Spring Canyon
Gadsden County

(98 acres)

Owners : Helen and Tom Roth

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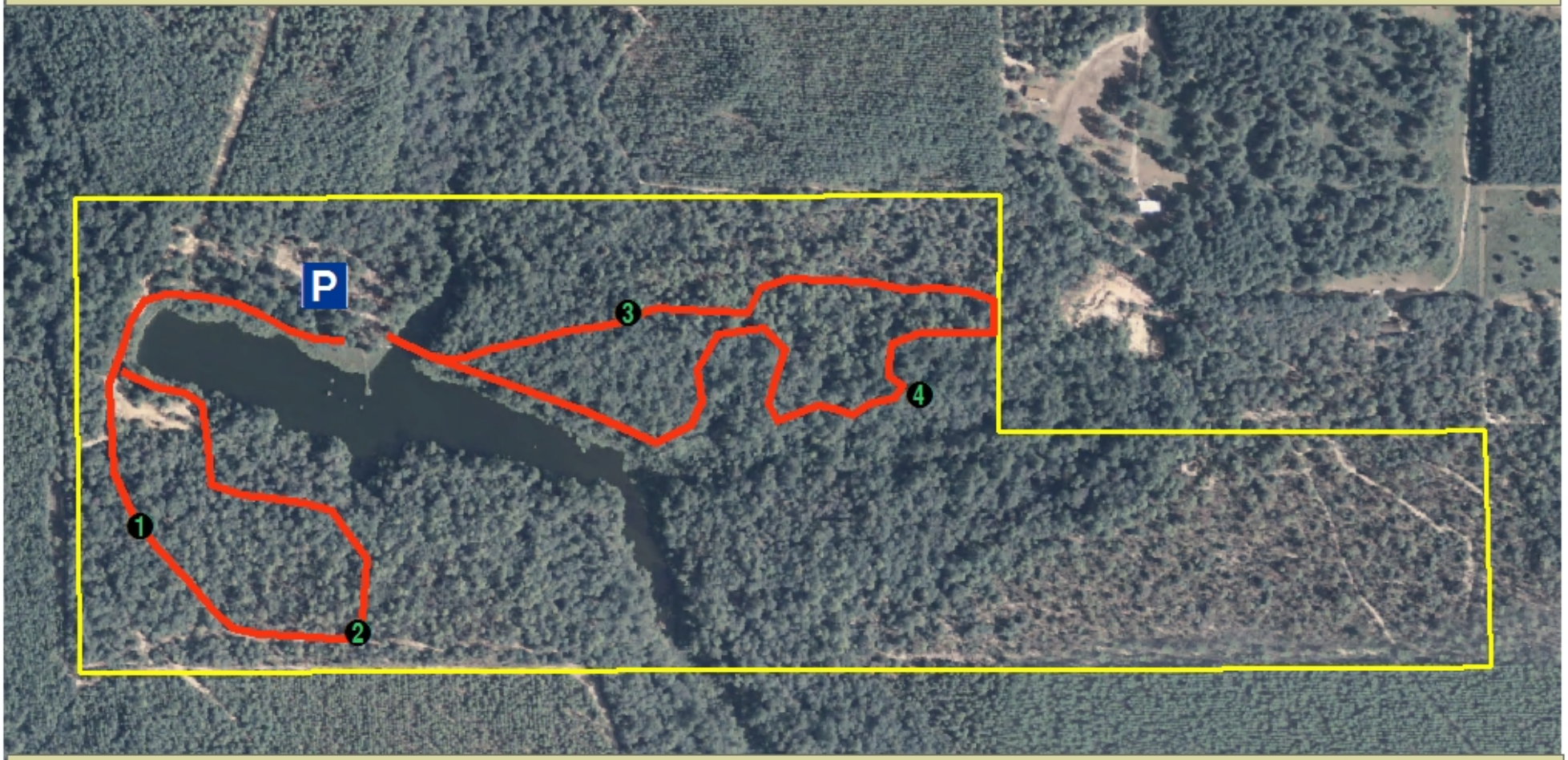

Legend

Property Boundary

P Parking

Tour Route

Stops

2 Brush management completed stage

1 Brush management beginning stages

3 Refernce site

4 Steephead ravine

0 210 420 840 Feet

Map Prepread by:
Arlo H. Kane
FL Fish and Wildlife
Conservation Commission

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Property Tour / Hike

Spring Canyon LLC

Property of Helen and Tom Roth

Gadsden County, FL

Date: **Thursday, April 23, 2015**
Sign in, meet and greet at 9:00 AM Eastern
Adjourn after lunch

Tour: This will be a moderately strenuous hike on some steep terrain but well worth the effort! Spring Canyon LLC is a beautiful 100-acre property owned by Helen and Tom Roth. The property is home to steephead ravines and longleaf pine-wire grass sandhills. Helen has traced the history of the property back to 1926 near the end of the turpentine era. Their goal is to improve the upland habitat for threatened and endangered plants and animals. Through a lot of hard work and assistance from the Forest Stewardship Program and USDA Conservation Programs, Helen and Tom are working to restore the uplands back to what they were before many decades of fire exclusion. They are removing hardwoods to allow light to reach longleaf pine seedlings and understory grasses and forbs, and getting fire back in the system. Some larger flowering and fruiting hardwoods are left for wildlife and aesthetic value. In addition to working on and enjoying her property, Helen loves to use the property to educate others about the benefits of active management in restoring the plant and animal communities at Spring Canyon.

Funding for Florida's Forest Stewardship Program is provided by the USDA Forest Service through the Florida Department of Agriculture and Consumer Service's Florida Forest Service and the Florida Sustainable Forestry Initiative Implementation Committee.

Tour agenda:

9:00 am **Sign in, meet and greet**

9:30 **Introduction, begin tour**

Stop 1
Beginning stages of brush management to restore longleaf pine forest
Helen Roth, Arlo Kane

Stop 2
Completed stages of brush management, prescribed fire
Helen Roth, Arlo Kane, Karyn Ruis-Toro

Cost-share assistance
Karyn Ruis-Toro, Arlo Kane, David Findley

Stop 3
Reference site for upland pine restoration
Helen Roth

Stop 4
Steephead Ravine, unique plants
Helen Roth, Scott Davis

Best Management Practices for Water and Wildlife
Roy Lima, Arlo Kane

12:30 pm **Lunch at the pond- THANKS SPONSORS!** (see back cover)

Please fill out your Tour Evaluation and give to Chris Demers before you go!

Tour Resource Contacts

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Helen and Tom Roth
Landowners
Spring Canyon, LLC
troth001@comcast.net

Questions about this or other Forest Stewardship Program activities can be directed to Chris Demers at (352) 846-2375 or by email at cdemers@ufl.edu. For more information and events see the UF Forest Stewardship web site at:

http://www.sfrc.ufl.edu/forest_stewardship

Florida's Forest Stewardship Program

Forest Stewardship is active management of forests and related resources to keep these lands in a productive and healthy condition for present and future generations, and to increase the economic, environmental and social benefits of these lands. Forest Stewards are landowners who manage their forestlands on a long-term basis by following a multiple resource management plan.

The Forest Stewardship Program addresses the improvement and maintenance of timber, wildlife, soil and water, recreation, aesthetics, as well as forage resources.

Eligibility

Private forest landowners with at least 20 acres of forest land and have a desire to manage their ownerships according to Stewardship principles can participate in the Forest Stewardship Program. Also, adjacent landowners, with similar management objectives, may combine their holdings to meet this acreage limitation.

Benefits to Landowners

- A customized management plan that is based on the landowner's objectives. The plan will include forest stand characteristics, property maps, management recommendations, and a five-year time line for future planning. This plan also serves as documentation of active management on the property that may help reduce tax liability.
- An opportunity for future public recognition as a certified "Forest Steward".
- Educational workshops, tours and a quarterly Stewardship newsletter developed and distributed by the University of Florida, IFAS Cooperative Extension Service.

