FOREST SCIENCE FACT SHEET

# REGENERATING HARDWOOD FORESTS

## MANAGING COMPETING PLANTS, DEER, AND LIGHT

Bigstock

Forest regeneration, or regrowth, requires sufficient numbers of desirable tree seedlings to replace today's forest following harvest. Under many circumstances, regeneration is not easy. Competing plants, deer, and insufficient light on the forest floor interfere with regeneration and, in the long run, may threaten forest sustainability.

In this fact sheet we look at how an understanding of competing plants, deer, and light can lead to successful forest regeneration and the sustainability of hardwood forests. It is our hope that, after reading this fact sheet, you will view your forest management role in a new way. We hope you will use these key concepts to ensure a future for your forest.

## How Do We Benefit from a Healthy Forest?

We all benefit from a healthy, productive, viable forest. To name a few of the benefits, forests:

- Clean our air by using carbon dioxide and providing oxygen
- Protect and filter our water supplies
- Provide a home for countless plants and animals
- Make up a vital part of the economy
- Provide a major source of employment
- Supply the key ingredients for more than 5,000 products

**SUSTAINABLE FORESTRY** is defined as managing our forest resources to meet the needs of the present without compromising the ability of future generations to meet their own needs.

## Forests Are a Precious Natural Resource

We depend on forests for the quality of life we enjoy. We use them to sustain life as we know it. Wisdom tells us that future generations, your children and theirs, will also use forests for these same benefits. The science of forestry was developed to "sustain" our forests.

Currently, with a maturing forest and increased harvest levels, "sustainable forestry" is an increasingly important concept. While many claim to practice forestry, only about half do so in a sustainable manner. The problem lies not in forest science but in its rampant misuse in name and practice.

Howard Nuernberger

As forests mature and people begin to conduct harvests, potential regeneration problems need to be identified. This mature forest clearly lacks regeneration.

## How Are We Doing?

A comprehensive study in 1995 examined 85 randomly selected timber harvest sites in Pennsylvania. The study sought to determine whether or not our current harvesting practices are affecting timber sustainability. *It found that 47 percent of the harvests were unsustainable.*

What was wrong with these timber harvests? The concerns most often identified were:

- Failure to retain quality trees of desirable species
- Failure to establish adequate regeneration
- Failure to remove sufficient overstory to foster existing regeneration development
- Failure to control competing plants

Three of these concerns deal with problems *regenerating* (or regrowing) our forests; harvests are occurring without adequate plans for tree replacement. Sustainable forestry depends on regenerating healthy, young forests for future generations.

Recent U.S. Forest Service data from Pennsylvania's statewide forest inventory (2019) document regeneration problems. In forest stands where light conditions are adequate for regeneration development, just over 50 percent have adequate seedlings and saplings to regenerate the forest. This finding includes all tree species capable of growing into the forest canopy. When only commercially desirable species are considered, less than 40 percent of these forest stands have adequate regeneration to replace the existing forest.

Many times, forest owners believe that by harvesting forests "selectively" they are addressing regeneration issues. This is not the case. The remaining trees often cast too much shade, are of too low a quality, or are a less desirable species to warrant having been left for future harvests. Regenerating a forest is a process, not an event. That is, harvesting does not always lead to successful regeneration—it takes planning, care, and investment to ensure an adequately stocked forest for the future.

## What Can You Do?

The challenge for each landowner is to use our forest resources without jeopardizing resource health or future. Landowners, loggers, and foresters all play key roles in achieving a successful timber harvest outcome. Each has equal responsibility for creating healthy forests in the future.

For decades it has been obvious that there have been difficulties in achieving successful regeneration of fully stocked stands across Pennsylvania.

**—DR. JAMES FINLEY, PENN STATE**

David Jackson

This area has severe interfering fern cover. Desirable regeneration is not likely to develop until the ferns are controlled.

## Combating the Regeneration Issue

Most hardwood regeneration occurs naturally—that is, without planting trees—but many factors can affect forest regeneration. To regenerate naturally, the current forest must produce seedlings, stump sprouts, and root suckers that will become the next forest following a harvest or natural disturbance. The right conditions are necessary for forests to regenerate naturally. Unfortunately, the "right conditions" often are not met.

In this section we will look at three factors affecting forest regeneration and introduce practices to help make timber harvests sustainable. The three factors are *competing vegetation, deer impact, and light on the forest floor.* We abbreviate this "C-D-L." Following the practices outlined by this simple acronym will encourage healthy, new forests after timber harvests.

