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Vegetation Management in Florida's Private Non-Industrial Forests[1]

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Introduction

Forest vegetation management is usually defined as the practice of controlling the growth of non-crop plant species so sunlight, moisture, and soil nutrients are channeled to trees that produce useable forest products. When other vegetation is not controlled, the growth of the stand of crop trees may be slowed. So, effective vegetation management increases the landowner's financial rewards in four possible ways:

- The crop trees can be harvested sooner because they reach merchantable size at an earlier age. Or, at a given age, more trees will be large enough for higher value uses such as plywood and poles. Also, owners are more likely to have a fully stocked stand of crop trees, with more crop trees to harvest.
- Wildfire severe enough to damage or destroy the crop trees is less likely.
- Because of ease of access and good visibility in the stand, timber sale preparation and logging costs may be lower.
- Costs of establishing new forest stands following harvest are reduced because there is less residual vegetation. Therefore, less timber sale income has to be earmarked for site preparation, planting, and other stand establishment costs.

Varied Management Objectives

Many of Florida's private, non-industrial forest landowners, including those in the Forest Stewardship Program, have objectives in addition to growing wood or other commercial tree products: wildlife and fisheries management, grazing, biodiversity, recreation, and aesthetics.

In keeping with this broad range of management objectives, it is appropriate to have a broad view of vegetation management. When these other objectives for forest lands are considered, many non-commercial plants and plant communities become important. Often they need vegetation management just as much as commercially grown pines do.

Even with these other objectives, many owners count on their forested lands to produce income. Accordingly, they manage at least a portion of their forests primarily for timber production. In Florida, sound silvicultural practices, such as vegetation management, are both profitable for wood production and often compatible with managing for wildlife, recreation, and biodiversity. The landowner who wishes to enhance non-timber resources can do so in keeping with the primary objective of timber production.

Private non-industrial landowners willing and able to invest in establishing commercial timber stands tend to opt, with good reason, for low intensity, low cost methods of stand establishment. As Buffon (a

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Frenchman) noted in 1742, tree growers must always bear in mind that each dollar spent on establishing a tree may, through compounding, have grown to many dollars by the time the tree is harvested and the establishment expense can be recouped.

From the standpoint of many private non-industrial forest landowners, it may be all right if stand establishment takes a few years longer and the next harvest is correspondingly delayed, if--by so doing--costs are substantially reduced. Some of the vegetation management options outlined in this document should appeal to landowners who hold this view.

Scope

A general document such as this cannot fully cover the diversity of environments in Florida, nor the uniqueness of each holding and set of landowner's objectives and resources. We therefore encourage landowners to use their intimate knowledge of the land in combination with the technical expertise of state and private specialists to decide how best to apply vegetation management for each particular situation.

And bear in mind, for vegetation management activities to produce the desired results they should be coordinated with other kinds of activities--planting, thinning, and timing of final harvest--that are part of an overall management plan.

Assumptions

In Florida, as in most Coastal Plain and Piedmont areas of the southeastern United States, investment in wood production is usually associated with planted pine trees. So, the main part of this document focuses on vegetation management in southern pine plantations.

- First, we present vegetation management options to consider when either preparing for planting or natural regeneration, or once the young crop trees have become the dominant vegetation on the site. Investment in vegetation management is usually greatest during the early years of a stand's life. We give herbicides special attention in this section.
- Second, we will look at specific practices used in some of Florida's more common ecosystems.
- Finally, we will briefly consider those vegetation management practices used specifically for restoration of longleaf pine communities and enhancement of wildlife habitat.

Vegetation Management Methods

Treatment Options

It used to be the norm to use heavy machinery in various combinations of discing, drum chopping, raking, windrowing, and bedding to prepare a cutover site for planting. The aims were: 1) to consolidate the logging debris so there would be no obstacles to mechanized tree planters, and 2) to disrupt existing vegetation so that competition with the crop trees would be less severe. These measures were not entirely satisfactory in terms of vegetation management: competing vegetation soon regrew from seeds, stumps, and pieces of roots that remained on the site. So, in addition to the intensive mechanical work, herbicides were often necessary for site preparation and/or release treatments to kill the roots as well as the above-ground plant parts and achieve a more lasting effect.

During the last 15-20 years, several factors have prompted foresters to implement site preparation methods involving much-less-intensive use of heavy machinery. First, mechanical site preparation operations may be expensive and these costs, incurred early in the life of a stand, are recovered only when the trees are harvested years later or--partially--as tax deductions for reforestation costs (see Long and Long, *Income Taxes and Private Forest Landowners*.)