Getting into the Program

Contact your local Florida Forest Service County Forester and tell them that you would like to have a Forest Stewardship Plan prepared for your property. More information and application here:

http://www.freshfromflorida.com/Divisions-Offices/Florida-Forest-Service/For-Landowners/Programs/Forest-Stewardship-Program

Tree Farm Program

The American Tree Farm System® is a program of the American Forest Foundation and was founded in 1941 to promote the sustainable management of forests through education and outreach to family forest landowners. Nearly 26 million acres of privately owned forestland and 80,000 family forest landowners in 46 states are enrolled in this program and committed to excellence in forest stewardship. About half of all Tree Farms are located in the South.

Eligibility

Private forest landowners with at least 10 acres of forest land and have a desire to manage their ownerships according to sustainable forestry guidelines can participate in Tree Farm.

Benefits to Landowners

Tree Farmers are good stewards of their forestland committed to protecting watersheds and wildlife habitat and conserving soil. They manage their forestland for various reasons, including timber production, wildlife, recreation, aesthetics, and education/outreach. Tree Farmers receive many benefits:

- Representation on local, state, and federal issues affecting forestland owners.
- Exposure to a network of forestry professionals and landowners committed to sustainable forestry.
- Access to seminars, field days, and workshops to help manage their Tree Farm even better.
- Certification that meets international standards of sustainable forest management.
- Participation in local, state, regional, and national Outstanding Tree Farmer of the Year awards and recognition.

Getting into the Program

Contact your local Florida Forest Service County Forester and tell them that you would like to join the Tree Farm program. More information here:

http://www.floridaforest.org/tree_farm.php

Forestry
Wildlife Best Management Practices for State Imperiled Species

- Forestry Wildlife Best Management Practices for State Imperiled Species (WBMPs) were adopted into Florida Administrative Code (Rule 5I-8) on October 21, 2014.
- WBMPs were developed through a partnership between the Florida Department of Agriculture and Consumer Services' Florida Forest Service and the Florida Fish and Wildlife Conservation Commission (FWC).
- WBMPs are **voluntary** practices designed as a practical approach for avoiding and minimizing the loss of **State Imperiled Species** due to silviculture operations.
- WBMP practices address the 16 State Imperiled Species which are considered to be potentially vulnerable to silviculture operations including ten aquatic species, two burrowing animals, and four nesting birds.
- WBMPs are designed to supplement the existing water quality-based Silviculture BMPs which already provide many valuable benefits to the conservation and management of fish and wildlife in Florida.
- Landowners and other forestry resource professionals can enroll in the voluntary program by completing a WBMP Notice of Intent. Those who do not wish to enroll will continue to be subject to all current laws and regulations regarding State Imperiled Species.
- Once enrolled, applicants who **properly implement** WBMPs will no longer be required to obtain a permit authorizing the incidental take of State Imperiled Species during bonafide ongoing forestry operations. In addition, they will not be subject to any fines or penalties associated with an incidental take of the State Imperiled Species covered by the WBMP Manual.
- WBMPs are not designed to facilitate wildlife habitat restoration or species recovery and expansion. Also, they do not address any Federally Listed Species. For information on Federally Listed Species, refer to FWC's online "Florida Wildlife Conservation Guide."
- To obtain more information or a copy of the WBMP Manual and Notice of Intent, contact your local Florida Forest Service BMP forester (see below) or a FWC Landowner Assistance Program biologist (850) 488-3831.

<u>Florida Forest Service BMP Foresters</u>

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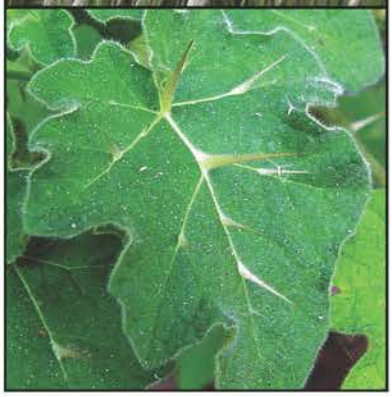


Got Invasives?

Invasive exotic plant problem? Use the Florida Invasives.org website to find financial and or technical assistance to manage or prevent an infestation.

FloridaInvasives.org is an online resource of management assistance programs to help in your fight against problematic plant species. This resource takes the guesswork out of finding the agencies or organizations offering assistance and will direct you to available programs. It will also provide the requirements for each program, to help you decide if they are a good match for your needs.

Why was FloridaInvasives.org developed?

Public and private land managers have identified the high ecological and economic cost of invasive species as a statewide problem in Florida. The Florida Invasive Species Partnership (FISP) is a collaboration of federal, state and local agencies along with nongovernment organizations in Florida, formed to link efforts at preventing and controlling infestations of invasive exotic plants across agency and property boundaries. FISP has developed an on-line tool of available financial and technical assistance sources to make it easier for landowners and land managers to find them.

How does FloridaInvasives.org help you?

Each year, multiple agencies and organizations provide cost-share programs, grants and/or technical assistance to help landowners and land managers with various agriculture or natural resource management practices. Invasive exotic species management is an important practice covered within many of these programs.

FISP has created a searchable database, accessible at FloridaInvasives.org, that allows you to determine which agency or organization(s) might have an assistance program for your needs. Simply provide your county, target species and other pertinent information into the online tool, and you will retrieve a current list of available programs along with the most up-to-date contact information. Floridainvasives.org will help provide focus to your search so that you can get the right person at the right program.

FloridaInvasives.org builds community awareness, leverages limited resources through cooperation and may reduce individual land management costs. This resource will be regularly updated with the most current program information to provide you the most up-to-date opportunities. Log on at http://FloridaInvasives.org to find assistance with your invasive species problem.

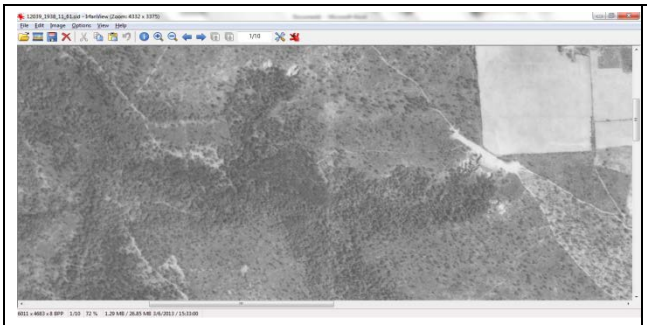
Conclusion

The Florida Invasive Species Partnership has created FloridaInvasives.org to help connect Florida's landowners and land managers with available technical and/or financial assistance programs to prevent or control invasive exotic species problems. These programs have been collected, evaluated and categorized in a single resource, making it easier to find the financial and/or technical assistance available to Florida landowners.

Go to FloridaInvasives.org to find out more.

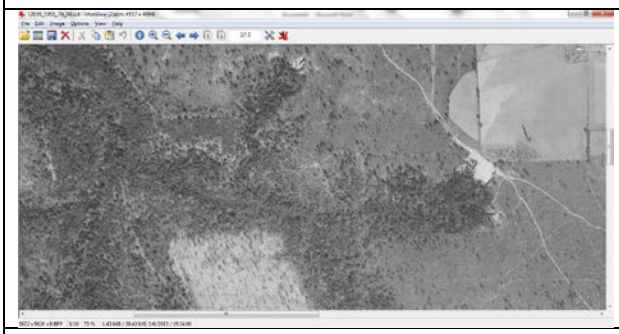
Florida
Invasive Species
Partnership

Think Locally, Act Neighborly
Invasive exotic species know no boundaries!