### Competing Vegetation

Competing vegetation consists of plants that interfere with the germination and growth of desirable seedlings by casting dense shade across the forest floor. Some competing plants also provide cover for small mammals that feed on tree seeds and seedlings.

Several factors favor the development of competing vegetation. Many interfering plants tolerate shady understory conditions and are not typically browsed by deer. Some, such as Japanese barberry, are also *invasive*, meaning they spread rapidly and suppress native plant communities. Competing plants are similar to weeds in your garden—they interfere with the establishment and growth of your future crop. Undesirable trees and plants can take over a forest just as weeds can take over a garden.

David Jackson

Hand application of herbicides is appropriate for small areas or when treating individual invasive or competing plants.

Howard Nuernberger

When competing plants cover extensive areas, herbicide treatments using track-mounted mist blowers are effective. Make applications prior to harvesting timber.

The most common competing plants found in Pennsylvania include hayscented and New York ferns, some grasses, striped maple, American beech, mountain laurel, ironwood, and spicebush. Many other plants can also interfere with seedling growth and development. Only so much space, water, nutrient material, and sunlight are available for plant growth. Whether you are growing corn, grass, or trees, you must make choices about resource use.

Competing vegetation can inhibit diverse and valuable forest regeneration as well as the establishment of desirable nonwoody plants, such as native wildflowers, forbs, and herbs. If competing plants are present and left untreated in an area you propose to harvest, they may become your next crop. Timber harvesting will increase light on the forest floor

> The predominant challenge for sustainable forestry in Pennsylvania is prompt reforestation with desireable species.
>
> **—DR. SUSAN STOUT, USDA FOREST SERVICE**

and magnify problems caused by competing plants. It is not uncommon in Pennsylvania to see forest understories covered with competing plants.

Often, successful forest regeneration depends on controlling competing vegetation. Extensive research and testing have provided low-risk and effective herbicide recommendations or "prescriptions" for controlling most competing vegetation. Public and private forestry organizations across the state have experience with herbicide use for this purpose. Consult them for detailed prescriptions addressing your specific competing vegetation problem. For additional resources, visit the Penn State Extension Forest Vegetation Management website at **https://extension.psu.edu/forests-and-wildlife/forest-management/invasive-and-competing-plants**.

If you are reluctant to use herbicides, mechanical control of competing vegetation works in some cases. Typically, mechanical methods such as cutting or pulling are not as effective as herbicides and are ineffective at controlling nonwoody plants like fern and grass. Mechanical removal generally involves having the harvesting operator break off or cut competing seedlings and saplings. With this method, the competing plants will likely resprout; however, they may no longer have a height advantage over desirable seedlings.

To sustain our forests, competing vegetation problems need to be recognized and treated before harvesting timber. Dealing with competing vegetation before harvest is important because after harvest:

- Logging slash can impede access
- Increased light will cause competing plants to flourish
- Desirable species may be more easily harmed by herbicide treatments
- Costs for controlling competing plants are typically higher

## Deer Impact

Through preferential browsing, deer have the ability to broadly affect forest plant communities. Specifically, they can reduce tree seedling numbers, seed availability, species composition, and seedling height growth. They can also affect herbaceous plant composition as they feed on some species and ignore others.

In many areas, deer have reduced seedling numbers, shifted tree species composition to less desirable species, and slowed the growth of surviving seedlings. Research has shown that when the deer population density exceeds what the land

Attempting to raise more deer than the land can support has been the greatest mistake in the history of wildlife management in Pennsylvania.

**—DR. GARY ALT, PENNSYLVANIA GAME COMMISSION**

Gary Alt

Forest regeneration inside versus outside a fence. Research demonstrates that, when deer impact is high, forest regeneration is inhibited.

David Jackson

Note the "browse line," where deer have eaten the preferred palatable vegetation from ground level to a height of 5 feet. Browse lines are an indication of high deer impact.

can support forest regeneration suffers. In regions of the state where decades of overbrowsing have severely depleted the habitat, even relatively few deer can have significant effects.

In many parts of Pennsylvania, deer numbers have adversely affected habitat. In fact, many state residents have never seen a healthy forest understory unaffected by deer. Habitat repeatedly damaged by overbrowsing continues to decline, losing its ability to support additional deer. In many areas, poor habitat conditions limit deer numbers more than hunting does. The only way to increase the number of deer land can support is to temporarily reduce deer numbers still further and allow the habitat to recover. When the habitat improves, deer managers can gradually allow deer numbers to increase until a balance is reached between desired habitat conditions and deer populations.