Secondly, research has demonstrated that intensive mechanical site preparation tends to reduce the long-term productivity of the site by:

- removing soil nutrients and organic matter from soil surfaces and concentrating them in piles or windrows;
- compacting soil and damaging soil structure; or
- causing excessive erosion and runoff on bare mineral soil before vegetation reestablished itself.

The first effect is most pronounced on the sandy and nutrient-poor soils found on many Florida flatwoods and sandhill sites. The latter two effects often occur on clayey soils, particularly on sloping lands, as in some of Florida's uplands.

Other factors also contributed to the decreased need for intensive mechanical site preparation. Formerly, most pine plantations were established on land that had previously supported stands with a large, often dominant, hardwood component. Many unmerchantable hardwood trees and a large quantity of limbs and tops were left on those sites. Because there was so much debris, hand planting was difficult even after a broadcast

burn for site preparation. Machine planting without first piling or windrowing the debris was out of the question.

The Current Situation

Today in Florida, most pine harvests come from plantations. These sites have less debris because:

- plantations have fewer large hardwoods;
- increases in hardwood pulpwood stumpage prices have made it profitable to harvest more of the hardwood; and
- whole-tree chipping (which leaves very little debris) is more common.

Thus, hand planting can now usually be done without difficulty. In many cases, machine planting can also be conducted without intensive mechanical site preparation; a small blade mounted on the front of the vehicle that pulls the planter clears away light debris that remains after site preparation. Finally, the demand for lower intensity site preparation, and therefore for more hand planting, has produced experienced and competent hand planting crews.

Other methods often cost less than intensive mechanical site preparation and they minimize soil disturbance. The focus now is on more effective vegetation management and reduction of logging debris in place rather than by moving it.

The most common tools used are herbicides, fire, and mechanical operations such as bedding on wet sites, scalping on old fields, and roller chopping prior to prescribed burning. Bedding creates raised mounds to keep seedling roots above the water table and increase survival. Scalping removes a strip of sod for planting old fields without disrupting vegetation between planting rows. Chopping crushes vegetation and slash closer to the ground for a more complete burn. All three mechanical operations are relatively low-cost and do not displace soil organic matter and nutrients. More intensive mechanical site preparation may still be advisable on a few tracts where much logging debris remains on the site and operations to pile slash with root rakes will facilitate tree planting without moving top soil.

Advantages of low-intensity site preparation

Low-intensity site preparation--combinations of herbicides, low-cost mechanical treatments, and/or fire--can have several advantages for wildlife. The stumps and unburned logging debris that remain scattered on the land rot, providing food and habitat for many insects, reptiles, amphibians, and small mammals, all of which are also prey for birds and other animals. Mushrooms and other fungi that grow on the rotting wood are food for larger wildlife. Residual hardwoods can be left standing (all would be knocked down during intensive mechanical site preparation) to provide homes for cavity-dwelling wildlife. One even has the option of leaving a few living oaks or other mast-producing hardwoods as a perennial source of food for wildlife. However, landowners still might have to make special efforts to protect these individual trees or shrubs from broadcast herbicide treatments and prescribed fires.

Although forestry herbicide use has increased dramatically, on some tracts satisfactory stand establishment can be achieved without herbicides or mechanical site preparation. On cutover sites with little competing vegetation, a pre-planting burn--a hot summer fire to minimize stump sprouting--may be all the site preparation that is necessary. In other situations, even with only a minimal investment in site preparation, crop trees may be able to establish themselves adequately without using herbicides. Crop tree growth in such cases is, nonetheless, generally slower than it would have been with the correct application of herbicides as a site preparation treatment or release treatment.

Another low-cost option

One other, low-cost option for reducing competing vegetation in plantations also has potential for immediate revenue benefits: Grazing cattle in young pine plantations can benefit both cattle and the crop trees. This is most often the case on pastures that have been converted to pine plantations. On such sites the pasture grasses continue to dominate the vegetation between the trees. Grazing cattle greatly reduce competition with the young crop trees and, by reducing the fuel load, decrease wildfire risk. The cattle may also eliminate the need for other kinds of release treatments. As good as this sounds, this tactic requires patience. First comes the tree planting. After planting, cattle cannot be introduced to the new pine stand for two or three years, when there is risk of significant browsing damage to the trees. Once cattle have been introduced to a young plantation they should be carefully monitored and moved to other areas before forage is depleted.

