4-7). Clearcutting simulates regeneration conditions after a catastrophic windstorm, fire, or other disturbance. This method creates conditions optimal for regeneration of light-demanding species adapted to growth in full sunlight.

Traditionally, unmerchantable trees in a stand that was being clearcut would be felled or killed standing. Only desirable seedlings and saplings (advance regeneration) would be left to grow. Today, however, retaining scattered trees or patches inside clearcuts is becoming more common. Residual trees and patches provide vertical habitat for some wildlife species, particularly raptors, which use the residual trees as perch sites. Residual trees also provide some age, size, and perhaps species diversity and may improve the visual quality of a clearcut. On the other hand, residual trees may be subject to wind damage and can interfere with the

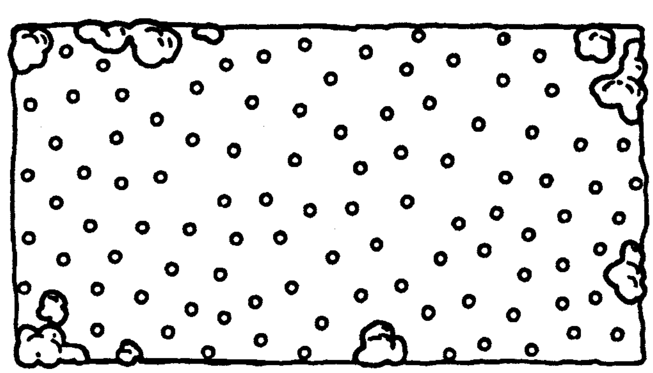

Figure 4-7. Clearcutting system.

regeneration of desirable species that do not tolerate shade. For these reasons, residual trees often are left in patches rather than distributed uniformly throughout the clearcut. Clearcuts typically are larger than two acres, but vary greatly in size and shape.

As in all regeneration systems, sources of regeneration must be determined before harvesting, but they may include seedlings already present before the harvest (advance regeneration), natural seed on the forest floor or on tree branches at the time of harvest, natural seed produced by adjacent stands, direct seeding, replanting, or stump sprouts and root suckers sprouting after harvest.

Clearcutting is not appropriate where the removal of a mature overstory would allow the water table to rise and inhibit the regeneration of a new stand.

Seed Tree

This system leaves mature trees of desirable species scattered throughout a harvested stand at intervals close enough to furnish seed to the entire cut area (Figure 4-8). Residual stocking (unharvested trees left standing) is not sufficient to protect, modify, or shelter the site in any significant way. Once the new stand is established (typically three to ten years after the initial harvest), seed trees may be harvested or left to grow through the next generation. This system is appropriate only for tree species that produce wind-dispersed seed. To obtain maximum seed production, seed trees must be healthy, large-crowned, and wind-firm. Seed trees usually are left singly, but may be left in small groups for wind protection. The number of seed trees required depends on the species' ability to produce seed and the distance that seed can be dispersed reliably by wind. In most cases three to ten seed trees per acre are left.

The initial tree harvest should occur after seeds have been dispersed in a year when there is a good seed crop. Site preparation usually is necessary before the harvest to create a receptive seed bed.

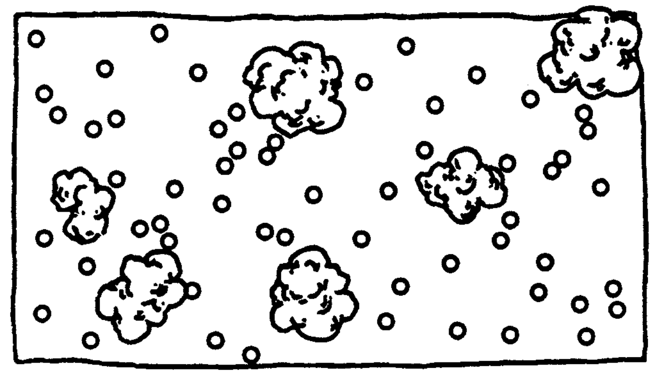

Figure 4-8. Seed-tree system.