Deer have taste preferences; some plants are highly preferred while others are hardly touched. By selectively browsing preferred species, deer have the ability to completely change the species found in forest understories. Selective browsing can greatly reduce or eliminate preferred species or those not resilient to browsing and favors less preferred, more resilient species. Deer food preferences vary by region and season, but in general, deer prefer oak, maple, ash, and yellow poplar over species such as beech, birch, and cherry. Deer, on average, consume 4 to 8 pounds of browse per day for seven months of the year. Clearly, the state's deer herd has a tremendous potential to influence what grows (or doesn't grow) in the forest.

Landowners can use several indicators to assess whether deer impact in their forest is high or low. Indicators of high deer impact include severely browsed or hedged seedlings, obvious browse lines, and forest floors dominated by species that deer do not prefer or species that are resilient to browsing. Deer do not readily eat ferns, striped maple, beech, ironwood, mountain laurel, blueberry, or spicebush.

There is strong evidence that the expansion of understory fern in forests across Pennsylvania results from deer overbrowsing, which removes plants that would normally compete with ferns. Forests with a dense fern carpet are the result of high deer impact over many years. Research has shown that fern density increases as deer impact increases. Unfortunately, after fern cover dominates the understory, the forest's ability to support deer declines. A severely damaged forest may appear to have no deer at all. Likely, a few deer will continue to suppress desirable tree species. The cycle of browsing and poor habitat is difficult to break.

Estimates of deer impact on regeneration success suggests deer browsing is directly responsible for more than 85 percent of the regeneration failures.

**—DR. DAVID MARQUIS, USDA FOREST SERVICE**

If you recognize that deer impact on your forest is high, you should take steps to reduce populations even if a timber harvest is not planned for the immediate future. Consider harvesting additional antlerless deer. The Pennsylvania Game Commission's Deer Management Assistance Program (DMAP) helps landowners meet their forest management goals. DMAP allows hunters to harvest additional antlerless deer from a property during the regular hunting seasons.

Although hunting is by far the most practical means of reducing deer impact, other tools include fencing, seedling protectors, and deer repellents. Areas with low deer impact will support healthy, diverse understories, preparing the forest for future replacement following planned timber harvests or natural disturbances.

## Light on the Forest Floor

The amount of sunlight reaching the forest floor plays a key role in determining which tree seedling species will germinate and grow. Tree species have different requirements for sunlight, a factor referred to as *shade tolerance*. Shade tolerance describes the light level at which a species is best able to germinate and grow. Foresters generally separate trees into three shade-tolerance classes: intolerant, intermediate, and tolerant.

Examining the shade-tolerance classes of three valuable timber species, we find they fall into different shade-tolerance classes: black cherry, intolerant; northern red oak, intermediate; and sugar maple, tolerant (see Table 1). Understanding the shade-tolerance characteristics of desirable species forms the basis for developing harvest prescriptions.

For example, if a forest is managed for shade intolerants and intermediates such as yellow poplar, white ash, black cherry, and oak, you have to increase the amount of light across the forest floor to stimulate seed germination and seedling growth. Harvesting activities *must* consider shade tolerances of the species for which you are managing.

**Table 1. Shade tolerance for common Pennsylvania trees.**

| Species | Shade Tolerance |
|---|---|
| Black cherry | Intolerant |
| White ash | Intolerant |
| Hickory | Intolerant |
| Yellow poplar | Intolerant |
| Northern red oak | Intermediate |
| White oak | Intermediate |
| Basswood | Tolerant |
| Red maple | Tolerant |
| Sugar maple | Very tolerant |
| American beech | Very tolerant |

If you control competing vegetation, reduce deer impacts, and take into consideration the light requirements of the species you are trying to regenerate, you will be successful in establishing and sustaining new forests.

**—MR. DAVID JACKSON, PENN STATE EXTENSION**

Foresters have developed harvesting systems that create openings to mimic natural disturbances. These systems regenerate diverse, healthy forests. Harvesting systems used in Pennsylvania to create light conditions for shade-intolerant and intermediate species include group selection, shelterwood, and clearcutting.

*Group selection* cuts create small openings across a forest with the intent of establishing regeneration in each opening. This method harvests all trees larger than 2 inches in diameter in groups ranging in size from 1 to 4 acres scattered across a property. Openings less than one acre will not provide adequate sunlight for shade-intolerant tree species. By scheduling group selection harvests at 10- to 20-year intervals, landowners can produce periodic income and encourage habitat diversity. This harvesting system is desirable for aesthetic reasons since it retains areas of large, mature trees and the openings created are relatively small. The harvested groups are large enough to encourage the regeneration of shade-intolerant tree species in the center and more shade-tolerant tree species along the edges.