Weighing the options

Each landowner must weigh the probable benefits of more intensive vegetation management against the costs. Given the same hypothetical site, some landowners would opt to pay for herbicide treatment(s) during stand establishment so that the crop trees would reach harvestable size as soon as possible. Others, unwilling or unable to make an additional long-term, low-liquidity investment to increase the growth of the stand of crop trees, would accept slower growth of the crop trees--due to greater competition from other plants--in exchange for lower expenses early in the life of the stand. In most cases, the option of more intensive vegetation management would yield greater net income when the stand is harvested. But, the lower-intensity vegetation management options would, in many cases, yield a higher rate of return on the amount of money invested in the stand. Either approach is the "right" one when it helps landowners to meet their objectives without going over budget, and the "wrong" one when it does not.

Silvicultural Herbicides

Herbicides, in addition to their value in site preparation and stand establishment on cutover sites, are frequently used--usually as a site preparation treatment--for plantings in old fields and pastures. Herbicides have an advantage over other methods: they have a more-lasting effect on competing vegetation, yet create little site disturbance. Herbicides can also be used instead of fire for understory control in established stands. Herbicides control woody plants in the understory for a longer time than does fire, and they do not produce smoke--an important issue in urban areas. On the other hand, a single herbicide treatment for understory control is several times as expensive as a single prescribed fire.

What about Herbicide Toxicity?

Application of a broad-spectrum herbicide (one that affects many species) can transform a cutover site supporting lush green vegetation into a brown, apparently lifeless, expanse. Clearly these are powerful chemicals and many people are concerned about their possible harm to humans, wildlife, water, or nearby agricultural crops, and lawns. However, when used correctly in forestry operations, today's herbicides are not dangerous to humans, animals, or plants other than the targeted vegetation.

This is because the unique life processes of green plants are different from those of humans and animals. Plants make their own food using the sun's energy; humans and other animals do not have this ability. Today's herbicides disrupt the life processes that go on in plants but not in animals; they are "specific" to plants. (In contrast, insecticides are more dangerous to humans, livestock, and wildlife than herbicides because many insecticides disrupt life processes that insects have in common with other animals.)

The LD_{50}--the single dose of a substance that would be lethal to half (50%) of the subjects receiving that dose--is often used as a measure of toxicity. By this index, most herbicides registered for use in forestry are less poisonous than aspirin or table salt--and far less toxic than caffeine (Table).

Table. The relative toxicity of commonly used silvicultural herbicides.

Trade Name	Active Ingredient	LD_{50}* of the Active Ingredient mg/kg
Arsenal	imazypyr	5,000
Garlon	triclopyr	630
Oust	sulfometuron methyl	5,000
Roundup	glyphosate	4,320
Tordon	picloram	8,200
Velpar	hexazinone	1,690
Weedone	2,4-D	375
For Comparison:	Table Salt	3,750
	Aspirin	1,700
	Malathion (insecticide)	370
	Caffeine	200

*LD_{50} is the dose that is lethal to 50 percent of a test animal population, expressed as milligrams (mg) of chemical per kilogram (kg) of body weight.

For example the LD_{50} of imazapyr, the active ingredient in Arsenal™, an herbicide commonly used in forestry, is about 5000mg per kg of body weight. That translates to 375gm (> 13 ounces) of the active ingredient (or 750gm of formulated herbicide) for a 75kg (165lb) human. One person would have to ingest or absorb through the skin all of the herbicide concentrate that would be used in an average application on about one acre of site prepared land to reach the LD_{50} level of 5000mg. As a contrast, the LD_{50} of pure caffeine is

200mg/kg, much more toxic in the chemical form than Arsenal™.

Although the *oral* toxicity of most herbicides is very low, some chemical formulations contain ingredients that are dangerous eye irritants or may burn the skin. Be sure to read the labels.

Used according to directions by trained and experienced supervisors and applicators, the herbicides registered for forestry uses today will not harm humans, wildlife, or non-target plants (such as nearby agricultural crops). They will not affect air or water quality or poison the soil if applied according to label instructions. On the other hand, careless use can certainly damage crop plants and possibly cause health problems in humans and animals.

Precautions

In weighing the possible dangers of using herbicides in forestry we also must bear in mind that they are usually applied only once, and rarely more than twice, during the 20 years or longer it takes to grow a stand of timber. This is far less frequently than for most agricultural crops and residential yards. The people most at risk from using forestry herbicides are those who regularly mix and apply the herbicide--or supervise the operation on the ground. All should take reasonable precautions to minimize their exposure, as should any landowner. Chemical labels describe appropriate and common safety procedures. ALWAYS, repeat ALWAYS, READ AND UNDERSTAND THE LABELS ON HERBICIDES OR OTHER PESTICIDES YOU USE.