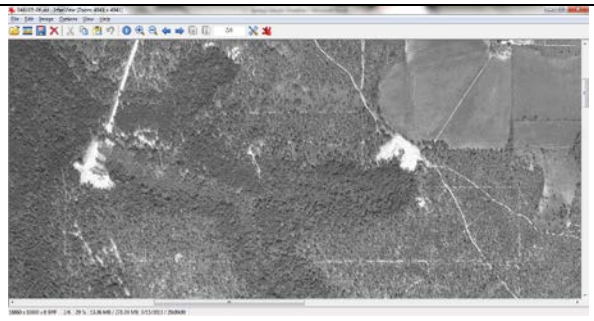


1938 – Lincoln Gardens invalid deeds were in 1926

1947 – O.F. Shephard Timber Deed to Jinks Lumber

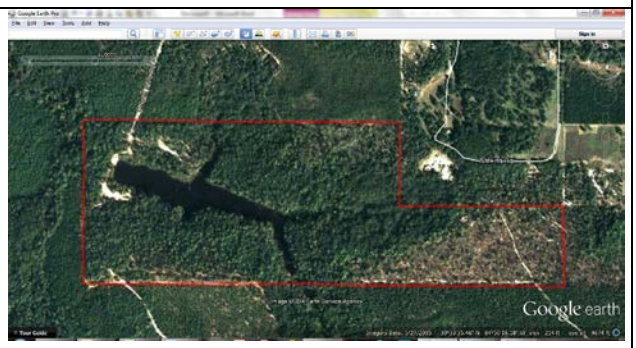


1955 – C. K. Wall - donated land to church in 1960

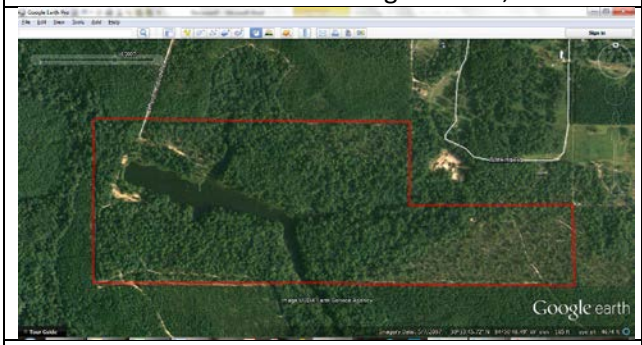


1966 – 1st Baptist Church of Greensboro

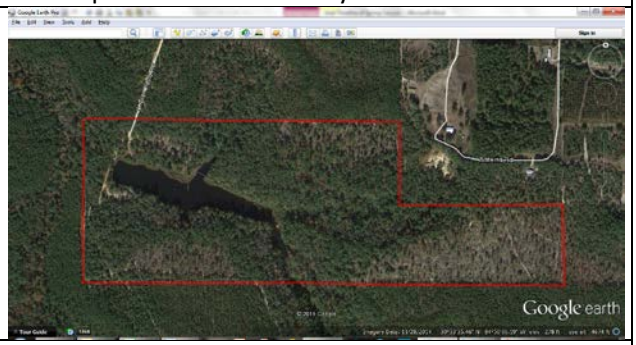
1992 – Sold to Mark C Bane III in 1993. He also had a hunt lease on the surrounding St. Joe 1,000 AC



2004 – One year prior to MCBIII DOD 11/2005
He did prescribed burns only in the NE section



2007 – sold to Spring Canyon, LLC in 2008
2/2011 – 1st prescribed burn – NE,SW, SE sections
3/2014 – 2nd prescribed burn – NE,SW, SE sections



11/2014 – latest image – after clearing SW section
3/2015 – 3rd prescribed burn – SW section

		
Gholson's Gayfeather – S1 LE	Alabama Milkvine – S2 LE	Pyramid Magnolia – S3 LE
		
Florida Flame Azalea – S3 LE	Toothed Savory – S3 LT	Baltzell's Sedge – S3 LT
		
Mountain Laurel – S3 LT	Florida Anise – Special Interest	Piedmont Azalea, Sp. Int.
		
Downy Serviceberry – Sp. Int.	Southern Crabapple – Sp. Int.	Sessileleaf Bellwort – Sp. Int.
		
Sourwood –great fall color	Sandhill Hawthorn	Rusty Blackhaw Viburnum

		
Carolina Silverbell	Horse Sugar	Wild Olive
		
Bigleaf Snowbell	Fringe Tree	Beautiful Hawthorn
		
Coastalplain Honeycombhead	Pinkscale Gayfeather	Beach False Foxglove
		
“Cat-Faced” Longleaf Pines	Adult Gopher Tortoise	Juvenile Gopher Tortoise
		
Bobcat	Rattlesnake near GT burrow	Eastern Hognose Snake

UF UNIVERSITY of FLORIDA
IFAS Extension

SS-FOR-13

Longleaf Pine Regeneration[1]

Chris Demers, Alan Long and Patrick Minogue[2]

Longleaf pine (*Pinus palustris*) has many favorable characteristics for landowners who have long-term, multiple-use resource management objectives. Of all the southern pine species, longleaf pine is the most insect-, disease-, and fire-resistant and has the greatest longevity. When burned regularly, longleaf pine forests develop a stable grass savannah ecosystem, providing ideal habitat for many plants and animals.

Longleaf pine is a pioneer species on a variety of sites but is intolerant of competition and flooding during its grass stage, when it appears like a clump of grass. Historically, fire and moisture have been the principal factors controlling longleaf distribution within its natural range. In the lower Coastal Plain longleaf grows on sandy, well-drained to excessively well-drained soils where loblolly or slash pine perform more poorly. Fire removes competing vegetation, exposing the bare soil necessary for successful seedling establishment. In the historic fire-dominated longleaf pine grass savannah ecosystem, relatively stable plant communities are characterized by an overstory of uneven-aged, widely spaced longleaf pines and fire-tolerant oaks such as bluejack oak (*Quercus incana*) and turkey oak (*Quercus laevis*) and a predominate ground cover of bunch grasses such as wiregrass (*Aristrada stricta*) and bluestems (*Andropogon* spp) which facilitate ignition and spread of periodic fires (Landers 1991). It is interesting to note that, despite this tree's performance on high, dry ground, its Latin name means "swamp pine." It does grow sparsely in wet areas as well.

Artificial Regeneration

Options for artificial regeneration include planting of bareroot or containerized seedlings or direct seeding. Control of pine stocking (density) is best when seedlings are planted and container-grown seedlings generally provide the best survival rate. However, direct seeding may be a viable option for some situations, such as regenerating relatively small areas.

Site Preparation

Longleaf pine is very intolerant of shade and is difficult to regenerate successfully without vegetation control. Vegetative competition around seedlings must be kept at a minimum until an adequate number of seedlings emerging from the grass stage are at least as tall as the competition. The type and degree of site preparation and the choice of

1. This document is SS-FOR-13, one of a series of the School of Forest Resources and Conservation, UF/IFAS Extension Service, Institute of Food and Agricultural Sciences, University of Florida. First published January 2000. Revised November 2010. Reviewed August 2013. Please visit the EDIS website at **http://edis.ifas.ufl.edu**.

Chris Demers, forest stewardship coordinator; and Alan Long, former professor, Forest Operations and Environmental Regulations; and Patrick Minogue, assistant professor, Silviculture, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville 32611.

2. All chemicals should be used in accordance with directions on the manufacturer's label.

site preparation methods before planting longleaf seedlings will depend on the regeneration technique used, site conditions and your management goals.

At the very least, prepare the area for direct seeding by first performing a prescribed burn. Disking also enhances seeding by exposing mineral soil and reducing competing vegetation for a short period of time. More challenging site conditions require more extensive site preparation techniques to increase the likelihood of success.

The most common situations encountered include recently harvested forest sites and conversion of old fields and pasture land. On recently harvested forest sites, most residual hardwoods should be removed with heavy machinery such as a root rake or controlled using various herbicides (Table 1). Following herbicide treatment, broadcast site preparation burning is often done to improve hand or machine planting access. V-blade planters are used to improve machine planting access by pushing debris away from the planted row. On old fields and pastures ripping will help break hardpans (compacted soil layers) and scalping a narrow (1–2 ft) strip, about 2 to 3 inches deep, along the planted row will break up the sod and improve the effectiveness of the planting machine in setting the seedlings with good soil contact. Scalping and ripping are usually done following the contour on sloping land to avoid erosion problems. It is best to rip the soil during dry periods in the summer to obtain good soil fracture and well in advance of the planting season, so that eventually rain will settle the soil prior to planting in the late fall or winter. When planting into established grass sod, the most effective practice is to deaden the sod with glyphosate herbicide (Table 1) either by broadcast application or by treating a 5–6 ft wide band centered on the planted row *prior to planting*. Herbicide control of grasses is very important for successful longleaf establishment, and glyphosate is most effective when applied during periods of active growth. Disking established sod prior to planting is not recommended because it makes herbaceous vegetation control after planting very difficult.