*Shelterwood* cuts occur in two stages. The first stage leaves a prescribed number of desirable trees per acre to drop seed and provide conditions (partial shade, cooler temperatures, and higher moisture) conducive for seedling development. The residual trees provide an environment best suited for intolerant and intermediate tree seedling growth and development. Once regeneration is well established, the remaining overstory trees are harvested and the new forest grows in full sunlight. The timing of the final harvest is critical. The regeneration should be tall enough (greater than 5 feet) to be above the deer's reach but not so large (greater than 10 feet) as to be significantly damaged during final harvest when remaining overstory trees are removed.

*Clearcutting* should be practiced only where adequate forest regeneration is already present on the forest floor. This is called advance regeneration. The next forest is already in place and simply needs more light. In areas with high deer impact, adequate advance regeneration is difficult to achieve. It is often necessary to have at least one desirable seedling per square foot, 40,000 desirable seedlings per acre or more.

## What Are the Costs?

Managing C-D-L certainly involves investments of thought, money, and time. It is necessary to *address all three components* when planning a sustainable harvest. In most cases, failing to make the necessary investment for managing the interactions of competing vegetation, deer, and light will lead to inadequate desirable regeneration after a timber harvest. Regeneration failures devastate our forests and threaten many of the benefits we depend on every day.

When we discuss the costs of C-D-L and other efforts that help sustain our forests, we have to consider the costs of not using sustainable methods. Treating competing vegetation, managing deer impacts, and meticulously controlling light can be costly, but how does that compare to the degradation or loss of our forests' vitality?

## Putting It into Practice

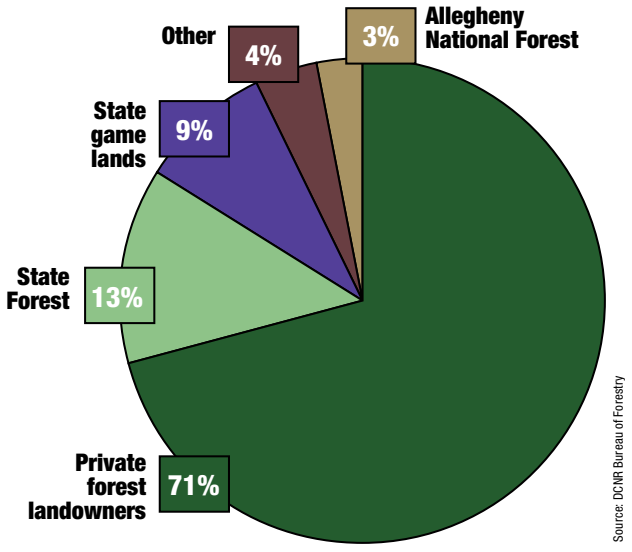
C-D-L practices are central to managing our public forests. Deer exclosures are common in state and national forests as well as state game lands. Herbicide treatments, clearcuts, shelterwoods, and other forest management practices that address C-D-L are also common. Unfortunately, the sustainable forest management practices used by public agencies are not occurring in many private forests. This is cause for concern.

Pennsylvania has vast forest resources—nearly 17 million acres. The amount of public forestland is actually small compared to the amount of forestland owned by private citizens (see Figure 1). Every day, private forest landowners make decisions that affect future forest values. Critical among these decisions is the need to ensure we are regenerating hardwood forests. The 1995 Pennsylvania study revealing that 47 percent of harvests are not sustainable is a benchmark for the future. If forest owners manage forest resources to meet today's needs without compromising the needs of future generations, all harvest sites will be sustainable. In this way, we will:

- Retain quality trees of desirable species
- Establish adequate regeneration
- Remove sufficient overstory to foster existing regeneration development

Because of our dependence on forest products for the quality of life we enjoy, we will continue to use our forests and harvesting in Pennsylvania's forests will likely continue. It is vital that every timber harvest proceed with the advice of a professional forester and be part of an overall forest management plan. The plan will provide custom guidelines to follow, guidelines that will certainly address C-D-L and other sustainable forestry considerations. Remember to plan! Remember to invest! Remember C-D-L! *Regenerate hardwood forests.*

**Figure 1.** Pennsylvania forestland ownership chart.




David Jackson

A sustainably managed forest. The deer population in this area was controlled using the DMAP program. The competing vegetation on the site was treated with an herbicide before harvest. The shelterwood harvest left a good seed source and allowed the proper amount of light to reach the forest floor. In a few years, the regeneration will be developed enough that a subsequent harvest removing the remaining overstory trees can occur.

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