Variables to Consider for Herbicide Use

Foliar herbicides are applied to plant leaves as a liquid spray and absorbed into the plant through leaf surfaces. Soil-active herbicides are applied to the soil in granular form or as a spray and are taken into the plant through the roots. If killing larger trees is necessary, there are herbicides that can be injected into the trunks using a special hatchet or applied to wounds made in the bark.

Properly used herbicides do not indiscriminately kill all plants. By selecting the right chemical or mixture of chemicals and application method, you can target the treatment to broadleaf plants or to grasses, focus on certain troublesome species--such as saw palmetto in the flatwoods or scrub oaks on sandhill sites--and include or exclude larger hardwood trees. You can broadcast the herbicide over the whole site or apply it only to those plants directly competing with the crop trees, such as when the chemical is applied in bands a few feet wide where each row of pines is to be planted in a pasture. Herbicides can be used after the planting--either by broadcast treatment using a chemical and dosage that will kill the competing vegetation without seriously affecting the young pines--or, using backpack sprayers or other equipment for directed spray, by applying the chemical only to the plants that crowd each young tree.

Individuals who plan an herbicide treatment (or perhaps determine that chemical vegetation management is not the best option for that particular site) must take into account the nature of the target vegetation and ecosystem:

- *species, age, size, and abundance of competition;*
- *size, shape, and accessibility of the area to be treated;*
- *type of soil;*
- *level of the groundwater table and the presence of wetlands and bodies of open water;*
- *proximity to agricultural crops, pastures, or lawns;*
- *presence or absence of crop trees on the land; that is, whether the treatment is for site preparation, release, or understory control.*

Skilled vegetation control managers tailor site-specific treatments using the variables under their control:

- *the various chemicals on the market or combinations of them;*
- *carriers and additives included in spray mixtures;*
- *the concentration or dosage used;*
- *different methods of application--sprays from motorized vehicles, backpack sprayers, aerial application, etc.;*
- *timing of the application (season, weather conditions, and time of day); and*
- *the option of broadcast or spot treatments, or both.*

Consulting foresters and others responsible for conducting vegetation management operations develop or identify prescriptions--the chemical, dosage, method, and timing of application--that give good results on typical sites in the areas they work. They then make adjustments as called for on specific tracts.

In summary, it is not difficult to kill plants with herbicides. However, it takes considerable knowledge and skill to safely and efficiently--at the lowest reasonable cost--achieve the desired results. The landowner should entrust the planning and execution of

chemical vegetation management to someone with considerable experience using forestry herbicides on similar lands. Ideally, a consulting forester or other natural resource management professional who assists the landowner with all phases of an overall management plan will be involved in the vegetation management operations.

Treatment Options for Pine Stand Establishment

To establish a stand of crop trees, vegetation management is usually needed as part of site preparation --or during the first few years after planting. The following descriptions outline site preparation and release measures currently used on three major site types in Florida--flatwoods, uplands, and sandhills--and explains why certain measures work better than others for each of them. Vegetation management treatments used for stand establishment vary with:

- the size of the treated area;
- the amount of logging debris on the site;
- the degree to which competing vegetation was controlled during the life of the prior stand;
- the amount of time between logging (or pasture/cropland abandonment) and initiation of stand establishment activities.

Flatwoods

Much of Florida is flat or gently sloping land where water stands at or near the soil surface during prolonged wet weather. These flatwoods sites naturally support stands of slash and longleaf pine and, in topographic depressions, clusters of cypress (cypress domes). In the flatwoods, the keys to successful timber stand establishment are the control of certain tenacious and common shrubby plants--especially gallberry and saw palmetto--and mounding or bedding the soil prior to planting so the seedling roots will not be in completely waterlogged soil during rainy weather.

Although bedding is not primarily a vegetation management measure, it does result in increased early growth of the pines, giving them more of a head start over other plants and decreasing the need for vegetation management to release the pines a few years after planting.

The equipment needed for bedding cannot do its work unless most of the debris left from any logging operation has been chopped into shorter lengths and/or burned. Roller chopping and burning are frequently used on flatwoods sites to reduce this debris. Roller chopping results in a marked decrease in saw palmetto cover for at least three years after chopping *if the chopper is pulled over the site twice (double chopping)*. A single roller chopper pass is effective against saw palmetto if done in the summer, when the soil is usually saturated. Unfortunately, roller chopping has little effect on gallberry. Fire kills both saw palmetto and gallberry, at least the above-ground portions, but both quickly resprout to compete with the young pines.