The best results are obtained when vegetation is managed both before and after planting. During the first and sometimes the second growing season following planting, selective herbicides are used to control grasses and broadleaf weeds (herbaceous weed control). This practice significantly improves seedling survival, and accelerates seedling growth rates by reducing the period that seedlings remain in the grass stage by one or more years. In longleaf plantations in the sandy soils of the Coastal Plain, hexazinone and sulfometuron methyl are the most commonly used herbicides for herbaceous weed control in longleaf pine plantations (Table 1). These herbicides may be applied directly over planted seedlings safely when care is taken to ensure the proper herbicide rate is applied and labeled method is followed. Pine tolerance to these herbicides is best when seedlings have initiated new root growth following transplanting. Many growers excavate a few trees to check for new roots, which are white in color, prior to herbicide application. Herbaceous weed control treatments are most effective when weeds just start to develop in the Spring, which is typically in late March through mid-April.

Once seedlings are established, a prescribed burning program is a natural and cost-effective means to manage hardwood vegetation and also shift the ground cover to grass savannah species which provide desirable habitat for many desired wildlife species (Platt *et al*. 1998, Noss 1989).

Planting

Since longleaf pine seedlings do not become truly dormant, they require greater care in handling and planting than other southern pines. The success of longleaf pine planting depends on: (1) good soil moisture at and following planting (2) a well-prepared, competition-free site; (3) fresh, healthy, top quality planting stock; (4) extreme care in handling the stock from lifting to planting; (5) quality planting; and (6) managing competing vegetation through stand establishment. High quality seedlings can be grown as either bareroot or container stock, but container stock is somewhat more forgiving of less than optimum conditions.

The appropriate planting density will depend on your objectives. Low planting densities, 300 to 500 seedlings per acre or less, may be appropriate for longleaf ecosystem restoration and/or to provide wildlife habitat (such as that for bobwhite quail), whereas 750 seedlings per acre or more may be desirable to optimize timber production and pine straw raking.

Supplies of longleaf pine seedlings may not be sufficient to meet demands, so order your seedlings by early summer at the latest. For a list of longleaf nurseries, call your DOF County Forester (http://www.fl-dof.com/field_operations/county_foresters/index.html) or the Longleaf Alliance, at 334-427-1029, and request a copy of the *Longleaf Nursery List*. This is also available on their website: http://www.longleafalliance.org/.

Choose a tree planting contractor that has experience with planting longleaf pine. Planting failures frequently result from improper seedling handling and planting. Hiring an experienced and reputable contractor may help to ensure

seedling survival and minimize the possibility of having to replant.

BAREROOT SEEDLINGS

Longleaf pine seedlings at the nursery are stem-less and resemble a carrot with a clump of pine needles on top. Ideally, bareroot seedlings should have: (1) a root collar diameter (RCD) of 0.4 to 0.6 inch; (2) a stout, 6- to 8-inch or longer tap root; (3) at least 6 well-developed, 6- to 8-inch lateral roots with evidence of ectomycorrhizal development; (4) a winter bud with scales; (5) abundant, large, fascicled needles that are free of brown-spot disease; (6) been grown at a reputable nursery; (7) been undercut in the nursery bed well before lifting; and (8) a seed source from the same region as the planting site. Seedlings with a RCD of 0.3 inch or less generally have low survival rates.

Longleaf seedlings come out of the grass stage and initiate stem height growth when the seedlings have a RCD of about one inch. After planting, longleaf seedlings allocate their growth to develop a tap root prior to initiating stem height growth. As noted above, seedlings may initiate height growth at a younger age if competing vegetation is controlled. Once the seedlings emerge from the grass stage, height growth is comparable with loblolly or slash pine of the same age.

CONTAINERIZED SEEDLINGS

There is increasing interest in using containerized longleaf pine seedlings (plugs) because they generally have greater survival than bareroot seedlings. Also, containerized seedlings can be planted throughout the year, whenever soil moisture is adequate *before and after planting.* Containerized seedlings have even been successfully planted during the hot summer months, when afternoon rains are common. They can be used to replant partial regeneration failures in the year they occur as well. Studies have shown that both fall-planted and late winter-planted containerized longleaf seedlings *often* have better survival and growth than winter-planted bareroot seedlings. Seedlings grown in large containers (large plugs) can enhance survival on adverse sites, but to ensure success sufficient site preparation and vegetation control measures must be taken.

The main drawback of containerized seedlings is cost. On average, the price per thousand is about twice as much for container-grown seedlings as the cost for bareroot seedlings. The larger the plug volume, the greater the cost to produce the plugs. Also, containerized seedlings are more bulky to handle during shipping and planting. However, cost-share programs and increased survival make them a feasible option.

NURSERY TO FIELD

Proper care and handling of seedlings from the nursery to the field includes several steps: (1) pick up seedlings from the nursery the day they are lifted; (2) protect roots from desiccation; (3) protect seedlings from wind and refrigerate them if possible during transportation to the planting site (place plugs loosely in large coolers or waxed boxes); (4) store seedlings in a cool, well-ventilated area for no more than three days before planting (or up to 3 weeks in refrigeration, 5 weeks with humidity control); and (5) do not expose seedlings to sunlight or heat. To optimize success, plant seedlings within three days of pickup from the nursery. Large planting jobs may require multiple trips to the nursery.

Longleaf seedlings are normally planted between November and the beginning of March when cool temperatures are prevalent and soils are normally moist. Planting during the early part of this time frame is best to give seedlings time to grow new roots before the dry weather of April and May. Containerized seedlings can be planted earlier whenever available soil moisture is adequate and rainfall occurs as noted above, but risks are diminished during the winter planting season. Avoid planting during periods of low soil moisture, dry weather, high temperature, low relative humidity, high winds or when soil is frozen.

Take enough seedlings to the field for one day of planting and keep them moist, but not submerged. When hand-planting bareroot seedlings, keep a little water or wet Tera-Sorb in the bottom of the planting bag. Make sure tree planters carry seedlings in the bag to prevent the roots from drying out.

For bareroot seedlings, machine planting is preferable to hand planting because the larger slit created by the machine provides for better root alignment. If hand-planting, bareroot seedlings should be planted with a shovel or large dibble. Containerized seedlings can be planted with a cylinder-type dibble or any of the flat-bladed implements used to plant bareroot stock.

For bareroot stock, position seedlings with taproots straight down and root collars at or slightly below the ground line (no more than 1 inch below), which allows the bud to be exposed once the soil has fully settled. Attention to detail during planting is critical -- a seedling planted too shallow will die quickly, and a seedling planted too deep will die slowly.

For containerized seedlings, position the plug so that the terminal bud is well above the soil surface. Tell planters to "leave the upper part of the plug exposed." This insures the seedling is not planted too deep.

Don't plant directly in a subsoiled/ripped furrow because the seedlings may sink. Instead, offset 2–4 inches to the side of the ripped furrow.

On scalped sites, anticipate soil movement back into the scalped furrow and plant more shallowly, leaving approximately 1 ½ to 2 inches of the plug above the soil surface. Very shallow planting also works well on wetter sites.

A WORD ABOUT COST-SHARE CONTRACTS

If you have a cost-share contract under the USDA's Conservation Reserve Program or Wildlife Habitat Incentives Program, the planting crew must know about it. If not, they may plant more than the maximum number of seedlings allowed in the terms of the contract, causing problems with your funding.