The seed-tree system has several disadvantages:

- Diseases carried by the seed trees could be quickly transferred to new seedlings.
- Seed trees may be killed by wind, fire, or insects before they produce seed.
- The wood product value of the seed trees will be lost if it is not economical to harvest them after regeneration occurs.
- New seedlings may be damaged by equipment used to harvest the seed trees.
- A good seed crop may not occur for several years, allowing undesirable shrubs and trees to invade the stand.
- There is little control over the spacing or number of seedlings throughout the stand.

Shelterwood

This system involves making two or three cuts in a stand to stimulate advance regeneration before a final clearcut. In a three-cut system, the first is a heavy thinning that removes undesirable species and poorly formed or diseased trees while leaving the best trees with plenty of growing space to expand their crowns, grow vigorously, and produce seed. This cut can be eliminated if intermediate thinnings have achieved the same results. The second cut is a thinning made when there is a good seed crop. It usually leaves 50 to 70 percent crown cover, but allows enough sunlight to reach the forest floor that seeds from shade-tolerant species can germinate and survive.

Site preparation (prescribed fire, mechanical, or herbicide) usually occurs just before or after this harvest to expose mineral soil for the seedbed and set back undesirable shrubs and trees. The final cut is made three to ten years after the previous cut, when advance regeneration is well established. It clears remaining mature trees, releasing the young stand to grow in full sunlight. It also may result in stump sprouting or root suckering to supplement the established seedlings. There are several variations in the pattern of trees cut (Figure 4-9.)