After bedding is completed, gallberry and other herbaceous (non-woody) and woody plants quickly regrow from remaining pieces of roots or seeds. Recultivation several months after initial bedding--ideally in late summer--destroys this regrowth. Recultivation (double bedding), done when new shoots have largely exhausted food reserves, results in much less vigorous regrowth and more lasting control of competing plants. Double bedding is purely a vegetation management technique. Instead of mechanical recultivation, landowners may have herbicides applied to beds before planting. This achieves even better control of competing vegetation.

Mechanical or chemical vegetation management treatments are typically applied only on the beds. Live vegetation remains on the strips of land between beds, serving as cover and food sources for wildlife and functioning as a living pump that tends to reduce water levels.

Proper bedding can be done without first chopping and burning in cases where there is little debris, such as conversion of flatwoods pasture to pine plantation or following harvest of a pine stand where non-commercial trees and shrubs have been kept to a minimum by regular burning and/or chemical means. A site-preparation fire followed either by double bedding or a single bedding plus a pre-planting herbicide application, may then be all the site preparation that is needed.

Uplands

Uplands comprise much of the land in the northern two-thirds of Florida's panhandle as well as many sites in predominately flatwoods areas. Uplands are higher in elevation than nearby flatwoods and generally more sloping. So, upland soils do not have waterlogged soil or standing water for appreciable periods. A preferred site preparation prescription for upland sites is an herbicide treatment followed by a prescribed burn. Herbicide is applied during the growing season after timber harvest; exact timing of application varies by chemical product. After treated vegetation dies and before planting, dead and dry material may be burned. The fire greatly

improves access for hand- or machine-planting and complements the herbicide's vegetation control function. A hot, late-summer fire usually gives the best results.

Upland commercial pine stands are often established on cutover sites where hardwood stumps and root sprouts are the main competition. A few years after planting, this regrowth may be vigorous enough to warrant another herbicide treatment. On upland sites where hardwood clumps are scattered unevenly over the site, backpack sprayers are the preferred method for applying herbicide. This method does not waste herbicide on areas where there is little hardwood competition. And, because the chemical is applied to each target plant--instead of being broadcast over the entire area--there is little risk of damaging the pine crop trees. Where hardwood competition is dense over most or all of the site, herbicides may be applied more cost-effectively by helicopters or ground-based machinery.

In the herbicide-plus-fire site preparation system, planting often cannot be done until a year or more after harvest. An alternative may be to plant as soon as possible after a summer, fall, or winter harvest on sites with low levels of competition, then concentrate your vegetation management investment on a release treatment, if necessary, a few years later.

Sandhills

Deep, well-drained sandy soils occur along the Central Florida Ridge--a strip of ancient sand dunes running from the Georgia border along the center of the Florida peninsula. Other sandhill sites are scattered in flatwoods areas. Sandhill soils have poor moisture-holding capacity, so rapid regrowth of dense herbaceous and shrubby vegetation is not a problem in pine plantation establishment. On these sites, scrub oaks are the main competition of planted pines. Chopping--or other mechanical treatments--only increases this competition, multiplying the oak root pieces which then sprout. On the other hand, certain herbicides are highly effective on the competition. In the sandhills, forest vegetation management for establishing commercial pine stands is clearly best done by herbicide treatments. A follow-up fire may be helpful for large accumulations of slash or other dead fuels.

Improving Natural Regeneration with Vegetation Management

Pine stand establishment via natural regeneration relies on seed from mature trees prior to harvest--or on residual trees left after harvest. The forest manager takes intentional steps to create an environment where the regeneration of the selected species can succeed and become the dominant vegetation. Careful vegetation management is a key to successful establishment of a pine stand using natural regeneration. While most hardwoods sprout back vigorously from the stump or roots after cutting, pines do not resprout: their natural regeneration comes exclusively from seeds that fall from the adult trees.

Ideally, several years before a stand is harvested, prescribed burns should be scheduled at one- or two-year intervals to reduce understory vegetation. Herbicides can be used for the same purpose, but usually at a considerably higher cost. In the full-sunlight conditions of a recently harvested area--absent any pre-harvest vegetation control--competing vegetation grows vigorously and significantly reduces natural regeneration.

Seed of Florida's commercial pine species must be on mineral soil to germinate successfully, so the last fire is mainly to remove enough of the litter layer to provide spots of mineral soil for falling seed. This fire is timed several weeks before the ripe pine seeds drop (in the autumn) and shortly before or after harvest. A harrow pulled behind a tractor can accomplish the same objective as fire. Of course, seedbed preparation should not be done unless abundant mature cones are on the seed trees.