POST-PLANTING CARE

Once seedlings are planted, the principal factors affecting seedling development are vegetative competition and brown-spot needle blight. Prescribed fire is the most common cultural treatment used to control both. If average brown-spot infection exceeds 20% of the cumulative foliage on sampled seedlings, a burn will be needed to control the disease unless it will result in excessive mortality. Seedlings in the early stages of height growth (coming out of the grass stage) are most susceptible to fire kill, especially when heavily infected by brown-spot.

Direct Seeding

Due to increases in seed costs, this once cost-effective regeneration option is now potentially cost prohibitive, and it involves substantial risk. Failure can occur as a result of inadequate control of competing vegetation, low seeding rates, using seed not treated with bird or rodent repellent, seeding at the wrong time, or adverse weather conditions. Often, direct seeding results in stands with patchy stocking, with some areas not adequately stocked and some areas with too many trees. Low, poorly drained sites that are likely to be covered with standing water a week or more after seeding should be avoided. Likewise, deep upland sands that dry out rapidly after a rain are also unsuitable for direct seeding. Generally, sites that can be successfully planted can also be successfully seeded. As with planting, site preparation methods must control vegetative competition and expose at least 50% of the mineral soil. Seeds must be in contact with the mineral soil for germination to take place. Seeds lodged in non-soil material will probably not become established.

In general, local seed sources are best. Seed or seedlings from North and South Carolina tend to grow poorly when planted on the Florida peninsula and vice versa. Most genetic improvement work with longleaf pine is concentrated on breeding for brown-spot disease resistance and accelerated initial height growth.

Purchase seeds from a reputable seed dealer. Longleaf seeds should be refrigerated at subfreezing temperatures until sowing. Sowing can take place in fall, when moisture is adequate and maximum daytime temperatures drop below 85 degrees. Seed can be sown at low cost by broadcast seeding at 3 pounds per acre, or spot seeding (dropping 3 to 5 seeds per spot). Row seeding, at 1 to 2 feet spacing between seeds, can be used when better control over spacing and density is desired. Large areas are best seeded by aircraft which use carefully calibrated equipment. After establishment (two to three years), clumps of seedlings can be thinned down to one tree.

Natural Regeneration For Even-Aged Stands

Landowners who already have stands of longleaf pine can take advantage of a practical, inexpensive natural regeneration method known as the *shelterwood* system, a natural seeding method well-suited to the biological requirements of this species. The shelterwood method maximizes per-acre seed production and yields sufficient needle litter to fuel fires hot enough to inhibit hardwood regeneration and to prepare a seed bed. Regular prescribed burns should be scheduled throughout the rotation to maintain a low understory. Most of the mature stand is removed at the end of the rotation, but a portion is left standing as a seed source until regeneration is well established. Success with this method depends on: (1) a good seed year with adequate seed supply, (2) a receptive seedbed, (3) minimal vegetative competition and (4) ample soil moisture.

The shelterwood system requires 3 cuts that serve 3 basic purposes: (1) to prepare the stand for production of abundant seed, (2) to modify the environment in a way that promotes germination and survival, and (3) to build up the amount and size of advance regeneration to ensure a well-distributed stand following overstory removal.

Preparatory Cut

The preparatory cut is 10 or more years before the planned harvest date of the stand and at least 5 years before the seed cut. This cut is essentially a thinning which reduces the basal area (BA) of the stand to a maximum of 60–70 square feet per acre of dominant and codominant pines. This cut promotes crown development and cone production. Most of the hardwoods not controlled by fire should also be cut at this time.

Seed Cut

The seed cut is made 5 years prior to the planned harvest date and leaves no more than 30 square feet BA per acre of dominant trees at least 15 inches diameter at breast height (dbh), with well-developed crowns. Trees with evidence of past cone production are favored. Cone production peaks in the range of 30 to 40 square feet BA per acre, but the lower end of this range is preferred because logging-related seedling losses increase when more trees are removed in the final cut.

Monitor the cone crop by taking spring binocular counts of both flowers (next year's cone crop) and 1 year-old conelets (this year's cone crop) on selected sample trees in the regeneration area. These counts will give an estimate of the potential for the cone crop to regenerate the stand so that the seedbed can be prepared before the cones open. Generally, few seeds are produced by trees under 30 years old or under 10 inches dbh.

In order to achieve adequate natural regeneration, the available seed supply must feed various forms of wildlife with enough left over to establish a satisfactory stand. A minimum of 750 to 1,000 or more cones per acre is needed for successful regeneration. Longleaf cone crops are highly variable. Good seed crops occur every 5 to 10 years. Seedfall begins in late October and continues through November, but most seeds fall within a period of 2 to 3 weeks. About 70% of viable seeds fall within 65 feet of the parent tree. Under favorable weather conditions, seeds will germinate one or two weeks after dispersion. A prescribed burn 1 year before seedfall will remove accumulated litter and expose sufficient mineral soil for seedling establishment. A late-spring burn is most effective in controlling woody stems.

Removal Cut

Once an acceptable stand of seedlings is established, the parent overstory can be removed. This cut can be delayed if necessary for management needs or market conditions. Seedlings can survive 8 or more years under the parent overstory with little or no effect on survival given exclusion of burning. However, logging damage becomes more serious once seedling height growth begins.

Naturally regenerated stands require the same attention as planted stands with respect to brown-spot disease and competing vegetation. Young stands should not be burned until at least 2 years after the removal cut to allow time for logging slash to decay and the seedlings to respond to release.

Natural Regeneration for Uneven-Aged Stands

Uneven-aged stands are created using the selection system. In the selection system, trees representing a range in size are harvested at fixed intervals (called the cutting cycle, which ranges from 10 to 25 years). Regeneration (either natural or artificial) occurs in the harvested openings. This management approach allows periodic harvests, while maintaining a continuous forest cover. Smaller, lower quality trees are also removed to improve the overall quality of the stand. This method is covered in detail in this publication on opportunities for uneven-age management: http://edis.ifas.ufl.edu/fr132

Conclusion

Longleaf pine has many desirable characteristics for landowners who have multiple-use forest management objectives. On appropriate sites, and with careful attention to detail during the regeneration phase, it is possible to enjoy the versatility of this species without compromising growth rates.

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Table 1. Common herbicide treatments for longleaf pine establishment on sandy, Coastal Plain sites. Read and follow all label directions.

Common Name	Herbicide Rate	Trade Name	Amount Product	Comments
A. Site preparation of recently harvested forest sites primarily to control hardwood and shrub vegetation				
Hexazinone	1.9 to 3 lb ai/A	Velpar L	2.5 to 4 lb/A	Hand "spotgun application" on grid pattern or to individual rootstocks, same sites as above
Imazapyr + Glyphosate	0.625 lb ae/A + 3lb ai/A	Chopper Gen2 Accord XRT II	40 oz + 2.2 qts	Tank mix, broadcast aerial or ground sprayer, clay soils, where maple, ti ti present
B. Site preparation in established pasture or grass sod				
Glyphosate	2 lb ai/A	Accord XRT II	1.5 qts	Foliar application, broadcast or apply to a band on tree rows prior to planting
C. Herbaceous weed control (grasses and broadleaf weeds) over-the-top of planted seedlings				
Hexazinone + Sulfometuron	6 oz ai/A 1.5 oz ai/A	Velpar L Oust XP	24 oz plus 2 oz	Tank mix, very broad spectrum
Hexazinone Sufometuron	7.6 oz ai/A 1.4 oz ai/A	Oustar	12 oz	Pre-package mix, very broad spectrum Use 10 oz product on sandy soil.

MANAGEMENT NOTES FOR:

Coarse Woody Debris

FWC LANDOWNER ASSISTANCE PROGRAM

GUIDELINES

Coarse Woody Debris (CWD) is an often overlooked component of southern pine woodland management. Coarse Woody Debris can be defined in many ways but encompasses above and below ground biomass such as snags, fallen logs and large branches, logging debris stumps, and stump holes. In bygone eras, CWD was a more conspicuous element of the piney woods. However, due to extraction of ancient stumps for naval stores, intensive site preparation techniques, short timber rotations, and the presumed need to salvage trees destroyed by lightning or storms, the presence of CWD across the pine woods landscape has been greatly diminished.