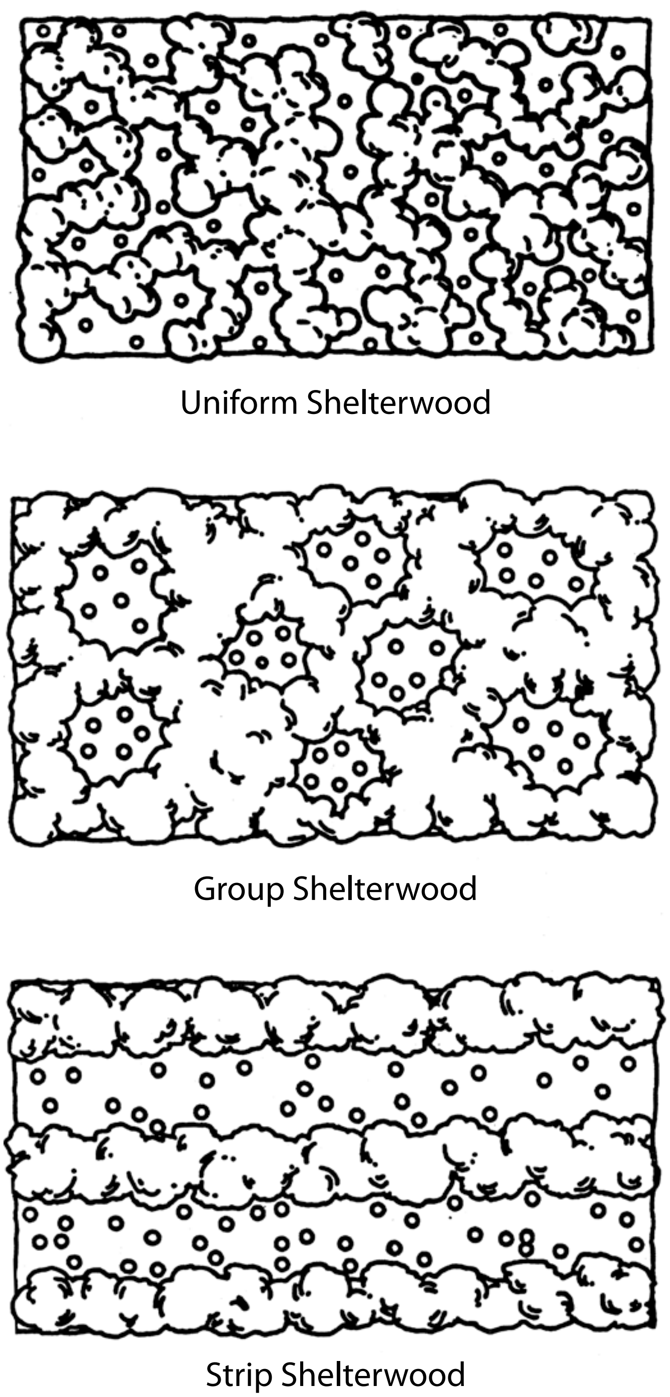

Figure 4-9. Shelterwood system.

The shelterwood system is used to develop advance regeneration before a final harvest. It is most appropriate for species that are intermediate to tolerant of shade, where residual trees are not subject to wind damage or epicormic branching, where logging damage to residual trees can be minimized, and where the increased cost of several partial cuts is acceptable. If naturally developing advance regeneration is not adequate, supplemental planting can be used.

Uneven-aged Systems

Uneven-aged systems promote a variety of species, ages, and sizes within a stand. In this system, light cuts at 5- to 25-year intervals encourage regular growth and prevent severe disturbances to the stand. Each cut may include thinning, harvesting, and understory treatments that create small canopy gaps where shade-tolerant tree species can regenerate. Some sapling and pole-sized trees may need to be cut to release the best stems from competition and encourage fast growth in the reduced understory light.

The goal is to achieve an optimum distribution of size and age classes so that that each class contains enough quality trees to replace those harvested in the next larger size class. Uneven-aged systems typically produce high quality wood because there are frequent opportunities to remove poor trees, allowing the best trees to grow longer. The visual quality of such stands may be superior to even-aged systems.

Two disadvantages of uneven-aged systems are that relatively small volumes of wood are harvested during each cut and repeated entries to the stand with heavy equipment can damage residual trees and hinder regeneration.

In an uneven-aged system, trees of all sizes are removed in each cut according to these general guidelines:

- Trees at high risk from insects, disease or other hazards
- Trees that directly compete with crop trees
- Cull trees
- Low vigor trees
- Unwanted species (to remove seed sources)
- Improve spacing (including thin dense sapling patches and stump sprouts)
- Mature trees

Tree diameter often is used as a measure of tree maturity. Consider these factors when determining an optimum maximum diameter for harvesting trees in an uneven-aged system:

- Higher quality sites normally allow trees to be grown to a larger diameter before growth rates decline significantly and decay becomes a major factor in tree value.
- Uneven-aged stands normally contain a variety of tree species, each with a different growth rate and life span that affect the optimum maximum diameter for the species.
- Each type and quality of wood product desired (such as pulpwood, sawtimber, and veneer) requires trees within a range of diameters.
- As a high-quality tree gets larger, it becomes more economically valuable due to its larger volume and higher grade. Grade is a measure of tree quality that determines the types of products (including veneer, high quality lumber, and low quality lumber) for which its wood is suitable. Attaining veneer size and grade can greatly increase a tree's value. Deciding whether to cut a large, valuable tree or let it grow longer must be weighed against the uncertainty of it still being alive and healthy for the next harvest.
- Your goals as the landowner affect the maximum diameter classes to keep. You may choose to extend a tree's life to enhance non-timber resources (such as aesthetics, wildlife food and shelter, and old growth character istics). Extending a tree's life may increase the volume of valuable sawtimber and veneer, but there is also an increased risk for reduced growth rates and damage.

You will need to consider additional criteria to enhance wildlife habitat, water quality, and aesthetic values.