The recommended additional use of fire in the last years before harvest is inexpensive: five to 10 dollars per acre per burn. Fire reduces or even eliminates the need for more expensive vegetation control measures to release the crop trees a few years later. Most landowners who are attracted to natural regeneration in the first place want to establish the next stand of crop trees at the lowest possible cost.

Natural regeneration is infrequent on many flatwoods sites, especially after the previous stand is harvested, because of high water tables. Bedding prevents waterlogging of seedling roots and planting on the beds insures a successful crop. Natural regeneration may be a viable alternative on higher flatwoods sites where bedding is not necessary because waterlogged soil and standing water are factors only in unusually wet years.

Sometimes, active work to establish a pine tree stand is not started until several years after harvest of the previous stand. If the timing of the logging operation and other factors happened to favor natural regeneration, there may be enough young pines already on the site to produce an adequately well-stocked stand. Check first for young pine trees in the dense vegetation typically found on such sites. If there are more than 250 to 300 seedlings per acre, spot herbicide treatment of the

vegetation competing with the existing pine seedlings or saplings may be all that is necessary to assure establishment of a new pine stand.

In a year of abundant pine seed--if conditions are especially favorable for germination and initial growth of seedlings--an over-stocked pine stand may result. In effect, much of the competing vegetation is really excessively dense young pine trees. Pre-commercial thinning, a special kind of release treatment, is needed to eliminate many of the pines. One possibility is to mow or harrow 10- to 12-foot strips alternating with rows of retained seedlings one to two feet wide. A more laborious--and hazardous--option is cutting unwanted trees with saws or machetes. Herbicides are another alternative, but must be used with extreme care since the "target vegetation" would be the same species as the plants to be retained as crop trees.

Vegetation Management in Older Pine Stands

General Considerations

Understory management

From the time a stand of pine crop trees reaches crown closure (branches of adjacent trees are touching) until the final harvest, the focus of vegetation management is to prevent the development of a dense understory of shrubs and young hardwoods. This is done to reduce:

- the risk of damaging wildfire by preventing a buildup of fuel;
- the cost of timber sale preparation and logging by creating easy access and good visibility; and
- the cost of subsequent site preparation and stand establishment from debris and vegetation's competing with the next stand of crop trees.

Prescribed fire

Prescribed fire is the most commonly used tool for vegetation management in established pine stands, although herbicides can also be used in either very dense conditions or to kill large scattered hardwoods.

As noted in a previous section, fire is commonly used prior to planting (or managed natural regeneration) to reduce debris--facilitating other site preparation and planting operations--and to kill the above-ground portions of competing vegetation. For several years after planting, fire cannot be used as a vegetation management tool because it would destroy or seriously damage the young pines.

Fuel-reduction burns

When the crop trees are at least 15-20 feet tall, skilled prescribed fire managers can make a fuel-reduction burn. At this stage the crop trees should be considerably taller than the other vegetation and, under Florida conditions, their growth is not greatly hindered by this burn. However, if dense understory vegetation is not controlled during the remainder of the rotation, there is a risk of a destructive wildfire. Understory trees and shrubs draped with dead needles and leaves act as ladder fuels allowing fire to climb into the overstory crowns.

By the time the young pines are large enough to withstand a well-planned prescribed fire, they have often been left for at least a few years without any control of the competing vegetation. The height and the amount of the other vegetation may be such that the first fuel-reduction burn can easily scorch the crowns of the young pines, killing them or at least greatly retarding their growth. The first burn, carried out in the dormant (cool) season, requires exacting conditions of wind, humidity, and temperature. Moderate wind velocities and cool temperatures reduce risk of scorch damage.

Prescribed fires are most effective in killing hardwood stems less than three inches in diameter at ground level. Larger stems are likely to survive and continue to grow--unless treated with herbicides. In most cases, after the initial dormant season fuel-reduction burn, a prescribed fire every three or four years provides adequate control of the understory vegetation, keeping hardwoods smaller than the three-inch threshold.

Seasonal burns

Winter (dormant season) burns usually kill the above-ground parts of the understory trees and shrubs but they later sprout back from the roots. Late spring or summer burns kill many of the rootstocks as well. A common recommendation for opening up the understory of a stand that has gone many years without vegetation management is at least one dormant season burn followed by two or more annual or biennial summer burns. The frequency of the burns depends on having enough fuel present to sustain the fire.