VALUE TO WILDLIFE

Snags, or standing dead trees, are the most recognizable form of CWD to the public. They are important as nesting habitat to dozens of species of birds and mammals. Many species either excavate holes in dead wood for nests and den sites or are secondary cavity nesters that are dependant upon excavators. Many birds of prey build nests in the tops of snags and may use snags as perches for foraging, roosting, and/or feeding. Snags are home to a diverse group of insects that provide an important food source for some species of wildlife. Some wildlife such as woodpeckers store food for later use or hammer on hard snags as a form of communication.

Coarse Woody Debris on the ground serves many of the same functions as standing dead wood. The benefit to wildlife will depend on the species, size of material, stage of decay as well as the environmental conditions present such as soil moisture, relative humidity, and fire history. Wildlife such as black bears, whitetail deer, bats, woodpeckers, salamanders, turtles, lizards, snakes, small mammals utilize CWD for foraging, caching, nesting, and shelter. Plants, bacteria, fungi, lichens, mosses and a suite of invertebrates use CWD for habitat as well as a food source.

VALUE TO FORESTED ECOSYSTEMS

Natural tree mortality, insects, disease, fire, and storms can all contribute CWD to the forest. Through decomposition, CWD contributes nutrients such as carbon, nitrogen, potassium, and phosphorus that are essential to plants and animals. Fungi, bacteria, and insects consume dead wood thereby accelerating the rate of decomposition. Of great importance, is the ability of CWD to significantly contribute to carbon sequestration or storage. Living trees store atmospheric carbon using photosynthesis. After they die, CWD will continue to hold the majority of the carbon while releas-

QUICK NOTES

- **Dozens of vertebrates rely on micro-habitats associated with CWD.**
- **CWD from mature longleaf pine can last for decades.**
- **CWD can influence plant community structure.**
- **CWD is important in the ecosystem (carbon storage, nutrients, etc.)**
- **The presence of CWD can increase biodiversity.**
- **Not all snags are created equal. Snags which are tallest and widest will be most attractive to a variety of wildlife.**

MANAGEMENT NOTES

COARSE WOODY DEBRIS

WILDLIFE HABITAT

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COARSE WOODY DEBRIS

ing some into the soil via decomposition. CWD, particularly on hillsides, can act to stabilize soils slowing the movement of organic material and mineral soil allowing some material to collect behind the CWD. Where CWD does burn it does so at much higher temperatures- these subtle differences can increase plant diversity at a small scale.

Severe Disturbance. In the event of a large disturbance such as a hurricane, tornado, severe wildfire or outbreak of beetles, CWD can act as a "lifeboat" by providing habitat (cover, food, nesting sites) and energy to organisms in the post-disturbance environment. It also provides a suitable microclimate and structural diversity that may be important to a variety of wildlife. Depending on the size of the disturbance, opportunities for new or advanced (already established) regeneration may occur.

Tips for CWD and Wildlife Management

- Fallen trees with intact crowns are considered excellent habitat for deer.
- Both turkey and quail are known to utilize brushy areas so consider creating brush piles for wildlife refuge. Leave logging debris (cull logs, butts, and tops) scattered in harvest areas instead of piling and burning.
- Consider leaving lightning strike trees standing instead of harvesting.
- Groups of snags provide foraging and nesting habitat in one spot.
- When thinning pines, consider creating snags utilizing the equipment on site. Use poor quality pines and hardwoods. Doing so helps weed out poor genetic material. Removing the top of trees will create the longest lasting snag while cutting or girdling will create shorter-lived snags.
- Before burning, prep around base of snags to reduce the risk of ignition instead of dropping trees to ground.
- Consider leaving stumps in place in harvest unit. These will rot in time and the subterranean burrows are very important for wildlife.
- Nest boxes are beneficial but are no substitute for natural cavities.

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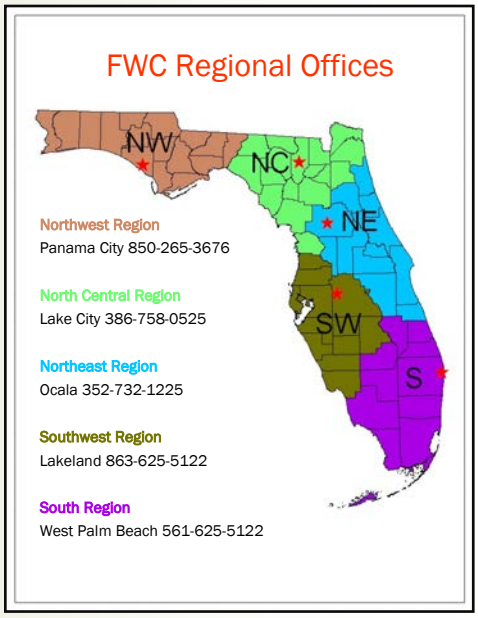
For more information on Coarse Woody Debris visit these sites:

www.srs.fs.usda.gov/pubs/gtr/gtr_se094.pdf

http://snohomish.wsu.edu/forestry/documents/SNAGS.pdf

Contact a Private Lands Biologist



CWD CAN LAST FOR DECADES IN THE SOUTHEAST AND CENTURIES IN THE PACIFIC NORTHWEST

Vertebrate Use of Snags in Longleaf Pinelands (partial list)

Birds

Bald Eagle
Osprey
Eastern Screech Owl
Red-tailed Hawk
Red-shouldered Hawk
American Kestrel *
Great Crested Flycatcher *
Tufted Titmouse *
Carolina Chickadee *
Red-headed Woodpecker *
Red-bellied Woodpecker
Pileated Woodpecker *
Downy Woodpecker *
Hairy Woodpecker *
Northern Flicker *
Eastern Bluebird *
Brown-headed Nuthatch *
Carolina Wren*

* Cavity Nesting Species

Note: At least 86 species of birds consisting of residents, winter, and neotropical migrants can be found in longleaf woodlands.

Mammals

Fox Squirrel
Flying Squirrel
Grey Squirrel
Black Bear
Bobcat
Raccoon
Evening Bat
Cotton Mouse

Note: At least 36 species of mammals are characteristic of longleaf pine savannas.

Reptiles & Amphibians

Grey Rat Snake
Corn Snake
Scarlet Kingsnake
Broadhead Skink
Five-lined Skink
Fence Lizard
Green Anole
Green Treefrog
Pine-woods Treefrog
Barking Treefrog

Note: At a minimum 38 species of reptiles and 34 species of amphibians may be found in longleaf ecosystems.

Benefit to Wildlife

Dozens if not hundreds of additional vertebrate species use CWD and stumpholes for cover, basking, nesting, feeding, thermoregulation, and courtship display.

Additionally hundreds of invertebrate may be found in longleaf woodlands and these often overlooked organisms help to form a vital link in the food web.

MANAGEMENT NOTES FOR:

Growing Season Fire

FWC LANDOWNER ASSISTANCE PROGRAM

Prescribed Fire is one of the most important tools land managers and owners of timberland have at their disposal. In Florida, nearly all naturally occurring communities and their inhabitants depend on fire. The frequency of prescribed fire varies from 2-15 years in the majority of natural communities; with less frequent burning of 50 years or more occurring in other communities. In earlier times, before the land became fragmented and forests became cities and pastures, a lightning strike could have started a fire in Albany, GA and that same fire could arrive several weeks later in Tallahassee, FL. The Native Americans also used fire extensively for clearing brush for cultivation, driving game while hunting, and for signaling. Early settlers' reports talk about the use of fire by the Native Americans in multiple seasons including summer. The settlers themselves used fire for many reasons. One of the most important reasons was to refurbish grazing land. These fires were often set in the late winter. In recent times, most of the prescribed fires have been set in winter in an attempt to gain control over summer wild fires by trying to reduce fuel loads before the drought season (April to June) occurs. Summer wildfires are often started by lightning strikes.