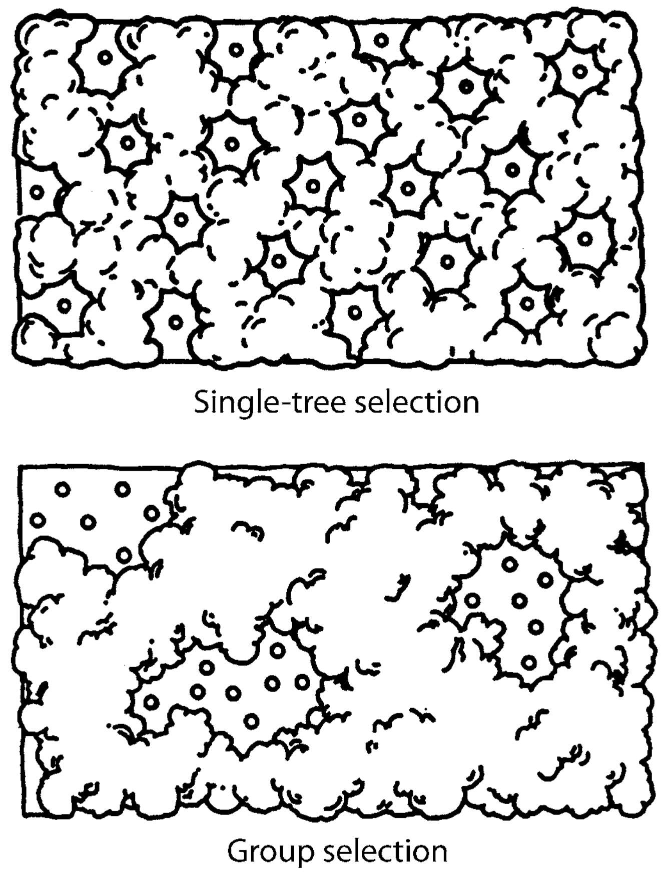

Figure 4-10. Selection system.

Single-Tree Selection

In this system, individual trees of various sizes and ages are periodically removed to provide space for seedling development and to promote the growth of the remaining trees. Although both shade tolerant and intolerant species may regenerate in the newly created gaps (see shade tolerance table, Table 3-1, Chapter 3, p. 28), over time intolerants will die out and tolerants will survive. One major disadvantage of this system is that residual trees of all sizes can be damaged by logging equipment, especially while dragging logs from scattered sites out of the stand.

Group Selection

Under this method, trees are removed in small groups ranging from 1/50th acre ((34-foot diameter circle) up to 1/2 acre (167-foot diameter circle). Smaller openings favor the regeneration of very shade-tolerant species, while larger openings may allow regeneration of species rated intermediate to tolerant of shade. Less logging damage may occur on residual trees than in the single-tree selection system, but such damage is still a concern.

Influence of Climate Change

You may wonder whether your woodland management plans should be altered in anticipation of the changing climate. The world's leading scientists and institutions agree that our climate is changing, but the impacts on forests in any given region are still uncertain. For instance, the scientific community is unable to say whether the Lakes States region is likely to get warmer and wetter or warmer and drier. Likewise, it is uncertain how temperatures are likely to fluctuate within a year. Will both seasonal highs and lows increase or will the pattern of temperature fluctuation vary? Whatever the exact nature of regional climate change, it is likely to stress trees and cause some mortality in existing mature stands. Because each species will respond differently to changing conditions, maintaining a wide diversity of species and age-classes in your woodland and across the surrounding landscape is a prudent management approach.

Additional Resources

USDA Forest Service, *Woody Plant Seed Manual,* Agricultural Handbook 727, www.nsl.fs.fed.us/nsl_wpsm.html

Activity

Trees of the Past, Present, and Future

Good regeneration treatments simulate natural disturbances and work with the direction of natural forest growth and development on a site. As a first step in developing a vision and plan for your woods, look for trees of the past, present, and future. For each category, note the species, and see what you can learn about how the stand is naturally changing.

- Trees of the past are represented by stumps, snags or big, old, dead, and dying trees. Some trees of the past may be widely spaced wolf trees, with huge spreading crowns. Others may be smaller than average trees in dense stands that were crowded out by faster growing trees.
- Trees of the present form the main canopy and currently dominate the stand.
- Trees of the future are seedlings, saplings, and midstory trees that are ready to become dominant when canopy trees are harvested or die from natural causes.