Hardwood control practices

Some forest managers have begun to challenge the notion that hardwoods should not be allowed to grow large enough to take up space in the overstory. Over the

past 20 to 30 years, hardwood pulpwood stumpage prices have increased more rapidly than pine prices. While pine is still more valuable, the gap has narrowed. This trend is expected to continue. Control of hardwoods may result in increased yields of pine timber, but is it enough to justify the cost of the hardwood control treatments and the harvest price the hardwoods might bring if allowed to grow? It is likely that the future trend will be towards less intensive understory control and greater tolerance of hardwoods in the main canopy.

Vegetation Management for Pine Straw Collection

Demand for pine straw (recently fallen needles) as landscaping mulch has greatly increased in recent years. Accordingly, sale of pine straw has become an important source of revenue for some tree farmers in the southeastern United States. Based on 1992 prices, a landowner would make $240-950 per acre over the life of a stand selling the straw on the ground to a contractor who then has responsibility to rake, bale, ship, and market the straw. This assumes that the straw is collected four times during a rotation--the recommended maximum number of straw harvests to avoid soil impoverishment through loss of nutrients and organic matter in the removed straw.

Pine straw harvests are maximized in pine stands that are free of understory vegetation, which interferes with raking of the straw and contaminates it with hardwood leaves. So, pine stands most suitable for pine straw collection have practically no vegetation other than the crop trees.

Most of the recent pine-straw collection has been done in stands growing on land previously in use for pasture or cultivated crops. These lands tend to be more fertile than cutover sites and the rapidly growing pines produce more straw than trees on less productive lands. Also, because old field plantations characteristically have almost no understory, pine-straw collection requires no special vegetation management measures. In cases where there is enough understory vegetation to interfere with pine- straw collection, herbicides or mowing machines are used to reduce or eliminate it. Here, fire has a major disadvantage: while removing vegetation that prevents efficient pine-straw collection it burns up the recently fallen needles.

Because of the potential for profit, some owners of plantations on cutover flatwoods and upland sites are attempting to manage these stands for pine-straw collection. On most cutover sites intensive vegetation management will be necessary before raking can begin. Herbicides may be used to kill targeted plants, with subsequent mowing to shred the standing plant parts that would hinder raking operations. Vegetation management to facilitate pine straw collection should be timed so that the target vegetation is dead and down by late autumn, before needles begin to drop.

Present pine straw prices probably justify large investments in vegetation management, if needed, to create stand conditions suitable for raking the straw. However, if the number of plantations supplying marketable pine straw increases to the point of filling market demand, prices will fall. At lower prices, pine straw might remain profitable for owners of old field stands, who spend little or nothing to prepare the stand for raking, but not for owners of stands that require considerable vegetation management work before pine straw harvests can take place.

Forest landowners are urged to obtain up-to-date pine straw price information and to study straw price trends in their area before starting intensive vegetation management to prepare pine stands for raking.

Restoration of Longleaf Pine Ecosystems

Longleaf pine ecosystems once covered vast areas of the southeastern United States--including much of Florida. Fires every few years were an indispensable feature of longleaf pine communities. Due to conversion of most of the original forests to other land uses and to exclusion of naturally caused fires from the remaining forests, this ecosystem now covers less than 10% of its former area. Some owners of land that formerly supported longleaf pine ecosystems may wish to restore this characteristic feature of natural Florida and help protect some of its unique wildlife and plant species.

When fire is excluded from a longleaf pine community it gradually becomes a hardwood forest. Once there has been no fire for 20 or more years, burning may not be the best way to start the restoration process. Studies indicate that an herbicide application can kill mature and seedling oaks that dominate the encroaching hardwoods. Then, more sunlight reaches the forest floor, creating conditions once more suitable for grasses and development of a fuel type that will carry a fire. Frequent fires can then be reintroduced, favoring regeneration of wiregrass and longleaf pine while killing oak seedlings. Although herbicide applications help initiate the restoration process on many sites, they do not take the place of fire over the long run because longleaf pine and wiregrass are both dependent on fire for their regeneration.

On some sites, vegetation management measures--and time--are all that is needed to restore a longleaf pine community on land where it formerly existed.

Elsewhere, it may be necessary to replant longleaf pine and other key plants that have practically disappeared over many years of hardwood development or other land uses and to reintroduce wildlife species found only in longleaf pine communities.

Enhancing Wildlife Habitat

In previous sections of this document, we viewed pine trees grown for timber as the main crop plants on forest lands. Accordingly, vegetation management has been equated with controlling plants so they do not retard the growth of the pines or otherwise interfere with the production of merchantable wood. When one of the landowner's objectives is wildlife management, the goal may be to increase game species to be hunted or simply to provide habitat for as many wild animals as possible. In either case, vegetation management includes favoring those plants and plant communities that provide wildlife habitat--including food, water, nesting places, and cover.