SEASON OF FIRE

The use of prescribed fire has many benefits to the landowner. Some of these benefits include hazard fuel reduction, managing habitat for wildlife, and maintaining natural communities. There is strong, overwhelming evidence that frequent prescribed fire plays a big role in the shaping Florida's naturally occurring communities. Without prescribed fire at the appropriate time, biodiversity will decline. Dormant (winter season) burning (November - March) is often used for habitat and wildlife management. It is easier to apply prescribed fire when compared to growing season burns (April - September). While winter burning is better than no burning at all, it can lead to some changes in vegetation. Longleaf seedlings that are less than two years old can be eliminated if they are not protected. Frequent winter burning also prevents fire from carrying across wetland basins. In the absence of fire, woody shrubs and trees can become well-established. If this happens, the hydroperiod may be radically altered by shortening the depth and number of days water remains in a wetland basin. Periodic dormant season burns can decrease grass coverage. With the absence of grass coverage, woody species like palmetto, gallberry, and oaks will increase. These changes have broad implications for

- **Growing Season Fire is a good compliment to your existing burn regime.**
- **Growing Season Fire is more effective at controlling hardwoods than dormant season burning.**
- **Growing Season Fire is beneficial to quail and turkey.**
- **Growing Season Fire is essential to maintaining healthy wetlands.**
- **Growing Season Fire creates suitable conditions for longleaf seedling establishment.**
- **Frequent fire is key to restoring biodiversity.**

MANAGEMENT NOTES

GROWING SEASON FIRE

WILDLIFE HABITAT

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GROWING SEASON FIRE

amphibian and reptile populations, however that is beyond the scope of this document.

HARDWOOD CONTROL

Many land managers are continually battling to reduce the hardwood component on pine woodlands. The amount of oaks will vary depending on the natural community (sandhill, flatwoods, upland mixed woodland). An overabundance of oaks in pine-dominated woodlands is a result of previous land use history, fire frequency and season of fire. Oaks, like many other woody species, store large amounts of energy in the form of carbohydrates below ground in their root systems. Winter fires only kill the tops of shrubs so the number of stems below ground will often increase. To control oaks and other woody shrubs with fire, you will need to introduce fire in the early spring after leaf out and bud break. This is when the plants' carbohydrate reserves are lowest. They will have just used up a large amount of their energy reserves to produce new growth. Frequent growing season burns can rapidly reduce the amount of oaks in a relatively short period of time (3 burns in 5 years) while simultaneously enhancing groundcover and habitat for wildlife.

GROUNDCOVER AND SEED CATCH

Restoring biodiversity starts from the ground up. Longleaf woodlands in their natural state harbor hundreds of species of groundcover. Many species require fire in order to reproduce. Wiregrass is one of the most important and widespread species of groundcover. It will only produce viable seed if burned during the growing season (May - August). Frequent fire along with the inclusion of growing season burns will pay dividends if your goal is to promote wildlife and biodiversity. The use of growing season fire is also beneficial if you anticipate a longleaf seed crop in the fall. Longleaf germinants require bare mineral soil in order to germinate. Don't burn too late in the summer though as there will not be enough cover to hide seeds from predators.

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For more information on Growing Season Fire Management visit these sites:

www.talltimbers.org

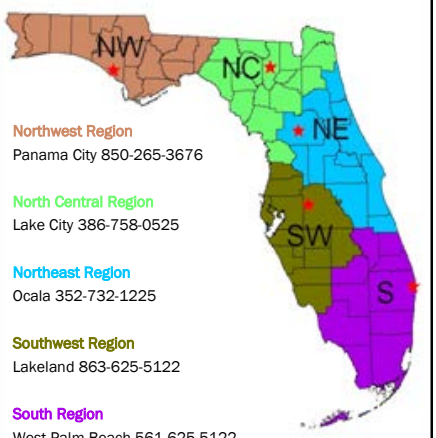
www.fl-dof.com

www.jonesctr.org

www.longleafalliance.org

Contact a Private Lands Biologist

FWC Regional Offices



Northwest Region
Panama City 850-265-3676

North Central Region
Lake City 386-758-0525

Northeast Region
Ocala 352-732-1225

Southwest Region
Lakeland 863-625-5122

South Region
West Palm Beach 561-625-5122

Burning shortly after leaf out & bud break is far more effective at controlling hardwoods than winter burning.

General Benefits of Fire

- Increases the quality and palatability of forage for wildlife
- Protein content in native plants increases in recently burned areas
- Protein in critical for reproduction for all wildlife and for antler development in deer
- Increases the amount of bare ground making it easier for wildlife (quail, snakes, tortoises, songbirds) to move around
- Increases insect populations which are critical for turkey poults and quail chicks

- Increases in grasses and forbs; decreases hardwood component
- Provides suitable nesting, brood-rearing, and summer foraging habitat for quail and turkey
- Helps promote the spread of fire by increasing grassy fuel component

Growing Season Fire Benefits

- Promotes seed production in wiregrass and native groundcover
- Vegetation structure lasts longer as compared to dormant season burning
- Creates suitable conditions for longleaf pine seedling establishment

- By incorporating growing season fire, you create seasonal resources for wildlife: e.g more diverse mosaic of different age roughs
- Extends burning season which provides more burning opportunities to achieve appropriate fire intervals
- Helps maintain ecotone, where wetlands meet uplands, in herbaceous condition as opposed to shrubs/hardwoods. Ecotones are often home to rare plants and are important for amphibian reproduction.
- **Benefit of Growing Season Fire to Game Birds**
- Improved breeding and wintering habitat

- Delaying burning to May - June may decrease predation while providing for more cover for quail during March/April hawk migration
- Increase in fall food availability which may lead to improved adult and juvenile survival
- ***"The use of prescribed fire during the growing season is a win-win situation for wild turkey...I hope this will ease the minds of turkey hunters the next time they smell the smoke of a growing season fire."***

- Dr. James Earl Kennamer, NWTF Senior Vice President for Conservation

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FOR276

The Decline of Florida Torreya: An Endemic Conifer on the Edge of Extinction[1]

Jason A. Smith and Aaron Trulock[2]

Overview

The Florida torreya (*Torreya taxifolia*) is a critically endangered conifer endemic to the Apalachicola River drainage of the Florida panhandle and adjacent southern Georgia. Florida torreya has experienced a significant die-off and subsequent decline during the past century. Although the decline has been attributed to numerous abiotic and biotic causes, however, our findings are that the most likely reason for the decline is fungal disease. This fungal disease is likely caused by a *Fusarium* species and our suggestions for a new understanding of the actual cause of the decline are addressed in this fact sheet. Current efforts to assess the population and develop a recovery plan are discussed.

Introduction

Florida torreya (a.k.a "gopherwood", "stinking cedar") (*Torreya taxifolia* Arn.) (Family: Taxaceae) is a federally listed, critically endangered conifer endemic to bluffs and ravines along the Apalachicola River in Gadsden and Liberty Counties in Florida and Decatur County in Georgia (Schwartz, 1993; Baker and Leonard, 1982). Although there are 5 species of *Torreya* distributed in western North America (*T. californica*), Japan (*T. nucifera*) and China (*T. fargesii*, *T. grandis* and *T. jackii*), *T. taxifolia* is considered the rarest conifer in North America and one of the most endangered in the world (Farjon, 2010).

Figure 1. Natural range of *Torreya taxifolia* (Burns and Honkala, 1990).

1. This document is FOR276, School of Forest Resources and Conservation, UF/IFAS Extension. First published November 2010. Please visit the EDIS website at http://edis.ifas.ufl.edu.

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Description

The Florida torreya is an evergreen tree that historically has grown to 60 feet and occasionally still reaches this size in cultivation (Fig. 2). It has whorled branches with short, dark green needle-like leaves that are less than 2 inches long, and a canopy spread of up to 20 feet. The tree is described as slow growing with a conical canopy shape. The foliage and female cones (Fig. 3) release a pungent odor and are useful in identification (Barnes, 1983). The remaining population of Florida torreya is found on the bluffs and ravines along the east side of the Apalachicola River. The tree grows naturally in Gadsden and Liberty counties in Florida, and in southern Decatur County, GA. There is also one reported population located west of the Apalachicola River in Jackson County, FL (Stalter, 1984).