Wildlife-favoring practices

In the view of the landowner who wants a forest that supports an abundant and diverse wildlife population, many plants other than pine trees are "crop" plants. A variety of food sources should be available in each season. The following practices tend to favor wildlife:

- Plan small, elongated or irregularly shaped harvest areas rather than large, contiguous ones. Wildlife utilize the abundant foraging opportunities of recently cutover areas, but may not venture far from the cover of adjacent forested terrain.
- Retain several living mast-producing hardwoods (oaks, hickories, southern magnolia, etc.) on each acre during site preparation and stand establishment. This may entail marking some merchantable trees so that loggers do not cut them.
- Retain hardwood or mixed hardwood and pine stands on some upland areas. These are valuable mast production areas and also provide nesting sites and cover for wildlife.
- Use herbicides to kill some hardwoods that remain after a stand is harvested but leave them standing to serve as nesting and foraging sites for birds, reptiles, amphibians, and small mammals.
- Apply different understory control treatments to different pine stands to encourage a variety of wildlife food plants.

For example, an herbicide treatment in one stand might control understory hardwoods and encourage grasses, forbs, and smaller shrubs such as blueberries and blackberries. Frequent (every 2 to 3 years) cool-season prescribed burns in another stand would produce an understory with many small hardwoods, resprouting from rootstocks not killed by the fire. This tender new growth is attractive to and accessible to wildlife. Less intensive vegetation management in nearby areas or parts of the same stand allows development of wildlife cover and a midstory of hardwoods important to some bird species.

- Manage pines so that some sunlight, water, and nutrients are available for the growth of understory plants. That is, thin the pine stands as early as possible within budget and time constraints. The response in growth of wildlife food plants will be especially good if an understory burn precedes or follows the thinning.
- Plan for longer rotations with one or more thinnings. Do not use whole-tree chipping at harvest, but instead leave branches and tops on the site where they will host mushrooms, other fungi, insects, and small vertebrates.
- Take advantage of road and power line right-of-ways where more sunlight reaches low-growing plants. High-nutrient forage plants for wildlife can be seeded here.

Even where there is need for maximum economic yield of pine timber from a property, conditions favorable for many wildlife species can be maintained by having more, smaller stands of different ages rather than a few large stands nearly the same age. Even though the habitat diversity within any given stand is lower than it would be in a natural pine community, hardwood hammock, or mixed pine hardwood stand, the between-stand diversity will favor many wildlife species. The interface or "edge effect" between contrasting environments will also be important for wildlife that need a variety of habitats for food and cover.

Successful management practices

Although this publication does not specifically discuss vegetation management for aesthetics, biodiversity, or recreation, successful management for one or more of these objectives is based on the same principles outlined in the material about wildlife:

- withholding some otherwise suitable areas of the property from intensive pine timber production;

- being aware of the need to manage for many different plants and plant communities;
- planning so that contrasting vegetation types or stand ages are next to one another to create "edge effect" zones; and
- maximizing the utility to wildlife of wetlands, streamside protection zones, and reserved upland hardwood areas by linking them with forest corridors.

Conclusions

Through day-to-day observations and occasional consultations with foresters, wildlife biologists, and other natural resource management professionals, landowners gain a working knowledge of the tradeoffs involved with each management decision. They learn how to tailor each operation, including vegetation management, to fit the conditions of a given stand, and the multiple objectives for which the entire holding is managed. It is challenging and educational, and can reward the landowner emotionally as well as financially, to gain, apply, and refine this knowledge of complex ecological interrelationships. The astute landowner blends years of first-hand observation with technical specialists' knowledge to develop a deep understanding of the life of the land and its relationship with human society.

Valuable formal research has developed and tested herbicides, studied fire behavior, and evaluated the economics of different treatments. But specific vegetation management methods are developed by practical landowners, foresters, and other natural resource management professionals to address problems and meet needs encountered in real forest management situations.

Your challenge, as non-industrial private forest landowners and natural-resource management professionals that work closely with them, is to continue to develop cost-effective vegetation management practices tailored to each landowner's needs. We wish you well in this innovative work and hope that the information in this publication helps you toward that end.

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** Items 2, 3, 5, 6, 8, 11 and 12 are available from the Forestry Extension Office, PO Box 110410, University of Florida, Gainesville, Florida 32611-0420.*