Figure 2. Large healthy cultivated Florida torreya in Madison, Florida.

Figure 3. Female cone on a cultivated Florida torreya in Atlanta, Georgia.

In 1983 *Torreya taxifolia* was listed as an Endangered Species under the 1973 Endangered Species Act (USFWS 1984). Although a recovery plan was promptly organized, many of the objectives are either still ongoing or not initiated (Spector, 2009).

Decline

Considered a common tree in its restricted habitat until just before WWII, by 1962 Florida torreya had declined so severely that the species was considered to be destined for extinction (Godfrey and Kurz, 1962). The decline of Florida torreya was first observed around 1938 (Alfieri *et al.*, 1967). By the 1960s, no adult individuals could be found and the outlook for the species seemed very bleak (Alfieri *et al.*, 1967). The rapid decline of the species was then attributed to an unknown fungal disease because of the abundance of leaf spots and stem cankers and the rapid nature of the decline (Godfrey and Kurz, 1962). Since then, Florida torreya has continued to decline and in addition to disease, has been subjected to changes in hydrology, forest structure, heavy browsing by deer and a loss of reproductive capability (Schwartz and Hermann, 1995). Despite these challenges, Florida torreya stems which have been killed by disease often re-sprout from the stump in a manner reminiscent of American chestnut following chestnut blight, although seed reproduction has been non-existent for decades in the wild (Schwartz and Hermann, 1999). Estimates show Florida torreya has declined 99% since pre-settlement population levels, from an estimated population of 357,500 individuals in 1914 to approximately 1,350 in the 1990s (Schwartz *et al.*, 2000). It is believed that the population has declined further since 2000 to current estimates of 400–600 individuals (T. Spector, unpublished data, 2010).

Despite several attempts to conclusively determine the causal agent responsible, disease etiology has not been previously elucidated (Alfieri *et al.*, 1967; Alfieri *et al.*, 1987; El-Gholl, 1985; Lee *et al.*, 1995; and Schwartz *et al.*, 1996). In the first pathology studies conducted on *T. taxifolia* (Alfieri *et al.*, 1967), it was noted that disease symptoms of leaf spots, needle necrosis, defoliation and stem lesions were common on native and cultivated *T. taxifolia.* Several pathogens were isolated commonly from symptomatic needles (*Macrophoma* sp., *Rhizoctonia solani*, *Sphaeropsis* sp. and *Sclerotium rolfsii*), however, no pathogens were

isolated from cankered stems and Koch's postulates (proof of pathogenicity) were not demonstrated. About 20 years later, El-Gholl (1985) implicated *Fusarium lateritium* as a causal agent by demonstrating this species' capacity to cause leaf spots, however, the causal agent of the canker disease remained unknown. Alfieri *et al*. (1987) completed more pathogenicity studies with a *Phyllosticta* sp., *Xylocoremium flabelliforme* and *F. lateritium*. They also completed Koch's postulates with *F. lateritium* as a leaf spot pathogen, but the canker-causing organism remained elusive. In 1991, Schwartz *et al*. implicated *Pestalotiopsis microspora* as the causal agent of the canker disease, having isolated the pathogen from 56 symptomatic plants and completed Koch's postulates on 10 stems. However, no information was given on the canker development, morphology or ability to cause mortality. Typically *Pestalotiopsis* spp. are considered opportunistic pathogens (Sinclair, 2005). Lee *et al*. (1995) investigated the endophytic and pathogenic chemical attributes of *P. microspora* infection and artificial inoculations resulted in stem canker development, however, again no stem mortality was observed.

Subsequent studies by Hermann and Schwartz (1997) implicated a *Scytalidium* sp. due to frequent isolation from cultivated and naturally occurring Florida torreya. Inoculation attempts led to small lesions on needles, but cankers were not observed.

In addition to biotic causes of decline, researchers have looked into changes in soils, drought, global warming, sunlight exposure and fire regime as possible causes of decline (Schwartz *et al*., 1995). Some of these environmental changes are thought to have occurred because of the building of the Woodruff Dam along the Apalachicola River in 1957 (Schwartz *et al*., 1995), and changing land uses in the surrounding areas. However, none of these environmental hypotheses have been demonstrated as a cause of the decline. The rapid nature of the decline during the period of 1938 to 1945 and numerous observations of disease symptoms provides ample evidence that a pathogen, possibly non-native, was involved (Schwartz *et al*., 1995).

Current Status

The most recent published survey results suggested there are between 800 and 1,500 individual Florida torreya trees in the wild (Schwartz and Hermann, 1993). However, the current number is likely far fewer (<600) (T. Spector, unpublished data), most of which occur on protected lands, but some are on privately held lands. Most of the remaining trees are only stump sprouts between 1 to 3 feet tall and are greatly suppressed. No one has reported seeing any wild seeding from Florida torreya in decades. There is a concerted effort by the Florida Division of Environmental Protection, Florida Park Service, University of Florida and Atlanta Botanical Garden, as well as many concerned volunteer citizens (including small private landowners) to find, record and map each individual to better understand distribution and survivorship of the current trees. Atlanta Botanical Gardens is also propagating Florida torreya using cuttings in order to perpetuate the current individuals, and to produce seed. There are also efforts by researchers in Georgia to use tissue culture and mass produce cloned offspring of Florida torreya. These efforts will be key in restoring the species in its native range once the decline is successfully managed. The Torreya Guardians is a group of private individuals who are transplanting Florida torreya to new localities in the southern Appalachians in an attempt of "assisted migration" (http://www.torreyaguardians.org/). This "assisted migration" takes endemic plants out of their natural range and plants them in private properties and natural gardens. There has been no research into the success or effects of re-introducing Florida torreya on alternate sites and there are risks (i.e. movement of the pathogen(s), potential invasion of the species, reduced focus on preserving the extant population) associated with this approach to conservation (Schwartz, 2005).

The authors have been part of a group (in conjunction with the Atlanta Botanical Garden, Florida Department of Environmental Protection and the Florida Parks Department) assessing the extant Florida torreya populations for the past 3 years. To date, 225 trees have been located and surveyed on public and private lands. The overall condition of the trees is alarming, with an average height of < 1 m, average basal diameter of < 2 cm. Mean canker incidence is about 90% on 8 sites surveyed (Figs. 4–6). In addition, the existing population is stressed by shading by deciduous tree canopy, leaf spot pathogens (Fig. 7) and an overpopulation of deer – which causes frequent stem damage from rubbing of antlers and occasional browse.

Pathology studies conducted by the authors have shown that a previously unknown *Fusarium* sp. is the causal agent of the canker disease observed in the field and this has been confirmed from frequent isolation as well as completion of pathogenicity tests (Koch's postulates) in the greenhouse. This disease, though only recently identified, is currently thought to be the single most important factor in Florida torreya decline and potential extirpation. Further information on the biology of the *Fusarium* canker disease is needed to develop control strategies aimed at reducing the disease on extant populations and also on re-introduced

individuals from *ex situ* collections and breeding (at the Atlanta Botanical Garden). There are currently no options for management of any of the diseases affecting Florida torreya.

Although Florida torreya has been in Florida for over 10,000 years, it continues to be on the brink of extinction. Less than 1% of the historic population survives, and reproduction of Florida torreya is nonexistent in wild populations (Schwartz and Hermann, 1993). Further research is needed to rescue this ice age relic from extinction.

Figure 4. Stump sprout with top killed by canker disease in the wild.

Figure 6. Close-up of canker in the wild (Photo Credit: Matthew Croxton):

Figure 5. Cankers causing branch dieback on *Torreya taxifolia* (Photo Credit: Lacey Mount).

Figure 7. Leaf spots on *Torreya taxifolia* from unknown agent(s) (Photo Credit: Keumchul Shin).

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